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AN INVESTIGATION INTO QUESTIONS OF SOCIAL HYGIENE IN THE COUNTIES OF VÄSTERBOTTEN AND NORRBOTTEN, SWEDEN

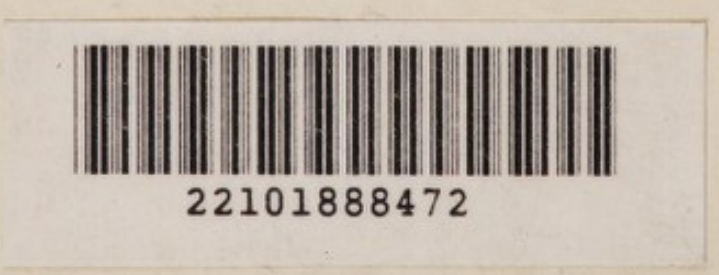
CONDUCTED WITH THE SUPPORT OF THE ROYAL MEDICAL BOARD IN 1929—1931

PUBLISHED IN SWEDISH IN 1934

ENGLISH, PARTLY REVISED, EDITION

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PREFACE TO THE ENGLISH EDITION.

The Swedish edition of this work was published in June 1934. The original intention was to publish an English edition simultaneously with the Swedish. Unfortunately, owing to lack of funds, this part of the plan could not be carried out. Generous private donations, however, have now made it possible to present this work in English dress.

The present English edition, broadly speaking, is a translation of the Swedish text without substantial alterations. Certain passages, however, have been revised and brought up to date.

An outline of the contents of the Swedish edition is given on pp. IX—XI of the present edition. As mentioned in foot-notes to these pages, certain chapters have been omitted, as being of minor interest to foreign readers. Here and there additions have been made in order to explain certain Swedish conditions which are presumably unknown to most foreign readers.[1]

Part IV — »Investigations on the amount of antiscorbutic vitamin in Norrlands berries and certain preserves made from those berries» — was considered by its author, Professor GUSTAF GÖTHLIN, *M. D., to be too popular in form and to contain too little scientific evidence to be of much interest to the expert. At his request, this Part has been replaced by a scientific paper by him on the same subject, published in 1933 in »Acta Medica Scandinavica», Supplement LIII, entitled: »Determination of the antiscorbutic potency of vegetable products, chiefly berries, grown in Norrland etc.»*

Some doubt was at first entertained as to whether Part V, relating to improvements in hygiene in Upper Norrland, should be incorporated in the English edition. It has been published separately — like other parts of this work — and is written in

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[1] *In addition, certain passages in Parts I and V have been edited by the translator of those Parts, in order to render them more intelligible to English readers. — Translator's Note.*

such a form as to be intelligible to non-medical readers. But, after mature consideration, we came to the conclusion that this part, in an abridged form, might also be of sufficient interest to the medical profession in other countries to warrant its translation. It gives some insight into the public health and medical services of Sweden, besides information about institutions, associations, etc., for the promotion of hygiene in this country. It will also enable the reader to obtain some idea of the endeavours which are being made in Sweden to improve sanitary conditions. Furthermore, it will serve to show that vigorous and systematic efforts are now being made in this country to improve housing conditions, the care of children and personal hygiene in general, as well as to enlighten the people and impress upon them the importance of a rational diet.

The translation of this work has entailed certain difficulties. Owing to its volume and the diversity of its contents, it has been found necessary to employ the services of several translators. It has not been possible entirely to obviate the drawbacks which this arrangement has involved. I trust, however, that they will not affect the substance of this work.

Stockholm, July 1936.

Nils Hellström, M. D.,
Formerly Director General of the Royal Medical Board.

PREFACE TO THE SWEDISH EDITION.

As the present work is intended not only for medical experts but also for the general reader interested in questions of hygiene, it might be desirable to begin this preface with a definition of the concept »social hygiene». It is difficult, however, to find any generally accepted definition of this term, and those given in the literature would convey but little information to the layman. It may, therefore, be more useful to endeavour to throw some light on the significance of »social hygiene» by a brief outline of some of its leading aims and fields. One of the aims of social hygiene is to investigate those causes of sickness which frequently have their origin in certain social phenomena — such as poverty, bad housing conditions, inadequate nutrition, work which, by reason of its special character, unduly long working hours, or bad division of time, is detrimental to the health, injurious habits and customs etc., to show their noxious effects on the health, and to give advice and suggestions for their prevention. Another of its aims is to suggest measures for combating those diseases, or groups of diseases, which originate in prevailing social evils, notably tuberculosis, chronic joint affections, occupational diseases, alcoholism, etc. One of the most important fields of social hygiene is the so-called »*preventive care*»: maternity welfare, care of infants, small children and school children, housing, bathing, questions of dietary, etc.

An investigation into questions of social hygiene in the Counties of Västerbotten and Norrbotten was conducted with the support of the Royal Medical Board from 1929 to the end of 1931. The results were controlled by subsequent examinations made in 1932. The main objective of the investigation was to try to ascertain the causal connection between the dietary deficiencies prevailing in those counties and certain morbid conditions, notably lowering of certain functions of the stomach (achylia), catarrh of the large intestine (colitis) and anaemia, which appeared to be of more

frequent occurrence there than in the more southerly parts of the country.

Certain evils which prevail particularly in the above-mentioned counties, notably flagrant disproportion in the composition of the dietary, defects in the preparation of food and excessive consumption of coffee, have long been engaging the attention of medical men, and have induced them to take measures for their prevention.

When, in 1923, a special medical department was organized at the Umeå hospital, its first superintendent medical officer, Dr Martin Odin, took up the study of the causal connection between the inadequate and unvaried diet and the above-mentioned morbid conditions. This subject was subsequently dealt with in the annual reports of that hospital.

These preliminary studies indicated that there were good prospects of extending our knowledge of these important matters. In view of the comparatively small number of patients at the Umeå hospital, however, there seemed to be little or no possibility of conducting the investigation on any wide scale, or carrying it out within a reasonable length of time. Such an investigation furthermore necessitated the examination of a number of apparently healthy subjects, pursuing their daily occupations. It was also considered highly desirable to organize an expert dental examination of *hospitalized* patients, in view of the light that would thereby be thrown on certain aspects of dietary deficiency. But this involved cooperation between medical men in and outside the hospital, as well as between them and dentists, and no funds were available for the purpose. There were also other difficulties. The required cooperation could scarcely be effected without the assistance of a central institution. In connection with an inspection of the Umeå hospital at the beginning of August 1928, this matter was taken up for consideration by the Royal Medical Board. The latter were then forced to the conclusion that this hygienic problem was of the greatest importance, being of vital concern to a large section of the population of the extreme north, where the severe climate made life a perpetual struggle for bare existence.

Shortly after this question had been taken up by the Medical Board, the attention of the general public was directed to hygienic conditions in Norrland by a paper published by Dr E. Perman,[1]

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[1] »Ett förslag till förbättring av de hygienisk-dietiska förhållandena i Norrland».

Stockholm, in »Socialmedicinsk Tidskrift» (October 1928), containing suggestions for the improvement of the hygienic and dietary conditions in Norrland, and by another paper in the same journal (December 1928) by Professor G. GÖTHLIN,[1] Upsala, on certain aspects of the vitamin C question in Norrland. Both these articles were extensively quoted in the press and attracted wide interest. They encouraged the Medical Board to continue their efforts to extend the scope of these researches. Professor GÖTHLIN's paper moreover exercised a direct influence upon the planning of the investigation. It was furthered also by scientific contributions on the part of Dr GÖSTA WESTIN, State Dental College, Stockholm.

On the basis of the results obtained by Dr ODIN as well as of observations submitted in the two above-mentioned papers, and in consultation with certain specialists, the Medical Board, in the autumn of 1928, drew up a plan for an investigation in the Counties of Norrbotten and Västerbotten. This plan was followed in essentials (cf. Part I, Chapter II).

In the course of this investigation some 17,400 persons were subjected to medical examination, and about 4,400 to dental examination. A considerable number of them underwent both examinations.

The main aim of the Medical Board was to secure, by a well-organized scientific investigation, a substantial foundation for measures with a view to improvements in hygiene. Hence the purpose of the present work is not only to furnish a comprehensive report on the results of this investigation, drawing attention to any points which may be of interest to the medical profession, but also to give the non-medical reader a survey of the results obtained, as a basis for further practical work in the field of social hygiene. The report on these researches is accordingly followed by a section containing suggestions for the adoption of certain hygienic measures which the investigation has shown to be urgent, or at any rate, desirable.

It has naturally been very difficult to maintain uniformity in the arrangement and presentation of the various parts of this work.

We are quite prepared for the objection that this report, in form and general structure, is addressed to the medical profession, and is not suited for readers without medical training. There is

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[1] »Norrlands vitaminfråga belyst rörande C-vitaminet.»

some justification for such criticism. But if this report had been presented in a popular form, it would scarcely have been possible for the several authors to give the bases of their results and conclusions, which would have detracted considerably from the value of their contributions. For the convenience of the lay reader, however, a comprehensive general survey [1] of the results of the investigation has been given in Part V.

When the investigation now completed was being planned, no enterprise of a similar nature had apparently been carried out before, whence the Medical Board did not have the benefit of previous experience. Difficulties were thus encountered from the very outset.

Though the Medical Board were accordingly fully prepared for criticism, they felt justified in offering their assistance, nay morally compelled so to do. They could set to work, at any rate, in the assurance that these researches would be conducted by recognized authorities and good judges in their several fields.

The Medical Board desire to acknowledge their great indebtedness to the following gentlemen: Professor GUSTAF GÖTHLIN, M. D., Upsala University, Dr MARTIN ODIN, M. D., then Medical Superintendent of the Umeå Hospital, now of the Borås hospital, and Dr GÖSTA WESTIN, State Dental College, who have conducted these researches in their several fields. The Medical Board highly appreciate, and are most grateful for, the willingness with which these investigators have undertaken such arduous labours, in addition to their already heavy duties. The Board are further indebted to Dr JOHN BYTTNER, Medical Counsellor and Principal, Royal Medical Board, and to Dr GUSTAF ANKARSWÄRD, Chief County Medical Officer, Luleå, for their contributions to the present work. They also desire to convey their thanks to Mr JOSEF ENGVALL, Counsellor to the Royal Board of Education, Dr HARALD ERNBERG, M. D., Medical Superintendent of the Sachs Children's Hospital, Stockholm, Mr NILS SONESSON, Assistant Principal, Royal Board of Agriculture, Dr ERNST ABRAMSON, M. D., Dr HARALD HOLTZ and Dr ARON LINDSTRÖM, Head Assistants, State Dental College, and Miss INGEBORG SCHAGER, formerly Principal of the State Training College for Teachers of Cookery.

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[1] Not included in the English edition.

The Medical Board desire to express their gratitude for the valuable advice and suggestions kindly offered by the late Mr Nils Ringstrand, Governor of the County of Västerbotten, Mr Victor Ekerot, Director of the State Own Home Board, Mr Ernst Höijer, Principal, Central Office of Statistics, Dr Erik Björnwall, Chief County Medical Officer, Umeå, and Dr Harald Ramberg, Dentist, Member of the Council of the Medical Board, Stockholm.

The Board furthermore wish to thank those medical officers and dentists who have so generously devoted their valuable time to the collection and elaboration of material for the investigation. Thanks are due also to those teachers, nurses and other persons who have assisted, in various ways, in the practical work connected with the investigation or in the scientific elaboration of results. Here the Board particularly have in mind the staff of nurses at the Umeå hospital.

The financial side of the investigation forms the subject of a separate chapter.[1] Here, however, I desire to acknowledge the indebtedness, and express the most cordial thanks, of the Medical Board and myself, to all those who have financially supported this undertaking.

An outline of the contents of the Swedish edition is given below. In the English edition detailed tables of contents precede each Part. As indicated by the appended notes, some changes have been made in the last-mentioned edition. But, as will be shown by a comparison between this outline and the various tables of contents, the arrangement in both editions is substantially the same.

Part I.

A brief description of the geographical and climatic conditions etc., in the Counties of Västerbotten and Norrbotten.	by *N. Hellström*, Director General.
Antecedents and planning of the investigation.	» »

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[1] Omitted in the English edition. The total expenditure entailed by this investigation, inclusive of the publication of this work, amounts to somewhat more than 100,000 Swedish kronor (100 kronor = about £ 5).

Observations on the investigation material, etc.[1] — by *N. Hellström*, Director General.

Expenditure entailed by the investigation.[1] — » »

General observations on the housing and mode of life of the rural population of Upper Norrland. — by *G. Ankarswärd*, Chief County Medical Officer, Luleå.

Results of the medical examination of school children. — by *J. Byttner*, Medical Counsellor.

Part II.

Diseases and morbidity in Upper Norrland, with special reference to the composition of the diet. — by *M. Odin*, M. D., Medical Superintendent, Borås.

Introduction.
Nutritional conditions of the population.
Basal metabolism (B. M.) in relation to the composition of the diet.
Occurrence of gastric achylia, its characteristics and causes.
Occurrence of peptic ulcer (gastric and duodenal).
Occurrence of intestinal disorders and their characteristics.
Occurrence of anaemia, its degree, nature, etiology, etc.
Occurrence of minimal urinary haemorrhage (*haematuria minima*).
Occurrence of hypovitaminosis.
Summary and clinical survey of the symptoms produced by the unvaried milk-meal diet, as a nosographic unit.
Conclusions.

Part III.

The teeth and their diseases in Upper Norrland. — by *G. Westin*, Director of the Dept. of Operative Dentistry, State Dental College, Stockholm.

Introduction.

Picture and frequency of caries; also the growth of the permanent teeth and their course of development. — by *H. Holtz*, Head assistant to the above Dept.

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[1] Not included in the English edition.

The common diseases of the mouth and their connection with the dietary forms and general health. — by *P. A. Lindström*, Head assistant to the above Dept.

The histopathology of the teeth, with special reference to hypovitaminotic changes. — by *G. Westin*.

Part IV.

Investigations on the amount of antiscorbutic vitamin in Norrland berries and certain preserves made from those berries.[1] — by *G. Göthlin*, M. D., Professor, Upsala.

Part V.

Improvements in the public health service, with special reference to Upper Norrland — by *N. Hellström*, Director General, in collaboration with other authors.

Introduction.
Survey of the results obtained in the investigations in Norrland.[2]
Present-day measures with a view to improvements in housing, personal hygiene, etc.
Advice and guidance on improvements in hygiene.
Concluding observations.
Annexe: The Norrland Housewife's Guide.[3]

Stockholm, March 1934.

Nils Hellström, M. D.,
Director General of the Royal Medical Board.

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[1] Replaced in the English edition by »Determination of the antiscorbutic potency of vegetable products, chiefly berries, grown in Norrland, etc.», Acta Medica Scandinavica, Supplement LIII, 1933.

[2] A popular account of the results obtained in that investigation. This chapter has not been considered essential for the English edition.

[3] A propaganda manual intended for the general public, dealing mainly with diet, but also with the care of children and sanitary conditions in the home. It has been distributed gratis in large editions, some 50,000 copies having been disseminated among the population comprised in this investigation (about 400,000 inhabitants).



Map of Sweden, showing Counties and Provinces.

PART I

INTRODUCTORY DESCRIPTION AND EXPLANATIONS GENERAL OBSERVATIONS ON HOUSING REPORT ON MEDICAL EXAMINATION OF SCHOOL CHILDREN

By

Nils Hellström, Director General of Medical Board
Gustaf Ankarswärd, Chief County Medical Officer
John Byttner, Medical Counsellor

TABLE OF CONTENTS.

		Page
Chapter I.	A brief description of the geographical and climatic conditions etc., in the Counties of Västerbotten and Norrbotten, by *Nils Hellström*, Director-General of the Royal Medical Board	5
Chapter II.	Antecedents and planning of the Investigation, by *the same author*	23
Chapter III.	General observations on the housing and mode of life of the rural population of Upper Norrland, by *Gustaf Ankarswärd*, Chief County Medical Officer	42
Chapter IV.	Report on the results of the medical examination of school children, by *John Byttner*, Medical Counsellor	55

CHAPTER I.

A brief description of the geographical and climatic conditions in the Counties of Västerbotten and Norrbotten

by

NILS HELLSTRÖM.

It will perhaps appear to be a work of supererogation to burden this book with a description of the geographical and climatic conditions, the population and their occupations in the area — the Counties of Västerbotten and Norrbotten — where the investigation into social hygiene recorded in the following pages was carried out. But, as this investigation may be of interest also to a reading public beyond the borders of Sweden, it may nevertheless be desirable to give some succinct information on the subject.

In Sweden, which extends from the 55th to the 69th parallel of north latitude, the population of the north have always been engaged in a hard struggle for existence. The three northernmost counties, Norrbotten, Västerbotten and Jämtland, though not entirely comparable in this respect, have many features in common. This applies especially to Norbotten and Västerbotten, which are often grouped together under the designation of »Upper Norrland».

As will be shown by a glance at the accompanying map, No. 1, the southern boundary of Upper Norrland at its extremity reaches midway between the 63rd and 64th parallel of latitude, whilst its northern boundary coincides with the Swedish frontier, its extreme point touching the 69th parallel.

In the direction from west to east the boundaries of this region extend from the 14th to the 24th meridian of east longitude. It has a total land area of 15,423,096 hectares.[1]

[1] 1 hectare = 10,000 square metres.

Geographically, the Counties of Västerbotten and Norrbotten are on the whole of uniform character. Adjoining the coast there is a fringe of country which emerged from the sea after the



Map No. 1.

glacial period, and is therefore largely covered with marine deposits, sand and clays. Its breadth averages about 50 kilometres and nowhere exceeds 120 kilometres. Its highest elevation above sea level is 260 metres. Beyond this zone there is an area of

wooded moraine country, about 175 kilometres in breadth, which in many places, especially in the basins, is of a marshy character. Finally, between the last-mentioned area and the Norwegian frontier, there is a mountainous region, where the loftiest peaks tower to a height of more than 2,100 metres. Its breadth ranges from 75 to 150 kilometres. Through deep-cut glens between the mountains, swiftly-flowing rivers, tumbling into cascades, rush, in a south-easterly direction, on their course towards the sea, here and there expanding into long narrow lakes. From the coastal zone, where we find the major part of the arable and pasture land in Upper Norrland, but which is mostly wooded, cultivated tracts extend along the river valleys into the interior. The forests in the coastal zone and wooded area consist mainly of firs and pines. Adjoining the mountainous region there is a narrow belt covered with stunted knotty birches. The approximate boundaries of these three areas are shown on the map.

The climate in this entire northerly region is severe. The winters are long and cold, the summers short, lasting only two to two and a half months. The nearer we approach to the sea, the milder is the climate; as we get further inland the winters become longer and colder. Owing to these differences in climate and the high elevation of the interior, there are marked disparities in the mean temperature even on the same latitude. The subjoined table will serve to give some idea of the temperature conditions at various latitudes and altitudes during the four seasons of the year.

Mean temperatures for the years 1859—1925.

Locality	Lat. North	Altitude	Degrees Celsius				
			Jan.	April	July	Oct.	Whole year
Karesuando ...	68°27′	333 m.	— 14.5	— 4.5	+ 12.5	+ 2.7	— 2.7
Gällivare	67° 8′	365 »	— 12.9	— 2.0	+ 13.9	— 1.5	— 1.1
Haparanda	65°50′	9 »	— 10.9	— 1.6	+ 15.1	+ 1.4	+ 0.6
Stensele	65° 4′	328 »	— 12.1	— 0.7	+ 13.9	+ 0.3	— 0.1
Umeå	63°50′	17 »	— 8.0	+ 0.2	+ 15.0	+ 2.8	+ 2.1

According to Professor P. Hellström, the »vegetation period» in northern Lapland may be estimated at 139 days, in southern Lapland 142, in the coastal zone of Norrbotten 148 and in that

of Västerbotten 160, as compared with 230 days in Östergötland and 256 in Skåne (provinces in the southern part of Sweden).

The brief duration of the summers is in some measure compensated by the length of the days and the abundance of sunshine. On the 69th degree of latitude the sun remains above the horizon for no less than 53 days and nights. On the 66th degree the longest day is nearly 24 hours, and on the 64th nearly 21. By way of comparison, it may be mentioned that the longest day in the southernmost part of Sweden, on about the 56th degree, is 17 $^1/_2$ hours. The number of sunshine hours in the coastal zones of both the above-mentioned counties is about 350 in the month of July, in southern and central Sweden 250 to 275.

The population living in this vast territory amounted at the end of 1931 to only 407,096 persons. It is thus very thinly populated. The density of the population in the Counties of Norrbotten and Västerbotten is in fact only 2 and 3.7 per sq. km respectively. The distribution of the population in these counties is shown in map No. 2.

The population inhabiting this area is preponderantly of Swedish race. This is the case especially in Västerbotten, where the two other races — the Finns and the Lapps — according to the census of 1920 were represented only by about 1,700 persons, that is, 0.9 per cent of the entire population. In Norrbotten, on the other hand, especially in the southern mountainous region, the inhabitants are for the most part of Lappish origin, or of a mixed race of Lapps and Swedes. Towards the north the Finnish element becomes more marked. In the districts bordering on Finland there are many villages where the older inhabitants cannot speak, or even understand, Swedish. In the interior of Norrbotten it is only in the mining districts of Kiruna and Gellivare that the population is predominantly of Swedish race. In these districts it consists largely of workmen, shopkeepers, officials, etc., who have migrated from more southerly parts of Sweden. In the small communities which have been built up in the vicinity of railway stations a number of railway workers, as well as tradesmen who have followed in their wake from more southerly parts of the country, have settled. Whereas the population of Lappish and Finnish origin in Norrbotten amounted


Tät bygd (Cultivation predominant)
Spridd bebyggelse (Scattered cultivation)
1872 års odlingsgräns = östlig gräns för lapparnas område (Lower (east) boundary of the Lapp reservation from the year 1872)
Töre Station för provinsialläkare (Station for Health-officer)
Risbäle Plats för undersökning (Place for medical examination)
NORRBOTTENS LÄN
VÄSTERBOTTENS LÄN
BOTTNISKA VIKEN
Kiruna
Vittangi
Malmberget
Gällivare
Tärendö
Pajala
Jokkmokk
Arjeplog
Harads
Töre
Nederkalix
Överkalix
Övertorneå
BODEN
Råneå
LULEÅ
PITEÅ
Älvsby
Gammelstad
Norrfjärden
Öjebyn
Arvidsjaur
Sorsele
Malåträsk
Stensele
Jörn
Byske
Boliden
Norsjö
SKELLEFTEÅ
Bureå
Burträsk
Lycksele
Vilhelmina
Dorotea
Åsele
Vindeln
Degerfors
Robertsfors
Nysätra
Lövånger
Bygdeå
Bjurholm
Vännäs
UMEÅ
Nordmaling
Tärna
Haparanda
16° E. GREENW.
A.-B. KARTOGRAFISKA INSTITUTET

Map No. 2.

at the end of 1920 to 18.6 per cent of the entire population, the corresponding figure for Västerbotten, as above mentioned, was merely 0.9 per cent.

The population of the two counties, tabulated according to towns, urban communities, and rural districts, is shown below:

	County of Västerbotten	County of Norrbotten
In towns	17,066	23,633
» urban communities	12,498	20,965
» rural districts	175,890	157,044
Total	205,454	201,642

Setting aside those who have emigrated or have moved to more southerly parts of Sweden, the inhabitants of this region have dwelt on and tilled the same land from generation to generation, taking up the work of their fathers as the latter ended their strenuous lives. There has, as above indicated, been some immigration from the south; but it has been confined mainly to the towns, the mining districts, the communities in the vicinity of stations and the industrial districts scattered along the coast. The attempts made by settlers from southerly parts of the country to establish themselves in Upper Norrland have, generally speaking, not been a success. These settlers have found it difficult to stand the severe climate and the isolation, and still more, perpaps, the unwonted hard work.

The total area of the two counties, as above mentioned, is no less than 15,423,096 hectares. The areas of the different kinds of land, in hectares, are shown in the table below (the figures are for the year 1927): —

	Gardens and orchards	Arable land	Hay fields	Pasture land	Forests	Other land	Total
Norrbotten...	60	56,962	156,086	29,354	3,711,181	5,912,366	9,866,009
Västerbotten	79	100,521	85,202	75,216	3,013,014	2,283,055	5,557,087

The chief occupations in the two counties are agriculture and forestry. Apart from the timber industries and mining, industrial activity in this part of Sweden is on quite a small scale. There are very large iron ore mines and deposits at Gellivare and Kiruna in Norrbotten, and at Boliden in Västerbotten there is a gold mine, from which copper ore and large amounts of arsenic are also extracted.

Though the size of the County of Västerbotten is not more than half that of Norrbotten, the area of arable land in the first-mentioned county, as will be seen from the above table, is nearly twice as large as that of Norrbotten. This is chiefly due to the climatic conditions. Whereas in the coastal zone of Västerbotten 8 per cent of the total area is under cultivation, the corresponding figure for Norrbotten is only 4 per cent. In the interior of both counties cultivated land constitutes merely a fraction of the area, namely 0.1 and 0.2 per cent respectively.

Agriculture in Upper Norrland is quite different in character from that in central and southern Sweden. This is not because the soil is actually more barren: the principal reason is that the climate is much severer and the period of vegetation much shorter. The farmer in these regions is therefore obliged to select such species of cultivated plants as are distinguished by hardiness and early ripening. Otherwise, particularly in exposed localities, he runs the risk of having his crops ruined by the early frosts. In Upper Norrland the farmer has a very limited time to till and prepare his soil before sowing in spring and after harvesting in the autumn. Hence the cultivation of cereals and other crops which require much tending has to be considerably reduced. The soil is therefore cultivated chiefly with a view to the production of fodder plants, and agriculture is based almost entirely on the utilization of fodder by cattle-raising and dairying.

In Västerbotten only 19 per cent of the area of arable land, and in Norrbotten merely 15 per cent, is devoted to the cultivation of cereals, as compared with an average of 43 per cent for the whole country. In Upper Norrland the area set apart for the cultivation of the principal bread cereals, wheat and rye, according to the agricultural census of 1927, totalled merely 469 hectares (in Västerbotten 301, in Norrbotten 168). The cereal most cultivated is the six-rowed barley, which ripens earlier than other cereals and is still used in Norrland for making bread.

In 1927 the area devoted to the cultivation of this species of barley was 12,074 hectares in Västerbotten and 6,183 hectares in Norrbotten. In addition, oats are cultivated in places which are not much exposed to frost. Oats — often mixed with vetches or German sand-peas — are also grown on a considerable scale for harvesting unripe, in order, after drying, to be used as fodder. Potatoes, in normal years, ripen right up to the 68th degree of latitude. In 1927 the area devoted to the cultivation of that plant was 3,099 hectares in Västerbotten and 2,303 hectares in Norrbotten. The remainder of the arable land is used as grass land, which is sometimes left untilled for ten years or more before it is ploughed up. In 1927 grass land comprised over 70 per cent of the area of arable land, as compared with 40 per cent in central Sweden and merely 20 per cent in the flat country of the province of Skåne.

In the interior of Lapland, on the fringe of the cultivated zones, the area of arable land owned by individual farmers is often very small, being sometimes merely a little plot for potato-growing. In these parts agriculture is based on the utilization of the yield of natural meadow, and is exclusively concentrated on cattle-raising. Bread cereals and flour have to be procured from other parts. So far as agriculture can be said to exist at all in this region, it consists in the cultivation of potatoes and rotation grasses. The outcome of the farmer's labours is entirely dependent on the kind of weather which prevails during the harvesting. Persistent rain, which impedes, or perhaps entirely prevents, the reaping of low-lying meadows, may mean that ruin is at the farmer's door. For in this remote region, where the communications are so bad, it is difficult to procure such a bulky commodity as fodder from other parts. The further we get from the mountainous region, the larger is the cultivation of cereals, first barley and further down oats. In these parts too a few frosty nights in August, or even towards the end of July, may blight the farmer's hopes of a good crop of cereals or potatoes. The garnered crops are used for feeding cattle, whilst the bread cereals required have to be procured by purchase.

As indicated above, the arable soil in Upper Norrland is by no means poor: in favoured spots, and if the summer has been warm, it may yield a very good harvest. But, owing to the severe climate, the yield per hectare — with the exception of potatoes —, on an average for a series of years, is considerably

lower than in the more southerly parts of the country. This is shown by the table below.

Average yield of certain crops in kilogrammes per hectare during the last decade.[1]

	County of Västerbotten	County of Norrbotten	County of Uppsala	Whole of Sweden
	kg.	kg.	kg.	kg.
Autumn rye.....	1,280	1,210	1,700	1,640
Barley	1,290	1,570	1,910	1,760
Oats	1,170	1,350	1,770	1,590
Potatoes	13,500	14,980	10,930	11,400
Meadow hay.....	2,270	2,850	3,550	3,520

It will be seen from the above table that the figures for the yield per hectare in Västerbotten and Norrbotten, with the exception of potatoes, are considerably lower than those for the County of Upsala (in central Sweden), as well as below the average for the whole of Sweden. In Upper Norrland the yield of potatoes per hectare is larger than in any other part of the country.

In 1930, when the harvest in Upper Norrland was fully medium, the yield of the principal crops in tons was as follows: autumn rye 700, barley 30,000, oats and mixed crops 14,000, potatoes 90,000, feeding root crops 16,000, hay from cultivated soil 300,000, and hay from natural meadow 200,000.

In view of the great extent of the meadows and pastures compared with the area of arable land, Upper Norrland naturally affords considerable facilities for cattle-raising. On the other hand, it should be observed that the cattle cannot be kept on the grazing-grounds for more than a short season of the year, and that the natural pastures are rather barren. For this reason cattle are bred mainly for dairying purposes and only in a minor degree for fattening. The 1927 figures for the live stock in Västerbotten and Norrbotten were, respectively, 92,752 and 65,283 head of cattle; 16,576 and 5,720 pigs; 54,660 and 42,232 sheep and goats. Poultry-breeding, especially in Norrbotten, is on a very small scale. If the entire live stock is reckoned in units, 93 such units in Västerbotten and 83 in

[1] The Swedish edition was published in 1934.

Norrbotten correspond to one hundred of the agricultural population. The corresponding figures for the County of Upsala are 169 and for the whole of Sweden 143 (in 1927). It should further be noted that the live stock in Upper Norrland in general give a smaller yield than the stock in the flat country of central and southern Sweden. The annual production of milk per cow in Västerbotten and Norrbotten was estimated in 1927 at about 1,700 kg., as compared with an average of 2,200 kg. for the whole of Sweden and 2,500 kg. for the flat country of central Sweden. These figures indicate that the production of animal foodstufs relatively to the size of the agricultural population is considerably smaller in Upper Norrland than in the southern and central parts of the country.

Now that the settled population are no longer entitled to keep reindeer, reindeer-breeding is of minor importance in their economy. Reindeer flesh is consigned for sale in considerable quantities to the southern parts of Sweden, or exported.

The yield of agriculture, generally speaking, goes to the maintenance of the farmer's own family. If there is any surplus, it is depreciated in value by the difficulty of marketing, owing to the great distances. But the chief reason why agricultural produce is marketed on such a small scale is that the agricultural holdings are, generally speaking, very small. This is strikingly shown by the following figures for the year 1927. Out of a total of 16,698 agricultural holdings in Norrbotten, 23.1 per cent had an area of arable land of not more than 1 hectare, 23.6 per cent 1—2 hectares, 34.3 per cent 2—5 hectares and 15.3 per cent 5—10 hectares. Only 3.7 per cent had an area of more than 10 hectares. The corresponding figures for Västerbotten were 13.1, 19.9, 37.4, 24 and 5.6 per cent of a total of 23,755 holdings. It may be mentioned, by way of comparison, that the number of holdings with a tilled area of more than 10 hectares was 22.3 per cent for the whole of Sweden.

Agriculture as a source of livelihood is of chief importance in the coastal zone of Upper Norrland. Its yield diminishes as we proceed northwards and further into the interior. The approximate northern limit within which barley ripens in normal years is shown in map No. 1.

In Upper Norrland gardening plays quite an insignificant part in the national economy. This, of course, is largely due to the severe climate, but also to the lack of knowledge of gardening and of the uses of garden produce. It has in fact been shown that ordinary vegetables, such as carrots, cauliflower, turnips, cabbage, spinach and radishes, ripen without artificial aid in the Lapp district of Västerbotten right up to the mountainous region, in the coastal zone and in the greater part of Norrbotten. Rhubarb grows almost anywhere, strawberries ripen in the Lapp district, except in very cold spots, and in the coastal zone of Västerbotten apple-trees, apart from the choicest varieties, yield a good return. Apples have also been cultivated with success in the southern parts of the coastal zone of Norrbotten. The garden produce obtained in these northerly regions is quite equal in quality to that grown in other parts of the country, and indeed is considered by impartial judges to be actually superior to it in taste.

The most common fish are pike (*Esox lucius*), perch (*Perca fluviatilis*), eelpout (*Lota vulgaris*), roach (*Leuciscus rutilus*), id (*Leuciscus idus*), gwyniad (*Coregonus lavaretus*), whitefish (*Coregonus albula*), grayling (*Thymallus vulgaris*), salmon (*Salmo salar*), salmon-trout (*Salmo trutta*) and char (*Salmo alpinus*).

Sea-fishing is carried on along the coasts of the two counties on a considerable scale. The principal fish caught are Baltic herring (*Clupea harengus*), salmon, and gwyniad.

The population of the mountainous region eke out their earnings by the shooting and hunting of game, such as ptarmigan, black cock and capercailizie. In other parts of Upper Norrland shooting and hunting are of minor importance as a source of livelihood. As game is usually regarded as a high-priced luxury, which should be reserved for sale, it is not a large item in the fare of the population.

On the basis of the above information and other known facts regarding the daily life of the population of Upper Norrland, the following account may be given of their diet: —

Flour and meal, in the form of bread and porridge, are very large items in the daily fare. As these foodstuffs are not produced in sufficient quantities in the two counties, the requirements are covered to a considerable extent, especially in the interior, by purchase from other parts of the country. There is a large consumption of sifted rye meal and barley meal, in addition to wheaten flour. Potatoes are another large item in the fare. In the interior, where the potato plots are small and the families often large, it happens rather frequently that the supply of potatoes gives out in the winter, without being replaced by other vegetables. Among animal foodstuffs the largest item is milk. The butter produced on the farms is often sold and replaced in the farmer's household by margarine. Apart from the coastal zone of Västerbotten, the replacement of butter by margarine is usual among the non-agricultural population. On the coast and in the vicinity of the big lakes in the Lapp district, fish, fresh or salted, is much consumed: in the coastal areas the small Baltic herring, in the interior whitefish, char and salmon-trout. In other parts of Upper Norrland the fish diet consists of salt Baltic herring and such fish — mainly pike, char, perch, roach and whitefish — as are caught in the lakes or waterways in the vicinity. So far as the requirement of meat is not met by home production, it is covered by imported salt pork, which is a highly esteemed food in the interior.

In addition to the large mines and iron ore deposits at Kiruna and Gellivare in Norrbotten and the Boliden gold and copper mine in Västerbotten, the forests are the principal natural resources of the two counties. The largest owners of wooded land and forests are the State and the communes. In the latter part of the nieteenth century and about the beginning of the twentieth century, especially in Västerbotten, large domains previously owned by farmers had passed into the hands of companies possessing comparatively large capital. The following figures, based on the 1928 assessment, indicate the value and area of wooded land and forests in the possession of the above-mentioned groups of owners: —

Ownership of forest property in Norrbotten and Västerbotten.

	State or communes	Companies	Farmers	Total
		Value in kronor		
Norrbotten	54,250,200	12,061,900	27,539,400	93,851,500
Västerbotten	49,812,300	41,615,100	58,094,700	149,522,100
		Area in hectares		
Norrbotten	2,222,912	394,420	1,089,448	3,706,780
Västerbotten	1,105,334	740,196	1,165,891	3,011,421

The economic importance of forestry in this part of the country is due to the fact that it not only provides work (in sawmills, pulp mills etc.) for persons not employed in agriculture, but is also an additional source of livelihood for the agricultural population. The transport of timber in the winter, timber-floating in the spring and summer, and the clearing of waste lumber in the summer and autumn create a great demand for labour. But for these extra earnings the standard of life of the population would be very low indeed.

This brief survey of the conditions in Upper Norrland may fitly be concluded by giving some figures showing (1) the supply of foodstuffs to this part of the country, and (2) the distribution of the population according to occupational groups. These figures are summarized in the following tables I and II.

The data in Table I are unfortunately not comprehensive. This is due to the fact that the available statistics did not include piece goods traffic by rail, nor transport by road, nor the transport by sea of goods not dutiable in the ports. Apart from a few classes of goods, such as certain kinds of vegetables, fruit and fish, the amount of goods transported in these ways is, however, quite insignificant. The table would, of course, have been of greater value if comparative figures had been given for other parts of the country. This, however, would have involved a very elaborate investigation.

Despite these deficiencies, the table gives a fairly good idea of the extent to which Upper Norrland, broadly speaking, is dependent on the supply of foodstuffs from outside. It shows that the total net »import»[1] of foodstuffs into Upper Norrland

[1] The term »import» here refers mainly to the procuring of supplies from other parts of *Sweden*.

Table I.

Supply of foodstuffs to Upper Norrland.

(Västerbotten and Norrbotten together in 1929.)

	Live stock	Dairy produce, meat, eggs etc.	Fish and shell fish	Cereals, peas, milling and bakery products etc.	Sugar, groceries, tobacco, coffee, tea etc.	Potatoes, edible roots, and vegetables	Berries and other fruit, etc.	Beverages
	Head	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Total »import»	6,367	8,117	3,657	73,431	17,696	2,032	3,563	2,577
Total »export»	16	657	158	5,186	674	9	1,603	365
Excess of »imports»:								
Total	6,351	7,460	3,499	68,245	17,022	2,023	1,960	2,212
Kg. per head of population	—	19	9	171	43	5	5	6

Table II.

Relative distribution of the population in groups of occupations at the end of 1930. Whole of Sweden, and the seven counties in which at least 45 per cent of the inhabitants are engaged in agriculture and its associated callings.

	Percentage of population engaged in occupations listed below								
	Agriculture and associated callings	Industry and crafts	Commerce and communications	Other occupations	Forestry	Other agricultural occupations	Mining, mineral, metal, and machine industries	Timber and wood goods industries	Other industries
Whole of Sweden	34.7	31.7	15.5	18.1	3.2	31.5	7.3	3.8	20.6
Counties:									
Västerbotten	58.6	21.1	8.7	11.6	8.1	50.5	2.4	6.2	12.5
Jämtland	57.6	15.5	10.6	16.3	15.6	42.0	1.2	3.0	11.3
Gotland	52.4	20.3	10.6	16.7	0.1	52.3	1.6	1.0	17.7
Skaraborg	51.3	22.5	9.7	16.5	0.7	50.6	3.1	2.9	16.5
Kronoberg.....	48.4	25.9	9.4	16.3	1.5	46.9	2.3	4.8	18.8
Norrbotten	47.7	24.9	13.0	14.4	10.4	37.3	8.2	5.4	11.3
Halland	45.9	25.5	12.5	16.1	0.3	45.6	4.1	2.3	19.1

in 1929 amounted to more than 102,000 tons, besides nearly 6,400 head of live stock. These »imports» represent on an average about 260 kg. per head of the population. No less than 67 per cent consists of cereals and products thereof; 17 per cent sugar, groceries, etc.; 7 per cent dairy produce; 3 per cent fish; and the remaining 6 per cent other foodstuffs. The »export»[1] of foodstuffs from Upper Norrland amounts barely to 8,700 tons. Berries from the forests are one of the principal »exports». The amount of berries and other fruit »exported» by rail is larger than that »imported» in the same manner.

Table II bears out the observations made above regarding the importance of agriculture for the population of Upper Norrland. It will be seen that about 59 per cent of the population of Västerbotten and 48 per cent of that of Norrbotten are engaged in agriculture with associated callings (forestry), and 8.6 and 13.6 per cent respectively in mining and timber industries. No less than 67.2 per cent of the population of Västerbotten and 61.3 per cent of that of Norrbotten are engaged in these three groups of occupations.

Life in these northernmost counties is affected not only by the severe climate and the scanty yield of the soil, but also by the isolation. In the interior the people live in diminutive villages, often consisting of merely a few farms and isolated homesteads. The population have settled chiefly in the river valleys, along the shores of lakes and on hill slopes, which were considered to afford protection against frost. During the last thirty years or so railway construction, new roads in the interior, regular motor bus services, new telephone lines and broadcasting have, indeed, greatly contributed to dispelling the intense isolation. But the low economic standard of the population in general prevents them from making full use of facilities for communication, so that their habits of life change but slowly. It will be seen from the following chapters that this stagnation is due also to other factors.

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[1] The term »export» here is inclusive of consignments to other parts of *Sweden*.

It might have been desirable to supplement this review of the conditions in Upper Norrland by detailed figures of mortality. It would in fact be of the greatest interest to ascertain whether the mortality in Norrbotten and Västerbotten is in excess of that of other counties. But, owing to the way in which the Swedish mortality statistics are compiled, it would not have been possible without much labour to give data showing the mortality at different ages and the causes of death. I must therefore confine myself to the summary data contained in the following table.

Average number of deaths in various parts of the country in 1926—1930.

Areas	Average population 1926–1930	Deaths			
		Total average per year 1926—1930		Deaths from tuberculosis, average per year 1926—1930	
		Absolute figures	Percentage	Absolute figures	Percentage
City of Stockholm	470,184	5,491	11.68	749	1.59
Cities of Gothenburg and Malmö	353,893	3,602	10.18	469	1.33
Counties of Stockholm and Södermanland	453,985	5,333	11.75	494	1.09
Counties of Östergötland and Gotland	367,051	4,568	12.45	361	0.98
Counties of Jönköping and Kalmar	462,617	5,768	12.47	521	1.13
Counties of Kronoberg and Kristianstad	402,820	5,050	12.54	451	1.12
Counties of Blekinge and Malmöhus, except city of Malmö	535,345	6,373	11.90	578	1.08
Counties of Halland and Göteborg & Bohus, except city of Gothenburg	363,027	4,317	11.89	471	1.30
Counties of Älvsborg and Skaraborg	556,522	7,101	12.76	587	1.05
Counties of Värmland and Örebro	491,348	6,050	12.31	607	1.24
Counties of Upsala and Västmanland	302,666	3,735	12.34	345	1.14
Counties of Kopparberg and Gävleborg	531,032	6,299	11.86	766	1.44
Counties of Västernorrland and Jämtland	411,458	5,171	12.57	710	1.73
Counties of Västerbotten and Norrbotten	395,078	4,774	12.08	909	2.30
Whole of Sweden	6,097,026	73,632	12.08	8,018	1.32

This table shows (1) the number of deaths absolutely and relatively and (2) the number of deaths from tuberculosis of the lungs, in the same way. The figures are averages for the years 1926—1930. The areas given in the table have been selected so as to correspond as far as possible with the two northernmost counties in regard to the approximate size of the population.

It will be seen from the table that, during this five-year period, the average number of deaths in Västerbotten and Norrbotten is proportionately *lower* than in no less than 7 of the 14 areas included in the table. Thus the population of Upper Norrland are by no means in a bad position in this respect. In short, the peculiar and trying conditions in which a large part of the population of this region live are not reflected in the wholesale figures of the table.

One of the objects of this report is to draw attention to defects in hygienic conditions. As similar investigations have not been made in other parts of Sweden, it would be rash to conclude that the defects observed in Upper Norrland are specially characteristic of that region. Defects due to the climate are obviously peculiar to that part of the country. Other evils, such as the excessive consumption of coffee, the abuse of tobacco, insanitary conditions in the homes, defects in personal hygiene, and bad cooking are unfortunately by no means unknown in other parts of Sweden.

It may therefore be advisable to warn the reader against concluding that the population of Upper Norrland are, in general, on a lower intellectual plane than that of the rest of the country, and that their sense of responsibility towards the rising generation is less developed than elsewhere.

In the nature of things, a section of the population which has long lived in a state of isolation, and to a large extent is still doing so, is very liable to become narrow-minded and one-sided. It is also easy to understand that, in default of a variety of impressions and new impulses, the people in the north are apt to cling to habits and customs which might seem indicative of backwardness and indifference.

It should also be borne in mind that a severe struggle for life, an existence which often verges on sheer distress, compels the head of the family and the housewife to strain every nerve and devote their whole attention to the earning of a scanty livelihood. In such circumstances it is only human that weariness

and discouragement should tend to deaden interest in anything that is not absolutely necessary to maintain existence, and that people often fail to see that it would be possible by quite simple expedients to improve hygienic conditions and the health of the family, and thus also the happiness and comfort of the home.

CHAPTER II.

Antecedents and planning of the Investigation

by

NILS HELLSTRÖM.

Antecedents of the investigation.

The peculiar conditions in which the population of Upper Norrland live have naturally attracted the attention of medical men practising there. The annual reports submitted by district medical officers concur in their complaints of unsatisfactory hygienic conditions and of noxious habits and customs. The principal complaints relate to shortcomings in the following respects: (1) insanitary dwellings, or bad use and maintenance of dwellings, (2) defects in the care of infants, (3) the unvaried diet, and (4) excessive consumption of coffee and abuse of nicotine in the form of »snuff-chewing». True that the conditions in these respects have improved considerably in the course of the last twenty or thirty years. There are nevertheless large areas in which the hygienic conditions leave much to be desired. The most marked consequences of the defective conditions there, as observed by the medical officers, are high infant mortality, high incidence of tuberculosis, frequent occurrence of digestive disturbances, anaemia, and numerous cases of dental caries.

In 1900 Professor Robert Tigerstedt published the results of an investigation conducted by him, together with Dr Nils Englund, on the diet of forest labourers in the north-western part of Ångermanland.[1] Dr A. D. Hassler, County Medical Officer, subsequently dealt with the same subject in a lecture. This question has also been repeatedly brought up before the Riksdag.

The medical men practising in this part of Sweden have been

[1] Tigerstedt, R. Hygiea, p. 121. — Ångermanland is a province immediately south of Västerbotten.

limited to the resources of the general practitioner. For this reason, as well as owing to lack of time, they have not had sufficient opportunity for scientific studies of the above-mentioned disturbances in the health of the population, their incidence, and their causes. Nevertheless these officers, in connection with their medical duties, have done very valuable work also in the field of general hygiene.

The establishment of a special medical department at the hospital at Umeå — the residence of the Governor of Västerbotten — provided facilities for a more thorough scientific study of the above indicated conditions, which soon attracted the attention and interest of the superintendent medical officer, Dr Martin Odin. In view of the numerous cases of achylia, ulcer of the stomach or duodenum, colitis, anaemia and haematuria which he had encountered among the population of Norrland, he set to work, almost immediately after he had taken up his post (in 1924), to carry on investigations with intent to ascertain the nature, the causes and the incidence of these diseases. The results were summarized in the annual reports of the Umeå hospital to the Medical Board, from which the following extracts may be quoted: —

In the 1925 report it is stated: »In regard to the incidence of diseases of the digestive organs, attention should be drawn to the astounding frequency of achylia gastrica, which in these parts is commonly known as »the Västerbotten sickness». Achylia is often combined with gastric ulcer, which is a peculiar phenomenon requiring special investigation.»

»Gastric ulcer is very frequent and shows distinct roentgenological changes in 75 per cent of the cases, which is likewise highly remarkable.»

The 1926 report contains the following passage in regard to disease statistics: »The most prominent of all the diseases in these parts is anaemia. Cases of this disease are extremely frequent, and many of them are of a secondary type. It has in fact been very difficult to classify the various cases. It often assumes very severe forms». »Even in the worst cases the prognosis has been good. Two factors which have undoubtedly played an important part in causing these anaemias are firstly the unvaried diet (which deserves a special study), and secondly the darkness during the long winter. The therapy has consisted in supplementing the diet with plenty of fruit, syrup and vegetables, in ultra violet-ray treatment, as well as in the administration of arsenic and, if necessary, iron. In many cases the results have been excellent: seemingly hopeless cases have recovered within a few weeks.»

»Typical pernicious anaemia, on the other hand, seems to be of relatively rare occurrence. In no cases where the diagnosis indicated

this disease, was the occurrence of tape-worm (*Bothriocephalus latus*) revealed. And yet that worm is comparatively often found among hospital patients in Norrland.»

The 1927 report contains the following statements: »In the annual report for last year I made some comparisons between hospital patients in the north and in the south of Sweden, especially in regard to internal diseases.»

»As regards gastro-intestinal diseases, I have previously drawn attention to the incidence of achylia gastrica (being cases showing the absence of free hydrochloric acid and with a total acidity below 20). Cases where the gastric juice actually shows an alkaline reaction to litmus are not infrequent.»

»Cases of chronic colitis have been very frequent among hospital patients.»

»The cause of the great frequency of gastro-intestinal diseases is apparently, in the vast majority of cases, the very monotonous diet. Most of the patients come from the agricultural population, whose chief food consists of unfermented hard bread, butter, gruel and barley-meal porridge, the small Baltic herring, and potatoes, The excessive consumption of coffee and, among the men, snuff-chewing seem to be contributory factors of considerable importance. It is noteworthy that many of the patients with alkaline gastric juice are snuff-chewers.»

»The incidence of anaemia has been very marked this year also.»

These annual reports from Umeå hospital had attracted great attention among medical men, and had aroused interest in matters relating to the nutrition of the people of Upper Norrland. This interest was further promoted by a treatise by Dr G. Bohmansson, (then in charge of the surgical department of Umeå hospital),[1] containing observations on the simultaneous occurrence of achylia and gastric ulcer.

In 1928 Dr Einar Perman (Lecturer to »Karolinska Institutet»), drew further attention to these dietary deficiencies in a paper in »Social Medicinsk Tidskrift».[2]

He stated that »in the north of Sweden diseases of the stomach and intestines are much more frequent than in other parts of this country. There is no doubt that this is due to the very bad nutritional conditions in large areas of Norrland, characterized by an unsuitable and unvaried diet, a shortage of suitable fooodstuffs, and the abuse of coffee and tobacco.» »But, before taking vigorous measures to suppress these diseases», Dr Perman continues, »it will first be necessary to investigate them more closely, to determine their incidence, and to endeavour to

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[1] Studien über die chirurgische Behandlung von Gastroduodenalgeschwüren etc.» Acta chirurgica scandinavica. Vol. LX, Suppl. VII.

[2] »Ett förslag till förbättring av de hygieniska-dietiska förhållandena i Norrland.» Social Medicinsk Tidskrift, 1928, p. 180.

ascertain the abuses to which they are due.» PERMAN also draws attention to the bad teeth of the people in these parts, the frequency of anaemia and the high incidence of tuberculosis. He attributes these diseases to the gastro-intestinal disturbances caused by the unvaried diet, the vitamin deficiency, and »the immense consumption of coffee», which he regards as one of the most serious abuses. PERMAN concludes his paper with an outline of an extensive plan for improvements in these respects. This matter will be reverted to in a following chapter.

PERMAN's paper was summarized in the daily press and attracted great attention. It led to a number of interviews, for example, with Dr JOHN BYTTNER, then the chief County Medical Officer in Norrbotten and Västerbotten, and Dr G. WESTIN, Lecturer to »Karolinska Institutet». The latter, who, together with Dr ODIN, at Umeå, had previously studied the effects of diet on the teeth, especially with reference to the deficiency of the C vitamin, stated that there were strong reasons for presuming that »in large sections of the population of Norrland, precisely owing to the diet conditions, there exists a latent form of scurvy, the first symptoms of which manifest themselves in the teeth». He considered, therefore, that a thorough investigation should be made with a view to ascertaining whether these suspicions were well founded.

In the autumn of 1929 a valuable contribution to the discussion of this question was made in a paper by Professor GUSTAF GÖTHLIN of Upsala,[1] on the subject of the vitamin question in Norrland.

He considered that the scientific basis of the above statement made by Dr WESTIN deserved further investigation. He maintained that, in view of the diet, a shortage of C vitamin was more liable to occur in Norrland than in the more southerly parts of the country.

After pointing out that morbid changes in the dental pulp and socket were the earliest characteristic symptoms of scurvy in man, Professor GÖTHLIN observed that »two important questions, namely regarding (1) a possible deficiency of C vitamin in the diet and (2) the exact nature of the wide-spread decay of the teeth among young people in Upper Norrland, might most readily be solved by a statistical — and also roentgenological — investigation, organized by a State authority, of the nature of the gums, the socket and the teeth in a suitably selected section of the population of Upper Norrland». This paper also contained a survey of the principal foods containing C vitamin in Norrland, and their value as vitamin supplies. He stressed the necessity of a thorough

[1] Norrlands vitaminfråga, belyst rörande C-vitaminet. Social Medicinsk Tidskrift, 1928, p. 224.

investigation into the C vitamin content of whortleberries and bilberries. He also recommended further studies of the C vitamin content of cloudberries, currants and gooseberries, as well as of preparations thereof.

The questions thus raised, though of the greatest importance from the point of view of health and nutrition and of considerable scientific interest, could obviously not be studied on any large scale without reinforcing the medical staff at Umeå. Such an investigation also involved observations among the population, particularly the children, in their homes and in pursuit of their daily occupations.

In these circumstances I considered it my duty to offer my services in arranging for an increase of the medical staff at Umeå hospital and in organizing cooperation between the staff of that hospital and outside doctors and dentists, with a view to a more thorough elucidation of the questions at issue.

Planning of the investigation.

As a basis for the planning of the forthcoming investigation, Dr Martin Odin had drawn up a special report on certain diseases observed in Umeå hospital, from which we extract the following: —

Certain groups of diseases and symptoms, notably gastro-intestinal disorders, anaemia, and haematuria, as well as combinations of these morbid conditions, are very frequent in Västerbotten. For example, among the medical patients examined for these symptoms at Umeå hospital (inclusive of out-patients), they were observed in more than 500 cases a year. This figure does not include cases in which these disorders were sequelae to other diseases, such as tuberculosis, arthritis, etc. Though the figure is, of course, not a real index of the frequency of these symptoms, it plainly indicates that they are extremely common. In fact, the frequency of these diseases is bound to make a very strange impression on any medical officer who had previously practised in the south of Sweden.

The chief diseases of the digestive organs are cases of gastritis with achylia, often combined with gastric ulcers and colitis.

The blood changes consist of anaemia, which is often very

pronounced. The primary and secondary types are about equally frequent.

Haematuria is usually moderate, there being from 2 to 10 red cells in the field under the microscope, with no other symptoms of nephritis.

In order to investigate the clinical features of the various groups of diseases and to be able to form an opinion as to their frequency and inter-dependence, their incidence in different groups of occupations and ages as well as at different seasons of the year, their relation to the diet, and the results of the treatment, the following procedure was adopted. All the in-patients, as well as some of the out-patients, who were not suffering at the same time from some other disease which might be presumed to be a contributory factor in the development of these morbid conditions were registered on cards.[1] In addition, certain other examinations were made, so far as circumstances permitted, especially in regard to the blood and the gastric juice. Some of them are mentioned below.

Besides the blood examinations recorded on the cards, tests were made in a certain number of cases of anaemia in order to ascertain the coagulation time, the clot retractility, the clot resistance, and the coagulation valency with a view to the determination of the tendency towards thrombosis and hemorrhage.

Cases of anaemia are often characterized by the absence of the regenerative forms of the blood cells. They are, in short, of the »aplastic» type. This lack of regenerative power in the blood cells in anaemia is indicated by the fact that the disease is very frequent and very pronounced in pregnancy, when the entire system and thus also the blood-forming organs are more severely taxed. The high incidence of anaemia in children points in the same direction.

The symptoms in the gastro-intestinal tract were observed not only by the tests recorded on the card with a view to ascertaining the character of the achylia (Ewald's test-breakfast), but also by fractional gastric analysis, gastric analysis after histamin injections, and test-meals with coffeine and alcohol. Tests were also made for the pepsin content in the gastric juice, so far as was desirable with a view to prognosis. Cytological and bacteriological examination of the centrifuged remnants of test-meals was also considered desirable, in view of the light it might throw on the nature and extent of the morbid processs in the stomach. Special importance was attached to such examination when conducted parallel with roentgenography and pathological microscopical examination of resection and autopsy material from stomachs. On X-ray examination achylia often shows indications of serious inflammatory changes. A large number of such examinations were made.

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[1] See annexes on p. 38—41.

We thus come to the question of the connection between ulcer and gastritis. The usual combination between achylia and ulcer has already been pointed out. It seems to have attracted particular attention among the general public, which is presumably to be attributed to Dr Gösta Bohmansson's above-mentioned interesting dissertation on the subject.[1]

Colitis as a rule is of the type characterized by constipation alternating with diarrhoea. It often assumes a very severe character, being phlegmonous and ulcerative. Microscopical examination of the stools was made regularly after or without special test-meals. It did not, however, yield results of much value.

The occurrence of intestinal worms was carefully studied at Umeå hospital. The stools were regularly examined for ovules of worms. These examinations led to the conclusion that the occurrence of worms was not apparently a contributory factor in the development of gastro-intestinal disturbances or anaemia.

In regard to haematuria little remains to be added to the observations made above.

In our examinations special attention was given to the state of the teeth. The number of whole, decayed and missing teeth, as well as the general character of the set of teeth, were recorded on the cards. In some cases the teeth were X-rayed in order to ascertain the occurrence of denticles as indicative of previous or existing latent scurvy.

In the case of all the in-patients, and also some of the out-patients, notes on the patient's usual diet were made on the cards. For the sake of convenience, the various types of diet were designated by letters and figures. Thus the principal diet of the agricultural population, especially in the coastal zone, which consists solely of meal and milk dishes, Baltic herring, potatoes, butter and bread, was designated by the letter *L*. The diet of the forest labourers, which is composed mainly of pork, meat, rolls baked on charcoal, bread soaked in blood, and ordinary bread, was denoted by the letter *S*. There is no special designation for mixed diet on these cards. The degree of monotony of the diet was indicated by the Roman figures I—III, its content of C vitamin (especially the C vitamin in syrup, fruit and vegetables) by the letters a, b and c. In connection with the diet the daily consumption of coffee, the use of tobacco and snuff-chewing were noted on the cards.

Even a superficial examination of the cards indicated that we must be prepared for surprises in regard to the relation between

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[1] Bohmansson, Gösta, Acta chirurgica scandinavica. Vol. LX, Suppl. VII.

the above-mentioned symptoms of disease and the composition of the diet.

The main lines of the proposed investigation were discussed by a number of medical experts at a conference convened by me in November 1928.

The members of this conference were agreed that the question of diet should form the basis and objective of the investigation. The first step to be taken was to obtain a better survey and a more accurate knowledge of the diet in the areas under investigation. The next stage would be, in the light of the knowledge thus acquired, to examine closely the incidence and nature of the diseases and morbid conditions which were apparently more frequent in Upper Norrland than in the southerly parts of Sweden, namely achylia, colitis, anaemia and haematuria. In the opinion of the members, the continuation and extension of the investigation then proceeding at Umeå would greatly conduce to the solution of these problems. It was, therefore, considered that the projected enquiries could be based in essentials on the paper by Dr Odin, and the latter was invited to submit a plan for continued investigation in conformity therewith. A question which had been brought up in regard to district and school investigations as well as the examination of patients at the military hospital of Boden was deferred for further consideration.

At this conference it was also pointed out that there was reason to suspect a connection between dietary deficiencies and the bad state of the teeth of the people in these parts, a serious matter which had been engaging the attention of medical officers for years. Owing to our lack of knowledge of the causes of dental caries and the confusion of that condition with other diseases of the teeth, many theories had been advanced in explanation of their great frequency. When the important part played by vitamins in the metabolism had become known, vitamin deficiency had also been suggested as a cause of dental caries. Attention was drawn to the view expressed by Dr Gösta Westin that there was strong reason to suspect the existence of a latent form of scurvy, the first symptoms of which manifested themselves in the teeth. In the opinion of some members of the conference, there was much to be said for the view propounded by Dr Westin that the cause of this morbid condition was a diet deficient in

C vitamin. It was pointed out that greater attention should be paid to the state of the gums, the socket and the pulp, and that roentgenographic studies should be made with a view to ascertaining the occurrence of atrophy of the alveolar process or of denticles in the pulp. In that case, it was thought, the investigation might yield valuable scientific results. It was accordingly agreed that the investigation should comprise scientific examinations of the state of the teeth.

As vitamin deficiency has been suggested as a cause of certain dental disorders, and as the numberous cases of anaemia and haematuria without demonstrable lesion of the kidneys might be supposed to be due to the same cause, it was considered very desirable to investigate the occurrence of the C vitamin in forest berries and garden produce cultivated, or cultivable, in Upper Norrland.

In conformity with the above views and suggestions, the plan of the investigation was drawn up on the following main lines:

I. Investigation of the occurrence of achylia, colitis, anaemia and haematuria of the above-mentioned types, particularly with reference to their possible connection with the diet.

II. Examination of the teeth with a view to ascertaining the incidence of dental caries and the occurrence of such changes of the teeth and oral cavity as might be considered to be symptoms of scurvy, and thus due to a deficiency of C vitamin.

III. Investigation into the occurrence of C vitamin in forest berries and cultivable garden produce within the area under investigation.

I. The first part of this investigation was thus a *continuation and extension of the investigations already proceeding at Umeå hospital*. That hospital became the centre of the medical examinations in Norrland in their entirety, and its then medical superintendent, Dr Martin Odin, was placed in charge of them. As Dr Odin had previously made the necessary preparations, no difficulties were encountered in drawing up detailed plans for the hospital examinations.

On the other hand, some doubt arose as to whether the hospital examinations should be carried on at other hospitals within the area in question. A strong argument in favour of such an arrangement was that the investigation could thus be extended to Norr-

botten. The only hospital available there was the military hospital at Boden, which is also at the service of the civilian population and has a medical department. After further consideration, an enquiry was addressed to the medical staff of that hospital as to whether they willing to cooperate in our investigation, and a reply was received in the affirmative.

As it was suspected that the high incidence of tuberculosis in the two countries might be connected with the diet deficiencies, Dr Odin was invited to discuss with the medical superintendent of Hällnäs Sanatorium the possibility of elucidating this question by the examination of sanatorium patients. Some tentative investigations of this nature, which do not seem to have yielded much result, were abandoned on the transfer of the medical superintendent to another sanatorium.

In accordance with the main lines thus drawn up, which were eventually followed in essentials, except in regard to the hospital at Boden, the following detailed plan was laid down for this part of the investigation:

A. *Examination of in-patients and out-patients.* The investigation was (1) to amplify the enquiry into the various types of diet and elucidate their bearing on the development of the above-mentioned morbid conditions, to investigate other factors which might be found to play a part in the development of functional gastric disorders as well as colitis, anaemia and haematuria, and (2) to throw further light on the incidence of those morbid conditions.

On the above basis Dr M. Odin drew up a detailed plan for the investigation at Umeå hospital (See Part II). Owing to certain circumstances, the staff of the medical department at the military hospital at Boden were not able to cooperate for any length of time. They examined, however, 133 patients in connection with our investigation.

B. *School and district examinations.* Considerable difficulties were entailed by the organization of medical examinations outside hospitals, which were considered desirable for the following reasons. The hospital material might be presumed to be rather one-sided. It would therefore be very useful to supplement it by the examination of persons living at home and pursuing their daily occupations. Additional material was considered to be particularly necessary in the case of children of school age, in view of the frequency of anaemia and digestive disturbances as

well as the abuse of coffee even at that age. A further, very important, reason was the desirability of examining the teeth of school children (see below).

Another question was whether such examinations should be confined to the problems on which the hospital examinations were intended to throw light, or whether they should be given a wider scope.

After mature consideration, it was decided that the investigation should comprise district examinations of adults and school children. It was further resolved that these examinations should also include certain questions other than those of diet and the morbid changes suspected to be due to diet deficiency, and should be planned with the aim of ascertaining, as far as possible, the conditions in various districts within the area under investigation. For financial reasons, however, their scope had to be greatly limited, and they could not be expected to be anything more than »sample tests» on a rather modest scale. It was considered, however, that they would serve to elucidate the problems at issue better than the examination of an equivalent number of persons in a single district.

It was decided that the district investigations should be placed under the charge of the local county medical officers. This arrangement involved the drawback that it was not possible to ensure uniformity in the observations, a matter which caused trouble, for example, in regard to the haemoglobin determinations. On the other hand, it had the distinct advantage that these medical officers possessed the confidence of the people and were well acquainted with their habits and customs.

Most of these examinations were made in the late winter of 1929. This season was selected firstly because the effects of the severe climate and the darkness would then still be making themselves felt, and secondly because the lengthening days would enable the examinations to be performed without the use of artificial light. In a considerable number of places dental examinations were made concurrently with the other medical examinations.

As will be seen from the forms appended at the end of this chapter (Annexes 2 and 3), these district examinations were not confined to the problems on which the main investigation was intended to throw light. Serious complaints had been made about housing conditions, not only in regard to the structure of

the houses and the maintenance of the dwellings, but also with respect to the utilization of the available accommodation. Another reason for the extension of the scope of the investigation was that it was desirable to ascertain what demonstrable morbid changes might serve to explain cases of anaemia, disturbances of the gastric secretion, or colitis.

As is shown by the appended forms (Annexe 4), the medical examinations in schools likewise involved some attention to housing conditions. The query paper, which was drawn up in consultation with experienced school doctors, also included questions which might serve to throw light on the child's general state of health. On the part of the form to be filled in by the doctor notes were made regarding demonstrable diseases or defects.

In view of the interest which the question of latent scurvy has attracted, exception may be taken to the arrangement in accordance with which it has been left to the doctor's discretion to perform the so-called capillary hemorrhage test (Hess's test), or not. One of the reasons was that this test, which had previously been tried for several months at Umeå, was not considered to be of decisive importance in determining the existence of scurvy. There was in fact a considerable divergence of opinion as to the value of this test. Continued observations at Umeå hospital did not give any occasion for changing the arrangement made in this regard.

It may perhaps be regarded as an omission that the incidence of tuberculosis was not thoroughly studied in connection with the district examinations. The chief reason was that such a study would have considerably extended the scope of district examinations, which were subsidiary to the main investigation. In any case, the funds available for a direct study of the incidence of tuberculosis were so small that such a study would presumably not have led to any new discoveries. It must not, however, be inferred from these remarks that our work was of no importance in regard to the suppression of tuberculosis.

It would, of course, have been an advantage if questions 9 and 10 in the school form (Annexe 4) had been answered by the doctor. But, as it was not considered possible for the parents as a general rule to be present at the medical examination, which meant that in most cases it would be necessary to make enquiries

in the homes, it was thought desirable to leave it to the teacher to fill in this part of the form also.

The localities in which the district examinations were conducted are shown in Map No. 2. Unfortunately neither time nor available means permitted of such an extensive examination in the interior of the country as would have been desirable. It was considered advisable that the material collected in the course of the district examinations should be dealt with by the Umeå hospital. It was in fact included in the report compiled at that hospital on the various parts of the investigation in Norrland. This applies also to the examinations of school children. Dr J. Byttner, however, was asked to draw up a separate report on the school examinations. It will be found in the last chapter of Part I.

The county medical officers who conducted the district and school examinations were asked to supplement their reports by observations on their general impressions. These observations contain many points of interest, which serve to throw light on existing conditions. They are summarized by Dr G. Ankarswärd, Chief County Medical Officer, in Chapter III of this Part.

II. *The dental examinations.* As the object of these examinations was not only to ascertain the incidence of dental diseases, but also, as far as possible, to determine their connection with the diet, it was necessary to conduct them in close conjunction with the medical examinations. It was thought that this might afford opportunities to observe the condition of the teeth in connection with the general state of health, and especially with diseases in the digestive organs.

The registration of the persons examined was arranged accordingly.

Cooperation between doctors and dentists was organized not only in hospitals, but also in district and school examinations. Dr Westin undertook to take charge of the statistical work, to direct the scientific elaboration of the results obtained, and to assist in the organization of the dental examinations.

It was arranged that a dentist should collaborate with Dr Odin in conducting dental examinations at the Umeå hospital; that doctors and dentists should work together in the school and district examinations; and that in certain districts, where such

cooperation could not be established, separate dental examinations should subsequently be conducted.

The *statistical elaboration* of the material, which was arranged on a medico-odontological basis, was placed under the charge of Aron Lindström, head assistant of the State Dental College, and Filip Anger, a statistical expert.

A special *study of the caries picture* was made by Harald Holtz, head assistant of the above-mentioned college.

The *histo-pathological examination* of the dental material collected was made by Dr Westin himself.

The examinations mentioned under I and II were controlled by subsequent examinations in hospitals and schools in the province of Skåne.[1] By the kind permission of Professor S. Ingvar and Dr Thor Stenström, the first-mentioned examinations were made at the out-patient department of Lund hospital and at the medical department of Hälsingborg hospital. The number of cases examined in these controls was roughly 2,000. The examinations of school children, which included dental examinations, were made in the autumn of 1931 by Dr Stig Lindgren and Bror Hennichs, dentist. They comprised 400 children. Dr Odin, after his transfer to Borås[2] hospital, conducted control examinations of some 2,000 subjects at that hospital.

III. *The vitamin investigation* was placed under the charge of Professor G. Göthlin, who was asked to plan and organize the scientific researches. It was decided that they should include also the study of changes in vitamin content resulting from the cooking or conservation of foodstuffs, and that advice should be given to the general public in regard to the best ways of preserving that content.

It was further resolved that Professor Göthlin should first conduct preparatory experiments with a view to testing on laboratory animals (guinea-pigs) the most suitable composition of the basal diet; and that he should then make a series of definitive experiments in order to determine the minimum rations of various Norrland berries required to protect guinea-pigs from scurvy.

In accordance with this plan, 10 series of experiments, each comprising 20 guinea-pigs, were carried out by medical students.

[1] The southernmost province of Sweden.

[2] Town in West-Sweden.

The juices or preserves of berries examined in the several series were the following:

Bilberries (*Vaccinium Myrtillus L.*)
Arctic raspberries (*Rubus arcticus L.*)
Red currants (*Ribes rubrum L.*)
Raspberries (*Rubus idaeus L.*)
Red whortleberries (*Vaccinium vitis idaea L.*)
Cloudberries (*Rubus chamaemorus L.*)
Kale (*Brassica oleracea, var. acephala* D. C.)
Cloudberry preserves.

Red whortleberries and bilberries, which grow profusely in the Norrland forests, were treated in two series, cloudberries, which are likewise plentiful — at any rate in certain years —, in three.

These plans had not been completely elaborated until the beginning of 1929, and it was considered desirable to postpone the investigation into the diet of forest labourers till the winter of 1930. This question, however, was brought up before the Riksdag in a private bill in 1929. The result was that the Government on the 22nd November 1929 directed the Medical Board to investigate the dietary and hygienic conditions in a number of huts of forest labourers, with a view to ascertaining how far those conditions might be considered to have injurious effects on the labourers' health. The Medical Board were instructed to act in consultation with the Board of Social Welfare.

The investigation conducted in conformity with these directions was separate from that planned by the Medical Board, and its results will therefore not be published in this book.[1] The observations then made were, however, utilized by Dr Odin for the purpose of the main investigation in Norrland.

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[1] The report on this investigation is contained in *Statens Offentliga Utredningar* No. 38: 1933, *Socialdepartementet.*

Year: ..... No: ..... **Diagnosis:** .....

Name: ..... Birth: ..... Occupation: ..... Residence: .....

Date	Blood				Stomach							Faeces					Urine			
	Hb	R. b. c.	C. L.	Differential count	Retent.	Free HCL	Total acidity	T. M.	Mucus	Digest.	P. M.	Weber	Worms	Mucus	Catalase		Heller	Sed.		S. R.

Anamnesis: .....

Diet: ..... Teeth: caried: ..... intact: ..... missing: ..... Set of teeth: .....

Remarks: .....

Diet.

Coffee: (Number of cups a day)..... Empty stomach in the morning: .....

Tobacco: { Number of pipes: ..... / Number of cigars: ..... / Number of cigarettes: ..... } Snuff-chewing: .....

Consumption of spirits: .....

Usual composition of meals. State how *many times a week* the various kinds of food are included in the meals and (under Remarks) *in what form.*

	Breakfast	Dinner	Supper	Remarks
Bread				
Milk				
Butter.....				
Porridge.....				
Gruel				
Herring				
Baltic herring				
Other fish				
Pork				
Meat				
Potatoes.....				
Dishes with syrup or fruit				
Vegetables.....				
Pancakes				
Blood-pudding				
Fresh fruit				

Remarks

Annexe 2.

District Investigation.

Investigation No.[1] ... Counties: *Västerbotten* / *Norrbotten* — Desert region / Forest zone / Coastal zone — Home No:[2] .....

Parish: ..... Village: .....

Name: ..... Age: ..... Year: ... Month:... Occupation: .....

Dwelling:[3] Number of rooms in daily use { Window space per room 1... sq.m., 2... sq.m., 3...sq.m. / Floor area » » 1... » , 2... » , 3... »

Heating apparatus: Open fireplace, tile-stove, kitchen-range

Number of persons sleeping in the same room: No. 1..... No. 2..... No. 3.....

Noteworthy hygienic conditions: .....

Cigars..., cigarrettes..., pipes..., per day.

Snuff-chewing: Yes, No. Chewing-tobacco: Yes, No. Consumption of spirits: Yes, No.

Previous diseases worthy of note: .....

Tuberculosis in the family? .....

Subjective condition? ..... Are you equal to your work? .....

Any epigastric oppression and fullness? .....

Acid eructations? When? Before meals? After meals?

Vomiting? ..... Belching? .....

Constipation? ..... Craving for salt? .....

Diarrhaea? ..... Tape-worms? .....

General condition? Good, middling, bad.

Haemoglobin? Sahli (uncorrected) ..... (corrected) .....

Pregnancy? ... month. Recent child-birth? ... months ago.

Recent infectious disease?

Gastric analysis[4]: (On an empty stomach) / (Not on an empty stomach)

I. Lavage retention: Yes / No — Congo: Pos. / Neg. — Litmus: Pos. / Neg.

II. Test meal. Amount: ..... cc. Digestion: bad, moderate, good.

Mucus: 0, +, ++, +++. Congo: Pos. / Neg. — Litmus: Pos. / Neg.

III. Second lavage: — Congo: Pos. / Neg. — Litmus: Pos. / Neg.

Stools. Mucus: ..... Blood: ..... Ovules of worms: .....

Hess' test[5]

Other objective observations: .....

Heart: .....

Lungs: .....

Abdomen: .....

Other parts: .....

Other remarks: .....

The person examined sent for further examination to ..... hospital / cottage hospital / sanatorium

..... the / 1929.

.....

Medical Officer.

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[1] Not to be filled in. [2] The dwellings examined are numbered in each community. [3] Cross out questions not answered. [4] If the test is made without previous or following lavage, indicate this by crossing out the relevant heading. [5] If scurvy is suspected.

Annexe. 3.

Dietary Data.

Investigation No.[1] ... Diet group.[1] ... School investigation [2]
District »

Counties: *Västerbotten.* *Norrbotten.*

Name ..... Village ..... Dwelling ..... Desert region / Forest zone / Coastal zone

Is coffee taken regularly on an empty stomach? Yes. / No. How many cups a day? .....

Is tea taken as well / instead; how many cups a day? .....

Is cocoa taken as well / instead; made with water / milk; how many cups a day? .....

	Breakfast	Dinner	Supper	Remarks
The meals *normally* consist of[3]				
Bread, barley				
rye				
wheat				
fermented				
unfermented				
thick				
thin				
soft				
dry				
Milk, boiled, unboiled, skimmed, whole				
Sour milk with cream				
without cream ...				
Butter				
Margarine				
Cheese				
Porridge (what kind?)				
Gruel (what kind?)				
»Bryta» (bread and milk)				
Herring				
Other fish, fresh				
sour.....				
raw-pickled				
salted				
Pork, fresh				
salted				
Meat, fresh				
salted				
dried				
Blood-pudding with pork.....				
» » » potatoes ...				
Potatoes				
Dishes of fruit or juice, cooked				
» » » » » not cooked				
Pancake with jam.....				
» without »				
Vegetables (to be specified) ...				
In addition				

[1] Not to be filled in. [2] Cross out what is not applicable. [3] As regards foods not included in the daily diet, state how many times a week they are partaken of.

Investigation No:[1] ... *Annexe 4.*

A. To be filled in by the teacher.

Counties: *Västerbotten* / *Norrbotten* Child's age ..... years ..... months Boy / Girl

School situated in the parish of ....., desert region, forest zone, coastal zone.

1. Child's name ..... 2. Father's (or mother's) name and occupation .....
3. Number of rooms in the house, inclusive of the kitchen, inhabitated in winter ..... 4. How many persons live at home?...
5. How many persons sleep in the same room as the child?..... 5. a) in the same bed as the child? ...
6. Any tuberculosis in the family?[2] .....
7. Does the child take part in the household work? ..... 8. How long is the way to school?... .....
9. Does the child suffer from nervousness, repeatedly recurring headache, or periodical fever? .....
   9. a) Pain, burning or tension in epigastrium after meals? ..... 9. b) Vomiting? .....
   9. c) Constipation or diarrhoea? ..... 9. d) Has tape-worm been observed?... .....
10. Child's appetite? ..... Child's food.[3]

Special remarks: .....

.....
The teacher's name.

Investigation No:[1]...

B. Notes by the Medical Officer.

Kind of diet[1] ..... Haemoglobin ..... % Digestive disorders Yes / No Tape-worm Yes / No

Date of the examination .../... 1929.

1. Height ..... (without shoes, standing) 2. Weight ..... (nude)
3. State of nutrition, good, middling, bad.
4. Haemoglobin ..... %
5. Diseases found in the examination
   - Organs of circulation .....
   - Respiratory organs .....
   - Skin diseases.....
   - Enlarged lymphatic glands of the neck .....
   - Diseases of joints and bones (tuberculosis, rickets)
   - Phlyctaena or traces of it .....
   - Hess' test (positive, negative[4]) not performed

.....
Signature of medical Officer.

Additional remarks.

[1] Not to be filled in. [2] To be answered through the dispensary or by the examining medical officer. [3] To be recorded on a special card. [4] Only in cases suspected of scurvy at medical or dental examination.

CHAPTER III.

General observations on the housing and mode of life of the rural population of Upper Norrland

by

G. ANKARSWÄRD.

The following is a summary of the reports of the County Medical Officers from the following districts:

County of Västerbotten: Sorsele, Stensele, Tärna, Dorotea, Malåträsk, Lycksele, Norsjö, Bjurholm, Byske, Bureå, Umeå and Vindeln.[1]

County of Norrbotten: Arjeplog, Arvidsjaur, Öjebyn, Övertorneå, Vittangi and Gällivare.[1]

The medical officers who conducted the district and school examinations included in their reports also general observations regarding hygienic conditions. They had in fact received instructions to comment on housing conditions, personal hygiene and the care of infants. Separate reports were drawn up in regard to diet and matters connected therewith. The latter are dealt with by Dr Martin Odin (Part II).

It is only natural that reports submitted by no less than 15 medical officers should show considerable differences in treatment and scope. For financial and other reasons, a complete reproduction of these reports would be out of the question. But, as they contain much interesting and valuable information, I have attempted to compile a summary of them, despite the difficulties caused by the above indicated lack of homogeneity. This outline will, it is hoped, give the reader some idea of how the people live in the northernmost parts of Sweden.

[1] See map No 2. Chap. I.

Many of the observations made below are doubtless applicable also to other parts of Sweden, and most of the evils to which attention is drawn are found in the homes of the poor. That the rules of hygiene and cleanliness are apt to be neglected in such homes is, unfortunately, a common observation in most parts of the world. It is evident, however, that these evils are by no means always due to negligence and indifference. In many cases they must be attributed to lack of the necessary means, and to the fact that the poor, in their hard struggle for subsistence, have neither time nor energy to spare for carrying out desirable improvements. On the other hand, glaring violations of the rules of hygiene may be found even in more well-to-do homes, where the trying circumstances just alluded to cannot be pleaded in excuse.

Housing. It may be stated, in general terms, that the dwelling-houses erected during the last few years, as a rule, come up to a fairly high standard, especially those located in, or in the vicintity of, towns or municipal communities. On the other hand, many of the older dwelling-houses are very defective from a hygienic point of view. Broadly speaking, the dwelling-houses in the coastal area are better than those in the interior of the country, which is chiefly due to economic conditions.

In fact, the further inland we get, the worse is the housing accommodation. This is shown by the reports from the forest and mountainous regions. At Norsjö, for example, though very defective dwellings were observed only in exceptional cases, draughty houses were rather common. A similar remark may be made about Lycksele. At Stensele the dwellings were described as being, in general, in a bad condition. This applies also to the older dwelling-houses at Dorotea. At Tärna the housing standard is low as regards both the exterior and interior of the houses. They are built on a bad foundation, are put together in a primitive fashion without weather-boards, and have roofs of turf or shingles. At Sorsele too the dwellings are likewise remarkably mean, and in many cases very badly constructed. At Arjeplog the farm-houses are reported, generally speaking, to have a healthy location on dry slopes in the glens, or on islets, only a few being built on the heights. On the larger farms the buildings are generally satisfactory, whilst they increase in meanness according to the diminishing size of the farm. Unfortunately,

there are still many wretched dwellings, especially among the Lapps in the valleys. But, as small saw-mills have been erected in the vicinity of some of the villages, the supply of building timber has become more plentiful, with the result that the housing standard has considerably improved in recent years. Efforts are in fact being made in all quarters to secure better housing accommodation. At Övertorneå, according to the reports, the houses are usually well constructed and better fitted for winter habitation.

There are many complaints in the reports about the foundations of the houses. It is stated that the stone foundation and socles of the walls are, in many cases, more or less defective. As a rule the foundation is not of sufficient depth, the result of which is that the houses show a tendency to settle. At Arjeplog, it is reported, new houses are now often built on a stone foundation, which was formerly unusual. As a general rule, however, they are built on an earth embankment. The cavity under the flooring is filled with earth with the intention of preventing draughts. But, as the ground is very liable to thaw, resulting dislocations in the foundation may give rise to cracks which let in draughts.

The dwelling-houses in these parts are almost always built of timber, but are often devoid of weather-boards. In some cases the walls are made of so-called »*knubb*», that is remnants of boards from the sawmills, in other cases of ribs with fillings of sawdust. The outer walls are packed with oakum or, more commonly, with moss. At Jukkasjärvi and Gällivare (but not in the mining communities), where the buildings are often made of horizontally placed timbers, weather-boards are exceptional.

The inner walls are treated in various ways. At Byske, according to the reports, they are always papered, whilst the ceilings are covered with mill-boards. At Tärna the walls are sometimes painted, whilst at Sorsele they are usually hung simply with newspapers. At Jukkasjärvi and Gällivare wall-paper is likewise unusual, at any rate in the poorer homes. This, however, does not apply to the mining communities.

In certain districts the sound-boarding is of a very primitive character. Thus the lower boarding is usually filled with earth, less frequently with sawdust. The latter material or ant-hill stuff is used as filling for the upper boarding. The floors are often made of simple planks, which in many places are oil-painted. In certain districts the rough flooring is covered with rag carpets.

In spite of the severity of the climate, double windows are by no means universal in these parts, though they are coming more and more into use. But in many houses, for example at Arjeplog, they are fixed with hooks *outside* the ordinary windows, instead of being fitted from inside into the window-frame. In winter the windows are often nailed down or pasted with strips of paper round the edges. The window surface is usually large, so that they give sufficient light. Artificial light is largely electric, but there are extensive districts where paraffin lamps are still in use.

Formerly the rooms were warmed by open fireplaces, which were used also for cooking. They are now being replaced, in increasing measure, by iron stoves. In the kitchens of old houses an iron stove is often seen beside the open fireplace. Many of the living-rooms have no fireplaces at all, whilst others are warmed by open hearths. If a living-room without a fireplace is used also as a bedroom, it is warmed by leaving open the kitchen door. At Norsjö the cottages are warmed with small iron stoves, which in many places are provided with a bent pipe passing through the wall of an adjacent room. At Byske the kitchens are equipped with open fireplaces or iron stoves, and the other rooms with iron or porcelain stoves. Kitchens with iron stoves are naturally damper than, and not so well ventilated as, those with open fireplaces. At Arjeplog the chimney flue often leads straight into the open. In such cases the stove gives but little warmth after the stoking of the fire has ceased for the day. At Jukkasjärvi and Gällivare the kitchens are often equipped with an oven.

When rooms are warmed by open fireplaces scarcely any heat is accumulated. The rooms are warm and comfortable so long as the fire is kept burning, but begin to get cold as soon as it goes out. In this respect iron stoves are not much better. The observations made almost everywhere in this region in fact indicate that the warming arrangements are ill adapted to the severe climate. Thus it is reported from Tärna that the buckets of water in the kitchen often freeze in the small hours, when the outdoor temperatur falls below — 15 degrees centigrade. The unduly low indoor temperature is, of course, largely due also to the construction of the houses.

Although ventilators are exceptional and the windows usually pasted round the edges, the ventilation, as a general rule, is more than sufficient. In fact, through fissures in the walls, through the chimney, the damper of which is often left open, as well as

through single windows, which let in draughts, the air which comes in provides an excessive natural ventilation. In short, the dwellings are as a rule very draughty. This is indicated by the fact that during the coldest part of the winter these people are often as well wrapped up indoors as out of doors. The only difference is that woollen gloves and fur coats are removed. Head-gear is often retained indoors.

On small farms the dwelling usually consists of a kitchen, which is nearly always spacious, and one or two considerably smaller rooms. It is reported from Jukkasjärvi and Gällivare that entrance halls with porches are found only in the more modern houses. In several districts the entrance halls are said to be cold and badly constructed. Larders exist only in exceptional cases. At Arjeplog, Malåträsk and several other places a trap-door in the kitchen leads down into a cellar where potatoes and other provisions are stored. Otherwise the kitchen is used as a storeroom for provisions. Special closets for hanging clothes are quite exceptional. Outer garments are kept in a living-room or in the attic.

In the homes of the poorer classes the furniture is very plain. Close to the stove there is a chest for fuel, which is sometimes used as a carpenter's bench. Along one of the inner walls there is a cupboard or sideboard for porcelain etc. In front of one of the windows stands the dining-table with a drawer for the bread (Arjeplog). A washstand is sometimes found. Sofa beds are seen along the walls. The so-called »cupboard beds» (*skåpsäng*), which, being shut in, are most unhealthy, are nowadays rare. In many places, however, they are retained as a relic, though not used for sleeping purposes. In the living-room there is usually a chest-of-drawers. The furniture is generally made entirely of wood, and can thus easily be kept clean. Curtains are in common use. Even far up in the mountains, the houses are embellished with flowering plants.

The accommodation of the farm-house, even where it is spacious, is often badly utilized. Thus in the thickly populated districts of Vindeln and Umeå only the kitchen is used as a living-room. This mode of life is in fact characteristic of many places. As above indicated, the ordinary type of dwelling consists of a spacious kitchen and one or two smaller rooms. As a general rule, indoor work is carried on in the kitchen, which serves also as a bedroom. In some places, for example in the Jukkasjärvi

and Gällivare districts, one or both of the smaller rooms are used as a kind of pantry, where milk is stored.

It should be observed, however, that in regard to utilization of the accommodation a considerably improvement has taken place in recent years. Thus at Övertorneå people have begun to use other rooms than the kitchen as living-rooms.

Several of the medical officers were surprised to find that overcrowding was not so great as they had expected. Others, on the contrary, reported that overcrowding was very common. Thus one of them writes: »The number of persons that may be huddled together in a single kitchen is almost incredible». But, as the ventilation is usually sufficient, the air in these kitchens, as a rule, is not particularly foul.

Drinking-water. Here and there in the mountainous districts the practice of melting snow for the production of drinking-water still prevails. At Övertorneå snow is melted in the late winter, when the wells are liable to dry up. In the mountainous region drinking-water is often procured from lakes or rivers. Except during the spring flood, this water is usually quite fit for drinking and cooking purposes. Otherwise water is procured from artificial wells. As a general rule, they yield a plentiful supply of pure water. At Jukkasjärvi, Gällivare, Övertorneå, Dorotea, Bjurholm and Byske, however, it has been observed that the wells, in many cases, are too close to the cow-houses, so that the water is fouled by impurities emanating from the latter.

This seems to be the case with most of the farm wells, at any rate in Norrbotten. In many places, however, there are two wells, one for the cow-house and the other for household purposes. The wells are usually well covered and provided with high curbs.

At Byske, Stensele and Dorotea water is procured also from natural springs, which yield an abundant supply. Apart from those farms where water for household purposes is taken from wells close to cow-houses, it may be stated, broadly speaking, that the population of this area are well supplied with serviceable water. On the other hand, it should be noted that at Dorotea and several other places the insanitary practice of washing clothes at the wells still apparently prevails.

Personal hygiene. In regard to personal hygiene the conditions vary greatly in different places and homes. Whilst in most parts it is gradually improving, many more or less serious abuses have been observed in certain districts. At night, for example, people

huddle together in the kitchen for the sake of the warmth, and in many families several persons sleep in the same bed. Special night apparel is quite exceptional. The bedclothes in many homes are of the most primitive kind; in one district there are households where they consist solely of one or two rag quilts. As a rule, people sleep in their underclothes, and rather frequently under skin rugs or blankets without sheets, which in many places are still regarded as a luxury.

In poor homes it is not usual for underclothes to be changed weekly. Sometimes they are actually worn for months before being washed. Daily ablutions are often neglected. There are large areas where the people are very careless about their teeth.

In regard to baths the hygienic standard is high in the Torneå valley, where every farm or croft is equipped with a vapour bath, which is used at least once a week. At Arjeplog kitchens or bake-houses serve also as bathrooms. In most of the districts, however, there are practically no facilities for baths in winter. At some places, such as Tärna, the people rarely take a bath. It is in fact difficult to induce the older generation in these parts to take baths at all. On the other hand, it should be noted that baths are nowadays installed in, or in the vicinity of, the elementary schools. The rising generation, having thus got accustomed at school to taking baths, will presumably insist on keeping up the practice. It may therefore be expected that, in course of time, public baths of a simple type will be installed in one village after another.

The medical officers report that scabies, which had formerly been of common occurrence, has shown a marked decrease in recent years. Bed-bugs are rather frequent. Head-lice were formerly common, but the fashion of cutting the hair short has greatly conduced to diminishing the frequency of that pest. Body-lice are encountered among the most needy poor. Crab-lice and fleas have not been observed, at any rate in the mountainous districts.

Clothing. The following description is based on reports from Arjeplog, Jukkasjärvi and Gällivare.

At Arjeplog domestic industry is of considerable importance. The ancient practice of carding and spinning wool in the homes is still largely kept up. The women spend much time in weaving. Thus the fine homespun cloth named *vadmal,* which is used as a material for men's clothes, as well as a strong, coarse calico for women's dresses and for underclothes, is woven in the homes. The people, as a rule, understand and appreciate the value of these

home-made materials. Though knitting-machines are gradually coming into use, stockings and woollen vests are often knitted by hand. Most of the people wear home-made boots, namely in summer coarse laced top-boots,[1] in winter Laplander's boots of reindeer skin with the hair left on the outer side. The boots are lined with long, dry grass, which serves as a protection against cold in winter and moisture in summer. Sometimes dried grass is used in place of stockings. Men's and women's boots are similar in type.

In summer the men wear a soft hat or cap, a coarse shirt, pants, the above-mentioned boots, stockings (or simply dried grass in the top-boots), trousers of coarse calico or homespun kept up by a belt (rarely by braces), and a coarse workman's blouse of calico. In winter they wear a sheepskin cap, several shirts, two pairs of pants, dried grass in their top-boots with or without woollen stockings, one or two pairs of homespun trousers, a woollen vest, a coat and waistcoat of homespun, and, on very cold days or when driving, a sheepskin fur. The lower ends of the trousers are inserted in the top-boots, which are tightened round them by broad woollen laces. When engaged in timber-floating or other »wet work», the men wear thin skin gaiters, reaching up over the knee. Similar gaiters with the hair left on the outside are worn on cold winter days. Out of doors, in winter, the people wear thick home-made woollen mittens, covered by coarse leather gloves.

Apart from the foot-gear and the homespun cloths, the women's dress in this part of Sweden is not particularly distinctive.

The people, generally speaking, are well and warmly clothed. Unfortunately, however, the poorer section of the population are showing a tendency to buy cheap and inferior clothing in shops.

The children, broadly speaking, are dressed like their elders: the boys wear long trousers, and many of the small girls have long skirts.

At Jukkasjärvi and Gällivare the people are dressed much in the same style as in other country districts in Sweden. The men's underclothes consist of a shirt (sometimes two), worn next to the skin, one or more vests on top of it, and one or more pairs of pants. Their outer garments are a coat, waistcoat, and trousers. Their foot-gear consists of home-knitted woollen stockings and, as a rule, top-boots lined with dried grass: the latter are worn

[1] Called *pjäxor*.

especially by the older generation. The women wear a chemise, one or more vests on top of it, and a short blouse. As a general rule they wear drawers, but there are a good many exceptions, especially among the elder women. Outside their under-garments they wear one or more petticoats and a skirt. The stockings are held up by garters below the knee. Their foot-gear is similar to that of the men.

General state of health. Most of the medical officers report that the general state of health in the two counties is, broadly speaking, satisfactory, especially in view of the extremely indigent circumstances in which the majority of the population live. At Dorotea the general state of health of the population is stated to be somewhat less satisfactory than in regions with a milder climate.

The above observations, however, apply mainly to the male population: the women's health in many parts is far from satisfactory. Wives who have become mothers at an early age, who have borne children year after year, and whose energies are heavily taxed by the management of the home and the farm, are liable to become prematurely worn out. Among such women nervous disorders, anaemia, etc., are very frequent (Sorsele). Discreet enquiries have elicited the truth that in many families the men and children get the lions' share of the scanty supply of food. As the wives have to content themselves with what is left, it is small wonder that they are emaciated. In one of the districts in the interior of Västerbotten a good many cases of under-nutrition, absolute or relative, were observed.

As gastro-intestinal disorders are dealt with in special reports on diet, most of the medical officers have not recorded them in their general observations. This subjected is treated by Dr Odin in Part II. It may, however, be mentioned here that these disorders are very frequent at Sorsele and several other places. At Lycksele the medical officer found scarcely a single family where no one complained of stomach trouble. A good many cases of gastro-intestinal disorders were observed at Norsjö, and such disorders were found to be common also at Byske and Övertorneå.

Tape-worms are of frequent occurrence among the population of Jukkasjärvi, Gällivare, Övertorneå and Arjeplog — as regards the last-mentioned district in about 40 per cent of the population. Apart from a few latent cases at Arjeplog, scurvy is not

reported. Among children sequelae of rickets are frequent (Sorsele).

Physical constitution. The reports on this subject are, generally speaking, somewhat meagre. The population of the mountainous districts and the Torneå valley are short of stature, which is believed to be due to intermixture with the Lapps. According to the reports from some districts, the Lapps in the forest region, at any rate the younger generation, are physically defective, whereas the physique of the Swedish population does not seem to have been much impaired by intermixture with the other races. At Tärna the people are of remarkably spare build, which is presumably due to certain biological factors and inter-marriage with the Lapps. The inhabitants of the Arjeplog district are, as a rule, tall, powerfully built, wiry and hardy. In certain Lapp families, and in some villages where there has been much inter-marriage, numerous cases of psychosis and imbecility have, however, been observed. In many places in the Vindeln and Umeå districts, where there has likewise been much inter-marriage, the number of imbecile school children is reported to be remarkably large. Generally speaking, the severe struggle for life has set its mark on the inhabitants. In most other districts the people, according to the reports, have a good physique: the inhabitants of Lycksele are, generally speaking, a very fine race; and the forest labourers, especially in the Vindeln district, have athletic frames.

Care of infants. According to statistics for 1928, the infant mortality in Norrbotten is twice as large as the percentage for the whole of Sweden, and in certain districts, such as Tärna and Jukkasjärvi, actually treble. The population of these regions have from older times been accustomed to a high infant mortality, and in many places it is still considered perfectly natural that a large number of new-born babes should succumb.

At Dorotea bottle-feeding is comparatively rare, severer forms of rickets are unusual, and the care of infants has shown considerable improvement in recent years.

The reports from other districts give quite a different picture: they concur in stating that the care of infants is most unsatisfactory.

Whereas in former days babes were usually breast-fed, artificial feeding is now becoming the rule. In some places, however, breast-feeding is continued far too long, up to the age of three, partly because it is less trouble to suckle the infant than to prepare

its special food, partly because breast-feeding is supposed to have a contra-conceptive effect. The mother's milk is seldom replaced by suitable milk-mixtures: the infants are often given undiluted cow's milk. It is only in exceptional cases that cow's milk is mixed with a decoction of oats, and sugar is usually added according to fancy. Ordinary beer-bottles or the like are often used for feeding. Though rubber teats are now becoming more common, teats made of leather are also used (Arjeplog). The cleaning of bottles and teats is almost everywhere unsatisfactory. A little milk is often left in the bottle: it turns sour and vitiates the fresh milk afterwards poured in. The use of a »soother», that is, a rubber teat passed over a little piece of wood and fastened to a piece of string, is very common. It is seldom kept properly clean. In some places the mother or some relative moistens it with spittle before giving it to the child.

Fruit and vegetables do not form part of the country people's diet. Babes are weaned too suddenly: all at once the infant is given the same food as the adult members of the family. At Malåträsk the diet during the period immediately succeeding the abandonment of breast-feeding, when the child should be given mixed food, is reported to be particularly unsatisfactory. The foods is, in fact, but little varied: it consists, as a rule, mainly of milk and porridge. For the overworked mother this is the easiest food to prepare, and it can be taken by the little children without spoon-feeding. At Öjebyn it is common for cod-liver oil to be given to babes.

There are no regular meal-times for infants: they are fed when they begin to cry, whether by day or by night. Infants, as a rule, are badly provided for in regard to clothing: a complete outfit is quite exceptional. In the poorest homes the children are wrapped in rags, which are washed from time to time.

In the Öjebyn district babies are swathed in many layers of diapers, and are covered with too many blankets and quilts. It is not uncommon to see infants who are so warmly wrapped up that they sweat profusely in their cots.

The mothers are constantly in fear that their babies will catch cold. They are tended in front of a burning fire. As they are not bath'd often enough, dirty babies are by no means an uncommon sight.

In the infant stage children are kept indoors. This is chiefly because the mothers have so many other duties that they have

no time to take their babies out into the fresh air. An additional reason in some cases is the lack of suitable outdoor clothing.

The mothers, as a rule, do not realize how important it is that the babies should have regular sleep.

The above observations must not be taken to imply that the mothers are careless and indifferent. On the contrary, they show much tenderness in looking after their babies, often far too much. In short, the infants are regularly coddled. In some families they are carried and rocked in their cradles until they reach the age of three. This mode of upbringing naturally makes the children peevish and exacting, besides wearing out the mother.

Rickets, over-feeding and anemia are frequent, though these conditions do not often assume very serious forms.

As soon as children have reached the »frock-age», they are practically left to their own devices. They are allowed to live, generally speaking, much in the same way as their elders: they are given the same food and allowed to eat anything they like, and as much as they like. The mother's attention is often engrossed by the care of other children.

Children are expected at an early age to assist in the household work. They carry firewood, fetch water, help in washing-up, and make themselves generally useful. In the mountainous districts of Västerbotten children of seven or eight are sent to tend goats and cows in the summer, and are then left to themselves the whole day long.

Division of work among men and women. Almost all the medical officers report that the women work too hard, having, in fact, to perform men's jobs.

In order to understand why the women are so over-burdened, the following facts should be noted. In these northerly regions small holders cannot exist by agriculture alone. This is owing to the scanty yield of the soil, and the difficulty of marketing the produce. Hence the men have to eke out their earnings by work in the timber industry, in road-making, etc. The men are thus away from their homes for months, being engaged on timber-floating in the spring, on road works in the autumn, and on timber-cutting in winter. Also during the hay-harvest or when fishing the men are away from home for periods of a week or more at a time.

Owing to these circumstances, and as these small holders can rarely afford to hire a farm hand, the women are obliged to devote all the time and energy they can spare to carrying on the

farm work. They have thus been compelled by force of circumstances not only to perform a housewife's normal work, but also to tend the cattle, till the soil, fetch water, hew firewood, and sometimes even to attend to the fishing or to trap game. The housewife is the first to rise and the last to retire for the night.

Thus, with certain exceptions (ploughing, draining, carpentry, etc.) the women do practically all the household and farm work. The whole family, however, usually take part in hay-making and the setting of potatoes. The poorer the home, the more man's work do the women have to perform.

This division of work is not confined to Norrland. Also in other parts of the country the wives of crofters, cottars and small holders often have to perform men's work in order to make ends meet. It seems, however, that the time and strength of the women are more heavily taxed in Upper Norrland than in more southerly parts of the country.

The women, being inured to this struggle for existence, carry on their hard work without demur. It stands to reason, however, that their health suffers. In fact, they age rapidly, despite their exuberant vitality.

In addition to poverty, ancient, deep-rooted traditions, which encourage the maintenance of habits and customs inimical to health, greatly contribute to the above described abuses and violations of the rules of hygiene. But, in view of the rapid extension of communications and improvements in school education, there is good reason to expect that the progress which has been made during the last twenty or thirty years in the field of hygiene will, in course of time, be turned to account by a population which, owing to the rigours of the climate and the geographical conditions, are living under a greater strain than the majority of the inhabitants of this country.

CHAPTER IV.

Report on the examination of healthy school children

by

JOHN BYTTNER.

Introduction.

The data given in the following report relate solely to *healthy* school children from those parts of Norrbotten and Västerbotten in which our general investigation was carried out, as well as from the province of Skåne, in the south of Sweden, where control examinations were subsequently conducted. With a view to the greatest possible scientific exactitude, the material has been carefully sifted. This will explain some apparent discrepancies in the figures in certain parts of this report. In order to avoid tiresome repetition, reference has been made, as far as possible, to other Parts for information regarding material, methods and technique, etc. For the sake of coherence and clearness, however, it has been necessary to mention certain facts, and to include certain tables, which will be found also elsewhere in this work.

The results reported below are based on the records kept for every school child examined, in accordance with the forms reproduced in Chapter II of this Part. In addition to particulars necessary for the identification of each child and information concerning the general standard of, and the hygienic conditions in, its home, these records also give details regarding the child's diet, in accordance with the rules adopted for the investigation material in general. They show, for example, how many times a week certain foods or dishes have been included in the child's dietary, and the number of cups of coffee consumed per day.

The medical data based on anamnesis, and collected by the teachers, comprise answers to questions regarding hereditary tuberculosis, the occurrence of nervous symptoms, headaches and

periodical fever, gastro-intestinal symptoms, indications of tapeworms, and finally the child's appetite.

The examination made by the medical officers included the following particulars: the height of the child (without shoes), its weight (nude), its state of nutrition, the hemoglobin percentage determined by Sahli's method, the existence of gastrointestinal disorders, nervous symptoms, headache, skin lesions, enlargement of the lymphatic glands, joint and bone diseases, diseases of the eye, and any indications of scurvy.

The following report deals primarily with the blood examination and related matters of special interest.

Blood Examinations.

In a study of anaemic conditions in the northermost parts of Sweden, published in 1933,[1] WERDINIUS states, as being a generally recognized fact, that the blood picture undergoes certain changes in the course of the individual's development. NYLIN, in a previously published study of the blood picture in children,[2] found a medium hemoglobin percentage of 89 in children between the ages of five and six, and of 91 in children of school age. The medium hemoglobin percentage of children aged 1 to 6 examined *in Norrland* is shown in a tabular summary compiled by WERDINIUS, who was on the medical staff of Umeå hospital. His figures are as follows:

Table 1.

	Age (in years)						
	0	1	2	3	4	5	6 years
Boys: number	14	56	55	47	49	62	36
M % Hb.	69.7	65.5	70.7	72.3	73.3	76.6	75.9
Girls: Number	10	29	43	55	39	55	43
M % Hb.	73.0	66.7	69.4	73.4	75.0	74.5	77.5

It will be seen from these figures that the hemoglobin percentage *falls* during infancy as regards both boys and girls, and then

[1] WERDINIUS: Studien über die in nordlichsten Schweden gewöhnlichen Anemizustände. Gleerupska Universitetsbokhandeln, Lund, 1933.

[2] Acta Medica Scandinavica, Supplement XXXI, 1929.

rises from the age of one year, at first rapidly, then more slowly, up to the age of six.

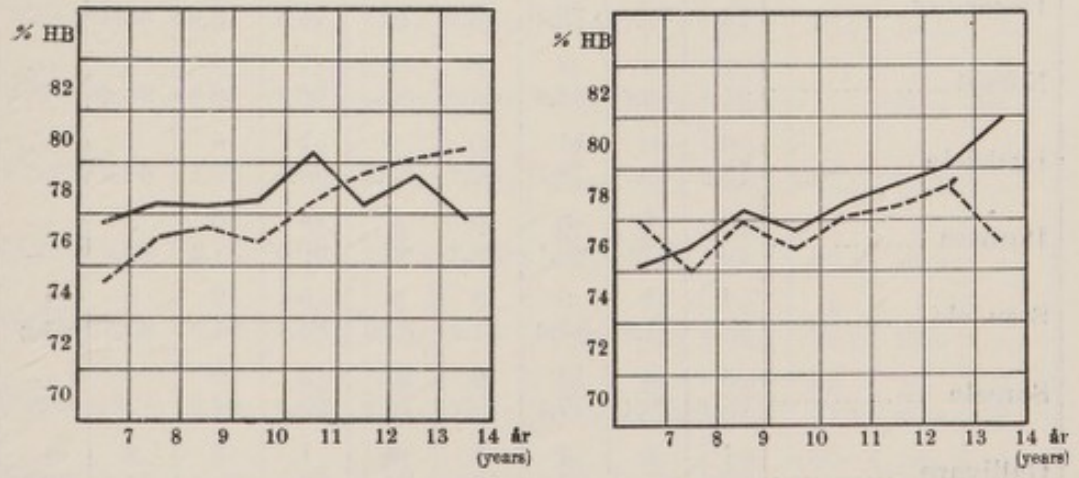
The following tabular summary of the average hemoglobin percentage (M% Hb.) in children of school age indicates that the percentage rises slowly and steadily in the case of girls, whereas the boys show a rather marked increase after the age of 14.

Table 2.

	Age								
	7	8	9	10	11	12	13	14	15 years
Boys: Number	211	288	318	301	232	247	215	85	19
M % Hb.	76.5	76.8	77.1	77.6	78.7	79.1	81.0	79.7	82.6
Girls: Number	204	285	268	299	213	269	228	122	15
M % Hb.	76.8	76.1	76.8	77.1	78.7	78.8	80.0	80.3	79.5

The following graphs illustrate the results obtained in 1931. They agree, broadly speaking, with the above figures, which are for the year 1929. Both investigations thus yielded the same general result: *the hemoglobin percentage increases with the age of school children.*

Diagram 1.



Boys 1931. Girls 1931.

——— Norrland. - - - - - - Skåne.

The results obtained in the control examinations in Skåne agree in essentials with the figures from Norrland.

With a view to studying variations in the hemoglobin percentage in school children of different ages, the figures have been

arranged according to the districts under investigation, and separately for boys and girls. The results are given in the following tables. They show the number of children examined in each age

Table 3. Figures for 1929. Boys.

District	Age								
	7	8	9	10	11	12	13	14	15 years
Umeå elementary school									
Number	53	32	54	38	5	20	25	4	—
M % Hb.	75.1	74.5	74.2	72.8	72.3	75.1	75.1	76.1	—
Umeå Training College	5	5	3	2	—	2	1	1	—
	78.1	81.1	71.1	83.6	—	78.6	81.1	76.1	—
Sävar and Bygdeå	3	5	10	10	10	11	11	—	—
	69.1	72.4	74.9	78.4	78.9	72.4	76.9	—	—
Bureå	11	20	15	23	9	6	7	—	—
	72.1	71.8	71.5	75.9	77.0	75.6	84.1	—	—
Byske	3	7	2	9	4	3	8	2	—
	62.0	74.3	86.6	70.4	73.6	79.2	76.6	72.5	—
Kalix	30	39	35	52	45	54	26	10	2
	72.8	71.6	75.2	72.9	76.2	77.2	79.0	73.5	79.0
Bjurholm	2	7	6	6	7	9	5	—	—
	63.0	73.0	68.8	68.8	72.3	71.3	87.0	—	—
Degerfors	7	4	14	5	8	6	6	3	—
	73.1	72.7	73.4	73.2	78.5	78.5	76.9	80.2	—
Norsjö.....	1	10	7	8	9	17	4	3	—
	81.6	88.6	81.6	83.0	83.4	86.6	88.3	90.5	—
Lycksele.....	6	10	11	10	9	7	8	1	—
	75.2	80.7	78.4	80.2	83.5	83.1	82.1	80.2	—
Dorotea	3	4	8	5	7	4	10	3	—
	75.5	82.5	83.1	88.2	86.9	90.0	87.2	82.9	—
Stensele	4	4	9	8	7	5	2	4	1
	83.5	77.3	81.6	81.6	81.0	85.0	81.0	83.5	81.0
Sorsele	3	8	12	6	13	9	9	—	—
	75.4	70.4	77.1	78.7	74.2	80.4	81.0	—	—
Gällivare	4	4	4	3	3	1	3	2	1
	63.9	66.4	67.7	73.9	72.2	68.9	75.6	76.4	73.9
Jukkasjärvi	51	71	48	41	24	9	44	34	10
	81.0	80.9	79.0	81.0	77.9	78.3	84.0	84.5	87.5
Tärna	6	7	11	11	8	13	11	8	4
	83.1	88.9	92.1	88.4	90.2	93.5	91.6	92.0	93.9
Löberöd	5	7	7	5	2	4	4	—	—
	70.3	67.0	77.0	87.3	78.8	87.6	87.6	—	—

Table 4. Figures for 1929. Girls.

District	Age								
	7	8	9	10	11	12	13	14	15 years
Umeå elementary schools									
Number	41	25	22	23	11	16	23	7	1
M % Hb.	72.9	70.1	72.5	71.2	72.8	76.4	76.4	77.3	72.3
Umeå Training College	4	4	—	5	1	3	7	—	—
	73.6	72.4	—	77.1	77.1	67.8	75.4	—	—
Sävar and Bygdeå	1	3	10	6	5	2	3	1	—
	52.4	72.4	73.4	69.1	72.4	84.9	69.1	67.4	—
Bureå	8	10	10	22	10	13	5	2	—
	71.1	74.8	75.3	76.4	76.8	77.9	78.8	59.8	—
Byske	2	14	1	11	6	6	11	4	—
	54.6	68.3	64.6	72.2	66.6	78.0	77.7	69.6	—
Kalix	18	54	49	55	40	58	35	10	—
	74.6	74.6	71.7	72.1	77.4	74.8	73.5	73.5	—
Bjurholm	2	5	5	6	5	5	2	—	—
	73.0	69.0	83.0	68.8	78.0	72.0	75.5	—	—
Degerfors	7	5	5	3	4	5	3	—	—
	70.9	78.2	74.2	75.2	72.7	72.2	66.9	—	—
Norsjö.....	7	9	7	10	5	7	3	3	—
	84.4	79.3	83.1	87.5	89.1	86.2	94.1	81.6	—
Lycksele...	7	11	9	16	11	14	8	3	—
	79.5	77.0	76.9	78.0	80.2	81.3	82.7	88.5	—
Dorotea	2	2	5	4	5	7	—	6	2
	91.2	81.2	78.2	82.5	84.2	83.3	—	85.4	91.2
Stensele	4	5	5	7	6	2	2	4	—
	82.3	80.0	81.0	79.6	84.3	83.5	83.5	83.5	—
Sorsele	5	5	12	12	12	4	3	5	—
	78.4	72.4	73.7	82.1	76.7	85.4	80.4	82.4	—
Gällivare	3	4	—	5	4	4	4	1	—
	70.6	67.7	—	72.9	71.4	72.7	72.7	68.9	—
Jukkasjärvi	55	61	57	45	11	14	66	52	7
	81.6	79.6	81.1	80.9	76.6	77.1	84.7	85.6	83.2
Tärna	1	10	11	8	10	13	10	8	2
	93.9	88.4	87.5	87.0	92.4	90.8	90.9	92.0	91.4
Löberöd	—	5	6	3	4	3	4	—	—
	—	72.3	81.3	81.3	82.6	86.3	88.8	—	—

group, and the average hemoglobin percentage (M % Hb.) after correcting the so-called »personal error». In regard to the latter the reader is referred to Odin's report on methods, etc. (Part II),

and to the above-mentioned study by WERDINIUS. The figures for 1929 and for 1931 have been given separately.

The figures for 1929 are illustrated in the following twelve graphs. The dotted line indicates the variations at different ages in relation to the general mean (the unbroken line). It will be seen that the curves show considerable divergences between different districts.

All the curves, however, show an increase of the medium hemoglobin percentage as the children's age increases. The curves for Umeå and Jukkasjärvi (especially the latter) show a falling tendency till the age of twelve, and afterwards rise, so that, in spite of the previous fall, they are considerably higher for the age of fourteen than for that of seven.

Whatever may be the explanation of such discrepancies, — a question which must be left open here — these graphs show that *the children of the interior have, on an average, a higher hemoglobin percentage than those of the coastal zone.* This result is in perfect agreement with the observations made in regard to adults.

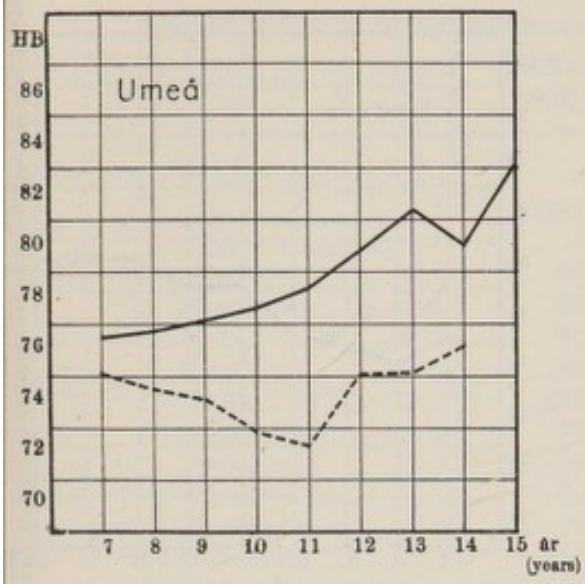
In order to reckon the medium hemoglobin percentage, for the total number of, say, eight-year-olds examined, it would be strictly necessary to take exactly the same number of children of that age in all the districts. But, as certain age groups are not represented at all in some of the districts, it has not been possible to make such a selection. The following procedure has been adopted, instead. The medium hemoglobin percentage for all the children examined in each separate district has first been calculated irrespective of age, in accordance with the formula:

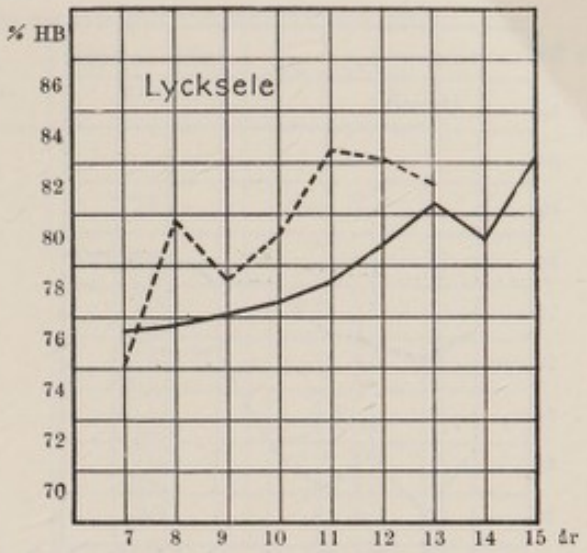
$$\text{M \% total.} = \frac{N_7 \times M_7 + N_8 \times M_8 + N_9 \times M_9 \text{ etc.}}{N_7 + N_8 + N_9 \text{ etc.}}$$

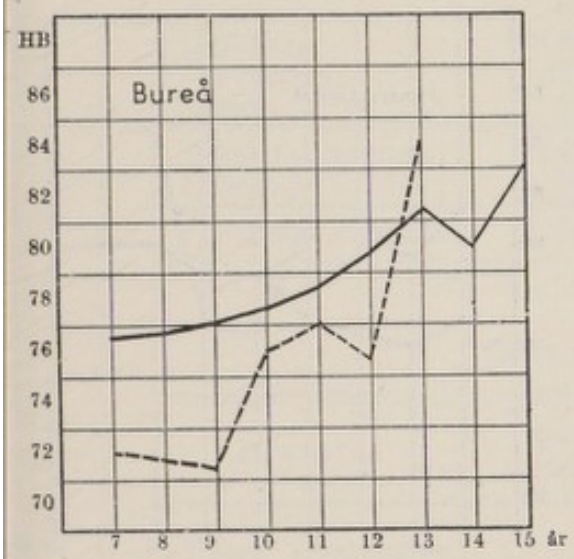
where N_7 signifies the number of seven-year-olds examined, N_8 the number of eight-year-olds, and so forth, M_7 the medium hemoglobin percentage in seven-year olds, M_8 that percentage in eight-year-olds, and so forth, in the several districts. Out of the total medium percentage thus calculated a »general medium» (G.M.) is then obtained for the total number of boys examined, in accordance with the same principle:

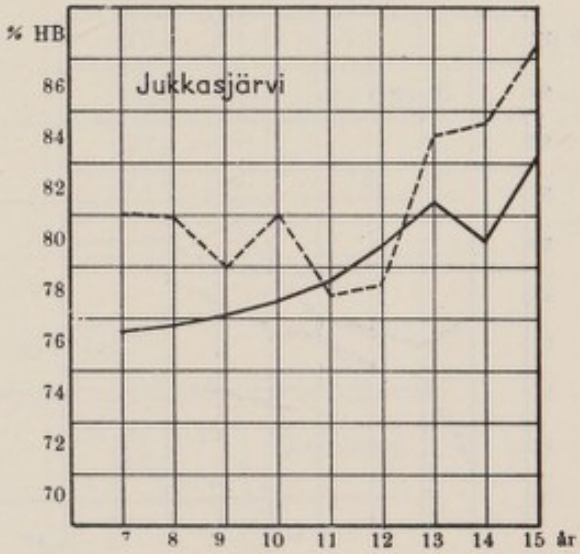
$$\text{G. M.} = \frac{(N_{\text{total Umeå}} \times M_{\text{\% total Umeå}}) + (N_{\text{total Bureå}} \times M_{\text{\% total Bureå}})}{N_{\text{total Umeå}} + N_{\text{total Bureå}}}$$

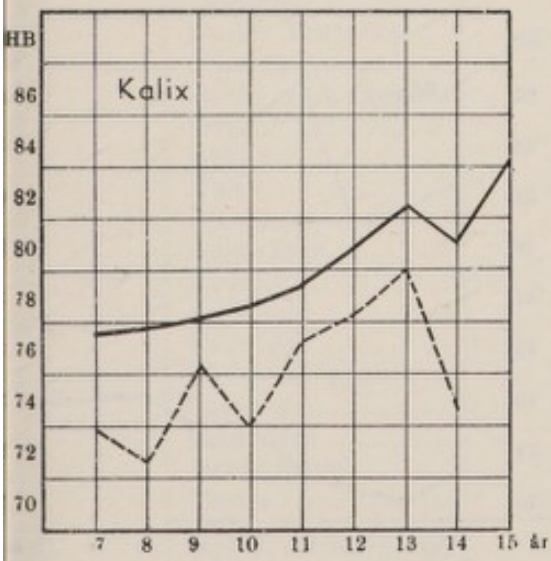
Diagram 2.


HB
Umeå
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år
(years)


% HB
Lycksele
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


HB
Bureå
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Jukkasjärvi
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


HB
Kalix
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år

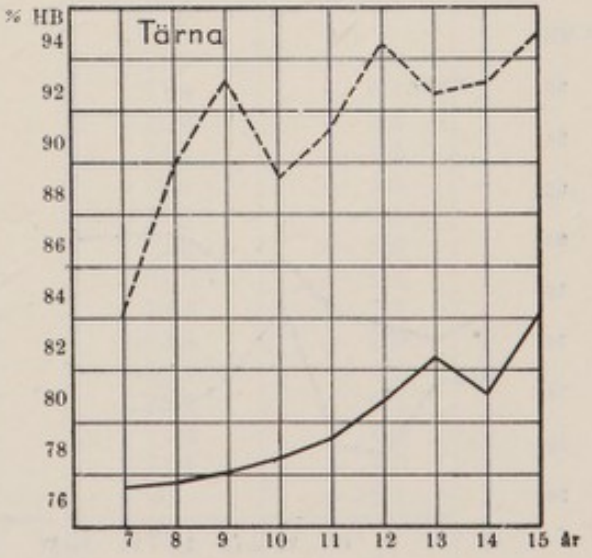
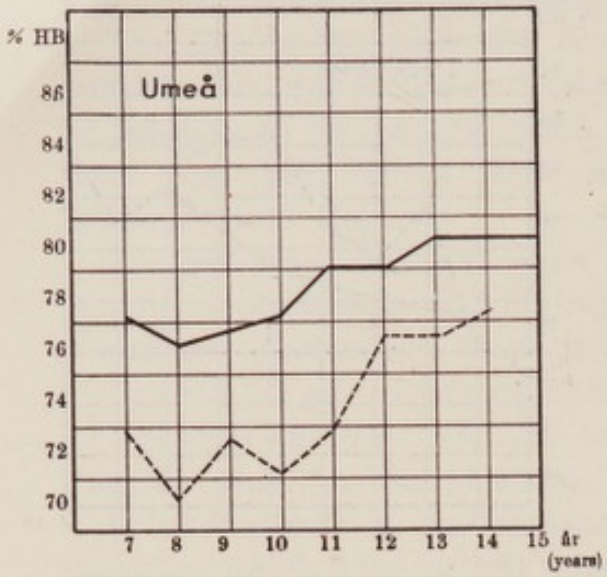
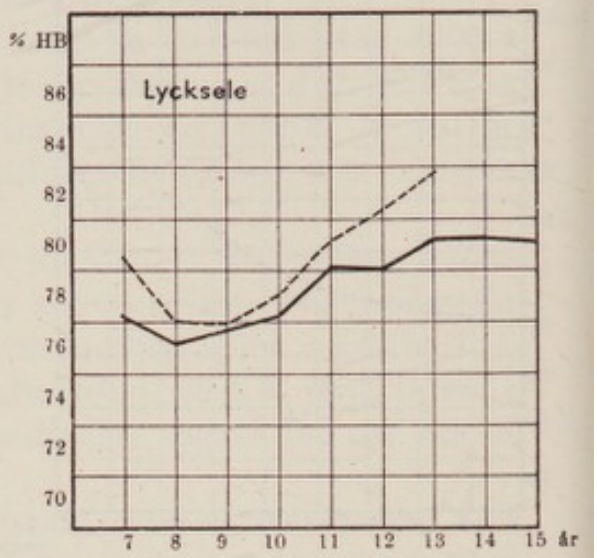
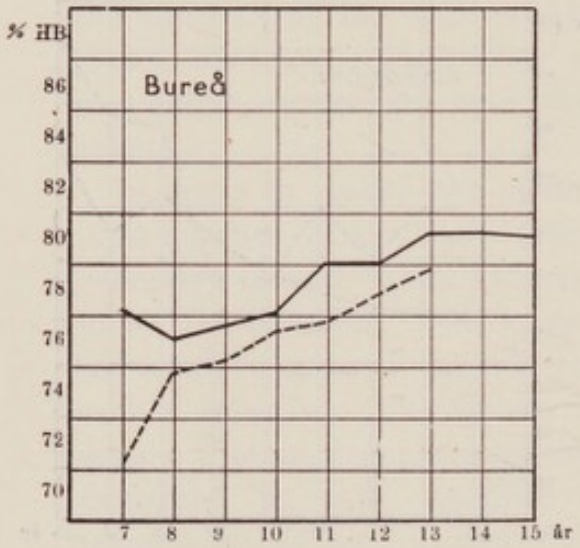
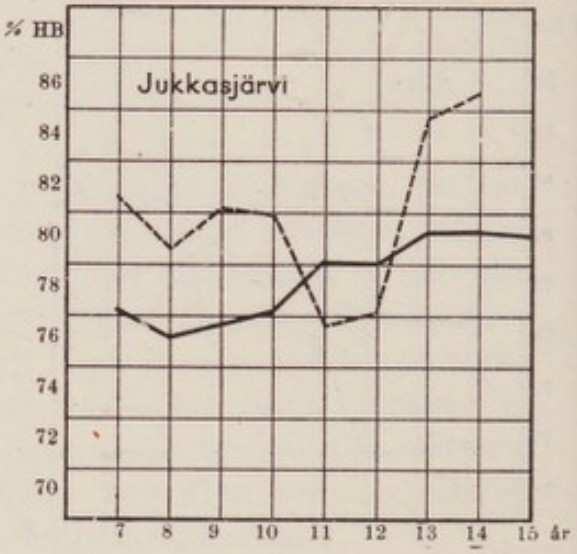

% HB
Tärna
94
92
90
88
86
84
82
80
78
76
7 8 9 10 11 12 13 14 15 år

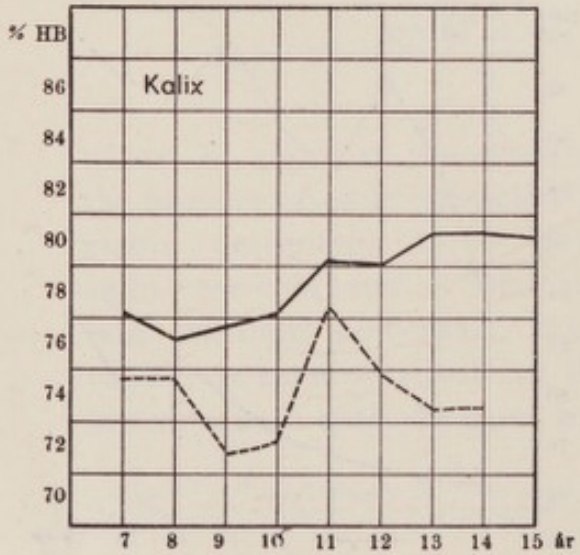
Diagram 3.


% HB
Umeå
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år
(years)


% HB
Lycksele
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Bureå
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Jukkasjärvi
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Kalix
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år

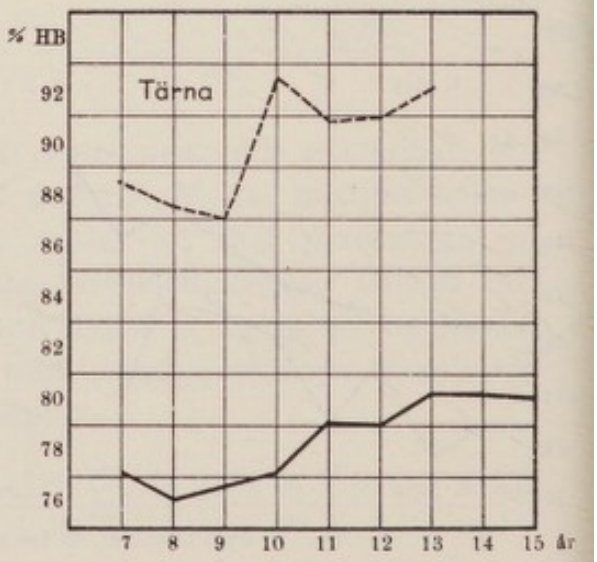

% HB
Tärna
92
90
88
86
84
82
80
78
76
7 8 9 10 11 12 13 14 15 år

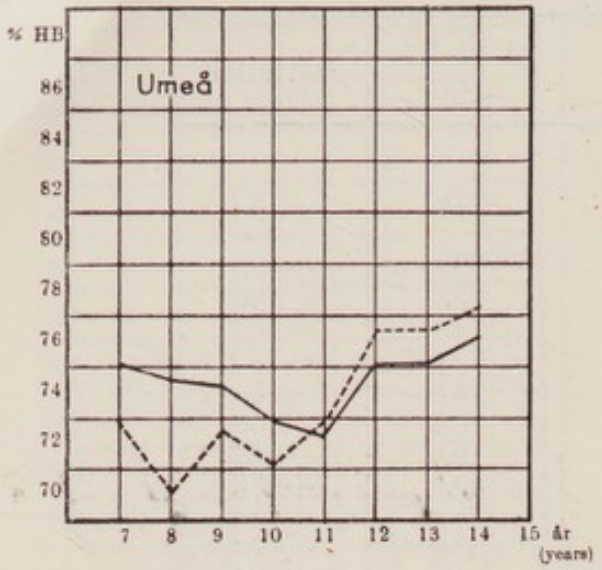
Table 5. Boys.

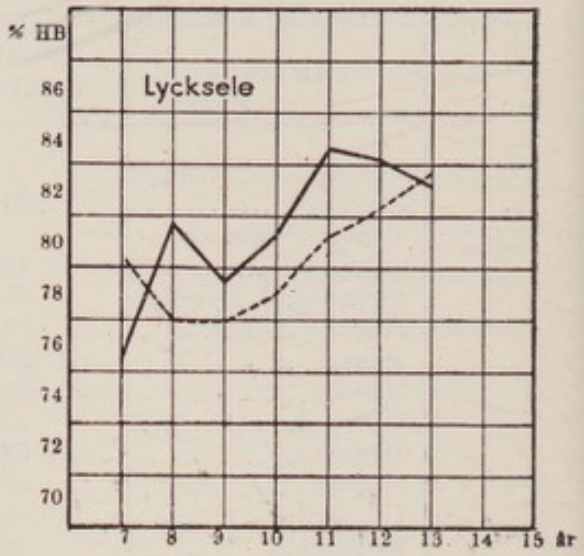
District	Total number	M % Hb total	Deviation
Umeå elementary schools	231	74.4	— 3.4
Umeå Training College	16	79.9	+ 2.1
Sävar and Bygdeå	60	75.7	— 2.1
Bureå	91	74.5	— 3.3
Byske	39	73.6	— 4.2
Kalix	299	74.8	— 3
Bjurholm	42	72.5	— 5.3
Degerfors	54	75.3	— 2.5
Norsjö	60	85.5	+ 7.7
Lycksele	62	80.4	+ 2.6
Dorotea	48	85.3	+ 7.5
Stensele	46	81.5	+ 3.7
Sorsele	60	76.7	— 1.1
Gällivare	25	70.1	— 7.7
Jukkasjärvi	332	81.3	+ 3.5
Tärna	80	90.8	+13
Total in Norrland	1.545	77.8	
Löberöd	34	77.5	— 0.3
Total material	1.579	77.8	

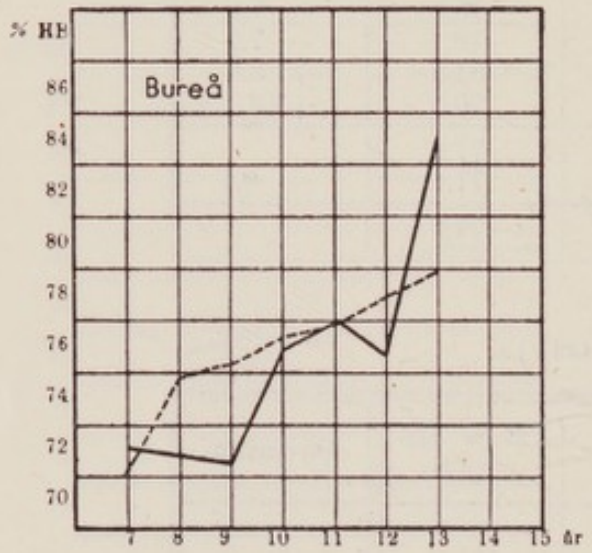
Table 6. Girls.

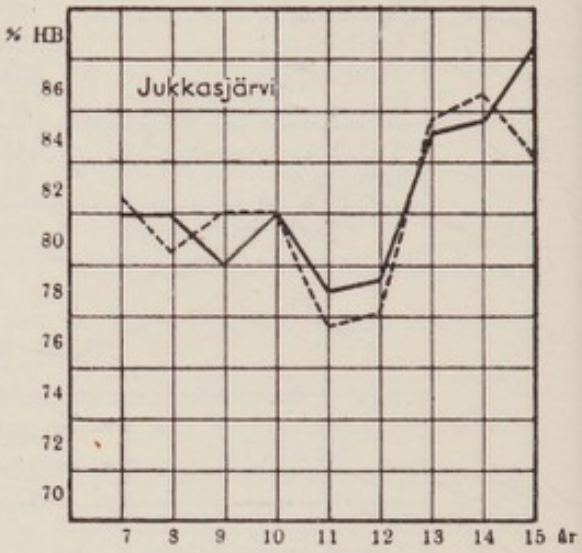
District	Total number	M % Hb total	Deviation
Umeå elementary school	169	73.2	— 4.7
Umeå Training College	27	73.7	— 4.2
Sävar and Bygdeå	31	71.8	— 6.1
Bureå	80	75.6	— 2.3
Byske	55	71.4	— 6.5
Kalix	323	73.9	— 4.0
Bjurholm	28	73.4	— 4.5
Degerfors	32	73.0	— 4.9
Norsjö	52	84.5	+ 6.6
Lycksele	80	79.6	+ 1.7
Dorotea	33	83.8	+ 5.9
Stensele	35	82.1	+ 4.2
Sorsele	59	78.3	+ 0.4
Gällivare	25	71.3	— 6.6
Jukkasjärvi	372	81.9	+ 4.0
Tärna	73	90	+12.1
Total in Norrland	1.474	77.8	
Löberöd	25	81.5	+ 3.6
Total material	1.499	77.9	

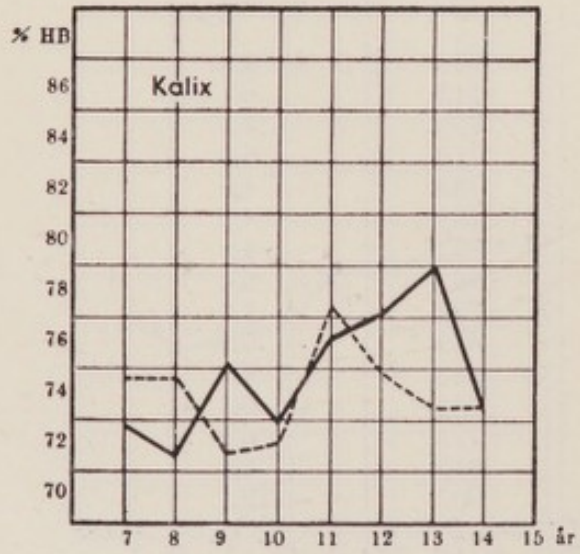
Diagram 4.

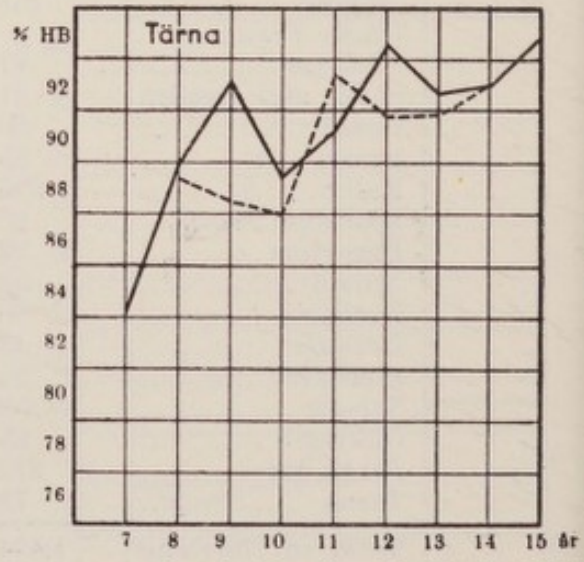

% HB
Umeå
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år
(years)


% HB
Lycksele
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Bureå
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Jukkasjärvi
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år


% HB
Kalix
86
84
82
80
78
76
74
72
70
7 8 9 10 11 12 13 14 15 år

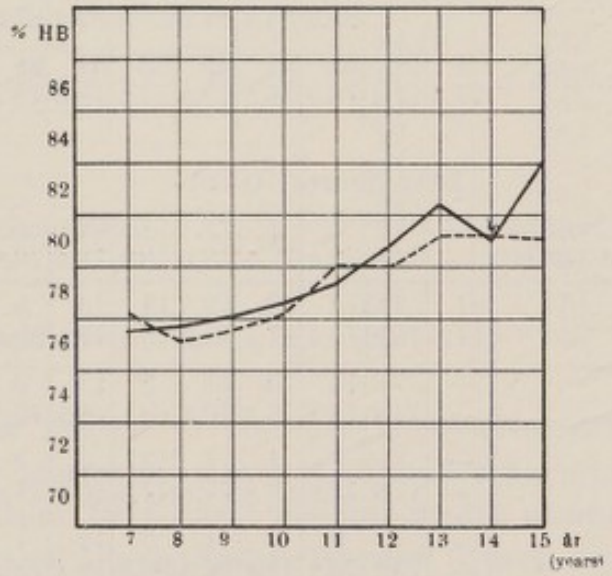

% HB
Tärna
92
90
88
86
84
82
80
78
76
7 8 9 10 11 12 13 14 15 år

In this way the *difference* between the total medium hemoglobin percentage for the district and the general medium can then be calculated. The result is shown in the subjoined tables 5 and 6.

The six graphs in the opposite Diagram 4 illustrate the medium hemoglobin percentage of boys and girls respectively. The conformity between the two curves both in regard to their actual level and with respect to variations according to age is rather striking, especially in those districts where the number of children examined is relatively large (Umeå, Kalix and Jukkasjärvi). It is interesting to note that in the Kalix district the curve for girls is two years in advance of that for the boys: there is a similar tendency in the Umeå district. In the Tärna district the girls are one year in advance of the boys.

A comparison between the general curves for boys and girls (see the following Diagram 5) indicates that the sexes show no distinct difference in regard to the hemoglobin percentage in children of school age.

Diagram 5.



1929. ——— Boys. ------ Girls.

The figures for 1931 are summarized in the following table 7.

The difference between the total medium hemoglobin percentage for the several districts and the general medium can be calculated from these tables in the manner previously described.

As previously indicated, the whole material shows a marked difference in the hemoglobin percentage between the coastal and the inland districts.

Table 7. 1931 figures: Boys.

District		Age										
		6	7	8	9	10	11	12	13	14	15	16 years
Kalix	Number	—	7	7	12	12	2	11	2	1	—	—
	M % Hb	—	79.4	79.4	76.5	80.6	79.8	79.6	82.3	77.3	—	—
Övertorneå		—	—	3	6	10	11	7	2	2	1	—
		—	—	75.6	76.5	74.3	80.0	77.3	77.3	79.8	72.3	—
Åsele		—	6	11	11	10	14	15	3	—	—	—
		—	73.9	75.9	76.8	78.3	79.1	75.6	77.3	—	—	—
Lycksele		1	—	12	3	6	4	7	1	—	—	—
		77.3	—	79.8	75.6	78.1	81.1	80.2	82.3	—	—	—
Arvidsjaur		—	—	5	13	2	5	11	8	3	—	—
		—	—	78.3	78.5	77.3	80.3	78.2	78.6	82.3	—	—
Jokkmokk		—	1	14	15	14	21	12	11	4	—	—
		—	77.3	75.9	77.3	75.2	76.3	74.8	76.8	72.3	—	—
Vaikijaur Nomad School		—	—	—	—	1	3	2	1	—	—	—
		—	—	—	—	72,3	77.3	74.8	77.3	—	—	—
Tärna		—	—	2	2	4	2	2	3	—	—	—
		—	—	82.3	84.8	87.3	89.3	87.3	87.3	—	—	—
County of Malmöhus		1	29	34	31	29	33	31	28	6	—	—
		77.8	74.4	76.0	76.5	75.9	77.5	78.6	79.1	79.5	—	—

1931 figures: Girls.

Kalix	Number	—	7	5	8	19	11	22	5	5	1	1
	M % Hb	—	74.6	79.3	77.9	78,1	78.2	78.9	76.3	78.3	77.3	77.3
Övertorneå		1	7	12	19	12	14	16	5	1	—	—
		77.3	75.9	76.9	77.6	75.2	75.9	77.3	83.3	87.3	—	—
Åsele		—	7	14	10	13	9	13	3	—	—	—
		—	74.4	73.7	76.3	76.5	80.1	78.5	79.0	—	—	—
Lycksele		—	3	3	1	1	3	7	2	—	—	—
		—	77.3	74.0	82.3	77.3	77.3	80.2	77.3	—	—	—
Arvidsjaur		—	7	9	3	1	5	12	7	2	—	—
		—	73.7	76.2	77.3	82.3	80.3	79.4	79.4	77.3	—	—
Jokkmokk		—	6	8	14	7	12	15	12	6	2	—
		—	76.5	77.3	76.6	74.4	76.5	77.6	78.1	84.0	77.3	—
Vaikijaur Nomad School		—	—	—	—	3	4	6	3	1	—	—
		—	—	—	—	75.6	73.6	74.8	75.6	72.3	—	—
Tärna		—	—	2	1	2	5	2	2	1	—	—
		—	—	77.3	82.3	77.3	84.3	84.8	89.8	92.3	—	—
County of Malmöhus		—	18	16	27	33	25	30	25	3	1	—
		—	77.0	75.0	76.9	75.8	77.2	76.5	78.4	76.1	77.8	—

Table 8.

Boys.

Districts	Total Number	M % Hb total	Deviation
Kalix	54	79.2	+ 1.4
Övertorneå	43	77.1	— 0.7
Åsele	70	76.9	— 0.9
Lycksele	36	79.0	+ 1.2
Arvidsjaur	47	78.8	+ 1.0
Jokkmokk	92	75.9	— 1.9
Vaikijaur Nomad School	7	75.9	— 1.9
Tärna	15	86.6	+ 8.8
Norrland total	364	77.8	—
County of Malmöhus	222	76.9	—

Girls.

Districts	Total Number	M % Hb total	Deviation
Kalix	24	78.0	+ 0.5
Övertorneå	87	77.1	— 0.4
Åsele	69	76.6	— 0.9
Lycksele	20	78.1	+ 0.6
Arvidsjaur	47	77.8	+ 0.3
Jokkmokk	82	77.4	— 0.1
Vaikijaur Nomad School	17	74.7	— 2.8
Tärna	15	83.6	+ 6.1
Norrland total	421	77.5	—
County of Malmöhus	178	76.7	—

In a manner similar to that previously described, the general media for the coastal zone and the interior have been calculated, and the deviation from these general media computed.

The districts of Umeå, Sävar, Bygdeå, Bureå, Byske and Kalix have been included in the *coastal zone*, those of Dorotea, Stensele, Tärna, Sorsele, Gällivare and Jukkasjärvi in *the interior*. The results of these computations are given in tables 9 and 10.

A striking feature in these tables is that the deviation from the general medium shows such marked differences in the several districts of *the interior*, as regards both boys and girls. It will be seen that the highest figure is that for the Tärna district, and that the percentage successively falls in the following order: Dorotea, Stensele, Jukkasjärvi, Sorsele and Gällivare. The diffe-

Table 9.

Coastal zone.

Boys (General medium = 74.8).

District	Age									Deviation
	7	8	9	10	11	12	13	14	15	
Umeå elementary schools										
Number	53	32	54	38	5	20	25	4	—	
M % Hb	75.5	74.9	74.6	73.2	72.7	75.5	75.5	76.5	—	— 0.4
Umeå Training Collage	5	5	3	2	—	2	1	1	—	
	73.0	76.0	66.0	78.5	—	73.5	76.0	71.0	—	+ 5.1
Sävar and Bygdeå	3	5	10	10	11	11	11	—	—	
	68.2	71.5	74.0	77.5	78.0	73.5	76.0	—	—	+ 0.9
Bureå	11	20	15	23	9	6	7	—	—	
	72.4	72.1	71.8	76.2	77.3	75.9	84.4	—	—	— 0.3
Byske	3	7	2	9	4	3	8	2	—	
	63.2	75.5	87.8	71.6	74.8	80.4	77.8	73.7	—	— 1.2
Kalix	30	39	35	52	45	54	26	10	2	
	72.8	71.6	75.2	72.9	76.2	77.2	79.0	73.5	79.0	0
Total	105	108	119	134	73	96	78	17	2	
M % Hb	73,7	73.1	74.4	73.9	76.3	76.4	77.8	74.1	79.0	—

Girls (General medium = 73.6).

District	Age									Deviation
	7	8	9	10	11	12	13	14	15	
Umeå elementary schools										
Number	41	25	22	23	11	16	23	7	1	
M % Hb	73.3	70.5	72.9	71.6	73.2	76.8	76.8	77.7	72.7	— 0.4
Umeå Training Collage	4	4	—	5	1	3	7	—	—	
	73.5	72.3	—	77.0	77.0	67.7	75.3	—	—	+ 0.1
Sävar and Bygdeå	1	3	10	6	5	2	3	1	—	
	74.2	74.5	75.2	70.9	74.2	86.7	70.9	69.2	—	— 1.8
Bureå	8	10	10	22	10	13	5	2	—	
	69.1	72.8	73.3	74.4	74.8	75.9	76.8	57.8	—	+ 2.0
Byske	2	14	1	11	6	6	11	4	—	
	56.8	70.5	66.8	74.4	68.8	80.2	79.9	71.8	—	— 2.2
Kalix	18	54	49	55	40	58	35	10	—	
	74.3	74.3	71.4	71.8	77.1	74.5	73.2	73.2	—	+ 0.3
Total	74	110	92	122	73	98	84	24	1	
M % Hb	72.4	72.7	72.3	72.6	75.3	75.5	75.4	72.8	72.7	—

Table 10.

The Interior.

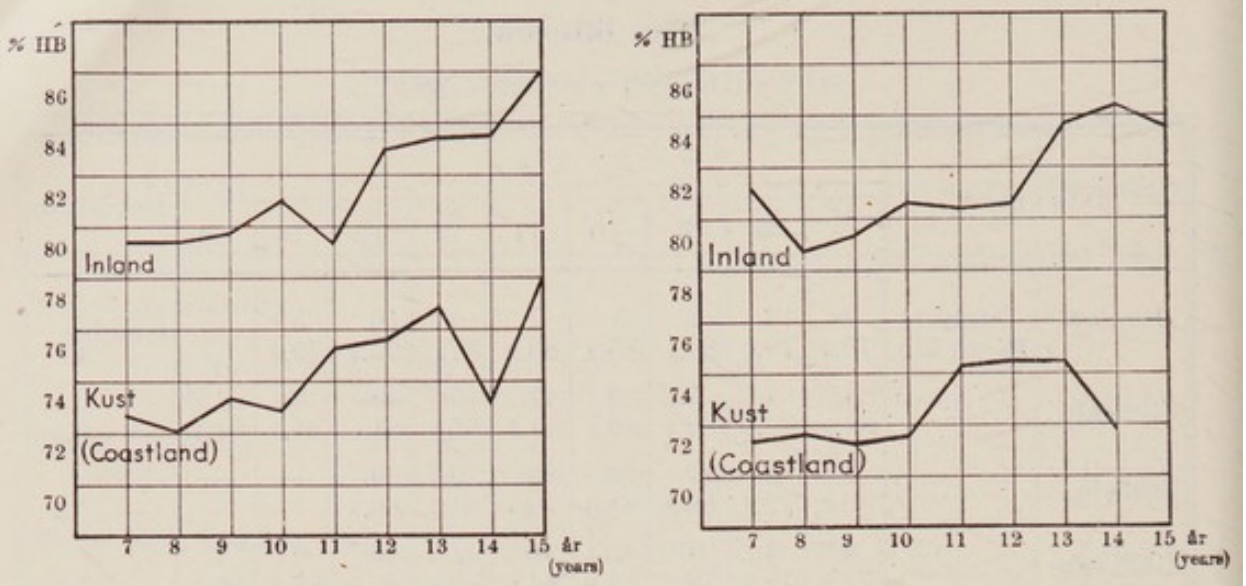
Boys (General medium = 82.0).

District	Age									Deviation
	7	8	9	10	11	12	13	14	15	
Dorotea Number	3	4	8	5	7	4	10	3	—	
M % Hb	72.5	79.5	80.1	85.2	83.9	87.0	84.2	79.9	—	+ 3
Stensele	4	4	9	8	7	5	2	4	1	
	84.0	77.8	82.1	82.1	81.5	85.5	81.5	84.0	81.5	— 0.5
Sorsele	3	8	12	6	13	9	9	—	—	
	80.7	75.7	82.4	84.0	79.5	85.7	86.3	—	—	— 5.3
Gällivare	4	4	4	3	3	1	3	2	1	
	75.8	78.3	79.6	85.8	84.1	80.8	87.5	88.3	85.8	— 11.9
Jukkasjärvi	51	71	48	41	24	9	44	34	10	
	81.7	81.6	79.7	81.7	78.6	79.0	84.7	85.2	88.2	— 0.7
Tärna	6	7	11	11	8	13	11	8	4	
	74.3	80.1	83.3	79.6	81.4	84.7	82.8	83.2	85.1	+ 8.8
Total	71	98	92	74	62	41	79	51	16	—
M %	80.4	80.4	80.7	82.0	80.3	83.9	84.6	84.6	86.9	—

Girls (General medium = 82.2).

District	Age									Deviation
	7	8	9	10	11	12	13	14	15	
Dorotea Number	2	2	3	4	5	7	—	6	2	
M % Hb	89.6	79.6	76.6	80.9	82.6	81.7	—	83.8	89.6	+ 1.6
Stensele	4	5	5	7	6	2	2	4	—	
	82.4	80.1	81.1	79.7	84.4	83.6	83.6	83.6	—	— 0.1
Sorsele	5	5	12	12	12	4	3	5	—	
	82.3	76.3	77.6	86.0	80.6	89.3	84.3	86.3	—	— 3.9
Gällivare	3	4	—	5	4	4	4	1	—	
	81.5	78.6	—	83.8	82.3	83.6	83.6	79.8	—	— 10.9
Jukkasjärvi	55	61	57	45	11	14	66	52	7	
	81.9	79.9	81.4	81.2	76.9	77.4	85.0	85.9	83.5	— 0.3
Tärna	1	10	11	8	10	13	10	8	2	
	86.1	80.6	79.7	79.2	84.6	83.0	83.1	84.2	83.6	+ 7.8
Total	70	87	90	81	48	44	85	76	11	—
M %	82.2	79.7	80.4	81.7	81.4	81.6	84.7	85.4	84.6	—

Diagram 6.



Boys. Girls.

rence in the hemoglobin percentage between Tärna and Gällivare is 20.7 % for boys and 18.7 % for girls.

The difference in the hemoglobin percentage in the coastal zone and in the interior is strikingly shown in the graphs headed Diagram 6.

The average distance between the two curves corresponds to the difference in the general media for the two sexes in the coastal zone and in the interior respectively. This difference is 7.2 per cent for boys and 8.6 per cent for girls.

These investigations thus show that the school children examined in the *coastal zone* of Upper Norrland have, broadly speaking, the same hemoglobin percentage in the various districts, and that this percentage is *considerably lower than in school children from the interior*. They also indicate that there are considerable disparities in the hemoglobin percentage in the different districts of *the interior*.

The material included in the investigations made in 1931 was so small that, from a statistical point of view, it is scarcely commensurable with that for 1929. But, if a direct comparison is nevertheless made, it will be found that the hemoglobin percentage for the total number of *boys* examined in Norrland was 78.1 % in 1929 and 77.8 % in 1931. The corresponding figures for girls are 77.8 % in 1929 and 77.5 % in 1931. The 1931 figures for Skåne are 76.9 % for *boys* and 76.7 % for *girls*.

Etiological factors.

Climate.

The marked difference in the hemoglobin percentage in school children from the interior and the coastal zone respectively is, as shown in other parts of this work, partly due to climatic conditions. In addition, the height above sea level seems to be a factor of some importance. The reader is referred to Part II of this book and to the previously mentioned study by WERDINIUS, from which the following table is reproduced:

Table 11.

	Boys					Girls				
	Towns	Coastal zone	Outer forest zone	Inner forest zone	Mountainous zone	Towns	Coastal zone	Outer forest zone	Inner forest zone	Mountainous zone
Number ...	247	543	199	215	705	196	513	199	216	711
M % Hb...	74.8	75.2	78.2	78.7	81.2	73.3	74.0	77.8	78.1	81.5

Anthropological factors.

It may be questioned, however, whether this striking disparity in the hemoglobin percentage is not partly due to anthropological factors. As has been pointed out in Chapter I, the population of the coastal zone is of purely Germanic origin, whereas that of the interior is partly of a pure Lappish race, partly a mixed race, of Germanic, Finnish and Lappish origin.

A basis for the determination of this question is afforded firstly by the records taken of the weight and stature of the school children examined, and secondly by the subjective estimates of the state of nutrition of the children. In the records the latter was designated as *good*, *ordinary* or *bad*.

The relation between the height and weight was computed on the basis of the tables published by CARL SCHIØTZ in 1922. The latter investigator adopted ROHRER's »*Index der Körperfülle*», recommended in RUDOLF MARTIN's »Lehrbuch der Anthropologie» (Munich 1914). This index expresses *the weight of the body in grammes, in percentage of a cube the edge of which is equal to the height of the body in centimetres.* The formula for the index is: $i = \frac{100 \times \text{body weight}}{(\text{height})^3}$.

As ROHRER's index varies according to age — or, what comes to the same, the stature —, a certain stature corresponds to a particular index. SCHIØTZ's tables are based on deviations from the »normal index», expressed in percentage of that index. Thus, given the height and weight of the child, the percentage by which the ratio between the height and weight deviates from the normal index can be read off straight from the tables.

In tables the plus or minus sign in front of the figure indicates whether the child is above or below the normal weight.

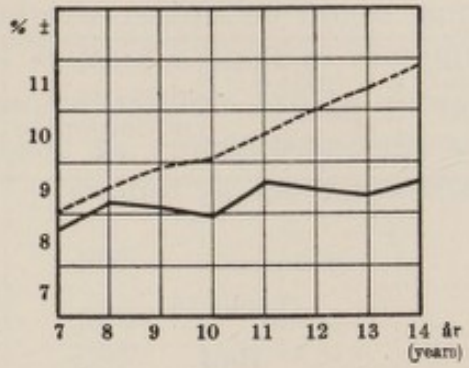
In order to avoid any possibility of misunderstanding, the following passage is reproduced from SCHIØTZ' study »Skolealdern» (1927).

»In medical literature comparisons are nearly always made simply on the basis of the estimated normal medium figures — in judging on a given occasion (say in the case of anomalous development) the normality of an individual or of a single dimension. In this way, however, it is not really possible to draw any conclusion whatsoever as to whether the individual (or the dimension) is abnormal, or »not ordinary», or normal. In order to arrive at such a conclusion — if the estimate is to have any value as anything more than a subjective opinion — it is quite indispensable to know the normal deviation from the medium.»

In regard to the ratio between the height and the weight of the body, SCHIØTZ has computed this deviation on the basis of a coefficient C, the formula of which is $C = \frac{100\,\sigma}{M}$. M designates the medium index and σ the standard deviation from that value within a certain age-group. In the above-mentioned study »Skolealdern» (p. 64) SCHIØTZ illustrates »*the deviation in the ratio between the height and weight in elementary school children — as expressed by Rohrer's index*», in the following graph (Diagram 7).

This diagram indicates, as regards the children examined by SCHIØTZ, that in the case of girls the coefficient of deviation is less according as the age is lower, and that in all ages it shows greater variation in girls than in boys. SCHIØTZ contends, with the support of other investigators, that his formula has a very wide application not only to children from diffferent parts of Norway, but also to those of other nations, though certain races — such as the Romance peoples and the Jews — show a typical

Diagram 7.



——— Boys ------ Girls.

deviation. It should furthermore be observed that a certain percentage of children under weight is normal in any large material. In fact only 68 per cent of the total number fall within the limits of the »normal» deviation. This signifies that normally 16 per cent should be under weight and 16 per cent above the proper weight.

On the basis of the above explanatory observations, let us first see how the subjective estimates of the state of nutrition of the children examined in 1929 and 1931 work out in relation to SCHIØTZ' estimates of the percentages of »over weight», »normal weight» and »under weight» children.

State of nutrition.

Table 12. According to our investigators.

According to Schiøtz	Good	Ordinary	Bad	Not stated	Total
Over weight.....	400	145	8	20	573
Normal weight	1,042	1,624	235	93	2,994
Under weight	133	455	280	19	887
Not stated	10	32	1	5	48
Total	1,585	2,256	524	137	4,502

Table 13. According to our investigators.

According to Schiøtz	Good	Ordinary	Bad	Not stated	Total
Under weight	133 15 %	455 51.3 %	280 31 %	19 2.10 %	887 100 %

The following table shows, in percentage, how the children who, according to SCHIØTZ, would be »under weight» have been classified by our investigators in their subjective estimates:

If we take the group of 524 children whose state of nutrition was designated by our investigators as »bad», the percentages according to SCHIØTZ work out as follows:

Table 14.

Bad.

Over weight	8	= 1.5 %
Normal weight	235	= 44.8 %
Under weight	280	= 53.4 %
Not stated	1	= 0.2 %
Total	524 children	

The above tabular summaries show in a striking way how important it is, in judging a large material such as this, to compare the results of different methods. Out of the 887 children who would be »under weight» according to SCHIØTZ no less than 66.3 per cent have been classified as having a »good» or »ordinary» state of nutrition (Table 13). And out of the 524 classified as having a »bad» state of nutrition, 46.3 per cent would, according to SCHIØTZ, be »over weight» and »normal weight» (Table 14).

Another question of considerable interest is *what the percentage of »under weight» children would be, according to* SCHIØTZ, *in the various districts*. The figures are given in the subjoined table, where the districts have been arranged according to their distance from the coast. It should be noted that the figures comprise the *entire* material, without any elimination.

In examining these figures one should bear in mind firstly the observation made above in regard to the normal percentage of underweight children, and secondly that the figures may be warped by certain errors due to the fact that the measurements have been made by several investigators each with their own instruments.

Noting these points, we find that, very broadly speaking, the percentages *within* the various groups correspond tolerably well

Table 15.

District	Year of examination	Underweight percentage	Number of children examined	
Umeå elementary schools	1929	24.8 %	423	
Umeå Training College	1929	16.7 %	54	Coastal zone
Sävar and Bygdeå	1929	6.6 %	106	
Bureå	1929	18.3 %	186	
Byske	1929	25.8 %	97	
Kalix	1929	18 %	661	
»	1931	41.7 %	139	
Bjurholm	1929	23.5 %	85	
Degerfors	1929	16.7 %	96	Outer forest zone
Norsjö	1929	21.0 %	119	
Övertorneå	1931	33.1 %	136	
Åsele	1931	13.7 %	139	
Lycksele	1929	23.8 %	143	Inner forest zone
»	1931	25.9 %	58	
Arvidsjaur	1931	28.3 %	92	
Dorotea	1929	10 %	90	
Stensele	1929	26.4 %	121	
Sorsele	1929	6.6 %	122	
Jokkmokk	1931	27.9 %	179	
Vaikijaur Nomad-school	1931	0 %	24	Mountainous zone
Gällivare	1929	0 %	57	
Tärna	1929	8.1 %	123	
»	1931	3.2 %	31	
Jukkasjärvi	1929	20.7 %	785	
County of Malmöhus	1931	13 %	399	
		Total	4.465	

with one another, whilst there are certain marked disparities *between* different groups. Thus in »the inner forest zone» we find the figure 13.7 %, in the coastal zone 41.7 %. — The figure 6.6 % for Sävar and Bygdeå in the latter zone deviates so markedly from the mean that its accuracy may be questioned. — In the »mountainous zone» Stensele, Jokkmokk and Jukkasjärvi (inclusive of Kiruna) show figures above 20 %, the other localities figures ranging between 10 and 0. Though Gällivare and

Jukkasjärvi were examined by the same investigator, they nevertheless show a difference of over 20 per cent.

The figures for 1931 were based on records made by a single investigator. It will be seen that the percentage of underweight children at Vaikijaur is *nil*, and that at Tärna it is extremely low (3.2). As regards the latter locality a very low percentage of underweight children (8.1 %) was recorded also in 1929. Remarkably low percentages were registered also at Dorotea and Sorsele in the last-mentioned year.

The facts just mentioned indicate that the ratio between the height and weight in the districts with a Lapp population differs from that on which SCHIØTZ' method was based. Children from the mountainous districts begin to be »thick-set» at the early age of 10 to 11, which may possibly be due to earlier puberty. The figures from the districts where the population is intermixed with the Finnish race (Övertorneå and Jukkasjärvi) are in fairly close conformity with those of the coastal zone, where the population is, as stated, purely Germanic.

In accordance with the method adopted in calculating variations in the hemoglobin percentage, we have worked out the medium ratio betweeen the height and weight at different ages in the various districts, as compared with SCHIØTZ' normal figures.

In order, as far as possible, to eliminate the play of chance, the material has been arranged in four groups. The *first* group comprises the coastal zone (Umeå to Kalix), the *second* the outer forest zone (Bjurholm to Övertorneå), the *third* the inner forest zone (Åsele to Arvidsjaur), and the *fourth* the mountainous zone. The results are shown in Table 16.

In the mountainous zone we find, both in boys and girls, *an average height-weight ratio very close to zero,* that is to SCHIØTZ' normal ratio. In the coastal zone it is the boys that have the »worst» height-weight ratio, in the forest zones the girls.

The graph in Diagram 8 illustrates the height-weight ratio actually measured, as compared with the normal ratio according to SCHIØTZ. For the sake of clearness, the graph shows only the curves for the coastal and mountainous zones and, for the purpose or comparison, the curve for the province of Skåne.

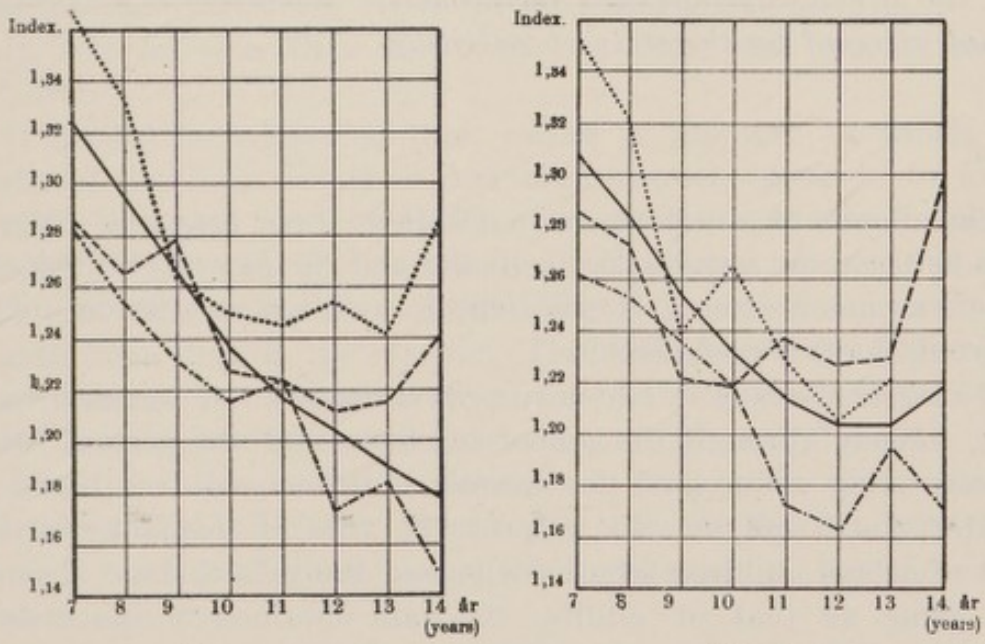
The curves for the coastal zone — if we imagine them levelled out — will be found, broadly speaking, to correspond fairly well with the normal curves, but lie below the latter. The curves for

Table 16.

Boys.

Zones	7	8	9	10	11	12	13	14	Total
Coastal	110 — 3.14	115 — 3.31	131 — 2.67	145 — 1.76	75 + 0.53	102 — 2.45	75 — 0.67	17 — 2.65	770 — 2.13
Outer forest...	12 — 7.09	23 — 2.17	32 — 3.13	28 — 1.61	35 — 1.72	42 + 1.55	17 — 0.59	8 — 0.63	197 — 1.47
Inner forest...	11 — 3.18	40 — 3.12	31 + 0.16	25 — 2.60	32 + 0.47	37 — 2.30	18 — 1.95	3 + 1.67	197 — 1.62
Mountainous	74 — 2.84	107 — 2.38	114 + 0.92	104 — 0.77	88 + 0.40	53 + 0.85	90 + 2.06	56 + 5.27	686 + 0.18
				Girls.					
Coastal	80 — 3.56	115 — 2.43	107 — 1.50	146 — 1.13	79 — 3.42	121 — 3.39	83 — 1.69	28 — 3.75	759 — 2.39
Outer forest...	22 — 5.91	30 — 6.16	35 — 2.86	33 — 4.55	29 — 2.24	28 — 6.78	15 — 2.67	5 + 8.00	197 — 4.16
Inner forest...	26 — 4.18	44 — 3.33	24 — 3.33	32 — 0.94	28 — 3.04	46 — 2.72	20 —10.75	5 + 2.00	225 — 3.18
Mountainous	78 — 1.60	91 — 0.77	112 — 2.59	99 — 1.16	70 + 1.86	63 + 1.90	102 + 3.19	78 + 6.60	693 + 0.71

Diagram 8.



Boys. Girls.

——— Normal. ····· Skåne. - - - - Mountainous zone. - · - · - Coastal zone.

the mounatainous zone, on the other hand, cross the normal curves. This seems to point to some difference in the laws of growth of the children in that region. The curves for Skåne, broadly speaking, follow the normal curves, but lie above them. The percentage of underweight children recorded in Skåne was 13 per cent, instead of the normal 16 per cent (cf. p. 73). But, as the measurements were made by a single investigator, this may be due to some »systematic error». In the Norrland coastal zone, on the other hand, the results of a number of investigators were compared with one another, so that possible »errors» would presumably neutralize one another.

* *
*

According to the standard handbooks on hematology, there is no constant connection between the hemoglobin percentage of an individual and his state of nutrition. In the case of loss of flesh the total amount of blood decreases in the same proportion as the other tissues, so that the relative amount of hemoglobin, or, in other words, the hemoglobin percentage, remains constant to the last. The reverse is the case in overfeeding.

To sum up, it may be stated that the investigations have borne out the previously observed fact that *the hemoglobin percentage is not affected by the state of nutrition*.

Diet.

The dominant question as to *whether there was any connection between the various kinds of diet and the hemoglobin percentage* was not answered by the school investigations as definitely as would have been desirable.

Owing to the way in which records were taken of the children's diet, namely through the school teachers, and for certain other reasons, only about half the number of school children could be treated statistically in this respect. In view of the fact that the diet of school children who have passed the infant stage is much the same as that of adults, the data obtained in the district investigations afford better guidance. In regard to the composition of the diet the reader is referred to Part II, Chapter I. B.

It may, however, be useful here to note the designations adopted for the principal kinds of diet: —

The *L*[1] *diets* consist of milk-meal food (inclusive of unfermented hard bread) as well as potatoes and butter, but very little meat.

The *B*[2] *diets*, in addition to milk-meal food, comprise also meat, pork and eggs. These diets are thus of a mixed character.

The *S*[3] *diets* consist of pork (American and Swedish) as the principal item, as well as bread, butter and coffee.

The Roman figures after L, B and S indicate how far the diet is varied (I = unvaried, II = somewhat varied).

The letters a), b) and c) indicate to what extent, if at all, fruit and vegetables are included in the diet, a) signifying the absence of those foods.

The L diet is particularly characteristic of the coastal zone. In view of its composition, however, it is rather common among children in general. Thus in some of the inland districts its frequency is about 60 per cent.

The frequency of the various kinds of diet in the various districts and the medium hemoglobin percentages (corrected) are shown in Tables 17—18.

These tables are compiled in the same way as those showing the variations in the hemoglobin percentage according to age. The kinds of diet are arranged in an a) series and a b) series, and separate tables are given for boys and girls.

It will be seen that the S diet is very rare among school children.

It should be reiterated that, owing to the way in which the material has been sifted, it has been scarcely possible to avoid certain errors in the hemoglobin percentages and the frequency numbers. But, as above indicated, experience shows that the LIa diet (the unvaried milk-meal diet) is more common in the coastal zone than in the interior. The basic data from Kalix were not amenable to statistical treatment. It seems, however, that the LIa and BIa diets are most common in that district.

It will be observed that the lowest hemoglobin percentage is found in school children whose diet was of the LI type (unvaried), and the highest hemoglobin percentage among those who

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[1] L = *lantbruksbefolkningen:* agricultural population. [2] B = *blandad:* mixed. [3] S = *skogsarbetarna:* forest labourers.

Table 17. Boys.

District	LIa	LIIa	BIa	SIa	LIb	LIIb	BIb	Total
Umeå elementary schools								
Number	8	31	43	—	2	17	76	177
M % Hb	66.1	74.7	76.3	—	74.8	75.8	74.6	74.8
Umeå Training College	—	—	3	—	—	4	9	16
	—	—	77.8	—	—	81.1	80	79.9
Bureå.....	27	29	22	—	—	—	—	78
	72.8	75.2	77.1	—	—	—	—	74.9
Byske.....	2	13	5	—	—	3	4	27
	72.5	72.3	78.2	—	—	68.6	73.6	73.2
Bjurholm	9	15	5	—	—	—	—	29
	73.0	68.3	65.0	—	—	—	—	69.2
Degerfors	—	15	8	—	—	—	—	23
	—	68.2	82.1	—	—	—	—	73.0
Lycksele	30	14	8	—	—	—	—	52
	79.9	80.2	79.6	—	—	—	—	79.6
Dorotea	6	16	14	—	—	—	—	36
	79.5	85.9	88.0	—	—	—	—	85.7
Stensele.....	20	10	7	1	—	—	—	46
	82.8	82.0	76.7	82.1	—	—	—	81.6
Sorsele	4	23	14	—	—	—	—	41
	76.9	77.8	80.4	—	—	—	—	78.6
Jukkasjärvi	11	51	23	—	4	30	18	137
	73.9	75.5	77.8	—	80.4	83.9	83.3	78.6
Tärna.....	9	30	39	—	1	—	—	79
	89.3	89.9	91.7	—	93.9	—	—	90.8
Total	126	247	191	9	7	54	107	741
						M % Hb		78.5

had a more mixed diet (BI); also that the b-diets (with some fruit and vegetables) show, broadly speaking, somewhat higher hemoglobin percentages than those without any fruit and vegetables (the a-diets).

The figures for Umeå und Jukkasjärvi bear out the view that school children whose diet has been somewhat mixed (BI) have a higher hemoglobin percentage than those who have subsisted on an unvaried milk-meal diet (LIa); and that children whose milk-meal diet has shown some little variety (LIIa) have a hemaglobin percentage intermediate between these two percentages.

Table 18. Girls.

District	LIa	LIIa	BIa	SIa	LIb	LIIb	BIb	Total
Umeå elementary schools								
Number	4	22	43	—	1	12	49	131
M % Hb	73.8	70.5	73.1	—	72.3	75.2	73.7	73.1
Umeå Training College	—	4	3	—	—	6	14	27
	—	68.6	76.1	—	—	73.6	75.7	74.2
Bureå	15	28	18	—	—	—	—	61
	78.5	76.9	77.6	—	—	—	—	77.5
Byske	5	13	7	—	—	8	9	42
	60.6	73.8	71.5	—	—	76.1	75.7	72.7
Bjurholm	9	4	2	—	—	—	—	15
	69.1	66.8	65.5	—	—	—	—	68.0
Degerfors	—	12	3	—	—	—	—	15
	—	71.5	75.2	—	—	—	—	72.4
Lycksele.....	24	29	12	—	—	—	—	65
	76.7	80.2	79.4	—	—	—	—	78.8
Dorotea	4	3	5	—	—	—	—	12
	85.0	82.9	84.2	—	—	—	—	84.1
Stensele	19	5	3	8	—	—	—	35
	81.5	83.0	74.3	85.4	—	—	—	82.0
Sorsele	1	25	10	—	—	—	—	36
	90.4	77.6	77.9	—	—	—	—	78.0
Jukkasjärvi	9	57	28	—	5	40	18	157
	73.9	78.3	80.3	—	78.9	83.7	82.3	80.3
Tärna	9	32	31	—	—	—	—	72
	84.5	91.6	89.9	—	—	—	—	90.0
Total	99	234	165	8	6	66	90	668
						M % Hb		78.4

In short, *the unvaried milk-meal diet (LIa) seems to result in a lower hemoglobin percentage, which increases according as the diet is rendered more varied by the addition of fruit and vegetables, or otherwise.*

The following tabular summary (Table 19) is the result of an attempt to show *how the height-weight ratio varies according to the principal kinds of diet.*

It should be noted (1) that the number of »underweight» children is considerably larger in the b) series than in the a) series; and (2) that the children in the LIa group have a lower

Table 19.

Diet	LIa	LIIa	BI	LIb	LIIb	BII	Total
Number	225	481	356	13	120	197	1,392
M % acc. to Schiøtz	— 2.0	— 0.9	— 0.6	— 2.0	— 3.9	— 3.2	

height-weight ratio than those in the LIIa and BI groups. As the LIb group is so small, its figure can be left out of account.

The observation made in the preceding paragraph under (1) seems surprising. As the caloric value of the diets in the b) series (with some fruit and vegetables) is certainly not less than that of the a) series, it may be presumed that other factors have come into play. If the same material is distributed according to the interior districts and the coastal zone, we obtain the following medium height-weight figures for *the interior*:—

Table 20.

Diet	LIa	LIIa	BI	LIb	LIIb	BII
M % acc. to Schiøtz	— 1.9	+ 0.4	+ 3.0	— 5.6	— 4.4	— 4.2

A comparison with the results obtained on the basis of the total material (Table 19) throws into relief the pecularities above noted. This again points to the curious deviation from the normal height-weight ratio according to Schiøtz which has been observed in the »mixed race» population of the interior.

The population of the coastal zone, being mainly of pure Germanic race, should, one might suppose, serve better to indicate the possible variation of the height-weight ratio according to the kind of diet. A tabular summary for the *coastal zone* works out as follows:—

Table 21.

Diet	LIa	LIIa	BI	LIb	LIIb	BII
M % acc. to Schiøtz	— 0.9	— 1.6	— 3.4	— 2.3	— 3.2	— 3.0

This table thus gives the curious result that children living on an unvaried milk-meal diet (LIa) have the best height-weight ratio according to Schiøtz.

In short, *these investigations have not borne out the supposition that the height-weight ratio of school children is affected by the composition of the diet.*

It should be added, for the sake of completeness, that the results of the investigations made in 1931 correspond, broadly speaking, with those of 1929. As regards certain diet groups, however, the 1931 material is so small that it is not fitted for statistical compilation.

Consumption of coffee.

In connection with the diet investigations, an attempt has been made to show how the consumption of coffee affects the hemoglobin percentage, and thus the health, of school children. This enquiry has not borne out the prevalent view that the consumption of coffee in Norrland is excessive as regards school children.

As a basis for this enquiry we have taken the number of cups of coffee consumed per day. For statistical purposes these numbers have been divided into groups, as follows:—

0	cups	a	day
1—3	»	»	»
4—7	»	»	»
>7	»	»	»

The following is the result of enquiries made on this subject in regard to 2,639 school children:—

498	(= 18.8 %)	no coffee =	0	cups	a	day
1873	(= 71.0 %)		1—3	»	»	»
118	(= 4.2 %)		4—7	»	»	»
150	(= 5.9 %)		>7	»	»	»
2639						

The relation between the consumption of coffee and the hemoglobin percentage is shown in Table 22. The frequency numbers are given in the upper row and below them the medium hemoglobin percentage, in the same manner as before.

It will be seen that this table does not warrant any definite conclusions in regard to the effect of the consumption of coffee on the hemoglobin percentage. Indeed we observe in a good many

Table 22.

District	Boys				Girls			
	0	1-3	4-7	>7	0	1-3	4-7	>7
Umeå elementary schools								
Number	102	138	1	—	76	95	2	—
M % Hb	73.7	75.5	72.7	—	72.0	74.4	70.2	—
Umeå Training College	10	9	—	—	20	14	—	—
	80.6	76.1	—	—	79.9	72.1	—	—
Sävar och Bygdeå	—	49	—	—	—	28	—	—
	—	71.3	—	—	—	71.0	—	—
Bureå	29	37	2	—	21	31	—	—
	72.6	76.4	82.3	—	76.2	76.6	—	—
Byske	14	26	—	—	17	38	1	—
	70.9	74.0	—	—	67.6	73.0	72.6	—
Kalix (1929)	33	111	3	—	35	119	—	—
	77.4	72.9	83.2	—	73.8	72.9	—	—
Bjurholm	5	41	—	—	3	28	—	—
	71.0	72.3	—	—	69.7	73.5	—	—
Degerfors	—	9	—	—	—	4	—	—
	—	81.9	—	—	—	74.0	—	—
Norsjö	—	63	—	—	—	55	—	—
	—	85.9	—	—	—	84.1	—	—
Lycksele (1929)	—	54	8	—	—	69	12	—
	—	80.5	79.6	—	—	79.5	79.4	—
Dorotea	3	34	—	—	—	9	1	—
	94.5	84.3	—	—	—	80.6	101.2	—
Stensele	—	41	3	—	—	32	2	—
	—	81.8	82.7	—	—	82.9	83.5	—
Sorsele	4	55	3	—	4	53	3	—
	74.2	77.0	70.4	—	74.2	79.4	67.1	—
Gällivare	—	20	5	—	1	19	5	—
	—	69.4	72.4	—	68.9	71.3	71.9	—
Jukkasjärvi	39	225	50	7	46	281	26	8
	83.4	82.8	74.2	73.2	81.6	82.8	74.7	76.4
Tärna (1929)	3	78	3	1	4	76	4	—
	88.9	90.3	92.2	83.9	85.7	90.3	81.4	—
Löberöd	—	34	—	—	—	23	2	—
	—	77.5	—	—	—	81.5	81.3	—

instances the seemingly paradoxical result that a larger consumption of coffee is associated with a high hemoglobin percentage.

The probable explanation is that the hemoglobin percentage is determined mainly by other factors, alongside of which the consumption of coffee, when kept within these moderate limits, is of quite subsidiary importance. The figures for Jukkasjärvi, where an excessive consumption of coffee seems to have been noted, indicate, however, that the hemoglobin percentage may be reduced by such abuse.

Nor has it been possible to trace *digestive disturbances* among school children to the consumption of coffee. This is shown by the following table:—

Number of cups of coffee	Number of children	Digestive disturbances %
0	498	11.7
1—3	1893	11.0
4—7	117	12.8
>7	16	18.7
	2524	

Records of digestive disturbances were taken in regard to 3,220 school children. Out of this number 377 (11.2 %) showed disorders diagnosed as follows:—

slight gastric disorders	in	28.3 %
more severe gastric disorders	»	8.2 %
diarrhoea	»	41.0 %
constipation	»	20.4 %

The incidence of digestive disturbances is about the same among boys and girls, being 11.5 per cent and 11.9 per cent respectively.

Digestive disturbances seem to be most frequent in the ages from 7 to 11 years, after which they slowly fall off till the age of 14 or 15 is reached.

The frequency of digestive disturbances in the various zones is shown by the following summary:—

Coastal	Frequency of digestive disorders
Coastal zone	16.8 %
Outer forest zone	20.6 %
Inner » »	5.6 %
Mountainous »	5.9 %

Hygiene in the homes.

As is shown in Part II, hygiene in the homes, and especially the standard of housing accommodation, is a factor which may affect the health of the population. It was for this reason that certain data in regard to housing were collected in connection with the main investigation.

As regards school children, a matter which specially engaged our attention was *overcrowding*. In about 50 per cent of the homes in respect of which reliable information could be obtained, it was found that four or more members of the family *slept in the same room*: only about 3 per cent had a bedroom to themselves. The extent to which overcrowding occurred is shown in a still more striking way by the following figures for the *number of persons sleeping in the same bed*:—

0.5 % of the children had 4 bed-fellows
3.0 % » » » » 3 » »
23.0 % » » » » 2 » »
46.5 % » » » » 1 » »

and

only 27.0 % slept in a bed of their own.

If the figures for the hemoglobin percentage are placed in relation to overcrowding — as measured by the number of persons sleeping in the same room — it will be found that *the hemoglobin percentages are particularly low in the case of school children from homes where overcrowding is very marked.* This is shown, for example, by the following figures from Umeå and Jukkasjärvi, where a large number of homes were investigated.

Table 23.

		Boys			Girls		
		0	1—3	>3	0	1—3	>3
Umeå elementary schools ...	Number	14	161	66	15	102	56
	%	5.8	66.8	27.4	8.7	59.0	32.4
	Hb	75.9	74.6	73.4	71.3	73.4	72.4
Jukkasjärvi	Number	21	176	127	26	214	132
	%	6.5	54.3	39.2	7.0	57.5	35.5
	Hb	86.3	82.9	78.2	87.2	82.9	79.3

Length of the way to school.

In view of opinions expressed to the effect that the health of school children might be effected by having a long way to go from their homes to their schools, it was considered desirable to make enquiries on this subject. It was found that the major part of the children questioned about this (63.6 per cent) lived at a distance of at most 1 kilometre from their schools, whilst merely 0.4 per cent had more than 5 kilometres to walk. The children in the Lapp district, as a general rule, live closer to their schools than those of the coastal zone. This is due to the existence of »school homes» etc., and to the fact that school children from out-of-the-way places are often boarded in families in the vicinity of the school. It has not been possible to show any distinct connection between the length of the way to school and the hemoglobin percentages.

PART II

DISEASES AND THE FREQUENCY OF DISEASES IN UPPER NORRLAND, WITH SPECIAL REFERENCE TO THE COMPOSITION OF THE DIET

By

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TABLE OF CONTENTS.

Page

Introduction 7

A. Plan and scope of the investigation 7
B. Ethnographical conditions in the area of the investigations 9
C. The investigation material 12

Chap. I. Nutritional Conditions of the Population 15
A. General points of view 15
1. Preparation of the food 17
2. Different types of diet 20
a. Dietary anamnesis 20
b. Classification of the various types of diet 21
c. Frequency of different diets 25
3. Consumption of coffee 29
4. Consumption of tobacco and spirits 33

B. Composition of the diet from quantitative and qualitative points of view 34
1. The diet of the rural population 35
2. The diet of the forest-workers 44

Chap. II. The Basal Metabolism in relation to the Composition of the Food 48

Chap. III. The Incidence of Achylia, its characteristics and causes 58
A. Methods of examination 58
1. Ewald-Boas' test meal 58
2. Fractional analysis 60
3. Histamine test 62
4. Neutral red test 63
5. Value of different methods of examination 63
6. Examination of peptic digestion 66

B. Frequency of achylia in the total material 68
C. Principles of elimination 76
D. Incidence of primary achylia and its characteristics 77
1. Incidence of primary achylia in the hospital material 77
a. Degree of functional disturbance 79
b. Symptomatology of the cases examined with test meals 82
2. Occurrence of gastro-intestinal disorders in the district material 85

Page

3. Incidence of gastric and intestinal disorders among school children 88
4. Causes of the high incidence of achylia in Upper Norrland .. 89
   a. Consumption of coffee 90
   b. Snuff-chewing, tobacco and spirits 94
   c. Condition of teeth 95
   d. Helminthic infection 100
   e. The diet 101
5. Treatment of achylia and its results 115
6. Cause of the inhibitory effect of the unvaried milk-meal diet on the gastric secretion 121
   a. Haematogenous toxic effects 123
   b. Constitutional disturbances 124
   c. Quantitative and qualitative defects 124

Chap. IV. Incidence of Gastric and Duodenal Ulcers 128

A. Ulcer in connection with achylia 128
B. Frequency and character of ulcer in relation to the composition of the diet 133

Chap. V. Occurrence of Intestinal Disturbances and their Characteristics 139

A. Material and methods of examination 139
B. Intestinal function in »healthy» subjects (Group I) 141
C. Occurrence of pronounced intestinal disorders (Group II) 143

Chap. VI. Occurrence of anaemia, its etiology and characteristics 152

A. Methods of examination 152
   Supplementary:
   The personal bias in calorimetric haemoglobin estimations 154
B. The Hb content and number of red corpuscles in children 155
C. The Hb value in adults 159
D. Etiology of the anaemia 163
   1. Hb value in relation to the composition of the diet 163
   2. Other factors which may influence the Hb content 167
      a. Consumption of coffee 167
      b. Use of tobacco 169
      c. Consumption of spirits 169
      d. Certain hygienic factors 170
      e. Helminthic infection 172
      f. Pregnancy and lactation 173
      g. Seasonal factors 174
      h. Highland climate 177
      i. Race-biological factors 180
      j. Gastric disorders, especially achylia 181
      k. Intestinal disorders 186
      l. Condition of the teeth 187

Page

E. Blood picture, especially in the L diet anaemias 188
F. Prognosis and therapy 193
G. Analysis of the causal relationship between the unvaried milk-meal diet and the occurrence of anaemia 195
1. Toxic factors 195
2. Quantitative under-nutrition 196
3. Qualitative under-nutrition 197

Chap. VII. Occurrence of haematuria minima 201

Chap. VIII. Occurrence of hypovitaminosis 206

Chap. IX. Capillary bleeding test in venous stasis 218

Chap. X. Summary and Survey of the Clinical Symptoms produced by the unvaried milk-meal diet 233

Introduction.

A. Plan and Scope of the Investigation.

The researches, an account of which is given in the present work, form part of the extensive social-medical investigation carried out during the years 1929—1931 in Upper Norrland [1] with the support of the Royal Medical Board. In regard to the preparatory stages, the extent and the planning of the investigation the reader is referred to Part I by N. Hellström, Director General of the Royal Medical Board.

This report comprises mainly the research work carried out at the hospital of Umeå, supplemented by comparative studies at the University Clinic of Lund and at the hospitals of Hälsingborg and Borås. Further, the so-called district examinations have to a certain extent been analysed in regard to matters relating to questions dealt with here. A detailed description of the composition of the material will be given below.

The purpose of that part of the Norrland investigation which was entrusted to me was briefly to ascertain the causes of the great frequency in Upper Norrland of gastro-intestinal disturbances, chiefly consisting in deficiency of gastric juice (achylia gastrica) and intestinal catarrh (chronic colitis), and the incidence of anaemia and minor renal bleedings (haematuria minima); facts which had been previously pointed out by the author on the basis of observations made at the Umeå Hospital.

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[1] Sweden is divided from north to south into 3 parts: Norrland, Svealand and Götaland. These investigations refer to the northernmost part of Norrland, i. e. the provinces of Norrland, Västerbotten, and Lapland. The County of Västerbotten comprises mainly the province of Västerbotten and the southern part of Lapland. The province of Norrbotten and the northern part of Lapland form the County of Norrbotten. In this work »Västerbotten» and »Norrbotten» denote the above-mentioned counties.

In view of the great extent of the material and the number of questions to be elucidated, it proved necessary to distribute the work of preparing the material among several persons. This was done by assigning a special task to each of the assistant physicians at the Medical Department of the Umeå hospital. The collected material was to be studied, in accordance with a detailed program, in order to elucidate certain questions raised. The results of these studies have already been published. The following is a list of these works.

Dr. S. Lindgren: Eine Studie über depressive Sekretionsanomalien des Magens. Acta Med. Scand. Suppl. XLVIII.

Dr. L. Abramson: On the occurrence of achlorhydria in gastric and duodenal ulcer. Acta Med. Scand., vol. LXXVII, p. 77.

Dr. L. Abramson: Clinical observations on intestinal disturbances among the population of Västerbotten (Sweden). Acta Med. Scand., vol. LXXVII, p. 127.

Dr. E. Werdinius: Studien über die im nördlichsten Schweden gewöhnlichen Anämiezustände. Dissertation. Lund 1933.

Dr. G. Bexélius: Studien über die Blutungstendenz der Hauptkapillaren bei künstlicher venöser Stauung. Acta Med. Scand., vol. LXXX, p. 281.

Dr. Hans Pettersson: Hæmaturia minima.

Drs. M. Odin and E. Werdinius: The Level of the Basal Metabolism of the Diet. Acta Med. Scand., vol. LXXXI, p. 249.

Drs. M. Odin and E. Werdinius: The Present Equation in the Colorimetric Determination of the Hæmoglobin. Acta Med. Scand., vol. LXXXI, p. 239.

The following report is based essentially on the above-mentioned studies, although it has been necessary to revise and complete them to a considerable extent. They have on all points confirmed the assumptions and conclusions which the primary observations made at the Umeå Hospital were considered to justify in regard to the incidence of the diseases, the nature of the symptoms and their causes. In one respect these investigations have extended our knowledge, in that Dr. Werdinius has succeeded in showing that the basal metabolic rate is lowered in persons living on an unvaried milk-meal diet. We have made a special study of this observation.

The researches, which could for the most part be carried out in accordance with the original program, were intended to extend and complete those already initiated by the author at the Umeå Hospital.

I wish to acknowledge gratefully the valuable aid unfailingly rendered by all collaborators and assistants. In addition to those whose published works bear witness of their participation in the investigation. I beg to thank Dr. Anna Stina Pettersson for her assistance in arranging the material with respect to the various types of test-meals, Dr. Bettan Persson for her cooperation in the investigations on the effect of the »Dauersound», and Dr. Hans Pettersson for his help in the preparation of the principal tables. I am also greatly indebted to the laboratory assistants of the Umeå Hospital, Miss Cecilia Jansson and Miss Mimmie Olsson, to the ward nurses, Miss Edit Larsson and Miss Gerda Johansson, and to the secretaries, Miss Dagmar Mark and Miss Astrid Häggglund, for their disinterested labour, never-tiring assistance and patience in collecting and preparing the material from the Umeå Hospital.

I also wish to express my indebtedness to the staff of the Medical Department of the Borås Hospital, in particular to the head nurse of the out-patient department, Miss Lisa Carlsson, and to my present laboratory assistant, Miss Cecilia Jansson, who moved from Umeå to Borås, for their valuable assistance in collecting the Borås material.

I beg to thank those who directed the other parts of the investigations in Norrland, especially Dr. Westin, Director of the Department of Operative Dentistry, State Dental College, Stockholm, Dr. J. Byttner, Medical Councellor, for their amicable and very profitable cooperation.

Finally, I beg to record my sincere and respectful gratitude to Dr. Nils Hellström, Director General of the Royal Medical Board. It is thanks to his initiative that these researches could be started, and it is owing to his great interest, indefatigable energy and most valuable assistance, not the least in regard to the economic side of the matter, that it has been possible to carry them out.

B. Ethnographical Conditions in the Area of the Investigations.

The preliminary investigations at the Umeå Hospital indicated that there was a causal relation between the symptoms of diseases prevalent in Norrland and the ethnographical conditions, the climate and the living conditions of the inhabitants, especially

their nutrition. These matters have already been partly dealt with by HELLSTRÖM, the Director General, in Part I. In order to understand the following report it may, perhaps, be appropriate to give a short summary of the principal lines of investigation. Since the diet, as was shown by the researches made at the Umeå Hospital, in all probability constitutes the most important etiological factor in the observed disturbances, one of the fundamental features of the investigations is to throw light on the nutritional conditions, which in their turn are associated with climatic factors, the mode of living and the habits and customs of the inhabitants.

That part of Norrland in which these investigations were carried out, here called Upper Norrland, is bounded on the North by the 69th, on the South, by the 63rd parallel of latitude. To the West it borders on Norway on the meridian of 42° E. Its eastern boundary lies on the meridian of 24° E., being the Gulf of Bothnia (Map 1). The territory has an area of 15,432,096 hectares and in 1930 had a population of 398,158. Thus it is a very thinly populated territory, and this applies especially to the interior, for the settlements, with the exception of the mining-fields in Norrbotten, are concentrated in the coastal districts and along the river valleys.

The territory may appropriately be divided into 3 large districts. Farthest to the East on the Gulf of Bothnia is a flat coastal district about 5—12 miles wide (1 Swedish mile = about 6 English miles) with large stretches of cultivated land, extending into the country along the numerous river valleys. To the West of that district is a belt of woods, chiefly consisting of coniferous trees interspersed with birches. Furthest to the West, on the Norwegian frontier, there is a pure fjeld-region, 8—15 miles wide (Map 2).

The climate is severe, especially the farther one gets into the interior, with long, cold winters and short, relatively warm summers.

The inhabitants are for the most part Swedes, but in the mountainous district, especially in the County of Norrbotten, partly of Lapp origin or a mixed Swedish-Lappish race. In the North, towards the border of Finland, there is a considerable number of Finns.

As a rule the inhabitants, especially in the County of Västerbotten, have for centuries cultivated the soil inherited from their ancestors (about 63 per cent of the population of the County of Västerbotten is agricultural), and have been engaged in farming and forestry. It is only in the towns and the industrial communities along the coast that any noteworthy circulation of the population has taken place, due to immigration from more southerly parts of the country. This is still more marked in the large mining districts in the interior of Norrbotten, at Kiruna and Gällivare. In the coastal district the people can subsist by farming, whereas in the interior this is impossible owing to the severity of the climate.

The hay-harvests are abundant, especially in the coastal district.

Among the cereals, barley and rye are the most important. These ripen in the coastal district, but not in the interior, especially in the fjeld-districts. Potatoes are grown extensively, also up on the mountains, and generally yield good crops. Other plants are of little importance, and until a few years ago vegetables were grown only on a very small scale. A change seems, however, to have taken place in this respect, especially in the coastal district, where the cultivation of vegetables has increased considerably, as the result of the propaganda conducted in connection with these investigations.

Cattle-breeding of any importance scarcely exists in the part of Norrland under discussion, not even in the coastal district, mainly owing to the long and cold winters. In the interior, on the other hand, reindeer-rearing is of great importance, even for the settled population, making the supply of good and cheap meat abundant. Poultry breeding is on quite a small scale and has no bearing on the nutrition of the inhabitants.

Hunting and fishing are of great importance to the inhabitants of the mountain district, especially in Norrbotten, but more from an economical point of view than for nourishment. In the coastal district fishing, mostly salmon and herring fishing, also play a certain rôle in this respect.

As mentioned above, forestry is of the greatest importance for the inhabitants. But for this source of livelihood the population of the forest district would not be able to subsist. It affords the people ample opportunity of eking out their income by selling, cutting and floating timber.

In addition to the nature of the country and the climate there is another very important factor in the life of the inhabitants, which differs in many respects from that of the population in other parts of Sweden. That is the isolation. The coastal district is rather well provided with roads. The villages are relatively large. But until quite recently communications with the south of Sweden had been very bad. The great increase of motor traffic during the last few years has, however, conduced towards minimizing the isolation.

In the interior of the country the villages become smaller and smaller, being composed of a few farm-houses or small cottages. Isolated small farms become more and more common. Often these small villages or farms have no roads. In this respect, however, a change for the better has taken place. For natural reasons the railroads in this extensive and thinly populated area cannot be extended. A much more important factor in dispelling the isolation is undoubtedly the extensive road-building that has been going on during the last few years, and the day is not far distant when a high road will lead to every village. It is obvious that this will be of vital importance in putting an end to the isolated life of the inhabitants and in the development of the country. The increased installation of telephones and the progress, of late years, of broadcasting have also contributed to the improved conditions.

Comparative investigations were carried out in the southern part of the Province of Skåne, situated on 56° N. latitude, and in the southern part of the County of Älvsborg, lying being 58° and 59° N. latitude.

The investigated area in Skåne is a fertile plain with a mild climate and lies less than 100 metres above sea-level. Wheat, rye and barley ripen and good crops are obtained. Cattle-breeding and poultry-farming are carried on very extensively. Fruit-growing and gardening also give the grower good returns. There are scarcely any large forests, and they are at any rate of secondary importance. On the other hand, industry is highly developed, especially in the numerous towns. But the investigations are mainly concerned with the agricultural population.

The communications in Skåne are very good. The district is traversed in all directions by an extensive network of roads and railways. This is also the most thickly populated area in Sweden.

That part of the County of Älvsborg, viz. the district of Borås, in which these investigations were made, consists of hilly woodland with farms and fields scattered here and there. However, in this district industry occupies the dominant position both in the town of Borås, with a population of about 40,000, and in the river valleys running in a south-westerly direction. Among these, the Viskan valley deserves special mention. The population is therefore chiefly industrial. It should be noted that the women are employed in the factories to the same extent as the men. Owing to the density of the population and the relatively small agricultural production the requisite supply of foodstuffs must be procured from surrounding counties; which is also possible thanks to the efficient means of communication.

C. The Investigation Material.

As already mentioned, the material on which these investigations are based consists mainly of patients in the out-patient and in-patient departments of the Umeå Hospital. The material in its entirety was collected and thoroughly examined by the author, and comprises in round figures 6,760 cases after considerable elimination; we shall return to this matter later. The majority of the cases were collected during the period from September 1928 to the end of 1929. Further, a number of examinations were made in 1930 and 1931 for the purpose of supplementing the material, and the author's hospital material from earlier years was also utilized in part.

A material, comprising 133 cases, was collected under the direction of *Dr. N. Rahm* from among the patients admitted to the military hospital of Boden (Norrland).

So-called »district examinations» were conducted by the county medical officers of Norrbotten and Västerbotten; they made special journeys for the purpose of examining entire villages (2,494 cases). These examinations were confined mainly to adults. In addition 3,406 school children in the above-mentioned counties were examined.

As it was necessary for a correct estimation of the incidence of diseases and also of the part played by the supposed etiological factors, climate, food etc., to obtain comparative material from other parts of the country, investigations for that purpose were carried out in southern and central Sweden.

In 1929 the hospital of Lund contributed 1,895 examinations, made under the direction of *Prof. S. Ingvar* and *Dr. H. Silwer.*

At Hälsingborg Hospital *Drs. Stenström* and *Silwer* supervised the examination of 122 cases, and at Borås Hospital (*Dr. Odin*) 2,000 cases were examined.

Moreover, 34 district investigations and 464 examinations of school children were made in the Province of Skåne.

Thus the total number of examinations amounts to 17,406, including 12,989 from Norrbotten and Västerbotten.

The main part of the material consists of persons who have attended the hospitals for some reason or other. Hence most of the material consists of patients suffering from some ailment. It was therefore not possible to utilize it for our purpose to its full extent; quite considerable weeding-out was necessary. The procedure adopted will be explained below. Briefly, the method of elimination resorted to implies that every case suffering from a disease which might be thought to have been conducive to the origin of the symptoms under discussion was excluded. This elimination was carried out very rigorously and thus resulted in the exclusion of about 50 per cent of the hospital material.

The drawbacks entailed in the fact that the material was thus composed largely of persons suffering from disease are counteracted to a great extent by the extensiveness of the material, as mentioned above, which made a very radical weeding possible. The advantage of investigating hospital material is that the examiner has the equipment and facilities of an up-to-date hospital at his disposal. It was especially valuable that the extensive researches at Umeå and Borås was made by the same person. The district and school investigations, on the other hand, were performed on healthy subjects, and thus usefully supplement the hospital examinations. They were performed, however, by several investigatiors, whence they gave room for various subjective points of view and interpretations. This material it thus somewhat lacking in uniformity. Nor could the examination of individual cases, for obvious reasons, be as extensive and complete as in the hospital investigations.

A record of every case examined was kept in accordance with the form below. More detailed records were kept of the examinations of the hospital patients. Chief attention was given to investigation of the diet and mode of life of the population, the occurrence of intestinal worms, gastric and intestinal symptoms, and the condition of the blood.

Form of record.

Date: ..... Name: ..... Age: .....
Occupation: ..... Domicile: .....
Diagnosis: .....

Brief data of previous condition.

Brief data of present condition.

Presence of: Oppression and tension in the epigastrium? When?
Pain? When?
Eructation? When?
Vomiting? When?
Constipation? Diarrhoea?
Worms?

Other data (pregnancy, parturition, indoor life etc.)
General cond.
Corrected.
Hb. (Sahli) Examination of blood corpuscles:
Uncorrected.
Gastric analysis, on an empty stomach:
1st lavage: Ret.: Free HCl: Tot. acid.
» » , hours after meal:
Test breakfast: Amount: Free HCl: 2nd lavage: Free HCl: Tot. acid.
Faeces: Mucus: Weber: Parasites:
Other remarks:

CHAPTER I.

Nutritional Conditions of the Population.

A. General points of view.

The mode of living of the inhabitants varies considerably according to the part of the country in which they live. This is due, as mentioned above, to the different possibilities of gaining their livelihood.

Thus the food of *the population of the coastal district* consists mainly of the products of the local farming, viz. a food rich in milk and carbohydrates. The number of live stock is seldom more than that necessary to supply the members of the farm with butter and milk and possibly a small quantity of cheese. In the last few years, however, a great improvement has taken place, owing to a more rational and intensive farming, and crops have increased. Cattle are slaughtered, as a rule, only once a year, but as a great part of the meat is sold the consumption of meat is strikingly low in many households. Pigs are bred, usually on a small scale, not to supply the requirements of the household but for marketing purposes. On the other hand, the supply of milk and butter is rather good. Few of the inhabitants keep poultry, and the eggs are generally sold. The inhabitants themselves eat very few eggs, and a fowl is seldom found on the table.

Fishing is of rather little importance except to the fishermen living along the coast and on the neighbouring islets. Hunting, too, is of no great importance in the coastal district from the point of view of nutrition.

Thus among animal foodstuffs only milk and butter are of importance to the nourishment of the agricultural population, whereas meat, fish and eggs form a very small part of their food.

Cereal products are the most important items in the food of the people. Barley and rye generally yield good harvests, and

there is therefore seldom any shortage of barley or rye meal. Wheat does not ripen in this part of the country, but wheat flour is nevertheless considered necessary for the household and is seldom wanting. It is imported from America and from the South of Sweden. Potatoes are also a very important article of food. The potato crops are generally very good. It is seldom that the supply is not sufficient for the whole year, at least in Västerbotten.

Thus the diet of the population of the coastal district consists mainly of meal and milk food, butter, bread and potatoes. The quality of the milk, butter and even potatoes is frequently rather good.

The diet of the population of the forest districts differs in many respects from that of the coastal population. In this part of the county the farmer can hardly obtain his whole livelihood by farming. For that reason the men spend a great part of the year in the forests, engaged in timber-cutting in order to eke out their income. Especially those forest workers who subsist for months on stores bought from home, and live in huts, live on a diet that differs widely from that of the population of the coastal district. The milk-meal diet is out of the question, and, instead, meat and bacon, both the so-called American fat bacon and the leaner Swedish kind, are the chief items of food. In former times the diet of these forest labourers was extremely unvaried, consisting of bacon, meal, bread and coffee. A considerable change has, however, taken place, especially in the last decade. Pork and bacon, it is true, still form one of the chief items of the diet, but also meat, mostly reindeer flesh and sausages, is eaten to a great extent. Further, milk, both fresh and so-called ropy milk, nowadays forms part of the provisions. Potatoes, too, are seldom lacking.

In the mountainous districts fishing is of great importance. There is plenty of fish in the mountain-lakes, and fish is a large item in the diet of this population. Hunting, as far as nutrition is concerned, is more important here than for the inhabitants of the other districts.

With regard to the diet of the population in towns and large industrial communities there is not much to be said. It does not differ much from the food in corresponding localities in other parts of Sweden, being an ordinary mixed diet.

It is obvious that between the above-mentioned principal types of diet there is an exceedingly wide series of transitional types

and variations. In our attempts at classifying the food, an account of which will be given below, we have as far as possible taken these circumstances into consideration.

A matter meriting special attention in this connection is the small supply of vegetables and fruit in Upper Norrland. There are still some of the inhabitants who have never seen or tasted an apple or an orange. Vegetables are not grown to any great extent except in the environs of the towns and large villages. Even if vegetables were procurable, the inhabitants dislike them too much to eat them. The only way in which fruit is eaten by the majority of the rural population is in the form of soup made of mixed dried fruit.

As a rule the inhabitants do not pick the wild berries growing in the woods for their own use. They may possibly eat them when ripe in the autumn but seldom preserve them for winter use.

In regard to the consumption of fruit and vegetables in Upper Norrland, like so many other things, there seems to be a gradual change for the better.

1. *Preparation of the food.*

In Upper Norrland food is generally boiled. Meat, for instance, is always boiled and is eaten either together with the broth or, which is more usual, the pieces of meat are taken out of the pot and eaten with potatoes, the broth being thrown away. Both fresh and salted meat are prepared in the same manner. Meat that is not sold or consumed at once is salted and eaten uncooked.

In the fjeld-regions in Västerbotten and in a great part of Norrbotten, where, as mentioned above, reindeer meat forms part of the food of the inhabitants, the meat is preserved in a different way. After being slightly salted it is hung on special drying-racks to dry in the air, and when ready for use is cut into thin slices and eaten raw, or is used for making meat soup. The dried meat is sometimes roasted together with bacon. When a reindeer is slaughtered the blood is kept very carefully. It is poured into the cleaned stomachs of the reindeer and then hung up to freeze. The blood is then thawed as required, and used for making blood puddings, etc.

Game, if eaten at all, is mostly boiled. Many will not take the trouble to feather game-birds and do not consider the small quan-

tity of flesh worth while cooking, and therefore game is often shot only for sale.

In Norrbotten game is eaten more than in Västerbotten.

Pork, fresh and salted, is sometimes boiled before being eaten. But it is mostly used as an ingredient in certain dishes chiefly consisting of flour and potatoes. Lumbermen, for instance, make a kind of dumpling with flour and bacon in the following manner: a dough is made of wheat flour and water and fried in a frying-pan in which the fat bacon has been melted, so that the pan is half filled with dripping. The dumpling floats in this dripping, absorbing the boiling fat. Sometimes cubes of bacon are mixed with the dough, as, for instance, in another dish peculiar to Norrland. Flour, grated potatoes and water are mixed and made into balls about the size of a goose's egg, filled with cubes of bacon and then boiled. By mixing blood with the dough another dish called »blood-dumpling» is made.

Salt herring and a small species of herring caught in the Baltic are the principal kinds of fish eaten. In the coastal district herring may be said to be the regular breakfast dish. The fish is always boiled.

The inhabitants of the inland districts of the county eat, besides herring, large quantities of salted fish caught in the mountain lakes, mostly gwyniad, but also pike, perch, trout and salmon-trout. As a rule the fish is boiled. In Norrbotten and in the Västerbotten Littoral, especially on the isle of Holmön, fish is eaten au naturel or »marinated», i. e. allowed to ferment; this is especially the case in Norrbotten. The fish used for this purpose is usually gwyniad, which is salted in the autumn, but not sufficiently to prevent it from fermenting in the following spring. It is eaten uncooked or boiled.

As already mentioned, the supply of milk is relatively good, except in certain parts of the mountainous regions, especially in Norrbotten, and there are few homes where no fresh milk is drunk every day, although the quantity consumed may not be large. Ropy milk is very much liked. Owing to the action of a special bacillus the milk becomes viscid and thready, hence the name. Sour milk, which is so common in South Sweden, is hardly ever used in Norrland. One of the properties of ropy milk is that in cold weather it can be kept for several weeks without deteriorating, and is therefore a very suitable item of food for lumbermen, who frequently take large supplies with them to work.

Butter is eaten daily by all those who have a cow-house of their own, but generally in very small quantities. In many quarters margarine has come more and more into vogue. Workmen in the woods and forests consume butter and margarine in about equal proportions. Among the industrial population the consumption of margarine is perhaps higher than that of butter.

Generally speaking, very little cheese is eaten in the coastal district. In the fjeld-regions, on the other hand, reindeer cheese is found on the table every day, and whole-fat cheese is much in demand among the population in the forest districts.

Bread is still baked mostly at home. All large farms are equipped with special bake-houses. The kind of bread usually made is hard bread, often of unfermented barley meal and in the form of very large, thin cakes. That is the rule in the coastal district of Västerbotten. In the interior thick, coarse, hard bread is more usual. In Norrbotten bread made of rye and wheat is preferred. Rye bread is leavened and so is bread made of mixed meals and flour. For baking purposes fine-bolted flour is generally used. Coarse, unbolted flour, however, seems to be getting more and more into favour.

A very important article of food, and one found almost daily on the table, especially in Västerbotten, is a dish called »bryta» (Sv. bryta = break), made of milk and so-called »clap-bread», thin, hard bread. This bread is broken into small pieces and put into a plateful of milk. The milk is seldom boiled. Another, but not so common, dish is a kind of sop, but in this case the bread is soaked in hot meat-broth.

Porridge is a daily item of the diet in the coastal district of Västerbotten. It is usually made of barley and wheat meal, whereas porridge made of rye meal and especially oats is a less common dish. In addition to »bryta», porridge and milk, different kinds of gruel form an essential part of the food of the seaboard population, especially in Västerbotten. Another kind of gruel, very common in this district, is served with batter-balls. Flour and water are mixed into batter-balls, which are then boiled in milk. Another common dish is pancake, made very thick and seldom contains eggs.

It is quite unnecessary to enter into any details with regard to the preparation of the food in the provinces of Skåne and Västergötland, since it contains no particulars of interest. The

composition of the food, in so far as it may be of interst to our subject, will be discussed below.

2. *Different types of diet.*

a. *Dietary anamnesis.* In order to form an idea of the diet of the population, especially in Upper Norrland, a special record was kept of the diet of the persons examined. The purpose of this record was to try to obtain an expression of the standard diet on which the person examined subsisted. The period of time chosen for the dietary anamnesis was one week. For this purpose a bill of fare was made up for each day of the week. As a rule no great difficulty was experienced in this matter, since there is very little variety in the diet. The dietary data, giving the dishes most frequently consumed, could therefore be recorded on very plain diet cards. Three such diet cards are reproduced below, properly filled in, showing the various types of diet (pp. 24—25).

As a rule the inhabitants have three meals a day, breakfast, dinner and supper. In the diet cards these meals were used as the headings of columns. The figures placed after each dish denote how many days a week that particular dish formed part of the meal. Further, the consumption of coffee is recorded in the card, the figures entered representing the number of cups drunk daily. It was also noted whether coffee was drunk on an empty stomach. It was also recorded on the card whether the person examined was in the habit of using tobacco in any form, and if he drank spirits.

By means of the diet cards a fairly good idea could be obtained of the standard diet of the person under examination. The possibility of a change taking place in the examined individual's diet from week to week, or from season to season, must, however, be always borne in mind. For that reason two diet cards were sometimes used for one individual, one for each season, especially in the examination of the diet of the forest-workers. It appeared, however, that the diet of the great majority of the inhabitants was astonishing unvaried. In spring, summer, autumn and winter the composition of the diet remains practically the same. The only classes that vary their diet to any notworthy extent are the

more well-to-do urban population and people living in large industrial communities. As far as these two last-mentioned categories are concerned a variation in the diet is noticeable even in the weekly bill of fare.

b. *Classification of the various types of diet.* In order to obtain a more surveyable arrangement of the entire material, with respect to the dietaries of the persons examined, it was found necessary to classify the diets into various types.

As indicated above, it is possible from the composition of the food, as far as Norrland is concerned, to distinguish three large diet groups. The first group is denoted by the letter L (the initial letter in the Swedish word »lantbrukare», meaning farmer). It is most numerously represented among those inhabitants who earn their living by farming. This group includes all persons whose chief nourishment consists of cereals and milk food. According to the degree of uniformity with which cereals and milk form part of the meals, two sub-divisions may be made, LI and LII.

In its extremest form the LI group consists of a diet in which the food of all three meals consists only of dishes made of meal and milk, such as porridge, different kinds of gruel, plain flour dumplings in milk, pancakes together with bread and butter and potatoes.

In one respect, however, the designation LI diet has for practical reasons been given a somewhat wider application. Small Baltic herring, or less frequently the larger North Sea herring, is an item in what may be said to be the standard breakfast meal of that portion of the population, which otherwise subsists almost exclusively on cereals and milk food. The designation LI is therefore used even if herrings are eaten for breakfast every day, since the quantity is very small, on an average 25 grammes daily, and may thus be regarded as simply a little tit-bit or relish with the other ingredients of the meal, which, as already mentioned, consists of potatoes, bread, milk and butter.

Meat for dinner once a week or every other week has been included in the designation LI. Meat is generally eaten on Sundays together with the other articles of food and usually in the form of meat broth. This addition of meat to the diet is by no means usual in all homes.

If fish or meat, in addition to the herrings in the morning, is eaten twice or three times a week, the diet has been referred to

the next group, LII. On the other hand, if meat or fish is eaten three or more times a week the diet has been classified as a B diet (= mixed diet); thus the designation BI denotes 4—5 fish or meat meals a week and BII more than 5 such meals weekly. It is obvious, however, that there are many variations within each group. If breakfast consists exclusively of cereals and milk, that is, no herrings are eaten, a somewhat greater number of additional meals of fish and bacon, two per week at most, has been permitted and the diet has been assigned to the LI group. But no diet containing an additional allowance of meat was assigned to this group, in fact such additions to the diet occurred very seldom. The fundamental principle of the LI diet is that it consists of an extremely unvaried cereal and milk diet with a minimum of animal products other than those contained in milk.

As already mentioned, the symbol B denotes those diets in which there is a greater variation of food-stuffs used. The fare served at a house-wifery school restaurant, that is, good homely fare, may be taken as the type of this diet. It follows of course that the B diet will comprise a considerable number of quite differently composed diets. This group includes, on the one hand, all kinds of fare that cannot be referred to the L group, but, on the other hand, cannot be classified in the following S group (the bacon diet). Attempts were made to form a number of other diet groups, for instance, one in which fish was the dominating item of the fare (among a portion of the inhabitants of the mountainous regions), another in which milk was absent, etc., but it was found that the plan could not be carried out.

The third diet group includes that type of diet in which bacon is the principal article of food. Typical consumers of this kind of food are found especially among forest-workers.[1]

It has already been pointed out that the men working in the forests are often compelled to live for months in temporary huts far from inhabited places, and have therefore to cook their food themselves from the supplies they bring with them from their distant homes. The most important articles of their food is fat American bacon or the leaner Swedish bacon. Formerly workers in the forests subsisted exclusively on bacon, meal, bread and

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[1] The Swedish word for wood or forest is »skog»; hence the designation S diet.

butter. This extreme type of S diet is designated by SI. There are still people who live on such a diet, but generally it is somewhat modified. The forest workman, it is true, still eats bacon once or even twice every day, but it is supplemented with meat, sausage, cheese, potatoes and milk. If the fare in this way becomes more varied, but still retains the character of the S diet (consisting chiefly of bacon), it is given the designation of SII diet.

This method of classifying the diets into different groups does not, however, supply much information concerning the amounts of food stuffs with a high content of vitamin C consumed. A rough assessment of the amount of vitamin C in the main groups mentioned above will show, however, that an L diet, by reason of the large quantities of milk it contains, is richer in vitamin C than an S diet, which contains considerably smaller quantities of milk. The consumption of potatoes is about equal in both diets. The most important source of supply of vitamin C, fruit and vegetables, has not, however, been taken into account in the above nomenclature.

The persons examined have therefore been specially questioned if fruit and vegetables formed part of their food, and if so, how often. On the basis of the data thus obtained a special nomenclature was adopted, viz. a-, b- and c-diet. An a-diet denotes a diet which does not contain fruit and vegetables. The diet of the great majority of the population must be referred to this group, since, as already mentioned, the consumption of fresh fruit and vegetables is very small among the rural population. The dried, mixed fruit which the people buy at the shops and use for making fruit soup cannot be considered an addition particularly rich in vitamins. For that reason a diet, containing one or, in exceptionally cases, two such meals a week was nevertheless classified as an a-diet. On the other hand, if 2—3 meals of fresh fruit and vegetables a month were served the diet was designated as a b-diet. A diet containing two or more such meals weekly has been recorded as a c-diet.

Thus the symbols employed to designate the different types of diet are: LIa, LIb, LIc, LIIa, LIIb and so on. Three diet cards, showing different types of diet, LIa, BIIc and SIa respectively, are reproduced below.

Diet LIa.

Coffee: number of cups daily: *5—6* On an empty stomach, in the morning: *1—2*

Tobacco { Number of pipes: / Cigars: / Cigarettes } *0* Snuff (chewing): *0* Spirits *0*

The meals generally consist of (the figures in the different columns denote *the number of times per week* the articles of food were ingredients of the meals, in the column of remarks information is given as to *the form in which the article of food in question was consumed*):

	Breakfast	Dinner	Supper	Remarks
Bread	*7*	*7* (»bryta» *2—3*)	*7*	»*Clap-bread*».
Milk	*7*	*7*	*7*	
Butter	*7*	*7*	*7*	
Porridge	—	—	*7*	*Made from flour and barley-meal 4.*
Gruel	—	*2—3*	—	
Herrings (large)	—	—	—	
Baltic Herrings (small)	*4—5*	—	—	*Boiled.*
Other kinds of fish	—	—	—	
Bacon	—	—	—	
Meat	—	—	—	
Potatoes	*4—5*	—	—	
Fruit-juice and fruit	—	—	—	
Vegetables	—	—	—	
Pancakes	—	*1*	—	

Diet BIIc.

Coffee: number of cups daily: *5—6* On an empty stomach, in the morning: *1—2*

Tobacco { Number of pipes: / Cigars: / Cigarettes } *0* Snuff (chewing): *0* Spirits *0*

The meals generally consist of (the figures in the different columns denote *the number of times per week* the articles of food were ingredients of the meals, in the column of remarks information is given as to *the form in which the article of food in question was consumed*):

	Breakfast	Dinner	Supper	Remarks
Bread	*7*	*7*	*7*	*Coarse hard-baked, soft, fine.*
Milk	*7*	—	*7*	
Butter	*7*	—	*7*	
Porridge	*2—3*	—	*3—4*	*Made of oat-meal or rye-meal.*
Gruel	—	—	—	
Herrings (large)	*1*	—	—	
Baltic Herrings (small)	—	—	—	
Other kinds of fish	*1—2*	*1—2*	—	
Bacon	*1—2*	*1*	—	*Roasted or boiled, mostly salted.*

	Breakfast	Dinner	Supper	Remarks
Meat	*1—2*	*4—5*	—	*Mostly roasted.*
Potatoes	*3—4*	*6—7*	—	
Fruit-juice or fruit	—	*2—3*	—	*Fruit, fresh or stewed.*
Vegetables	—	*2—3*	—	
Eggs	*2—3*	—	—	
Pancakes	—	—	—	
Tea	—	—	*3—4*	
Cheese	—	—	—	

Diet SIa.

Coffee: number of cups daily *5—6* On an empty stomach, in the morning: *1—2*

Tobacco { Number of pipes: / Cigars: / Cigarettes } *0*

Snuff (chewing): *0*

Spirits *0*

The meals generally consist of (the figures in the different columns denote *the number of times per week* the articles of food were ingredients of the meals, in the column of remarks information is given as to *the form in which the article of food in question was consumed*):

	Breakfast	Dinner	Supper	Remarks
Bread	*7*	*7*	*7*	
Milk	—	—	*4—5*	*Ropy milk 2.*
Butter	*7*	—	—	
Porridge	—	—	*4—8*	*Wheaten flour.*
Gruel	—	—	*4—5*	
Herrings	—	—	—	
Other kinds of fish	—	—	—	
Bacon	*7*	*4*	*2—3*	*Made into dumplings or fried. About same number of times.*
Meat	—	*1*	—	*Dried reindeer meat.*
Potatoes	—	*4*	—	
Fruit	—	*1*	—	*Boiled dried fruit.*
Vegetables	—	—	—	

c. *Frequency of the different diets.* The following table shows the frequencies of the different diets based on the data obtained in the district investigations in Västerbotten. In this table the province has been divided into 4 different districts. Owing to its great expanse the forest district has been divided into two separate districts, outer and inner.

	L diet	B diet	S diet
A. Coastal district	180 (59 %)	104 (34 %)	21 (7 %)
B. Outer Forest district	69 (47 %)	66 (45 %)	12 (8 %)
C. Inner Forest district	113 (31 %)	215 (59 %)	36 (10 %)
D. Mountainous district	105 (32 %)	115 (35 %)	108 (33 %)

Owing to the incomplete data supplied by the diet anamnesis it is hardly possible to separate the different diets into several

subdivisions, at any rate not without a considerable reduction of the number of cases. Such a subdivision would therefore be of no particular value.

The L-diet is most frequent in the coastal district, 59 per cent of the population subsisting on that diet. Farther inland this type of diet decreases in frequency. Nevertheless 31 per cent and 32 per cent of the population in the forest and mountainous districts still live on this kind of fare. The B diet is most common in the forest districts, where from 45 to 59 per cent of the population subsist on it. In the coastal and mountainous districts the frequency figures amount to 34 and 35 per cent respectively. The S diet increases in frequency the farther we get into the interior, being used by 33 per cent of the population in the mountainous district.

Only 9 per cent of the population eat fruit and vegetables to such an extent that their diet can be assigned to the b-diet. Not a single case that could be assigned to the c-diet was found in the district investigations.

Judging from the results of the district investigations, the women live on the L diet to a much greater extent than the men, the proportion being 2 : 1 ; the men subsisting mostly on the B or S diet. As regards the frequency of the S diet the proportion of men to women is 37 : 1, the reason being, as already pointed out above, that a great number of the men are employed in the forests and cook their food in huts or live on provisions brought with them from home.

The following table shows the frequency distributions of the different diets in the hospital material.

Thus in the hospital material practically only the L and B diets are represented. The frequency of the B diet is somewhat higher than that of the L diet, owing to the fact that the hospital material contains a relatively large number of townspeople. The L diet is more common among women. The frequency distributions for men and women are 35 and 48 per cent respectively. Fruit and vegetables occur much oftener in the diet of the hospital material than in that of the rural material. As mentioned above, this is due to the fact that a large number of those attending the hospital are townspeople. If the hospital material is grouped according to the diets and the home districts of the patients in the same manner as in the district investigations, the result will be approximately the same.

Frequency distributions of the different diets in the hospital material from Umeå.

Diet	Men		Women	
	Number of cases	Per cent.	Number of cases	Per cent.
LIa	98	17.8	196	29.5
LIb	9	1.6	10	1.5
LIIa	71	12.9	89	13.4
LIIb	16	2.9	25	3.8
Total L diet	194	35 %	320	48 %
BIa	192	34.8	158	23.8
BIb	108	19.6	156	23.5
BIIb	7	1.3	14	2.1
BIIc	13	2.4	15	2.3
Total B diet	320	58 %	343	52 %
SIa	4	0.7	—	—
SIIa	33	6	1	0.2
Total S diet	37	6.7 %	1	0.2 %

The contribution of the hospital material to the frequencies of the different diets is relatively small, compared to the extent of the material examined. This is due to the fact that a certain number of cases affected with diseases which may be suspected to have an influence on the diet had to be excluded. The cases included in the investigation can therefore be regarded as »healthy» subjects.

In Norrbotten the frequencies of the various diets are different. The percentage of the L diet group is lower than that of the B diet group, although the L diet group seems to be most widely represented in the coastal district. The farther we get into the interior of the country and the farther to the North, the B diet becomes more frequent, as shown by the following table.

Frequency distributions of the different diets in Norrbotten.
(Figures based on the examination of 1,280 cases.)

	L diet	B diet	S diet
Arjeploug	36 %	62 %	2 %
Jukkasjärvi	13 %	86 %	—
Övertorneå	12 %	87 %	—

Judging from the results of the present investigation, it appears that the L and S diets are relatively rare, and that the B diet

groups are predominant. As already mentioned, fish is a general item in the diet of the population in Norrbotten. Of the L diet groups the LIIa diet is practically the only one found in Norrbotten. In Västerbotten, on the other hand, the LIa diet is the most prevalent of the L diets.

Even in Norrbotten fresh fruit and vegetables are seldom present in the diet. Only 10 per cent of the cases could be assigned to the b- or c-diets.

A comparative inquiry was also made at the Lund Hospital for the purpose of throwing light on the dietary conditions in the Province of Skåne in South Sweden. The majority of the patients at the Lund Hospital are country people.

Frequency distributions of the different diets in the hospital material fom Lund.

Diet	Number of cases	% of the total material
LIa	24	1
LIb	17	0.9
LIIa	19	1
LIIb	28	1.5
Total L group	88	4.4 %
BIIa	507	27.5
BIIb	855	46.1
BIIc	404	21.8
Total B group	1866	95.4 %

It will be seen from the table that the population of Skåne, judging from the Lund material, subsists as a rule on a much more varied diet, which can generally be classified as a BII diet. The consumption of fruit and vegetables is also much more general than in Norrland.

The investigations of the diet of the industrial population in Central Sweden (the County of Älvsborg) show, as was to be expected, a still higher frequency of the B diet. Not less than 97 per cent of the inhabitants live on a B diet, practically all cases being assigned to the BII group. The frequency of the L diet is only 1.4 per cent, that of the S diet 1.6 per cent. Fresh vegetables and fruit form an almost regular part of the dietary, at least in

sufficient quantities to be characterized as a b-diet. In 47 per cent of the cases the diet was assigned to the c-group.

The diet of school children has, on the whole, the same composition and distribution as that of adults. The L diet is most frequent in the coastal district, decreasing in the interior of the country, where it is substituted by the B diet. The S diet is rare in this material. Still, the L diet is more frequent among school children than among adults. In the inland districts, too, it is the diet consumed by more than 60 per cent of the cases, which is explained by the fact that while at school the children have to live to a great extent on provender and milk brought with them from home. A diet, richer in vitamin C, corresponding to the symbol b, is taken by only 20,5 per cent of the school children examined. Most of the children subsisting on this diet live in the towns, 54 per cent of them, for instance, in Umeå, and in the industrial areas, 30 per cent. In the mountainous district and the forest district an a-diet seems to be a rule without exception for school children.

3. *Consumption of coffee.*

The investigations were also intended to obtain information about the quantities of coffee consumed and the possible effects of this consumption. The persons examined were questioned as to the number of cups of coffee they usually drink per day and if the coffee was drunk on an empty stomach. It is obvious that statistics based on these data should be taken with a certain amount of reservation owing to the sources of error incident to the acquisition of such information. But these statistics are of some value and they are also the simplest means of obtaining a fairly accurate general idea of the consumption of coffee.

According to all official records the consumption of coffee by the inhabitants of Upper Norrland is said to be very great. That is undoubtedly the case, especially as far as the forest-workers are concerned. A survey of the forest-workers in Norrbotten and Västerbotten, undertaken in 1930 by Lindgren and Blom at the request of the Royal Medical Bord, showed that a forest-worker usually consumed from 9 to 12 cups of coffee daily, equal to an estimated caffeine content of 58 cg. The average consumption of coffee for the entire population is not so high, as will be seen in the following table showing the figures obtained in the district

and hospital investigations. A brief description should first be given, however, of the method in which the inhabitants of Norrbotten prepare their coffee. Whereas the coffee drank by the forest-workers while at work in the forests is strong, that drunk in the homes is weak. As a rule coarse-ground coffee berries are boiled in water, more coffee being added every time. The coffee-grounds are not thrown away until the kettle is quite full. Very often, indeed, these grounds are carefully boiled up once more in order to »extract all the strength».

This way of making coffee is also customary in many parts of the South of Sweden, at least in the Province of Skåne.

The table showing the consumption of coffee in Västerbotten is based partly on the examination of 1585 persons (710 males and 875 females) at the various district investigations, partly on the examination of the hospital material at Umeå, comprising 2793 cases (1260 males and 1533 females). The cases are grouped according to the number of cups drunk daily (see following table).

According to the results obtained in the district investigations, the average consumption of coffee is 5—8 cups a day. The men in particular drink large quantities of coffee.

In the hospital material the consumption of coffee is definitely lower than in the district material. About half of the cases take less than 5 cups a day, which is explained by the fact that the hospital material contains a large proportion of town-residents, who generally drink less coffee than country people.

As a rule 1—2 cups of coffee are drunk the first thing in the morning. Judging from the district investigation, this occurs in 93.7 per cent of the cases.

The coffee consumption of school children in Norrland is shown in the following table, the number of children examined amounted to 2504.

Coffee Consumption among School Children.

Number of cups	0	1—3	4—7	>7
Number of cases	498 (12.1 %)	1873 (74.6 %)	118 (4.7 %)	150 (6 %)

Thus the average consumption is 1—3 cups of coffee per day. There is no essential difference between the various districts investigated, although the consumption at Umeå and in the industrial communities is somewhat lower than in the rural districts.

District investigations:

Number of cups a day	0		1—4		5—8		9—12		> 12	
Number of cases.....	19 (1.2 %)		438 (27.2 %)		800 (50.5 %)		274 (17.3 %)		54 (3.5 %)	
	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.
Number of cases.....	7 (1 %)	12 (1.2 %)	163 (23 %)	275 (31 %)	362 (51 %)	438 (50 %)	142 (20 %)	132 (14 %)	36 (5 %)	18 (2.2 %)

Hospital investigations at Umeå:

Number of cups a day	0		1—4		5—8		9—12		> 12	
Number of cases.....	145 (5.2 %)		1175 (42.1 %)		1163 (41,7 %)		251 (9 %)		59 (2 %)	
	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.
Number of cases.....	70 (5.6 %)	75 (4.8 %)	508 (40.3 %)	667 (43.5 %)	519 (41.2 %)	644 (42 %)	124 (9.8 %)	127 (8.5 %)	39 (3.1 %)	20 (1.3 %)

Coffee consumption in Skåne and Västergötland.

The hospital material at Lund:

Number of cups a day	0		1—4		5—8		9—12		>12	
Number of cases	150 (8 %)		1116 (60 %)		569 (30 %)		29 (2 %)		—	
	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.
Number of cases	70 (8 %)	80 (8 %)	488 (55 %)	628 (64 %)	308 (35 %)	261 (27 %)	17 (2 %)	12 (7 %)	—	—

The hospital material at Borås:

Number of cups a day	0		1—4		5—8		9—12		>12	
Number of cases	82 (6.8 %)		820 (68.3 %)		267 (22.3 %)		31 (2.6 %)		—	
	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.
Number of cases	32 (5.9 %)	50 (7.6 %)	358 (66.2 %)	462 (70.2 %)	139 (25.6 %)	128 (19.5 %)	13 (2.4 %)	18 (2 %)	—	—

Coffee, together with bread and butter or cake, is taken by 42.1 per cent of the children immediately after getting up in the morning.

According to the investigations made at the Lund Hospital (891 males and 981 women) and the Borås Hospital (342 men and 658 women), the consumption of coffee among the populations of South and Central Sweden is shown in the table on p. 32.

Judging from these figures, the inhabitants of Skåne generally drink 1—4 cups of coffee per day. The average consumption of coffee is somewhat lower than that in Norrland, as shown by the data for the hospital material at Umeå.

The district investigations in Skåne do not allow of any definite conclusions being drawn as to the consumption of coffee.

Judging from the data obtained, the coffee consumption in the Borås material is still somewhat lower than in the Skåne material.

4. *Consumption of Tobacco and Spirits.*

The use of snuff, as a rule placed between the lips and the teeth, is very common among the men in Norrland. The snuff provokes an excessive flow of saliva. The saliva is diluted with tobacco juice, which is as a rule spat out, but not infrequently swallowed. The consumption of snuff varies between 100 and 500 grams a week.

The district investigations indicate that snuff was used in the above manner by 42 per cent of 735 men examined.

Of 460 men in the hospital material, 118, i. e., 25.6 per cent, chewed snuff. The difference in frequency is owing to the fact, mentioned above, that the hospital material comprises a fairly large number of inhabitants from the towns, where snuff-chewing is less frequent than among the rural population. Women never chew snuff.

In the Norrland material the number of smokers is not very high and the quantity of tobacco used is not very great either; some 40 per cent of the men state that they smoke tobacco. Among the women tobacco smoking is of rare occurrence. The elder generation of men smoke pipes, the younger cigarettes.

The consumption of spirits is very small. 23 per cent of the men say that they drink liquor, but not every day. Often they do not taste spirits for months. No case of alcoholism is recorded. It is only exceptionallly that the women drink spirits.

According to the information collected in the present investigations chewing snuff seems to be less common in South and Central Sweden than in Upper Norrland. In both the Lund and the Borås material the number of »snuff-chewers» among the men amounts to less than 20 per cent. Tobacco-smoking is somewhat more common. Cigarette-smoking is beginning to increase among the women, but, judging from the hospital materials, the number does not amount to more than 8 per cent of the cases.

The consumption of spirits in South and Central Sweden seems, from the material available, to be much more common in these parts of the country than in Upper Norrland. In the Lund material 67 per cent of the men and 25 per cent of the women drink spirits, in the Borås material the corresponding figures are 73 per cent and 25 per cent.

B. Composition of the Diet from Quantitative and Qualitative Points of View.

The account of the composition of the diet would not be complete without a study of its sufficiency, quantitatively and qualitativly. Such a study necessarily involves weighing the foodstuffs used in the dietary. So much can, however, be stated a priori that any possible insufficiency in the quantity of food cannot be due to scarcity or want of means. In the years covered by the present investigation there was no dearth or famine. It can therefore be laid down as a rule of universal application that a sufficient quantity of food was at the disposal of the various groups of the population under investigation. The possible defects of the diet are to be ascribed to its lack of variation. The study of the sufficiency of the diet with respect to quantity and quality can therefore be confined to the two extreme type of diets, LIa and SIa. It is obvious that such a study had to be carried out in the homes. Owing to the great difficulties encountered and the amount of expenditure involved the investigation could only be carried out to a relatively small extent. It was, however, of great interest as it might corroborate the data on which the classification of the diets was based, which data were collected mainly from information supplied by the individuals examined.

The investigation was carried out as follows:— Dr. Werdinius undertook the task of weighing the food elements for one week

in a village on the coast (from his experience at the hospital clinic the author had formed the opinion that the population in that particular district subsisted on an unvaried milk-meal diet). Further, Drs. LINDGREN and BLOM, while engaged on another public commission, weighed the amounts of food consumed by the forest-workers living in temporary huts. These latter investigations are not in this connection of as great an interest as the former, since it was evident from the results of the preliminary investigations that the supposed disturbances, especially of the gastro-intestinal tract and the blood, were associated with the unvaried milk-meal diet. At any rate these investigations throw light on those factors, in the L diets and especially in the LIa diet, which are of interest in the study of the symptoms, and are therefore deserving of a brief description.

1. *The Diet of the Rural Population.*

a. Quantitive under-nutrition. Dr. WERDINIUS' investigation comprised three households of 23 members in all. One household, A, comprising 10 members, was examined for a period of 5 days, and two households, B and C, comprising 13 members, were studied for 2 days. The dietary constituents were carefully weighed, all necessary precautions being taken. Further, the body weight, height, age and sex of each person examined were recorded. The expected basal metabolism (B. M.) was estimated for adults with the aid of AUB DU BOIS' tables and for children by means of BENEDICT-TALBOT's tables. The calorie values were estimated by SHALL's method. The results of the investigations are shown in the table below.

As expected, the fare examined proved to be a typical LIa diet, consisting of herrings for breakfast every day or every other day together with bread and butter (clap-bread as a rule) and milk. The dinner consisted of gruel, »bryta» (described above) or ropy milk with bread and butter, and the supper was made up of porridge of boiled barley meal, bread and butter and milk. In household A meat-soup was eaten once a week or every other week, in the other households only on festive occasions. In household B blood-dumplings with bacon, and in household C pea soup and pork were served on one of the two days during which they were under investigation. In the investigator's opinion, these additions

Weights of foods consumed by the individual members of 3 households.

Home	Family member	Age (yrs.)	Height cm.	Weight kg.	B. M.	Calories per day	Surplus calories per day	Total protein intake per day	Vegetable protein per day	Butter per day g.	Other animal fat per day g.	Milk per day g.	Potatoes per day g.	Cereals per day g.
A	N:r 1. M.	60	163	64	1480	2217	645	72.29	34.36	27	17	83	145	480
	» 2. F.	50	166	79	1571	1704	233	55.27	29.10	12	—	665	87	374
	» 3. M.	23	168.5	61	1607	3351	1744	110.85	54.65	16	10	1398	221	753
	» 4. F.	20	164	57	1439	1675	236	60.63	25.66	12	2	769	107	347
	» 5. M.	18	155.5	48	1481	3321	1740	106.68	59.15	13	2	1247	207	796
	» 6. M.	17	150.5	42	1378	2956	1715	98.11	53.13	13	2	1172	187	714
	» 7. F.	13	153.5	46	1243	2466	1223	77.31	41.48	18	4	919	299	682
	» 8. F.	12	146	40	1224	2963	1739	98.59	51.42	9	2	1224	197	702
	» 9. F.	10	132	29	1020	2469	1449	82.34	41.42	12	2	1064	171	572
	» 10. M.	6	114	18	804	2529	1735	85.56	41.46	11	2	1175	218	608
B	» 1. F.	56	158	80	1529	1876	347	47.95	25.61	37	30	488	189	431
	» 2. M.	25	166	71.5	1702	2528	926	69.65	35.86	42	34	697	214	564
	» 3. M.	23	172	71	1744	2778	1034	72.85	31.62	55	63	883	247	544
	» 4. F.	21	158	56	1404	1493	89	41.92	19.23	28	19	491	155	333
	» 5. M.	19	164	64.5	1678	3002	1324	86.29	39.74	38	45	1122	198	594
	» 6. F.	15	153	47	1465	1676	211	47.06	18.33	22	19	703	205	363
	» 7. M.	13	152	43	1501	2232	731	67.96	28.01	24	24	985	201	467
	» 8. F.	11	130	27	974	1133	154	29.92	12.12	35	5	450	200	292
C	» 1. M.	59	163	56	1440	2090	650	59.13	26.84	15	76	757	30	272
	» 2. M.	24	163	60	1555	3526	1971	101.32	46.11	38	77	1380	38	505
	» 3. M.	22	160	55	1479	2629	1150	78.08	34.71	23	55	917	95	438
	» 4. M.	16	147.5	45	1398	2804	1406	84.11	31.88	28	71	1289	28	343
	» 5. F.	14	152	50	1496	1787	291	49.31	17.90	18	72	736	23	187

Summary of weights of foodstuff consumed at Botsmark.

	Men	Women	Children
Cal. supply per day	2840 (2090—3351)	1687 (1493—1876)	2229 (1133—2963)
Cal. per kg. and hour	2.09 (1.44—3.26)	1.05 (0.90—1.22)	2.69 (1.49—5.85)
Protein, g. per day	85.53 (59.13—110.85)	51.44 (41.92—60.63)	69.13 (29.92—98.59)
Protein, per kg. and day	1.50 (0.97—2.36)	0.78 (0.60—1.06)	2.03 (0.99—4.75)
Veg. protein, g. per kg. and day	0.74 (0.44—1.27)	0.37 (0.32—0.45)	0.94 (0.39—2.30)
Potatoes, g. per day	158 (30—247)	135 (87—189)	171 (23—299)
Milk, g. per day	1046 (697—1398)	603 (488—769)	948 (450—1289)
Cereals, g. per day	408 (242—589)	237 (178—287)	297 (92—505)

to the customary fare were made because of his visit to the homes. It is to be regretted that the investigations could not be extended for a longer period.

Coffee was taken 3—4 times a day, with or without wheaten bread or cake.

The number of calories in the food is, as appears from the table, markedly low, not infrequently below 2000 calories per day even in the case of adults. The average calorie intake for men is 2480, for women 1687 and for children under 17 years 2227 calories. In some cases the daily calorie intake exceeds but slightly the supposed basal metabolism. This was so, for instance, in the case of members Nos. 2 and 4 in household A, members Nos. 1, 4, 6 and 8 in household B and members Nos. 1 and 5 in household C. As known, the calorie requirement varies very much in normal individuals, as already shown by LAVOISIER in his classical studies in 1793—1794. These variations are in a large measure due to the body weight, action and work, but also to the nature of the diet. The B. M. of adults corresponds to about 1 calorie per kilo body weight and hour (BENEDICT and others). When sitting, an individual's calorie requirement is increased to 1,2 calories (20 %). In more vigorous action and work the requirement is still greater. Benedict gives the following figures for a person weighing 70 kilos.

Resting	25—30	calories per kg.,	corresponding to 1750—2100 cal.
Doing light work	35—40	» » »	» 2450—2800 »
» medium work	40—45	» » »	» 2800—3150 »
» heavy work	45—60	» » »	» 3150—4200 »

The calorie requirement of children is relatively greater than that of adults (Du Bois, Benedict).

The work of that category of the population studied in these investigations was medium or hard. From the above figures one must therefore deduce that there is a certain degree of under-nutrition in a great percentage of the cases, but the under-nutrition is spontaneous and does not cause the individual any discomfort. All the individuals examined stated that they felt well, performed their fairly hard daily work, and »did not require more food». From their point of view the calorie intake must be regarded as physiologically adequate and the quantities given above as normal looked upon as a luxurious diet. It should be added that the individuals examined, as a rule, appeared to be in a rather good general state of health and well nourished, although not fat. This is also apparent from the relation between height and body weight (see table). As shown especially by Benedict in his Nutrition Laboratory, there occurs a certain degree of functional adaptation in the case of a low calorie intake. The number of calories required is lower when the individual is at rest or working. That may be the explanation of the comparatively good health of this category of the population in spite of the seemingly deficient calorie intake. We shall return to this point later.

Estimations were made of the calorie intake from the food on about one hundred patients at the Umeå Hospital belonging to the LIa group, the calculation being based on data supplied by the subjects themselves. It is obvious that the results of such estimations will be somewhat unreliable. In fact, the calorie values obtained varied between 1600 and 3200 calories per day. The average value was 2200—2300. This figure agrees rather well with the weights of the foods given above, and is low as compared with the figures cited for the normal calorie requirement. This applies to a population engaged in medium or hard work. As already mentioned, corpulent persons are rare among the native population in this part of the country.

Attempts were also made to estimate the daily calorie intake for persons belonging to the B diet group. Owing to the greater variation in the dietary these estimations were much more difficult to make. Values varying between 3000 and 3500 calories were obtained, the average calorie intake being 2500—2600 calories per day.

Weighings of the food and estimations of the number of calories consumed were also undertaken on 12 patients, 6 men and 6 women, belonging to the LIa group, at the Umeå Hospital. These patients suffered from diseases which could not be supposed to have any influence on the metabolism; they were not confined to bed and were allowed to perform light work. They were given the fare customary in their homes. (LIa). The total calorie intake varied in the different cases between 1900 and 2500 calories per day. The result obtained in these examinations, although by no means unimpeachable, indicate that individuals in the LIa group daily consume food less rich in calories than the diet of the BII group.

In order to obtain further support for this view we weighed 500 persons, about half of them belonging to the LIa group and the other half to the B group. Their ages varied from 20 to 45 years. On an average both the men and the women of the L diet group weighed about 2 kilos less than members of the B group. An arrangement of the cases examined into different age-groups gave on the whole the same results for the various age-groups. Thus these weighings also indicate that there is a certain degree of under-nutrition in some of the cases of the LIa group.

b. *Qualitative under-nutrition.* The L diets, especially the LIa diet, are characterized, in addition to their deficiency of fruit and vegetables, also by the low animal protein content (meat, fish and eggs). From this we assume that the amount of nitrogen present in the food is small, supplied chiefly by the milk. In the table showing the weights of the foods is also given the protein content of the diet (see table, p. 36). In 5 cases out of 23 (household A, No. 2; household B, Nos. 1, 2 and 4; and household C, No. 5) it is less than 1 g. per kg. body weight; the average for all individuals examined is 1.$_{50}$ g. for men, 0.$_{78}$ g. for women and 2.$_{03}$ g. for children. HAMMERSTEN gives the minimum protein requirement for adults at 0.$_{5}$ g. per kg. body weight. In our material it was never lower than this minimum, although in one or two cases the protein content very nearly approached the minimum requirement. HAMMERSTEN, however, states that the desirable amount for men would be 120 g., and for women 100 g. The average values in our material are 85.$_{5}$ g. for men, 51.$_{1}$ g. for women and 69.$_{1}$ g. for children. HINDHEDE gives 25 g. as the »practical protein minimum». According to BERTRAM and BORNSTEIN's comprehensive work, the »minimum requirement» lies at

80 g. for an individual of 70 kg. body weight. The values found in this investigation are in several instances below or very close to this minimum.

Estimations of the quantitiy of N per day in the urine were also made at the Umeå Hospital on about 50 patients, belonging to the LIa diet group, suffering from diseases which, as far as could be judged, had no influence on the N-metabolism. During the first few days of their stay at the hospital they were given about the same food as they usually consume at home. The quantity of N. in the urine, measured in this way, amounted as a rule to 6—8 g., but was sometimes as low as 4—5 g. Determinations of the N. content of the urine were carried out in the same way on a number of patients (20) belonging to the B diet groups. These showed a daily N-excretion of 8—18 g. in the urine. In the majority the quantity varied between 10 and 12 g. This result, too, indicates that with respect to the N-metabolism the cases of the LIa group are on a very low standard.

From a purely biological point of view one usually distinguishes between proteins of high or low value with regard to their capacity of maintaining the protein content of the body. This effect is no doubt in the first place due to the nature of the amino acids of the protein molecules. Milk and potato proteins, which together form an essential part of the protein component in the LIa diet, are considered to be of a comparatively high value, by some authors, such as Rose, Macleod and Bisbey, as equal or superior to meat proteins. This appears in a certain measure to make up for the low protein content of the LIa diet, all the more as this protein is present in an easily digestible form. Still, the protein content of the cereals (of a »low biological» value) amounts on an average to 50 per cent of the total intake of protein.

The amount of *fat* in the LIa diet is comparatively low. Besides the fat in the milk consumed, which is often lightly skimmed, small quantities of butter are also eaten, amounting on the average to 18 g. for men, 22 g. for women and 18 g. for children. It should also be pointed out that household A used, at least to some extent, margarin instead of butter, which has a bearing on the vitamin D content of the diet. Fat in other forms than the high-grade kind mentioned above is not consumed in any appreciable quantities.

By far the greater part of the calorie content of the food is derived from *carbohydrates*, especially cereals, the bulk of which

consists of fine-bolted wheat flour and barley-meal. The average quantity of cereals in the food amounts to 408 g. for men, 237 g. for women and 297 g. for children per diem.

As regards the *inorganic compounds* in the LIa diet our attention was in the first place directed to the supply of iron. Iron is an important factor in the building of the haemoglobin molecule, and it seemed very likely that the anaemias were at least partly due to the deficiency of iron in the LIa diet. This diet contains but very small amounts of iron-containing substances, animal protein and vegetables. Estimations of the iron content in barley-meal, and in milk and potatoes from Norrland were made by Prof. Widmark, the following results being obtained:

100 g.	barley-meal	contains	3.1	mg.	Fe = 4.4	mg.	Fe_2O_3
100 »	potatoes	»	0.64	»	» = 0.91	»	»
100 »	milk	»	0.15	»	» = 0.22	»	»
100 »	wheat flour	»	5.00	»	» = 7.00	»	»

(The flour is not from Norrland).

If, on the basis of these figures, we calculate the daily iron intake, we obtain the following values:

	Fe	(Maximum and minimum values)
Males > 15 years	17.5 mg.	10.4—23.4 mg.
Females > 15 »	11.0 »	8.4—12.31 »
Children	15.0 »	4.1 (8.1)—20 mg.

These values should be increased just a little, owing to the fact that the iron content of the butter, averaging 24 g. (9—55), and the herrings, averaging 26 g. (10—45), consumed daily, was not taken into account. At any rate the quantity of iron supplied with the food is very small. Besides, in the case of a number of the persons living on the LIa diet the absorption of iron is lowered owing to the decreased amount of hydrochloric acid in the gastric juice. This matter will be discussed more in detail later on.

No examinations were made of other inorganic substances in the food. The amount of sodium chloride is undoubtedly more than sufficient. Abundant quantities of salt are added to the food, especially butter and herrings, and occasionally salt is even put into the coffee. The amounts of calcium (Ca) and phosphorus (P) are also sufficient, mainly supplied by the relatively large quantity of milk in the diet. Determinations of the Cl, Ca and P contents of the blood were made, for another purpose, in a large number of cases, and they always showed normal values.

This might also be advanced as evidence that the Ca and P metabolism has not undergone any important changes.

A determination of the iodine content of the food might have been of a certain interest. However, there is scarcely any reason to suspect that the iodine content of the LIa diet is significantly lower than that of the B diet.

Vitamin Content. It cannot be determined by weighing the quantities of foodstuffs eaten whether the diet contains a sufficient amount of vitamins. The essential criterion of a sufficient amount is the absence of any evidence of hypovitaminosis. Still, by consideration of the kinds of foodstuffs entering into the diet, it should be possible to estimate, with a certain degree of probability, the amount of vitamins. As far as human beings are concerned, vitamins A, B_1, B_2, C and D seem to be the most important.

The LIa diet consists to no small extent of milk, butter and potatoes, a variety grown in the north of Sweden called »mandel potato», articles of food which are said to be comparatively rich in vitamin A. As regards potatoes, it is stated that yellow sweet potatoes, to which variety »mandel potatoes» belong, are rich in vitamin A. Aykroyd estimates the minimum daily requirement of vitamin A to be 500 rat units (U. S. P.). But he does not consider an optimum intake to be less than 1000 units. 100 g. of butter contain 500—5000 units, 100 g. of milk 50—200 units. The amounts of milk and butter in the LIa diet appear to cover the vitamin A requirement. If to this be added the vitamin content of the potatoes, it will be apparent that the amount of vitamin A supplied by the LIa diet is probably adequate.

Vitamin D (antirachitic vitamin) is present especially in the butter of the LIa diet, and also in the milk in proportion to its content of butter fat. The amount of vitamin D in butter and milk depends to an essential degree on the fodder of the cattle. During the summer months, June—September, the cows are kept out of doors. Thus the percentage of vitamin D should be high in the summer milk, whereas the vitamin D content of the winter milk and butter is considerably lower. The milk of the cows in Norrland, the so-called fjeld-race, is very rich in fat, as a rule amounting to 5 per cent. It is, however, skimmed slightly before being consumed. The minimum vitamin D requirement of adults is not known, for children it amounts to 100 preventive rat units (M. R. C.). Butter contains 20—100 units per 100 g., and milk

10—20 units per 100 g. The amount of vitamin D required is moreover dependent on the supply of Ca and P, the intensity of the radiation of light and not least on the percentage of cereals in the food. There is a certain degree of »antagonism» between the cereal content of the food and the vitamin D requirement. If the amount of cereals supplied is high more vitamin D will be required (GREEN, MELLANBY, HOLST). The LIa diet is characterized by an ample supply of cereals, especially barley-meal, which is said to have a relatively strong »antagonistic» influence on vitamin D. For that reason there is a risk of D-hypovitaminosis, at least in winter, especially if margarin is used to a great extent as a substitute for butter.

According to JUNG, the minimum requirement of vitamin B_1 (anti-neuritic vitamin) is 150 R. U. The requirement increases with the calorie intake. In an ill-balanced diet with a deficiency of proteins and organic salts the requirement increases. If the supply of carbohydrates is large the requirement is thus still greater (FUNK, COLLAZO, RANDOW and SIMMONET). As regards the content of vitamin B_1 in the articles of food most commonly used, the following figures have been given: potatoes, 10—15 units per 100 g.; fresh meat, 25 units per 100 g.; milk, 10—15 units per 100 g., while the same quantity of proteins and liver contains 50 and 100—160 units respectively. The flour used in the Norrland diets is of the finest sort, free from bran, and does not contain any appreciable amount of vitamin B. Thus it is evident from what has been said that the amount of vitamin B_1, especially in the LIa diet, is small. In the mixed diet it is greater (See table, Household A, Nos. 2 and 4; Household B, Nos. 1, 4 and 8; Household C, Nos. 1, 3 and 5).

The requirement of vitamin B_2 (anti-dermatic and anti-anaemic vitamin) is estimated, by JUNG, to be 150 R. U. The optimum value, however, is 3—4 times greater. The vitamin B_2 content of the foodstuffs used in the Norrland diets is: in 100 g. of fresh meat 350 units, in 100 g. milk 15 units, in 100 g. of potatoes 3—10 units and in 100 g. of liver 200 units. The fine flour used contains only a very small amount of vitamin B_2. Thus there also seems to be a certain risk of the LIa diet being deficient in vitamin B_2. As instances of this we may mention the same cases as those deficient in vitmin B_1.

Vitamin C (anti-scorbutic vitamin) is found especially in fresh fruits and vegetables, which seldom form part of the Norrland

diets nor of the LIa diet. Vitamin C is also present in milk and potatoes, which form the main part of this diet. The amount of vitamin C in milk, however, varies considerably depending on the food of the cows. Thus winter milk contains a much smaller amount of vitamin C than summer milk. But it should be pointed out that the chief fodder of cows in winter consists, in addition to hay, of root-crops and potatoes, which should make the milk richer in vitamin C.

There has been considerable discussion as to the occurrence of C-hypovitaminosis in the Norrland material and the question is deserving of serious study.

The minimum vitamin C requirement of adults (M. R. C.) is estimated to be 200—250 international units. 100 g. of potatoes contain 100—200 units. The number of units in milk is, as already mentioned, more variable.

The daily consumption of milk in the LIa group is about 1 litre for adult males and children and not quite $^2/_3$ litre on the average for women. As far as can be judged, this quantity of milk and potatoes satisfies the requirement of a sufficient supply of vitamin C. In a few cases the intake of vitamin C seems to be somewhat low, as for instance in the case of No. 8 in Household B and of all the members of Household C, especially Nos. 1 and 5. The vitamin C content of the food, where the intake of milk is relatively adequate, also satisfies the requirement estimated by GÖTHLIN for the prevention of C-hypovitaminosis (700—1000 g. of milk or 200 g. of potatoes boiled for 15 minutes).

The percentage of vitamin C is likely to become still smaller in proportion as the consumption of milk and potatoes decreases, which seems to occur when the diet is more mixed, as in the B diets or in the diets of the forest-workers, the S diets.

From this inquiry it seems to be clear that in the L diet the amount of vitamin A is fairly adequate, whereas the adequacy of the amounts of vitamins B, C, and D is more questionable. This applies especially to vitamins C and D during the winter months when the butter supply is scanty.

2. *The Diet of the Forest-workers.*

The following tables give the results of the analysis (chiefly compiled by BERGENSSON) of the diets the forest-workers in accordance with the reports of LINDGREN and BLOM.

Examination of the food and weighings of the ingredients used were made during a period of 5 days, with the exception of Case No. 15, where the food was weighed only on 4 days. Nos. 1—8 are from Norrbotten (Blom), Nos. 9—18 from Västerbotten (Lindgren).

Analysis and Weights of Food of Forest-workers.

	Calories daily	Total protein daily	Veg. protein daily	Total fat daily	Butter daily	Cereals daily	Milk	Potatoes
				Norrbotten.				
1.	5451	93.3	61.2	270	14.4	792	600	198
2.	3718	70.3	37.0	160	8	350	830	58
3.	6470	131.3	58.7	308	21.6	906	1100	0
4.	6487	131.5	65.8	334	106	858	1190	76
5.	6966	127.6	81	306	118	914	820	84
6.	4655	99.4	54.8	218	78	587	750	131
7.	4652	118.9	48.4	182	75	628	620	192
8.	4298	74.4	50.5	203	74	678	150	157
				Västerbotten.				
9.	5253	159.0	60.9	246	73.6	610	941	463
10.	4728	104.3	47.2	190	0	524	250	627
11.	3980	88.1	39.7	154	0	454	222	314
12.	4547	42	31	256	136.2	374	0	314
13.	4145	100.7	49.8	162	0	342	449	431
14.	5850	184.2	28.5	329	0	198	512	750
15.	6554	123.0	73.7	248	38.6	724	989	989
16.	4839	92.3	49.8	282	34.8	512	887	492
17.	5454	134.3	54.5	223	16.5	554	791	540
18.	5118	89.3	43.8	180	22.8	554	1089	416

Summarised Results of Weighings of Forest-workers' Diet.

Supply of calories per day	5176	(3718—6966)
» » fat g. per day	236	(160—334)
» » protein g. per day	109	(42—184.2)
» » cereal protein g. per day	52	(28.5—81)
» » milk g. per day	587	(198—914)
» » potatoes g. per day	346	(0—989)
» » milk g. per day	677	(0—1190)

In the above tables there is clear evidence that the calorie intake of the forest-workers is considerably higher than the intake of that portion of the coastal population subsisting on an LIa diet. The average daily calorie intake for each of 18 workmen

amounts to 5176 calories, the extreme values being 3718 and 6966 calories.

The *supply of protein*, too, is as a rule greater than in the diet of the rural population, especially with regard to animal protein. Nevertheless, we are not justified in characterizing the S diet as being particularly rich in protein, for in no less than 7 cases the protein content of the food is below 100 g. per day. Cases also occur among the forest-workers where the protein content of the diet is strikingly low, even lower than in the L diet, for instance in Case No. 12. This is quite remarkable considering the exceedingly hard work of the forest-workers.

The S diet is very *rich in fat*. From $^1/_3$ to $^1/_2$ of the total calorie yield is derived from fat. The main source of the fat is bacon, often American bacon. As a rule this food, so rich in fat, is digested well. »Work in the forests requires fat» is an opinion often expressed by those employed in the forests.

A liberal amount of *cereals*, averaging 587 g. per diem, chiefly in the form of wheat flour, also contributes to the rich supply of calories in the diet (v. Table).

The *iron content* of the S diet is comparatively high, according to estimations made by BERGENSSON, varying between 36 and 78 m.

This diet also contains a larger amount of salts than that of the inhabitants of the coastal district.

With regard to the amount of *vitamins* contained in the S diet the analyses of the foods supplied the following data:

The vitamin A requirement is fairly adequately satisfied by the intake of milk and butter. In some of the cases, where the food contains only small quantities of milk and butter, as in Cases Nos. 10, 11, 13 and 14, the required amount of vitamin A is derived from the relatively large quantity of potatoes forming part of the diet. Dishes prepared from the viscera of animals, which are rich in vitamins, not infrequently form part of the food of the forest-workers. The pork consumed probably contains some vitamin A.

The amount of vitamin D in the S diet is on the whole the same as that in the diet of the population of the coastal district. In winter-time the amount of vitamin D is probably insufficient in some of the cases, and even in summer in those cases where the butter and milk intake is low.

The amount of vitamin B in the S diet is greater than in the LIa diet, owing to the consumption of meat. The forest-workers usually eat coarse bread, which is often fermented.

The supply of vitamin C is not so well provided for, especially in those cases where the dietary contains only small quantities of potatoes and milk. Workmen in Norrland consume potatoes in but relatively small quantities (Cases Nos. 2, 4 and 5 less than 100 g. per day, and No. 3 none at all). The quantities of milk consumed are, however, comparatively large, 820—1190 g. But even in these cases there is a risk of a C-hypovitaminosis in winter, when the vitamin C content of the milk is reduced. In Case No. 8 the daily consumption of milk is very low, 150 g. Nor is the quantity of potatoes eaten particularly large, only 157 g. There is therefore a certain risk of a C-hypovitaminosis also in this case. The forest-workers in Västerbotten as a rule eat more potatoes, on an average 314—989 g. per day. This should be adequate to prevent a C-hypovitaminosis, even though the quantity of milk in the diet is relatively small, as in Cases Nos. 10 and 11, or none at all, as in Case No. 12.

Thus, as regards the vitamin content of the S diet, it will be seen that its content of vitamins A and B is fairly adequate, whereas the diet is not infrequently somewhat deficient in vitamins C and D. This is true of the vitamin C content especially when the food contains very small quantities of milk and potatoes, and of the vitamin D content when the consumption of butter decreases and when dishes prepared from animal viscera do not form part of the dietary.

It should again be emphasized that the quantitative data with regard to the vitamin content of the food obtained in such an investigation cannot be regarded as an exact measure of the adequacy or inadequacy of the diet, for on the one hand the need for vitamins differs in different individuals and is dependent on a variety of factors, among which may be mentioned age, work and, in the case of women, pregnancy and lactation, besides climate and sunlight, the amount of salts, especially Ca and P, in the food, while on the other hand the percentage of vitamins in a particular article of food varies considerably under different conditions. Finally, the correlation between the different kinds of vitamins is of great importance (Kollath).

With regard to the composition of the B diets there is not much to be said. The principal difference between the B diets and the other diets studied is that the former are somewhat more varied. The B diets contain more mixed food, hence the risk of a quantitative or qualitative deficiency should be relatively slight.

CHAPTER II.

The Basal Metabolism (B. M.) in Relation to the Composition of the Food.

In the preceding chapter it was shown that the daily supply of calories in the LIa diet is very low. Nevertheless it appears to be sufficient to maintain a fairly good condition of nutrition among the inhabitants and does not prevent them from performing medium or even heavy work. This can be explained by a low rate of metabolism while the individual is resting and at work. WERDINIUS was able to confirm this with regard to the basal metabolism.

In 128 cases, mostly consisting of healthy persons but also including others who had been affected with diseases which could not have had any influence on the results, WERDINIUS made estimations of the metabolism while the individual was resting and fasting (B. M.) by determining in the usual manner the amount of oxygen consumed in 10 minutes on an empty stomach in the morning.

As a rule the estimations of the B. M. were made on two or more consecutive days at the beginning of the patient's stay at the hospital. The food supplied was as far as possible similar to that taken at home. At the same time estimations were made of the nitrogen excretion in the urine. As known, it was formerly the custom when making determinations of the B. M. to put the subjects on a carbohydrate diet for three days before beginning the examination. That procedure was not adopted in our examinations. Instead the subjects received the same diet as they had been accustomed to for a long time. The determinations were made with the aid of a very accurately calibrated Benedict apparatus (large model), all precautionary measures having been taken.

The standard values for the estimation of the normal calorie requirement of the subjects were taken from Aub du Bois' tables.

The following tabulation shows the results of the B. M. tests.

B. M.	LI diet	LII diet	B diet
+14 — +22	2	—	2
+ 5 — +13	6	2	8
+ 4 — — 4	12	8	16
— 5 — —13	34	5	3
—14 — —22	15	4	1
—25 — —31	6	1	—
—32 — —40	3	—	—
Total number of cases	78	20	30
M (B. M.)	— 9.7 %	— 6.3 %	+ 2.1 %

It will be observed that in more than half the cases of the B diet group, 16 out of 30, the metabolism was normal, if 0 — ± 4 % of the standard values is considered as the normal B. M. In 4 cases the B. M. was somewhat lowered and in 10 cases somewhat raised, whereas the majority of the cases belonging to the LI diet group, 58 out of 78, or 74 per cent, had a lowered B. M., varying being — 5 and — 40. In the latter group only 12 of the 78 cases, 15 per cent, had a normal B. M. and 8 a slightly raised B. M. The greater difference between the maxima and minima in the cases belonging to the LI group is explained partly by the fact that some of the cases did not belong to this group, owing to the difficulty sometimes of defining this group exactly. Compared with the B group, the number of cases in the LII group with lowered B. M. is also high. Cases belonging to the B diet group had on the average a normal B. M. The mean value of the basal metabolism in the B group is equal to the normal standard values + 2.1 per cent. The mean values of the LIa diet and the LII diet are — 9.7 per cent and — 6.3 per cent respectively.

The lowered B. M. found in the L diet groups cannot be due to errors in the method. The apparatus was tested and re-gauged several times.

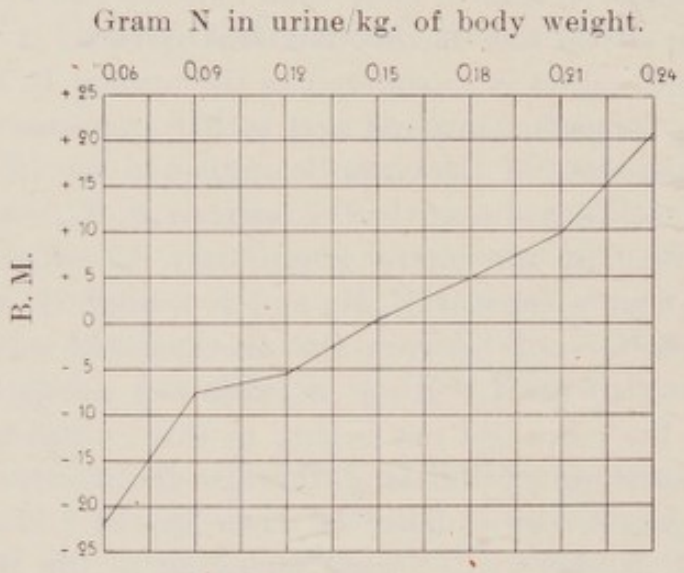
A shifting of the normal respiratory quotient (0.82), due to a relatively intense carbohydrate oxidation, would theoretically lower the B. M., but the reduction would amount to only — 3 per cent at most and therefore does not explain the result obtained.

The question now arises — What is the cause of the lowered basal metabolism? It has already been pointed out that undernutrition and starvation are common causes of a decrease in

the B. M. For further information on this subject the reader is referred to the fundamental works of ZUNTZ and LOEWY and of BENEDICT and his co-workers.

There is undoubtedly evidence of a certain degree of under-nutrition in some of the cases belonging to the L diet group, as has already been pointed out. Some of these cases have a calorie intake of less than 2000 daily.

Another conceivable cause of the lowered B. M. is the small amount of proteins in the diet. The following curve shows the relation between the N. metabolism, measured by the daily excretion of nitrogen in the urine in proportion to the body weight, and the B. M.



Thus in the cases examined we see that when the nitrogen metabolism, estimated on the basis of the daily amount of nitrogen excreted in the urine, is low, the B. M. is also low. A protein oxidation corresponding to 0.15 g. urinary N. per kg. body weight gives, according to the curve, a normal B. M. Many of the cases belonging to the LIa diet group have most probably lived for several years on a diet containing a smaller quantity of nitrogen. We are therefore justified in concluding that the small amount of proteins in the food of this group is a contributory cause of the comparatively low B. M. value. It should nevertheless be borne in mind that the low protein content of the diet in this group is not infrequently combined with under-nutrition.

The literature on the subject furnishes a certain amount of evidence in support of the assumption that the low protein content of the diet explains, at least partly, the lowered B. M.

The probability that this possible protein effect is due to the so-called primary specific dynamic action of the protein can at once be left out of account, since this action, according to the prevalent opinion, lasts for only 6—8 hours at most after the meal (see, for instance BENEDICT and CARPENTER's monograph).

In addition to the primary dynamic action of protein RUBNER mentions a more protracted »secondary dynamic action». A diet rich in protein will thus be followed by a rise in the B. M., lasting for several days. It is a priori not improbable that this »secondary» dynamic action influences the B. M. in a negative direction when the protein consumption is low.

The results of investigations by BERNSTEIN and FALTA, GRAFE and WISHART lend support to this view.

BERNSTEIN and LEIMDÖRFER have also found that the B. M. rises in proportion to the protein intake and that the effects of animal and vegetable proteins are equal in this respect.

LIEBESNY and SCHWARTZ call attention to the difference in the level of the B. M. during the Great War in America and Vienna, and they consider that this difference was due to the different amounts of protein compounds in the food.

Several investigators (HEINBECKER, ADOLPH, DE ALMEIDA, FLEMING, SOHLBERG and others) point out that, in addition to the composition of the diet, the climate has a great influence on the B. M. Attention has also been called (HEINBECKER, BENEDICT) to the fact that racial idiosyncrasies influence the B. M.

But neither climatic conditions nor racial idiosyncrasies can be the cause of the lowered B. M. found in the L group in the present material. If anything, the severe climate of Västerbotten should bring about a rise in the B. M. Further, the groups investigated belong to the same race and have been living under exactly the same climatic conditions. Thus neither the climate nor any racial idiosyncrasies can have been the cause of the lowered B. M.

The composition of the diet, apart from its absolute amounts of calories and N, may also be thought to play a certain rôle in the B. M. Certain kinds of avitaminosis show an altered B. M. According to SEEL and BALDWIN, A and D avitaminoses may in certain cases lower the B. M. Other investigators do not accept this view. With regard to the B avitaminosis the general opinion seems to be that there is a lowered B. M. This decrease is considered by the majority of investigators to be due to inanition

(Okada and co-workers, Arvay, Denel, Lawrow and Matzko), and that it occurs in advanced cases. Hopkins, Drummond and co-workers, Stepp and others are of opinion that this lowered rate is constant. According to Knipping, Groebbels und Chakowitz, C hypovitaminosis, on the other hand, shows an increased B. M. The possibility of the occurrence of a hypovitaminosis in the Norrland material has been discussed above with regard only to the composition of the food, and there seems to be a certain amount of evidence of specially B, C and D hypovitaminosis in the LIa diet group. A lack of vitamin B may therefore play a certain rôle in the decrease of the B. M. found and probably exercises its influence by under-nutrition.

Finally it may be mentioned by way of discussion that along with the mixed diet certain substances, for instance iron, are supplied, which are entirely absent or are present in only small quantities in the L diets, and which can be thought to have an influence on the degree of B. M. On the average, this diet group has a lower haemoglobin value than the B diet group, as will be shown later on. Opinions concerning the importance of iron for the rate of B. M. differ widely. Still there are investigations which indicate that a supply of iron increases the B. M. e. g. Langfeldt, Nishiura, Kockmann and Seel, and Schmidt). In general, however, these investigations were made on animals.

The effect on the B. M. of administration of iron was studied in a number of our cases. No positive effect on the B. M. was observed. The iron was administered per os in the form of ferrum reductium in a daily dose of 3 g.

As mentioned above, anaemia of a moderate degree was most frequent in the cases belonging to the LI diet group. Opinions differ with regard to the effect of anaemias on the B. M. There is a general agreement among investigators that if anaemia has any effect on the B. M. it should be in the form of an increase of the B. M (Curschmann and Bachmann, Grasstein, Aub and Taylor, Benedict and others). Hence the lowered B. M. observed in our cases cannot be ascribed to anaemia.

More than half the patients examined by us exhibited evidences of gastric achylia. The percentage of achylic cases, however, was not higher among those exhibiting a lowered B. M. than among those with a normal B. M. within the same diet group. This fact does not indicate that there is any causal relationship between the disturbance of the gastric function and the decrease in the B.

M. On the contrary, both symptoms are to be regarded as parallel expressions of the same cause.

From what has been said above it is evident that the rather frequent relatively low calorie intake and lack of proteins in the food or some factor associated therewith (possibly B-hypovitaminosis) constitute the primary factors in the decrease of the M. B. as found in the type of diet under discussion. The cause may of course be found in some other factor or factors hitherto unknown. The easily digestible nature of the food may also play a part. A lack of other substances may also produce this effect, — the amount of animal proteins is strikingly low, for although milk and potatoes are staple articles the diet does not contain eggs, fish and meat.

If under-nutrition and the relative deficiency of protein in the diet were the cause of the ascertained decrease in the B. M. it should be expected that a more abundant supply of food and especially a diet richer in proteins would raise the B. M. to a normal level or even higher in these patients. In fact such a rise often occurs. One example will suffice to illustrate this. During the first three weeks at the hospital a patient was given the same diet as he was accustomed to, the LI diet, but he ate very little. The daily calorie intake was 1500—1600 calories and the daily protein intake 60—70 g. During this period the B. M. was found on several occasions to be — 15 per cent. Afterwards the diet was supplemented with chiefly carbohydrates and butter to an amount of 2400 calories. The B. M. rose to — 9 per cent. An addition of a larger amount of protein in the following days, 120—150 g. per day in the form of meat, fish and cheese, brought about a further rise of the B. M. up to +12 per cent. It should be pointed out, however, that at the same time as the increase in the calorie content and especially the increase of animal food-stuffs there occurs a parallel increase of accessory food substances, e. g. vitamin B.

It is noteworthy that a rise of the M. B. did not occur in all our cases on the addition of supplements to the fare, especially by increasing the amount of proteins. A rise was obtained in only a few cases, at least during the short period of a few weeks in which they were under observation. Frequently this rise takes a comparatively long time, from 2 to 4 weeks, before it becomes discernible. The cause of this may be found in secondary changes,

particularly in the endocrine glands, brought about by the previous diet.

In order to ascertain whether there was any so-called endocrine disturbance, sugar tolerance tests and pharmacodynamic tests with adrenaline, pilocarpine and atropine were made on some of the cases belonging to the L diet groups. The sugar tolerance was investigated by ingesting 1 gram of glucose per kilo body weight. Adrenaline and atropine were injected subcutaneously in a dose of 1 mg., and pilocarpine in a dose of 10 mg.

The results of the glucose tolerance and the adrenaline tests in respect to the blood sugar curve are given in the table on p. 55.

In both tests, and especially after the injection of adrenaline, the blood sugar curve in the great majority of the cases shows a very slight and transient rise. There is no definite correlation between the results of the tests and the fall in the B. M. rate.

The effect of adrenaline on the blood pressure was also relatively slight. In Cases Nos. 5 and 8 there was no effect at all, while in the other cases there was a maximal rise of the blood pressure, varying between 10 and 60 mm. Hg. after an interval of 4—60 minutes and lasting for 10—120 minutes. In most cases the pulse rate was but slightly influenced, the maximal increase being 4—38 beats a minute, setting in after 2—180 minutes. The pulse rate returned to normal after an interval of 10—240 minutes. As in the case of the blood pressure there was no evident parallelism between the pulse rate and the decrease of the B. M.

The pilocarpine test produced in all cases a moderate diffuse perspiration and a salivation varying between 75 and 370 c. c. In Case No. 3 no measurable salivation occurred. The effect on the pulse rate and the blood pressure was in all cases either slight or absent altogether.

The injection of atropine as a rule produced no effect, but in a couple of cases there was a slight fall in the blood pressure (maximum 15 mm. Hg) and a moderate, transitory acceleration of the pulse rate.

On the whole it may be said that the persons subjected to the glucose tolerance test and to the pharmacodynamic tests showed an increased tolerance, indicating a reduced irritability of the vegetative nervous system. This system is intimately associated with the function of the endocrine system, so it is probable that there is an impairment in the function of the thyroid gland and possibly of the pituitary body and the genital glands.

Adrenaline (1 mg.) *Glucose tolerance test.*

No. Sex.	Blood sugar %								Blood sugar %						
	Before test	After injection of adrenaline							Before test	After ingestion of glucose					B. M.
		15 min.	30 min.	60 min.	90 min.	120 min.	150 min.	180 min.		30 min.	60 min.	90 min.	120 min.	150 min.	
1. M.	0.078	0.105	0.112	0.117	0.121	0.091	—	—	0.080	0.135	0.114	0.111	0.095	—	+ 6.4 ?
2. F.	0.092	0.104	0.122	0.143	0.152	0.125	—	0.083	0.080	0.129	0.139	0.143	0.085	—	+ 6.2 ?
3. F.	0.079	0.095	0.092	0.095	0.129	0.118	—	0.090	0.082	0.130	0.119	0.085	0.082	—	+ 4
4. F.	0.093	0.135	0.155	0.164	0.147	0.123	0.098	—	0.107	0.210	0.192	0.148	0.119	0.081	+ 3.7
5. F.	0.094	0.103	0.105	0.112	0.105	0.103	—	—	0.096	0.138	0.144	0.130	0.103	—	+ 3 à 4
6. M.	—	—	—	—	—	—	—	—	0.089	0.138	0.145	0.103	0.085	—	— 0.2
7. F.	0.085	0.103	0.125	0.147	0.148	0.141	—	0.094	0.092	0.125	0.113	0.110	0.092	—	— 0.8
8. M.	—	—	—	—	—	—	—	—	0.078	0.144	0.137	0.091	0.076	—	— 5.3
9. F.	0.078	0.096	0.082	0.080	0.075	0.080	—	—	0.082	0.139	0.157	0.129	0.076	—	— 8 à 9
10. M.	—	—	—	—	—	—	—	—	0.093	0.138	0.144	0.137	0.112	—	— 10.9 ?
11. F.	0.086	0.104	0.157	0.182	0.176	0.155	—	0.088	—	—	—	—	—	—	— 11.5
12. M.	0.084	0.098	0.116	0.137	0.130	0.093	—	—	0.077	0.112	0.108	0.103	0.077	—	— 11.5
13. M.	0.082	0.098	0 091	0.087	0.085	0.082	—	—	0.084	0.130	0.123	0.105	0.082	—	— 12.1
14. F.	0.056	0.058	0.072	0.083	0.092	0.088	—	0.077	—	—	—	—	—	—	— 12.7
15. M.	0.083	0.112	0.150	0.161	0.138	0.103	—	—	0.085	0.129	0.108	0.083	0.079	—	— 14.0
16. M.	0.089	0.098	0.129	0.137	0.128	0.102	—	—	—	—	—	—	—	—	— 13.5
17. M.	0.088	0.106	0.129	0.138	0.127	0.103	—	—	0.096	0.134	0.112	0.103	0.091	—	— 13.6
18. M.	0.078	0.100	0.094	0.093	0.087	0.089	—	—	0.081	0.113	0.090	0.083	0.081	—	— 13.7
19. F.	0.077	0.092	0.106	0.122	0.118	0.097	—	—	0.079	0.165	0.159	0.124	0.079	—	— 13.8
20. F.	0.086	0.094	0.104	0.104	0.115	0.110	—	—	0.091	0.142	0.145	0.121	0.082	—	— 16.7
21. M.	0.076	0.118	0.085	0.085	0.083	0.081	—	—	0.080	0.140	0.111	0.102	0.084	—	— 18.3
22. F.	—	—	—	—	—	—	—	—	0.081	0.120	0.112	0.101	0.079	—	— 23.0

Grafe, Biedl and others consider a rise in the B. M. and particularly in the dynamic action in hypernutrition to be the protection of the organism against adiposity. Analogously, in under-nutrition the organism can protect itself by lowering the B. M. and the specific dynamic action. The degree of nutrition and the basal metabolism balance each other (Helmreich). Both the basal metabolism and the specific dynamic action are intimately associated with the irritability of the vegetative nervous system and the function of the endocrine glands (Abelin, Arvey, Plaut, Thannhausen, Kestner, Krauss and others). As mentioned above, it has already been demonstrated experimentally that a rich supply of proteins gives rise to a secondary dynamic action with an increase of the basal metabolism for a long period. The secondary dynamic action, however, is also associated with the function of the endocrine glands (the pituitary body and the genital glands) (Grafe, Eckstein, Plaut and others). Thus an adaptation to the food by altering the function of the incretory glands is at least possible to a certain degree.

This assumption is supported by the following observations:

Plummer considers that he was able to ascertain the presence of hypothyreosis in under-nutrition. Curschmann and Tallquist state that there was a considerable decrease in the frequency of Basedow's disease during the Great War; and Peiser and Sehrt assert that they observed a decrease in the amount of hormones in the endocrine glands during the War.

A deficiency of vitamin B, too, causes degeneration and atrophy of the endocrine apparatus, the thyroid gland being not infrequently affected, as was shown by Funk and Douglas.

These observations indicate that under-nutrition and, especially, a low N content in the food as well as a deficiency of vitamins B produce changes in the function of the endocrine glands. However, we cannot wholly ascribe the decrease in the B. M. observed here to an endocrinic disturbance, especially a hypothyreosis in the ordinary clinical sense. None of our cases showed any evident signs of myxoedematous skin changes. Nor could any evidence of a disturbance of the pituitary body or the genital glands be observed.

The results of our investigations of the basal metabolism may be summarised as follows: The unvaried milk and meal diet, LIa, produces as a rule a decrease of the B. M. The cause of this may lie in the comparatively low calorie content of the food and its

deficiency in N. or some other associated factor (a deficiency of vitamins B). We are not prepared to admit that the caloric under-nutrition is the primary cause. This under-nutrition is not due to force of circumstances but is voluntary, arising from a diminished requirement. This diminished need for food is in turn conditioned by the low meat intake or some other factor associated with it. That the low meat content of the diet is not alone the cause is shown by the fact that in certain cases among the forest-workers, although the protein content of the diet is very low, the consumption of calories is nevertheless high (Cases Nos. 12, 2 and 8 in the table on p. 45; No. 2 ate no meat while Nos. 12 and 8 ate very little). Determinations of the B. M. were made on some of the forest-workers subsisting on a diet poor in nitrogen. All of them showed a rise of 10—20 per cent. Some studies on diabetics point in the same direction. The patients under investigation had been treated with Petrén's diet for several years, which diet is exceedingly poor in proteins, consisting mainly of fat and vegetables, but rich in calories, not infrequently containing up to 3000—4000 calories a day. Estimations of the B. M. were also made in some of these cases, the results obtained showed either normal or somewhat increased values.

Further, it may be pointed out that in those cases with lowered B. M. there is an increased tolerance for glucose, adrenaline, pilocarpine and atropine, indicating an impaired tonus of the vegetative nervous system. This may possible be regarded as a measure taken by the organism for the purpose of adapting itself to the caloric under-nutrition. It may also, however, be the direct result of a possibly existing B-hypovitamonosis.

CHAPTER III.

The Incidence of Achylia, its Characteristics and Causes.

One of the main objects of the present investigations was to demonstrate gastro-intestinal disturbances, specially with regard to their frequency and etiology. The most valuable material in this respect is the hospital material from Umeå. A detailed study of this material was made by collecting careful records of the history of each case, by functional tests, examinations of the gastric juice, faeces, etc. In the district investigations we were as a rule compelled to confine ourselves to ascertaining the presence of symptoms indicating gastro-intestinal diseases. Analysis of a test meal was made in only a comparatively small number of cases in the district investigations, and the stomach contents removed was examined only with Congo red paper. Still fewer examinations of stools were made in the district investigations.

A. Methods of Examination.

1. *Ewald-Boas' test meal.*

The most important test for estimating the stomach function is the test meal (Ewald-Boas). This test was made in quite a large number of cases. From observations made at the Umeå Hospital, it was already known, as is usual in hypochlorhydria, that there was frequently a rapid passage of the stomach contents by the patients in the Norrland material. In a very great percentage of the cases the stomach was emptied by means of the ordinary technique. The test meal, consisting of 35 g. of rusks and 400 c. c. of weak tea, was therefore removed after 30 minutes instead of the customary 45—60 minutes. With this technique a lower acidity value is perhaps to be expected than after a test meal removed after 45—60 minutes. Control tests were therefore carried out by

removing the test meal after 45 minutes. To meet any objection that might be raised against this early removal of the test meal we may point out that the same technique as that used at Umeå was also employed in the examinations of a relatively extensive comparative material from the hospitals at Lund and Borås.

In other respects the technique was that in general use. In the hospital cases the examination was made in the morning on a fasting stomach. It was preceded by a retention test when the patient was given two table-spoonfuls of cranberries in the evening and the contents of the stomach removed, followed by a lavage of the stomach in the morning before the test meal proper. In the material from the out-patient department test meal examinations were generally made without a previous retention test, frequently in the afternoon, but always 4—8 hours after a meal. From the removed contents the degree of digestive power was recorded as good, moderately good or poor; the amount of mucus was graded according to the scale: + = small, ++ = moderate, and +++ = abundant. The reaction of the removed test meal as well as of a possible retention and of the lavage fluid was determined by means of litmus paper. Further, the presence of »free» hydrochloric acid was determined by means of Congo red paper and, if the Congo red test was negative, with the aid of the phloroglucin-vanillin test. If »free» acid was found in this way, its amount was titrated with an n/10 NaOH solution, dimethyl-amido-azobenzene being used as indicator. To determine the total amount of acidity another titration was made with phenolphthalein as indicator.

It is an almost universal observation that the acidity values obtained with an Ewald-Boas' test meal vary very much in the same patient on different occasions. It may even happen that a patient one day shows a negative Congo test with low acidity values, while the next day he will show a positive Congo test with high acidity values. The occurrence of what has been called heterochylia, which is generally considered to be due to psychical causes, was demonstrated in Sweden by Abramson, among others, in 1928. His material, consisting of 188 Congo negative cases, gave a positive Congo reaction in 20 per cent of the cases on a repetition of the Ewald-Boas' test meal within a period of 14 days. It should be mentioned, however, that no less than 16 of Abramson's cases had a total acidity value above 20, and many of them above 30 in the first test. In a few of the cases there was a relatively long time between the test meal examinations, and in these cases it is possible that an improvement in the morbid process had occurred in the interval. If, in the same manner as Faber and Schütz, the diagnosis of achylia is made only when the total acidity value amounts at most to 20, the frequency of heterochylia in Abramson's material will be reduced by nearly 50 per cent.

There are several ways of differentiating between these »pseudo» or »functional» achylias and true organic achylia. The simplest of these methods is to repeat the test meal examination after an interval of a few days. In fact examinations of test meals were repeated in quite a large number of cases in this material.

2. *Fractional Analysis.*

Another method of revealing the possible presence of a so-called heterochylia is the fractional test meal examination (EHRENREICH, REHFUSS). Such a test was carried out on a large number of cases. The technique of this test is as follows: A thin tube is inserted into the stomach immediately after the test meal and allowed to remain there during the entire digestive process, small specimens of the stomach contents being drawn off at regular intervals and examined. The fractional test was made, in accordance with the method of FABER and SANDER, by giving rusks and water, for, according to these authors, such a test meal has a more stimulating effect on the gastric secretion than a test meal of oatmeal gruel (RYLE), 3 per cent alchohol (EHRMAN) or caffeine 0.2/300 (KATSCH and KALK).

Fractional examinations were made on 153 patients who had given a negative Congo red reaction in a test meal examination (E.-B.),[1] a positive Congo red reaction being obtained in 56 cases. By way of comparison it may be mentioned that EGGLESTONE examined 3000 cases, the gastric contents being removed 60 minutes after an Ewald-Boas' test meal, and obtained a negative Congo reaction in 18 per cent of the cases, while with a fractional test meal he obtained 10 per cent Congo negative cases, which signifies that 44 per cent of the cases that were Congo negative on an ordinary E.-B. became Congo positive on fractional examination.

With regard to the relatively short interval between the eating of the test meal and the removal of the stomach contents, it will be of interest to ascertain the time at which the Congo reaction became positive in the fractional examination. This is shown in the following table.

	minutes								
Congo positive after	15	30	45	60	75	90	135	150	195
Number of cases	1	14	14	16	6	2	1	1	1

It will be seen from the table that most of the cases, 41 out of 56, took more than 30 minutes to become Congo positive. But this does not justify us in concluding that a greater number of cases would have shown free acid in the stomach contents if the ordinary test meal had been removed after a longer interval than 30 minutes. For it has frequently been observed that the fractional examination gives a positive Congo reaction at a point of time when the E.-B. shows a negative reaction. This occurred in 15 of the cases recorded in the above table. This is often ascribed to psychical causes, but it may also be explained in another way. The fractional test meal may be more stimulating than the E.-B. The emptying time of the stomach may also be prolonged owing to the tube remaining in the stomach. Thus the fractional examination would exercise not only a stronger but also a more prolonged stimulation than an ordinary E.-B. test. Indeed it has been observed on several

[1] For the sake of simplicity, »E.-B.» will be employed in the following pages to designate an examination of a single test meal drawn off after 30 minutes.

occasions that specimens of the stomach contents were obtained by fractional examination even when the stomach was empty on E.-B. As already mentioned, some investigators consider that the cause is purely psychic, others are of opinion that the aspiration technique involved in the fractional test meal provides greater facilities for removing the stomach contents than by means of the ordinary stomach tube (Orlowsky, Vandorfy and others). Moreover, some authors are inclined to believe that the inserted tube has a stimulating effect on the secretion of gastric juice (among others Bondi, Galewski, Matthes and Diehl). In order to try to find out the cause of the difference in the results between the E.-B. and the fractional test meals, estimations were made of the carbon dioxide capacity of the blood (Van Slyke-Odin) before and at certain intervals after the test meal with and without the insertion of the tube.

CO_2 capacity of the blood in volume percentage in test meal examinations with and without a »Dauer» tube.

	Before meal	After meal				Difference [1]
		½ hour	1 hour	2 hours	4 hours	
1. Without tube	48	45	45	45	44	— 3
With »	42.5	46	47	47	47.5	+ 5
2. Without »	49	49	49	50	48	+ 1
With »	49	50	50	50	46	+ 1
3. Without »	46	46	49	46	45	+ 3
With »	43	47	48	52	47	+ 9
4. Without »	46	46	46	48	45	+ 3
With »	43	45	46	49	47	+ 6
5. Without »	47	48	48	50	49	+ 3
With »	50	51	50	48	48	+ 1
6. Without »	50	51	49	49	48	+ 1
With »	46	48	52	47	47	+ 6
7. Without »	48	47	47	51	46	+ 3
With »	51	51	56	55	51	+ 5
8. Without »	57	52	54	60	58	+ 3
With »	57	58	60	61	62	+ 4
9. Without »	48	48	50	53.5	48	+ 5.5
With »	50	52	58	56	54	+ 8
10. Without »	46	49	49.5	49	48	+ 3.5
With »	45	45	51.5	50	50	+ 6.5
11. Without »	48	47	48	50	52	+ 4
With »	53	52	49	49	47	— 6
12. Without »	50	52	52	52	51	+ 2
With »	47	53	52	50	48	+ 6

It will be seen from the table that no fewer than 9 cases out of 12 showed a greater and more protracted rise of the carbon dioxide capacity with the tube than without it. The result seems to indicate that the »Dauer»

[1] Difference here means the difference between the fasting value and the highest value of the CO_2 capacity found later in the test.

tube has a stimulating effect on the secretion of hydrochloric acid, a rise in the carbon dioxide capacity being explained by the fact that the blood is deprived of acid constituents.

In order to ascertain the influence of the »Dauer» tube on the emptying time of the stomach, 10 persons were given an equal amount of an opaque meal, and the emtying time was determined with and without the »Dauer» tube in the different cases by fluoroscopy, partly by recording the time when the stomach was empty and partly by noting the depth of the fluid layer in the stomach after 3 hours. The result obtained showed that 9 of the cases had a longer emptying time with the tube than without it. These tests thus go to prove that the insertion of the »Dauer» tube retard the emptying of the stomach. Hence the results of the fractional analysis cannot be regarded as fully equivalent to the results of an E.-B.

Fractional analysis was not made in all cases in this material. In fact it is questionable whether a powerful stimulant, such as we have shown the fractional test to be as compared with the E.-B., should be employed in demonstrating the occurrence of minor disturbances of the gastric secretion. It may happen that with this technique slight disturbances are overlooked. The demonstration of minor secretory disturbances is occasionally of some importance. This fact is disregarded by most modern authors, for they seem to attach no significance to the presence of a negative Congo reaction in E.-B. It may of course be disputed whether the results obtained by means of the fractional examination have not caused some investigators to go too far in disregarding slight secretory disturbances in the stomach. Fractional test meal analysis was undertaken in our material in order to form an idea of the degree of disturbance. For the same purpose the secretion of hydrochloric acid was examined in a number of cases after subcutaneous injection of 1 mg. of histamine (POPIELSKI, CARNOT).

3. *Histamine Test.*

At first, in the beginning of 1928, we employed the usual method with a subcutaneous injection of 1 mg. of histamine, on an empty stomach without a simultaneous test meal. Of 13 cases, which on E.-B. were Congo negative after 30 minutes, only 2 showed a positive Congo reaction after the injection of histamine. In the E.-B. test one of them had a total acidity value of 19, and the other 12. No fractional examination had been made previously in these cases. Of the other persons examined with histamine, 2 showed a total acidity value of 10 and 12 respectively, the remainder less than 9. On one of the cases showing a positive Congo reaction after the injection of histamine an ordinary fractional analysis was made later, when a positive Congo reaction was obtained. In all cases examined with histamine in this way only small amounts of secretion were obtained. For that reason the method was modified. Simultaneously with the injection of histamine a test meal (rusks) was given with the tube remaining in the stomach, i. e. a fractional analysis + histamine. In this examination 2 of the cases which were Congo negative in the histamine test without tube

and test meal, gave a positive Congo reaction in all specimens. Thus an injection of histamine combined with a test meal of rusks proved to be a more powerful stimulus to gastric secretion than an injection of histamine alone.

In consequence of this subsequent histamine tests were combined with a test meal of rusks.

Of 65 cases, in which E.-B. and fractional examination gave negative Congo reaction, 11, or 17 per cent, gave a positive Congo reaction in some specimen in a simultaneous injection of histamine. In some of these cases the fractional analysis was repeated a few days later without the injection of histamine, when they were all Congo negative. Thus it cannot be disputed that histamine + a fractional examination gives a stronger reaction that a fractional examination alone. Moreover, the results of the present examinations confirm FABER's view that the result obtained with a histamine injection alone, i. e. without a test meal, does not differ essentially from that of the fractional examination with a test meal.

4. *Neutral Red Test.*

The gastric function was also examined in a number of cases by means of an intramuscular injection of 0.5 c. c. of a 1 % neutral red solution (FULD, FINKELSTEIN, SCHAFFER, GLÄSSNER, and WITZENSTEIN), the presence of the dye in the gastric juice being demonstrated by drawing off samples of the gastric contents at 15-minute intervals. This is considered to be the most sensitive method for demonstrating acid in the stomach contents. If there is any acid-secreting parenchyma this test will give a positive result, i. e. the dye can be demonstrated in the stomach contents drawn off. The neutral red test, however, has not fulfilled the great expectations at first raised, when it was thought possible by means of this test to distinguish between a benign functional achylia and a malignant achylia, due to cancer (STUBER, WATHAUS) or pernicious anaemia (WILLCOX and HAAGENSEN).

In the beginning of our tests we injected the neutral red solution, in accordance with the customary procedure, without a test meal 1 hour after the histamine test, and the time at which the neutral red appeared in the gastric juice was ascertained by removing small specimens of the stomach contents at 15-minute intervals. The results obtained were unsatisfactory. Not a single positive result was obtained in those cases in which a histamine test and an ordinary fractional analysis had previously been negative. Subsequently neutral red was injected simultaneously with the histamine test and fractional analysis, in some cases with an ordinary fractional analysis alone, for it was found that in this way the test will give a positive result more frequently than after an injection of neutral red with a simultaneous test meal.

5. *Value of the Different Methods of Examination.*

The results of the different estimations of the hydrochloric acid secretion in the stomach by means of the methods described above are tabulated below so as to give an idea of their relative value.

Value of different tests for examination of gastric secretion.

Total acid. in E.-B.	Total number of cases examined	Single fractional analysis: Congo pos.	Single fractional analysis: Congo negative			Histamine neg.	
			Histamine test not made	Histamine pos.[1]	Histamine neg.[1]	Neutral red	
						pos.	neg.
0	2	—	—	—	2	—	2
2	5	—	1	—	4	1	3
3	2	—	—	—	2	1	1
4	24	1	4	2	17	4	12
5	13	1	2	1	9	2	4
6	19	4	4	3	8	3	3
7	9	2	2	1	4	2	1
8	21	5	8	1	7	4	1
9	1	—	1	—	—	—	—
10	7	4	2	1	—	—	—
11	1	1	—	—	—	—	—
12	8	5	2	1	—	—	—
14	9	8	—	1	—	—	—
15	5	3	2	—	—	—	—
16	5	5	—	—	—	—	—
17	1	1	—	—	—	—	—
18	4	4	—	—	—	—	—
19	2	2	—	—	—	—	—
20	6	6	—	—	—	—	—
23	1	1	—	—	—	—	—
24	2	2	—	—	—	—	—
26	1	1	—	—	—	—	—
Total cases	148	56	28	11	53	17	27

It will be observed that in the fractional examinations after a test meal free acid was obtained in 56 of the 148 cases, or 31 per cent, and in the histamine tests + fractional analysis in another 11 cases out of 64, or 17 per cent. Thus more than 50 per cent of the total were cases of »total» achylia. This indicates that the functional disturbances in the Norrland material is of a severe nature. This is also evidenced by the results of the neutral red tests and the frequently observed reduced peptic digestion together

[1] »Histamine pos.» and »histamine neg.» denote cases in which the histamine test was made, and the Congo reaction was respectively positive or negative. Histamine refractory is the same as histamine negative.

with the low total acidity values. We shall recur to this subject later on.

From the data given in the above table certain inferences may also be drawn concerning the result of the ordinary test meal examination as compared with other methods of examination. Not a single case with a total acidity value above 8 in E.-B. was histamine-refractory; all the 53 histamine-refractory cases showed in E.-B. a total acidity value of 8 or lower. Of all the 95 cases with a total acidity value of 8 or under, only 12 showed free acid in a simple fractional analysis. In 8 of these cases the histamine test was positive when a simple fractional analysis was Congo negative. In 21 cases, however, in which the fractional examination was negative, no histamine test was made. In only 14 per cent of the 95 cases with a total acidity value of 8 or under did the fractional analysis show free acid in one or more specimens drawn off. The great majority of the cases were histamine-refractory too (53 cases).

Consideration of the cases with a total acidity value above 8 in E.-B. will show that all cases (22 in number) with a total acidity value of 16 or above gave a positive Congo reaction even in the simple fractional analysis. Of the cases with a total acidity value between 9 and 15 (31 cases), 21, i. e. 70 per cent, were Congo positive in a simple fractional analysis. All cases which were subjected to a further examination with histamine gave positive results with secretion of free acid.

The results obtained are shown in the following table.

Total acidity in E.-B.	Congo pos. on simple fractional analysis	Congo pos. after test meal and injection of histamine
0—4	3 %	10 %
0—8	14 %	25 %
5—8	20 %	50 %
9—15	68 %	100 %
> 16	100 %	100 %

Judging from this table it is possible, simply by considering the total acidity value in an ordinary test meal, to determine with a high degree of probability the degree of secretory insufficiency and to conjecture the result that will be obtained by employing the methods of examination mentioned above.

Owing to the small number of tests similar deductions cannot be drawn with regard to the excretion of neutral red. Of 41 histamine negative cases 17 showed an excretion of neutral red. It is evident from the table, however, that even neutral red positive cases increase within the group of histamine negative cases showing the highest total acidity value. At a total acidity value below 5 a neutral red excretion occurs in 6 cases out of 24 (25 per cent), at a total acidity value of 5—8 neutral red was excreted in 13 cases out of 22 (about 60 per cent).

6. *Examination of the Peptic Digestion.*

The function of the stomach was examined in 316 Congo negative cases by measuring the peptic digestion. The technique employed was that of NORGAARD with METT's tubes made in accordance with JOHANNE CHRISTIANSEN'S method. The results are shown in the following table, in which the protein digestion is given in mm. The table also gives the total acidity values for the cases examined, along with the mean total acidity values at different degrees of protein digestion.

Total acidity	Peptic digestion in mm.				
	(0) 0—2	2.5—4	4.5—6	6.5—8	8.5—10
0—4	(2) 35	15	13	2	0
5—8	(4) 40	48	27	8	2
0—8	75	63	40	10	2
9—16	5	22	30	18	17
>16	0	4	22	6	2
>8	5	26	52	24	19
Total	80	89	92	34	21

From the table it will be observed that more than 50 per cent of the cases (169 out of 316) showed a considerable decline in the peptic digestion (maximum 4 mm. dig.). This points to a serious disturbance of the secretion of gastric juice. The peptic digestion is poorest at low total acidity values (0—4), when there is always a decrease; in 50 cases out of 65, i. e. 77 per cent, it was 4 mm. at most. At a total acidity value of 0—8 the peptic digestion is seldom normal, in 138 cases out of 190, or 72 per cent, amounting to not more than 0—4 mm. When the total acidity value is above 8 the peptic digestion is often more than 8 mm. (in 19 cases out of 126).

With a total acidity value above 8 a peptic digestion below 4 mm.

was found in 31 cases out of 126, i. e. 25 per cent. When the total acidity value is over 16 such a low rate of peptic digestion was observed in only 4 cases out of 24 (about 12 per cent).

The next table shows the correlation between the degree of decrease in the peptic digestion and the results obtained in the other functional tests.

From the table it will be seen that the peptic digestion is a measure of the degree of disturbance, from which it is possible to infer with a certain degree of probability the result of the fractional analysis with or without histamine and neutral red and also the total acidity value.

Peptic digest. in mm., estimated in E.-B.	Average value of total acidity in E.-B.	Simple fract. analysis Congo neg.	Histamine test. Congo neg.	Neutral red neg.
0—1 mm.	5	100 %	100 %	100 %
1.5—2 mm.	5.1	93 %	85 %	50 %
2.5—3 mm.	5.9	82 %	80 %	25 %
3.5—6 mm.	11.3	50 %	33 %	10 %
>6 mm.	12	30 %	0 %	0 %

The various functional tests have been treated rather fully because, as far as I am aware, no comparison has been made previously between the results obtained by these various methods of examination. The technique employed in the histamine and neutral red tests carried out in the present investigation was also improved by giving test meals simultaneously with the histamine and neutral red tests.

By reason of the correlation between the total acidity value and the results of the different methods of examination the importance of the ordinary test meal examination, as a means of estimating the degree of secretory disturbance, is enhanced. As shown by the examinations, it is possible even from the total acidity values to draw rather definite conclusions with respect to the function of the stomach and the degree of disturbance. Since the fractional examinations with or without histamine or neutral red test were carried out mostly in the early part of these investigations, and as no selection was made, apart from the exclusion of cases of cancer and pernicious anaemia, we are justified on the basis of the results obtained in drawing the conclusion that the disturbances of the stomach function were often of a serious nature. This aspect of the problem will be discussed later.

B. Frequency of Achylia in the Total Material.

During the years 1924—1931, when the author was head of the Medical Department of the Umeå Hospital, 4568 E.-B. test meal examinations were performed, specimens of the stomach contents being drawn off at intervals of 30—45 minutes. In not less than 1800 of these cases the Congo red tests were negative, amounting to 39.4 of the entire material.

The following table shows the distribution of the cases in the different years.

Year	Number of cases		Percentage of Congo negative
	Total	Congo negative	
1924	283	120	42.4 %
1925	428	191	44.6 %
1926	513	211	44.1 %
1927	584	273	46.7 %
1928	777	322	41.4 %
1929	880	302	34.3 %
1930	653	239	36.6 %
1931	450	142	31.6 %
Total	4568	1800	39,4 %

It appears from the table that the frequency of achylia (Congo negative cases) is very high but it will also be observed that there is a striking decline in the number of the cases during recent years. This decrease is due to several causes. The main cause is undoubtedly to be found in the enormous development of the means of communication during the last few years, which has brought about an improvement in the general nutritional conditions of the population, whereby one of the factors in the origin of achylia, as we shall see later on, the lack of variety in the diet, has been eliminated. Another contributory cause of the decrease in the incidence of achylia is the intensive work of spreading information and instruction carried on as the result of the present investigations, partly by means of newspaper reports, but mainly by means of lectures, instruction and advice by the physicians taking part in the investigations, who by coming into direct contact with the population have brought about a great reform in the matter of diet and hygiene. Finally, the great decrease in the years 1928

—1929 can be explained to a certain extent by the fact that in connection with these investigations test meal examinations were made more extensively than formerly, also on healthy individuals.

While the Norrland investigations proper were being carried out in the summer of 1928 — the autumn of 1930, 1382 E.-B. test meal examinations, the stomach contents being removed after 30 minutes, were made at the Umeå Hospital. Of these cases, 429, or 36.1 per cent, were Congo negative, a somewhat lower figure than that of the entire material, which is due to the fact, already mentioned, that a large number of healthy individuals were included in the examinations. For the sake of comparison we give below some data taken from the literature and from the Lund and Borås materials showing the incidence of achylia.

	Ewald-Boas	Number of cases	% Congo neg.
Koch	45—60 min.	350	2
Schütz	»	1000	7
Corner	»	5000	15.2
Kelling	»	3147	16.5
Van der Hof	»	500	16.2
Keefer-Bloomfield	»	1500	26.0
Egglestone	»	2399	18.0
Umeå	30—45 min.	4568	39.4
» 1928—1930	30 »	1583	36.1
Lund	» »	442	14.7
Borås	» »	525	13.5

The frequency of Congo negative cases is much higher in the Umeå material than in any of the others. This will be seen quite plainly if a comparison is made with the figures from Lund and Borås, where the technique was the same as that employed in Umeå.

The literature, however, also contains records of a still higher incidence of achylia. Bogendörfer states that more than 50 per cent of his material was Congo negative. Frigo-Emura, and Hubbard and Lichty found an incidence of 48.9 and 37 per cent respectively. The cause of these differences in the figures for the incidence of achylia is of course difficult to explain. It is no doubt partly due to the selection of the material and the methods of examination employed. Moreover, we cannot altogether reject the view that the cause of a higher incidence of achylia at one place than at another is the same as that responsible for the difference in frequency in the Umeå material on the one hand and the Borås and Lund materials on the other.

The objection might possibly be made that the great number of Congo negative cases in the Umeå material is due to the time at which the gastric contents was removed (generally after 30 minutes). But this supposition is incompatible with the comparatively low frequency of achylia found in the material from Lund and Borås, where the same technique was employed.

The results of the fractional analyses made in Umeå point in the same direction. Of 153 Congo negative E.-B. cases, 53, or 36.6 per cent, became positive on fractional examination. Assuming that the same figure is valid for the entire material, the result would be 24.5 per cent instead of 39 per cent Congo negative cases. Such an assumption is justified since the cases in which fractional test meal examinations were made were not specially selected, for during a certain period of the investigation such an examination was made in every case that gave a negative Congo reaction on E.-B.

The following data from the literature concerning the incidence of Congo negative cases on fractional examination are well worth quoting in this connection. EGGLESTONE found 10 per cent Congo negative cases in this material, ILVERT reports 10.3 per cent, and CORNER 15 per cent, figures which are considerably lower than those found in our investigations. On the other hand, HUBBARD and LICHTY found an incidence of up to 22.7 per cent. It should be borne in mind, however, that the test meal used by us in the fractional examination differs from that usually given in that it consisted of rusks, which, as already mentioned, proved to be a powerful stimulant to secretion.

In order to obtain some idea of the difference in the frequency of Congo negative cases and in acidity value in the E.-B. tests in which the contents was removed after 30 minutes and those in which the contents was drawn off after 45 minutes, the cases in which the test meal was removed after 45 minutes have been grouped separately. These examinations were made before 1928 but have since been supplemented, in 1930 and 1931.

When the test meal was removed after 45 minutes, 37.9 per cent of the 527 cases were Congo negative, thus a somewhat lower figure than that obtained for the entire material but, on the other hand, somewhat higher than that recorded for the test meal examinations made in 1928—1930. This apparently curious result is explained partly by the decreasing frequency of Congo negative

cases during the last few years, partly by the large number of tests made on healthy individuals in 1928—1930.

The frequency distribution of achylia in the two sexes is shown in the following table.

	Men		Women	
	Number of exam.	Congo neg.	Number of exam.	Congo neg.
Umeå	2260	820 (36.3 %)	2308	980 (42.5 %)
Lund	265	32 (12.5 %)	177	31 (18.1 %)
Borås	276	27 (9.8 %)	249	44 (17.7 %)

The table shows a considerably higher number of Congo negative cases amongst women than amongst men.

In the literature divergent statements are found with regard to the incidence of secretory disturbances in the two sexes. Thus, for instance, Schüle, Katsch and Corner state that achylia is more frequent in women, while others, e. g. Faber, find it more common among men. Faber considers this to be evidence in support of his theory of gastritis, that gastritis is the sole cause of achylia.

The frequency of Congo negative cases in different ages shows a regular increase with advancing age in the entire hospital material, in the Umeå material from 19.6 per cent between the ages of 15 and 20 years to 67 per cent between the ages of 60 and 70 years. These figures agree well with those recorded in the literature (Dedichen, Seidelin).

It was shown above that the frequency of Congo negative cases in the Norrland material, judging from the hospital cases, is considerably higher than in the materials collected from southern and central Sweden.

The next table gives the average values of free HCl and total acidity in the Congo negative cases found in the investigations at Umeå, Lund and Borås.

Further, in the table will also be seen the difference in acidity between test meals removed after 30 minutes and test meals removed at 45 minutes in Congo positive cases. The acidity values obtained in Umeå and Borås in tests on »healthy» subjects, i. e. persons who were not affected by any kind of disease at all, or were suffering from a disease which cannot be considered to have any influence on the gastric secretion of hydrochloric acid, have

Comparison between the acidity values in Umeå, Lund and Borås.

		Free HCl									Total acidity					
		Men			Women			Total			Men		Women		Total	
		Number of cases	Median	Average value	Number of cases	Median	Average value	Number of cases	Median	Average value	Median	Average value	Median	Average value	Median	Average value
Test meal withdrawn after 30 minutes	Total mat.	400	22	24	426	17	18	835	18	21	42	44	37	39	39	41
Umeå	Healthy pers.	69	22	25	88	17	19	157	19	22	41	42	38	39	39	40
Test meal withdrawn after 45 minutes	Total mat.	86	28	29	117	21	24	203	24	26	47	47	44	45	45	46
Lund	Total mat.	230	27	28	145	18	23	375	23	27	51	54	47	48	49	50
	Healthy pers.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Borås	Total mat.	233	33	32	180	20	22	413	27	28	56	58	46	47	52	53
	Healthy pers.	29	33	34	19	39	31	48	33	33	54	55	48	48	52	52

Frequency of hypoacidity and hyperacidity in the hospital material.

	Number of cases		Free hydrochloric acid						Total acidity					
			< 10		> 50		> 60		< 30		> 70		> 90	
	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.
Umeå	409	426	65 (15.3 %)	88 (20.7 %)	19 (4.9 %)	6 (1.4 %)	7 (1.4 %)	2 (0.5 %)	84 (20.5 %)	118 (27.7 %)	24 (5.9 %)	10 (2.3 %)	0	0
Lund	232	145	33 (14.2 %)	35 (24.1 %)	24 (10.4 %)	5 (3.5 %)	9 (3.9 %)	3 (2.1 %)	22 (9.5 %)	20 (13.8 %)	34 (14.7 %)	14 (9.6 %)	2 (0.9 %)	4 (2.8 %)
Borås	249	205	17 (6.8 %)	37 (18.0 %)	38 (15.3 %)	10 (4.9 %)	11 (4.4 %)	3 (1.5 %)	10 (4.0 %)	28 (13.7 %)	57 (22.9 %)	12 (5.9 %)	9 (3.6 %)	2 (0.9 %)

also been excluded from the total material and recorded separately in the table. Otherwise it may be thought that the lower values in the Norrland material are due to the inclusion in this material of diseases, which might lower the average value, or that the Borås and Lund materials include a higher percentage of diseases with a tendency to high acidity values (e. g. gastric ulcer).

From the table it will be observed that both the median [1] and the average [2] value of the acid secretion are considerably higher for the Lund and Borås materials than for the Umeå material. This applies to the values of the free acid as well as of those of the total acidity. The lower values for the Umeå material cannot be due to the nature of the cases, since the figures for the total material here are almost identical with those for the »healthy» subjects, and the same difference exists between the »healthy» subjects in Borås and Umeå as between the total materials from those places. In Lund no test meal examinations were made on healthy individuals.

If the test meal is removed after 45 minutes the acidity values, as expected, will be a little higher than when the test meal is drawn off after 30 minutes. As regards free acid the former values correspond very closely to the figures for the Lund material, in which the test meal was removed after 30 minutes. The total acidity values are still somewhat lower for the Umeå material. Compared with the Borås material the figures for the Umeå material are lower throughout, even if we compare the test meals drawn off after 45 minutes in Umeå with those drawn off after 30 minutes in Borås. The acidity values for men are higher throughout than those for women.

Further, it would be of a certain interest to study the frequency of cases of hypoacidity and of hyperacidity in the materials from the different hospitals. The next table illustrates the results of this study (p. 73).

The incidence of hypoacidity is, as a rule, higher in the Umeå material than in the Lund and Borås materials, and this appears in particular in the number of cases with a total acidity value below 30 in the different materials examined. On the

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[1] »Median» denotes the acidity value at which the number of cases with a higher value is equal to those with a lower value.

[2] »average value» is the arithmetical mean of all the acidity values.

other hand, the number of cases of hyperacidity having a free acid value above 50 and a total acidity value above 70 is much higher in the Lund and Borås materials. The Umeå material contains no case with a total acidity value above 90. In the Lund material, which is not half the size of the Umeå material, there are 6 such cases, and in the Borås material, about the same size as the Lund material, there are 11.

In the district investigations only a relatively small number of test meal examinations, E.-B. with removal of the contents after 30 minutes, were made. For that reason a grouping of the persons examined according to districts would be of little interest. No titrations of the stomach contents were made; the only available data are the results of the Congo red tests. These results may be summarized as follows: In 246 persons examined the Congo test was negative in 86 cases, or 37.3 per cent.

The frequency of Congo negative cases is higher in Västerbotten than in Norrbotten, the respective figures being 47.4 per cent (116 cases) and 23 per cent (130 cases).

The incidence of Congo negative cases in men and women is shown in the following table.

	Congo negative cases	
	Men	Women
Västerbotten	20 (40 %)	35 (49 %)
Norrbotten	14 (24 %)	16 (22 %)

Thus there is a somewhat higher incidence of achylia among the women in Västerbotten than among the men.

The distribution in the different age-groups was as follows:

	Number of cases	Congo negative %
13—18 years	6	(20)
19—30 »	22	30
31—50 »	30	33.3
51—65 »	27	51

Hence the frequency of Congo negative cases increases with increasing age.

The test meal examinations in the district investigations thus agree very well with the results of the hospital examinations.

C. Principles of Elimination.

It has long been known that certain diseases have an inhibitory influence on the hydrochloric acid secretion of the stomach. The frequent occurrence of cases with lowered HCl secretion in the Norrland material may therefore be thought to have been due to a great accumulation of such cases. In order to obtain a correct idea of the importance of other factors for the deficiency of acid in the gastric juice it is essential that such cases be weeded out of the material. The incidence of such diseases and the results of the test meal examinations on these cases are recorded in the table below. This table — like the material weeded — covers only the period from the autumn of 1928 to the autumn of 1930, as detailed examinations of the material with respect to diet, dental condition, etc. are available only for that period.

The influence of some of these diseases on the gastric secretion is perhaps open to question. In fact it is possible that the impaired function of the stomach in some of the cases recorded here can be explained by the same factors as give rise to a possible increase in the incidence of »primary» achylia in the Norrland material. The rigorous weeding of the material, however, strengthens the evidence of the effect of these factors and is therefore justified.

It may also be disputed whether the cases of chronic colitis, too, should not be eliminated. But as these cases are of special interest they have not been excluded.

Cases of peptic ulcer, with their tendency to high acidity values, should perhaps have been excluded from the material. If these cases were excluded the percentage of Congo negative cases would be increased, as not less than 164 patients suffering from peptic ulcer are included in the material, only 12 per cent of which were Congo negative in the test meal examination. The cases of neurosis also merit special mention. Cases exhibiting pronounced neurotic symptoms are not included. A high percentage of the cases manifested mild general symptoms of neurasthenia, fatigue and lack of energy and symptoms from

	Congo neg.	Congo pos.
Cancer ventriculi	31	6
Cancer oesophagi	2	0
Cancer sigmoidei	1	0
Anaemia perniciosa	12	0
Status post gastroenterostomiam	14	4
Morbus hepatis	14	18
Tbc. pulm. et pleurit.	12	4
Bronchit. chron. Bronchiektasiae	2	1
Polyarthrit. chron.	8	10
Nephrit. chron.	3	0
Nephrit. in graviditate	2	2
Chronic circulatory disorders	4	3
Splenomegaly	1	0
Polyneuritis	1	0
Endocrine disorders	4	0
Acute febrile diseases	8	16
Total	113	58

the gastro-intestinal canal in the shape of oppression and flatulency. These symptoms, however, may also be ascribed to the functional disturbance of the stomach or to a coincident anaemia and therefore cases exhibiting these symptoms have been included.

The material selected consists also largely of cases suffering from diseases that cannot be considered to have any influence on the secretion of hydrochloric acid, together with healthy individuals. In the following pages both these groups will be designated »healthy» or control cases.

D. Incidence of Primary Achylia and its Characteristics.

1. *Incidence of primary achylia in the hospital material.*

After eliminating from the hospital material all cases in which the causes of the deficiency in gastric juice were known, there remain 1215 cases, of which 380, or 31.3 per cent, were found on examination of specimens of a test meal drawn off after 30 minutes to be affected with achylia.

From these figures it is evident that the large number of Congo negative cases in the Norrland material is not due to the

abnormally high incidence of the above-mentioned diseases, which have a more or less pronounced tendency to lower the acid secretion of the stomach, for even after eliminating such cases the percentage of achylic cases is still very high, 31,3 per cent.

For the sake of comparison the materials collected at Lund and Borås were also weeded on the same principles, with the following results:

	Number of cases	Achylia	Percentage achylias	
			Men	Women
Lund	423	46 (10.9 %)	9 %	13.7 %
Borås	476	47 (9.8 %)	6.5 %	13.7 %

The achylic cases in Umeå (after weeding) showed the following age and sex distributions:

Age	Men			Women		
	Total examined	Achylia		Total examined	Achylia	
		Number of cases	%		Number of cases	%
15—20	44	4	9.1	80	16	22.5
21—30	170	26	14.7	237	70	29.5
31—40	147	41	27.9	158	57	36.1
41—50	99	31	31.3	109	57	52.3
51—60	65	30	46.2	55	26	47.3
61—70	26	10	38.5	25	10	40.0
Total	551	142	25.8	664	238	35.6

The frequency of Congo negative cases increases, as expected, with increasing age even in the selected material. This is also evident from observations made in other quarters. In our material only a few test meal examinations were made on individuals above 60 years of age, and the number of examinations made on individuals between 50 and 60 is also relatively small. These age-groups present no features of interest in the attempt to estimate the incidence and the causes of achylia in Norrland. The Norrland material consists mainly of individuals whose ages ranged from 20 to 50 years. The average age of the Borås

and Lund subjects is somewhat higher. This makes the difference in the incidence of achylia still more marked.

a) *Degree of functional disturbance.*

The cases remaining after the process of elimination are not the milder ones, if the results of the examinations of more »stimulating» test meals are taken as the measure of the degree of disturbance. This will be seen from the following table.

Single fract. test meal		Histamine examination				Neutral red test	
		Congo neg. on fract. exam.		Without preceding fract. exam.		Previously histamine neg.	
Congo pos.	Congo neg.	Congo pos.	Congo neg.	Congo pos.	Congo neg.	pos.	neg.
44	78	9	26	5	21	18	22

The higher percentage of »histamine negative» cases, unless a fractional test meal examination had been made previously, is due to the fact that in these cases, owing to their low total acidity values, a negative result was to be expected in a simple fractional test meal. Such a fractional examination was therefore not made in these cases, so as not to cause the patients any unnecessary discomfort.

The total acidity values for the selected cases are as follows:

Total acid.	0	1—4	5—8	9—15	16—20	21—30	Not recorded
Number of cases	80	46	123	105	61	15	10

Considerably more than half the number of cases (269 as against 181) thus show a total acidity value below 9, indicating, as already mentioned, a serious disturbance of the stomach function.

Examinations of the peptic digestion gave the following results for the Umeå material. The tests were made on specimens of the stomach contents recovered 30 minutes after the usual E.-B. test meal.

Peptic digestion in mm.	0	0.5–1	1.5–2	2.5–3	3.5–4	4.5–5	5.5–6	6.5–7	7.5–8	8.5–11
Number of cases	3	10	22	18	23	20	16	7	6	7

These results also point to a serious disturbance, as no less than 76 cases out of 132 (57 per cent) show a marked decrease in the peptic digestion to 4 mm. or less.

The next table shows the total acidity values for the Lund material. Fractional test meal examinations were only made in a few exceptional cases.

Total acid.	0	1—4	5—8	9—15	16—20	21—30	32	Not recorded
Number of cases	3	—	6	15	11	8	1	2

The results obtained in the Borås material were as follows:

Total acid.	0	1—4	5—8	9—15	16—20	21—30	31—40
Number of cases	3	—	10	12	11	10	2

The difference between the Lund and Borås results and the Norrland results is striking. Only 9 of the 42 Congo negative cases in Lund and 13 of the 47 cases in Borås showed total acidity values below 9. Thus the Congo negative cases in Norrland are not only more frequent, but the disturbance of the stomach function found is also more severe.

The specimens of the stomach contents removed after the test meal were also examined with respect to the degree of digestion and the presence of mucus. The contents were also examined microscopically after centrifugation.

The degree of digestion of the stomach contents drawn off after E.-B. was found to be the following for the Congo negative cases in the Norrland material (265 cases of the selected material):

Digestion in removed stomach contents.

Total acid.	Good	Fairly good	Rather poor	Poor
0— 4	3	2	14	31
5— 8	4	13	27	46
9—15	11	19	20	26
>15	18	13	9	7
Not recorded	—	—	—	2
Total	36	47	70	112

From the table it will be seen that in 182 cases (69 per cent) the power of digestion is »rather poor» or »poor». As was to be expected, the degree of disturbance in the acid secretion and the

degree of digestion agree very well. Thus in 90 per cent of the cases the digestion was »rather poor» or »poor» at a total acidity value of 0—4, in 81 per cent of the cases at a total acidity value of 5—8, in 60 per cent at 9—15, and in 36 per cent at a total acidity value above 15.

The amount of mucus found in the removed test meal is shown in the table below. Only finely diffused mucus originating from the stomach was taken into account. The amount of mucus in the removed stomach contents is recorded in 252 cases of achylia.

Amount of mucus in the removed stomach contents.

Total acid.	0	+	++	+++
0— 4	6	23	8	13
5— 8	13	50	9	14
9—15	10	43	3	12
>15	11	27	6	3
Not recorded	1	—	—	—
Total	41	143	26	42

It may be disputed whether such a small amount of mucus as that represented by +, can be regarded as pathological. Pathological amounts of mucus, ++ and +++, were present in 68 cases, or 27 per cent. The degree of mucous admixture shows a certain correlation to the total acidity value. If only cases represented by the symbols ++ and +++ are considered as pathological admixtures of mucus, the percentage of such cases with total acidity values of 0—4, 5—8, 9—15 and >15 will be 44 per cent, 28 per cent, 22 per cent and 19 per cent respectively.

The general opinion is that a mucous admixture in the removed stomach contents indicates the presence of an inflammatory process in the mucosa. On the other hand, the absence of mucus is no proof that there is no gastritis. On the contrary, the absence of mucus may signify a complete atrophy of the mucosa, the result or the final stage of a severe inflammation, with cessation of mucous secretion.

Estimations were also made of the number of leucocytes and the amount of albumen in the test meal, but they revealed nothing of interest.

The examinations of the degree of digestion and the amount of mucus present in the Congo negative cases among the Lund and Borås materials present no points of interest. With regard to the presence of mucus it is noteworthy, however, that more than 50 per cent of the achylic cases in the Borås material show an increased amount of mucus. The figures for the Lund material are about the same as those for the Umeå cases.

b) *Symptomatology of the cases examined with test meals.*

The table below will serve to illustrate the subjective symptoms of the patients. In order to get a better survey of these symptoms they have been grouped in respect to the nature of the complaints.

Symptomatology of cases examined with test meals in Umeå.

	Congo negative							Congo pos.
	Number of cases	Alk.	Total acidity				Not recorded	Number of cases
			0—4	5—8	9—15	>15		
Mild stomach trouble ...	137	2	20	45	38	28	4	321
Severe » » ...	130	6	17	42	36	27	2	231
Constipation	108	3	8	33	35	26	3	94
Stercoral diarrhoea	49	2	8	21	8	9	1	47
Diarrhoea	28	1	5	9	8	5	—	28
Healthy and controls ...	93	1	17	29	22	20	2	157

»Mild stomach trouble» denotes epigastric oppression and flatulency, occasionally eructations. »Severe stomach trouble» denotes pronounced pain, epigastric pains and gnawing, sometimes in connection with regurgitation and vomiting.

The achylic cases have been grouped according to their total acidity values. The group of »healthy» and »control» cases consists, as already mentioned, of subjects in whom test meal examinations were made for control or for the purpose of ascertaining the importance of the diet in the secretion of gastric juice. These cases will be dealt with more fully later on.

As appears from the table the secretory disturbance in these cases is not markedly less — judging from the total acidity values — than in those manifesting digestive disturbance. More than 50 per cent had a total acidity value below 9.

The Congo positive cases are recorded for the sake of comparison.

A particularly noteworthy feature with respect to the symptomatology is the large number of cases of achylia which manifested symptoms resembling those of peptic ulcur. Burning sensation and pains in the epigastrium after meals occurred in 130 of the cases (38 per cent). The corresponding figure for the Congo positive cases is 28 per cent. Thus ulcer-like disturbances are more frequent in the achylic cases than in the cases with free HCl in the gastric juice, in which the incidence of ulcers is nevertheless considerably higher than in the achylic cases.

In 59 cases of achylia these disturbances are associated with unsuitable diet, containing fat, salt food, blood-dumplings, pancake and coffee. In general the pains were said to set in shortly after meals ($^1/_4$—1 hour), in 26 cases from 2 to 3 hours after meals. 36 patients complained of hunger pains, which were relieved on taking food (milk or bread). Extra meals were eaten by a large number of patients in order to get rid of the symptoms. Generally speaking, there was a pronounced periodicity of the symptoms in these cases. Frequently the symptoms were especially prevalent in spring and autumn. Eructations were complained of by 57 patients, 39 declared that these eructations consisted of »sour» water, while vomitings occurred in 16 cases.

»Ulcer-like» symptoms, »hyperacidity trouble» or »acidism» in achylia have been described already by KATSCH and KALK, but they consider that these symptoms are relatively rare. That can hardly be said, however, to be the case in our material. In 22 of the cases, i. e. 5 per cent, X-ray examination revealed a niche, situated in the duodenum in 11 cases, and in the stomach in 11 cases. X-ray examinations were made in 168 additional cases, 16 of which manifested signs of inflammatory changes — gastroduodenitis — with pronounced swelling of the mucosa. The other cases were designated by the radiologist (Dr. JUNGHAGEN) as X-ray negative.

Among the Congo positive cases 165 (19 per cent) exhibited radiological signs of ulcer (niche), 34 in the stomach, 120 in the duodenum, while 11 had more than one ulcer. In 41 cases there were radiological signs of gastroduodenitis.

The relatively common combination of a radiologically demonstrated ulcer with decreased or absent HCl secretion was so

remarkable that a more detailed study of the question was considered justified. A short summary of the results of this study will be given in the following chapter.

It is highly probable that quite a number of the other cases with clinical symptoms of ulcer (»acidism» according to KATSCH) without radiological changes was affected with ulcers. In proof of this it may be mentioned that one of these patients, 9 months after the examination at Umeå Hospital, had to be operated on at another hospital for a perforated ulcer. The ulcer, which was localised to the corpus ventriculi, was removed.

Blood in the stools (Weber's test) could not be shown in any case.

Milder stomach troubles in the form of oppression and fullness in the epigastrium, as a rule after meals, occurred in 137 Congo negative cases (36 per cent). A small number of these patients complained of belching and regurgitation of stomach contents, bitter or entirely lacking in taste. Fresh milk disagreed with quite a number of these cases although, as a rule, they were able to stand sour and ropy milk very well. Very often the persons examined complained that they did not feel well after eating meat, which, as already mentioned, is as a rule boiled. Among the Congo positive cases slight stomach disorders were recorded in 321 cases (37.5 per cent), about the same incidence as in the Congo negative cases. This is noteworthy in view of the relatively higher incidence of peptic ulcer among the Congo positive cases.

With regard to intestinal symptoms, to be discussed more in detail in the following section, it should be mentioned here that constipation was much more prevalent among the Congo negative cases, 28 per cent as compared with 14 per cent among the Congo positive cases. Stercoral diarrhoea occurred also much more frequently in the Congo negative cases than among the Congo positive cases.

Diarrhoea was also more common among the Congo negtive cases, 7.6 per cent as compared with 3.4 per cent among the Congo positive cases. The symptoms were as a rule mild, persistent diarrhoea occurred in only 4 cases. In 15 cases periods of diarrhoea alternated with periods of normal defecation. In 9 cases the stools were of a porridge-like consistency, but the patients otherwise experienced no discomfort.

The degree of secretory disturbance of the stomach, gauged

by the total acidity value, does not appear to have any influence on the nature of the symptoms. In both groups, slight and severe gastric disorders, about half the cases had a total acidity value above 9. The same inferences may be drawn if the result of the fractional analysis with and without histamine and neutral red is compared with the symptoms.

Comparison of the symptoms occurring in the materials from South and Central Sweden will show very clearly that the achylic cases in Lund and especially in Borås manifest gastric trouble more seldom than in the cases in Umeå. The bulk of the achylic cases manifest intestinal symptoms, especially diarrhoea.

Symptomatology of cases examined with test meals at Lund and Borås.

	Congo negative					Congo pos.
	Number of cases	Total acidity				Number of cases
		0—4	5—8	9—15	> 15	
Borås						
Mild gastric disorders ...	18	2	5	2	9	100
Severe » »	5	—	1	2	2	136
Constipation	2	—	—	—	2	10
Stercoral diarrhoea	5	—	1	1	3	20
Diarrhoea	19	1	6	4	8	25
Healthy and control cases	—	—	—	—	—	47
Lund						
Mild gastric disorders ...	7	2	—	3	2	68
Severe » »	8	—	—	2	6	28
Constipation	2	—	—	—	2	18
Stercoral diarrhoea	1	—	—	—	1	16
Diarrhoea	9	—	1	3	5	12

No case of achylia was found among 47 healthy individuals examined by means of test meals.

2. *Occurrence of gastro-intestinal disorders in the district material.*

Owing to the incompleteness of the data it has not been possible to adopt the same method of subdivision into groups in respect to the symptomatology in the district examinations as

that above. The diarrhoea group here comprises also cases of stercoral diarrhoea.

	Västerbotten	Norrbotten	Total	Percentage of all examined
Mild gastric disorders	113	75	188	11.1
Severe » » ...	73	55	128	7.6
Diarrhoea	62	47	109	6.4
Constipation	73	20	93	5.6
Total	321	197	518	30.7 %

It will be seen from the table that gastric disorders are more common than intestinal disorders. Gastric disturbances occur in 18.5 per cent of the population. Generally they are of a mild character. (11.1 per cent). Intestinal disorders, too, are comparatively common, with a frequency value of 12 per cent. Diarrhoea, mostly of the stercoral form, is the most common intestinal trouble. But, as already mentioned, no reliable figures are available.

Of 735 men 212 (29 per cent) showed some form of gastro-intestinal trouble
» 955 women 306 (32 » ») » » » » »

As far as we are aware no report has previously been published on the frequency of gastro-intestinal disorders in a group of population examined in this manner. The figures for this material appear to be very high, but unfortunately there is, as just mentioned, no material available for comparison. The district investigation made in the Province of Skåne comprised only 40 persons. In this material gastric and intestinal disturbances were found in only 4 cases (10 per cent). The material is, however, too small to permit any definite conclusions being drawn. Blom and Lindgren, in their report of an investigation among the forest-workers (200 cases), state that 27 of the subjects complained of gastro-intestinal pains. In most of them the symptoms were slight, in 5 cases (2.5 per cent) more severe. Stercoral diarrhoea occurred in 6 cases, in 8 cases the stools were more »fluid than normal», while 9 had constipation. Thus gastro-intestinal disorders are less common, judging from the results obtained by these authors, among the forest-workers than among the population in general.

The sex incidence of digestive disorders in the Norrland material is as follows:

	Men	Women
Mild gastric disorders ...	40 %	29 %
Severe » »	27 %	27 %
Diarrhoea	22 %	19.5 %
Constipation	10.5 %	24 %

Among the men gastric symtoms are predominant, especially the milder forms, and even among the women gastric symptoms seem to be more common than intestinal symptoms, constipation being more frequent than diarrhoea.

The incidence of digestive disturbances increases with advancing age, as shown by the following table.

Age	13—18	19—30	31—50	50—65
Percentage gastro-intestinal symptoms	17	28	38	60

In general stomach troubles predominate in the younger ages, intestinal disturbances in the older.

In studying the frequency of digestive disorders in the various districts the same classification was made as that adopted in the case of the dietary investigations.

Coastal district:	Digestive disorders found in 38 % of cases examined
Outer forest district:	» » » » 36 % » » »
Inner » » :	» » » » 21 % » » »
Mountaionus » :	» » » » 23 % » » »

In the coastal district and the outer forest district gastric and intestinal symptoms are usually more frequent than in the other two districts. The lowest figure, 11 per cent, was found in the community of Malå, the next lowest, 18 per cent, at Tärna. The worst conditions prevails at Sävar and Bureå, with digestive disturbances in 48 and 44 per cent respectively of the cases examined.

The distribution of the various symptoms in the district investigations is in the main the same as in the total material.

In the County of Norrbotten the difference between the figures for the coastal district and the inland districts is not so marked. For instance, Arjeploug shows digestive disorders in only 19 per cent of the cases, whereas Övertorneå has 50 per cent; in

Jukkasjärvi the percentage is 40, while in Öjebyn it is only 18 per cent.

The causes of the differences in the frequency of gastro-intestinal symptoms in the different districts will be discussed later on.

With regard to the symptoms associated with gastric secretion it may be mentioned that among the Congo negative cases 73 persons complained of digestive trouble, while 11 had none. Of the Congo positive cases, 104 had gastro-intestinal disorders and 57 had no digestive troubles.

The following table gives the incidence of the various symptoms in relation to the gastric secretion.

	Congo neg.		Congo pos.	
	Number of cases	%	Number of cases	%
Mild gastric symptoms	30	41	24	23
Severe » »	10	13.7	23	22
Constipation	12	16.4	27	26.1
Stercoral diarrhoea	12	16.4	14	13.4
Diarrhoea	9	12.3	16	15.4

From what has been said above it will be clear that digestive disturbances appear to be more frequent in the district material examined by means of test meals than in the hospital material. This is quite natural, as in the latter material examinations of the gastric juice were often made for the purpose of control. Slight gastric troubles are most common in the Congo negative cases, severe disturbances (indicative of ulcer) in the Congo positive cases, thus quite the contrary to the state of things found in the hospital material. The higher incidence of severe gastric symptoms in the hospital material is explained by the fact that these symptoms more often require hospital examination. Constipation as well as diarrhoea are, contrary to the conditions in the hospital material, more common among the Congo positive cases.

3. *Incidence of gastric and intestinal disorders among school children.*

Information was obtained regarding the incidence of gastro-intestinal symptoms among school children. Of 3220 children

examined, 377, or 11 per cent, had such symptoms. The frequency distributions of the disorders in the different groups, adopted above, will be seen from the following table:—

Slight gastric disorders	28.3 %
Severe » »	8.2 %
Diarrhoea	41.0 %
Constipation	22.4 %

Intestinal disorders, especially diarrhoea, are the most frequent.

The incidence of digestive troubles is about the same among boys as among girls, 11.5 and 11.9 per cent respectively.

Gastric and intestinal symptoms occur most frequently between the ages of 7 to 11 years. In these ages the frequency increases from 10.8 per cent to 17.1 per cent. In children between 12 and 17 years of age (362 children examined) the incidence falls to 8.8 per cent.

The incidence of digestive disturbances among children from different districts shows on the whole the same relation as among adults, as will be seen from the following table:—

	Incidence of digestive disorders
Coastal district	16.8 %
Outer forest district	20.6 %
Inner » »	5.6 %
Mountain »	5.9 %

Test meal examinations were made on 51 school children, 8 of which (15.7 per cent) were Congo negative. The number of examinations is too small to allow any other inference being drawn than that even in children achylia does not seem to be uncommon.

4. *Causes of the high incidence of achylia in Upper Norrland.*

Constitution. In spite of the weeding of the material there still remains a very large number of cases with inhibited secretion of gastric juice. We are certainly not justified in assuming that a constitutional weakness in the inhabitants (Martius, Albu) is a causal factor in this high incidence of achylia, as

they are otherwise a healthy and industrious class of people. We shall return this question later.

Mode of living and customs. It is only natural that the cause of achylia among these people should be looked for in their mode of living and customs. In the introductory chapter we have already suggested that the etiological factor is probably to be found in the nature of the diet.

By having an unfavourable effect, either direct or indirect on the secretion of gastric juice, the diet may be thought to be a contributory cause of a decreased rate of secretion. This may occur either because the diet contains substances injurious to the secretion of gastric juice or because it is deficient in substances necessary to provoke this secretion. Closely associated with the diet is the use of coffee, tobacco and spirits. Excessive use of these substances may also be thought to have an injurious effect on the function of the stomach.

The *denture and condition of the teeth* are of vital importance in the proper mastication of the food, for if the dental condition is bad even a diet of excellent composition will place too great a demand on the gastric secretion. Caries and gingivitis may also have a toxic effect on and thereby cause injury to the glandular structure of the gastric mucosa.

The *presence of tape worms* (Dibothriocephalus latus and Taenia) has also been considered by several investigators to be an important factor in the high incidence of achylia in Norrland.

Let us therefore briefly consider these questions in so far as they have any bearing on the results of the present investigation.

a. *The effect of coffee consumption on the incidence of achylia.*

In Chapter I, dealing with the manner of living and customs of the population, we gave data showing the extent of coffee consumption in Norrland. It was found to be somewhat greater than in southern and central Sweden, but not to any considerable extent.

The general opinion is that coffee has a stimulating effect on the gastric secretion (von Bergmann, Crämer, Kuttner, Bickel, Haneborg, Katsch and Kalk, Öhnell and Berg and others). Opinions differ as to the substance present in coffee which causes this effect, caffeine, products evolved in roasting the berries or

some other substance. This is, however, of no interest in this connection. It should perhaps be pointed out that earlier observations on the effect of coffee are for the most part based on single tests. As far as the writer is aware no investigations have been made on the effect of the use or abuse of coffee over a long period.

The following table is intended to show the correlation between coffee consumption and the incidence of achylia.

Number of cups a day	Men		Women		Total	
	Number of cases	Congo neg.	Number of cases	Congo neg.	Number of cases	Congo neg.
0	44	23 %	63	33 %	107	29 %
1—4	196	28 %	312	36 %	508	32 %
5—8	96	31 %	92	33 %	195	33 %
>8	59	22 %	31	55 %	90	33 %

The table furnishes no definite evidence that an increased consumption of coffee increases the number of achylic cases and exercises an inhibitory effect on the secretion of gastric juice. It will perhaps be said by way of objection that persons without free acid in the stomach contents are likely to abstain from drinking coffee owing to gastric troubles, but persons who were on a diet and had thus reduced their coffee consumption have been excluded as far as possible from this material.

In the investigation, mentioned above, carried out by LINDGREN on 38 healthy forest-workers, who consumed 9—12 cups of coffee daily, only 2 Congo negative cases (father and son) were found. This does not seem to indicate that the habitual consumption of such large quantities of coffee has an inhibitory effect on the secretion of gastric juice.

A further attempt was made to obtain an answer to the question as to the influence of coffee on the secretion of gastric juice by estimating the average values of free acid and total acidity in proportion to the daily consumption of coffee. The results are shown in the next table. Only Congo positive cases are recorded.

Thus the acid value seems to be somewhat higher when more than 8 cups are drunk than when the consumption is more moderate.

	Number of cups a day							
	0		1—4		5—8		>8	
	No. of cases	Aver. value	No. of cases	Aver. value	No. of cases	Aver. value	No. of cases	Aver. value
Free Hcl	76	20.8	340	18.1	132	17.3	60	22.2
Totalacid.	76	39.5	340	38.3	132	38.5	60	42.8

Concerning the symptomatology in the hospital material with respect to the coffee consumption it should be mentioned that of 60 patients who consumed more than 8 cups of coffee daily, 17, or 28 per cent, revealed a radiologically demonstrable ulcer (niche), while the corresponding figure for the other 472 cases was 18.6 per cent. Clinical signs of ulcer (symptoms of acidism), not demonstrable on X ray examination, in the form of periodical pains, gnawing and burning pains in the epigastrium after »indigestible» food, the symptoms being frequently relieved by taking food, as well as regurgitations and not infrequently vomitings, were observed in respectively 15 and 11 per cent of the cases in the above two groups. In other words, ulcer and symptoms suggestive of ulcer were found in excessive coffee consumers in 46 per cent of the cases as against 33.4 per cent in the moderate consumers. This observation confirms the opinion that excessive use of coffee increases the secretion of gastric juice and to a certain extent creates a predisposition to ulcer. In fact, ulcer patients very often state that their symptoms become aggravated after drinking coffee.

The following table shows the occurrence of gastric and intestinal disorders in the district material in relation to the quantity of coffee consumed. The disorders have been divided into two main groups, gastric and intestinal symptoms. The gastric symptoms were oppression and flatulence in the epigastrium and,

	Coffee intake per day. Number of cups							
	1—4		5—8		9—12		>12	
Gastro-intestinal symptoms. No. and % of cases.....	134	31.1 %	234	29.3 %	96	35 %	92	41 %
Gastric disorders	53 %		63 %		70 %		68 %	
Intestinal »	47 %		37 %		30 %		32 %	

about as often, burning and gnawing pains, and occasionally vomiting. The intestinal disorders were either diarrhoea or constipation (Table p. 92).

The table shows a certain increase in the frequency of gastro-intestinal symptoms when the coffee consumption is high (more than 8 cups daily). This increase in symptoms occurs especially in the group of stomach disorders, while intestinal symptoms seem to decrease with excessive consumption. This decrease in the frequency of intestinal symptoms applies to the constipation group, which falls from 30 per cent in the group 1—4 cups a day to 9 per cent in the group >12 cups. The frequency of diarrhoea does not show any increase however. This may be explained by the fact that the group of diarrhoea cases included a good many cases of stercoral diarrhoea, where the occurrence of diarrhoea is partly due to obstipation. The exact figure for the cases of stercoral diarrhoea cannot be given owing to the incomplete data in the reports of the district physicians.

In the school children examined, no definite effect on the frequency of gastro-intestinal disorders was observed from an increased consumption of coffee, as appears from the following table:—

Correlation between occurrence of digestion disorders and coffee consumption in school children.

Number of cups of coffee per day	Number of children	Digestive disorders in %
0	498	11.7 %
1—3	1893	11 %
4—7	117	12.8 %
>7	(16)	(18 %)

Nor is it possible to show any positive increase in the gastro-intestinal symptoms when coffee is drunk on an empty stomach in the morning. According to the records, 1209 children drank coffee in the morning, and digestive troubles occurred in 12.2 per cent of the cases. For the total material the figure was 11.5 per cent. This is in agreement with the observations made on the adult material.

b. *Influence of snuff-chewing, tobacco and spirits on the frequency of achylia.*

As already mentioned, snuff-chewing is very common among the male rural population, 42 per cent of the males above 15 years of age using snuff in this way. Of 303 snuff-chewing males gastric disorders were found in 96, or 32 per cent. Of 426 men who did not chew snuff 116, or 27 per cent, were found to be suffering from gastric disorders.

Test meal examination of 118 snuff-chewers showed 42 = 35.6 % Congo neg.
» » » » 332 non- » » 78 = 23,5 % » »

The difference is statistically significant. Thus there is an increased incidence of achylia among those adults who habitually chew snuff.

The total acidity values for the achylic snuff-chewers were:

Total	alkaline	0—4	5—8	9—15	>15
Number of cases	2	14	13	6	7

From this comparison it seems clear that the secretory disturbance in snuff-chewers is particularly pronounced, no less than 29 out of 42 (69 per cent) showing a total acidity value below 9.

The amount of mucus in the stomach contents drawn off is often strikingly large in snuff-chewers, indicating the presence of gastritis. In the Congo negative cases the following results were obtained:

Amount of mucus	0	+	++	+++
Number of cases	3	18	9	12

Thus snuff-chewing seems to have an inhibitory effect on the secretion of gastric juice. But this does not explain the high incidence of achylic cases in our material. Only 42 of the 380 persons who were found to be Congo negative on an E.-B. examination were snuff-chewers. Nor is there any great difference in the incidence of achylia between snuff-chewers and non-chewers. There is still a very high incidence of achylia among those who do not chew snuff that must be accounted for in some other way. The incidence of achylia in the Norrland material is much higher among women than among men, although women do not chew snuff.

Smoking tobacco is not very common and the amount smoked does not seem to have any effect on the gastric function, as is evident from a special examination of the material. In fact

tobacco smoking and drinking spirits are more common in southern and central Sweden, where the incidence of achylia is lower.

c. *Condition of teeth in relation to the incidence of achylia.*

Several investigators (Faber, Lange, Katsch, Schilling) emphasize the importance of the dental condition in the occurrence of disturbances of the gastric secretions. If the teeth are bad, the food is not masticated sufficiently and this may conceivably have an injurious effect on the mucous membrane of the stomach. Extensive caries, almost always associated with local infections, may cause injury to the gastric mucosa either direct through the swallowing of infectious material or by means of a general toxic action.

The dental examinations carried out at the hospitals of Umeå and Lund by the investigating physician consisted in noting the condition of the teeth and denture, which were recorded as good, medium or bad. Further, the number of carious teeth were recorded in each case. The presence of caries, however, indicate only the present condition of the teeth, but old caries may also play an important rôle in the origin of achylia. Nor is it possible to decide the question simply be recording the quality of the denture, for this may have been improved by procuring false teeth. Filled teeth are rare in the Norrland material, especially as far as the rural population is concerned, which is the subject of this particular investigation. Some idea of previous caries is obtained by noting, in addition to carious teeth, also the number of sound teeth, as previously carious teeth have either fallen out or been extracted. In our tables the number of healthy teeth is therefore grouped specially.

The results of the dental examinations are presented in the following tables, which also include the Lund material. No dental examinations were made on the Borås material. The material has been divided into the following age-groups: 15—19 years, 20—39 years, 40—59 years. The number of cases above 60 years of age is so small that this group was not included.

It is not claimed that these dental examinations are complete or authoritative, but they are nevertheless valuable as a general orientation of the condition of the teeth of the inhabitants in Västerbotten and Skåne and of the influence of diet on the teeth. Detailed investigations were carried out by dentists (v. Part III).

Condition of the teeth at the age of 15—19 years.

	Västerbotten		Skåne	
	Men	Women	Men	Women
Denture				
Good	104 (83 %)	91 (69 %)	95 (86 %)	82 (84 %)
Medium	14 (11 %)	22 (17 %)	12 (11 %)	15 (15 %)
Bad	7 (6 %)	19 (14 %)	4 (4 %)	1 (1 %)
Carious teeth				
0—4	103 (78 %)	84 (64 %)	103 (93 %)	91 (85 %)
5—8	14 (11 %)	27 (21 %)	6 (5 %)	16 (15 %)
>8	14 (11 %)	20 (15 %)	2 (2 %)	0
Missing teeth				
0—4	94 (78 %)	84 (64 %)	76 (79 %)	84 (81 %)
5—8	20 (17 %)	27 (21 %)	16 (17 %)	13 (13 %)
>8	7 (6 %)	20 (15 %)	4 (4 %)	6 (6 %)
Healthy teeth				
0—8	1 (1 %)	6 (5 %)	0	0
9—16	11 (9 %)	33 (25 %)	2 (2 %)	6 (6 %)
17—24	50 (41 %)	45 (34 %)	55 (49 %)	41 (43 %)
25—32	60 (49 %)	49 (37 %)	54 (49 %)	48 (51 %)

Condition of the teeth at the age of 20—39 years.

	Västerbotten		Skåne	
	Men	Women	Men	Women
Denture				
Good	229 (66 %)	196 (47 %)	265 (71 %)	212 (58 %)
Medium	52 (15 %)	87 (21 %)	59 (16 %)	85 (23 %)
Bad	66 (19 %)	130 (32 %)	47 (13 %)	70 (19 %)
Carious teeth				
0—4	209 (62 %)	220 (53 %)	310 (81 %)	338 (83 %)
5—8	87 (26 %)	113 (27 %)	62 (16 %)	52 (13 %)
>8	42 (12 %)	82 (20 %)	11 (3 %)	16 (4 %)
Missing teeth				
0—8	190 (61 %)	172 (43 %)	293 (76 %)	224 (55 %)
9—16	94 (30 %)	125 (31 %)	69 (18 %)	107 (26 %)
17—24	17 (5 %)	62 (15 %)	16 (4 %)	51 (13 %)
25—32	9 (3 %)	45 (11 %)	6 (2 %)	24 (6 %)
Healthy teeth				
0—8	22 (7 %)	52 (13 %)	11 (3 %)	51 (13 %)
9—16	40 (13 %)	109 (27 %)	32 (8 %)	69 (17 %)
17—24	115 (37 %)	168 (42 %)	166 (43 %)	157 (39 %)
25—32	135 (43 %)	75 (19 %)	174 (46 %)	129 (32 %)

Condition of the teeth at the age of 40—59 years.

Denture	Västerbotten		Skåne	
	Men	Women	Men	Women
Good	88 (51 %)	36 (21 %)	98 (40 %)	93 (39 %)
Medium	28 (16 %)	18 (10 %)	59 (24 %)	46 (19 %)
Bad	57 (33 %)	121 (69 %)	87 (36 %)	101 (42 %)
Carious teeth				
0—4	135 (76 %)	87 (49 %)	207 (78 %)	251 (91 %)
5—8	20 (11 %)	39 (22 %)	38 (14 %)	18 (6 %)
>8	22 (12 %)	51 (29 %)	22 (8 %)	8 (3 %)
Missing teeth				
0—8	61 (34 %)	20 (11 %)	103 (40 %)	37 (15 %)
9—16	69 (39 %)	39 (22 %)	108 (41 %)	42 (17 %)
17—24	31 (17 %)	46 (26 %)	35 (13 %)	86 (35 %)
25—32	18 (10 %)	72 (41 %)	15 (6 %)	80 (33 %)
Healthy teeth				
0—8	41 (24 %)	65 (37 %)	36 (14 %)	141 (50 %)
9—16	25 (15 %)	54 (31 %)	62 (24 %)	87 (31 %)
17—24	48 (28 %)	50 (28 %)	108 (42 %)	41 (15 %)
25—32	58 (34 %)	6 (3 %)	52 (20 %)	14 (5 %)

Frequency of achylia in relation to condition of the teeth.

Denture	Men		Women	
	No. of cases	% Congo neg.	No. of cases	% Congo neg.
Good	167 (45 %)	33	108 (24 %)	19
Medium	127 (34 %)	24	151 (34 %)	33
Bad	75 (20 %)	28	188 (42 %)	48
Number of carious teeth				
0	154 (42 %)	24	148 (33 %)	34
1—4	109 (30 %)	36	134 (30 %)	40
5—8	71 (19 %)	30	93 (21 %)	38
>8	35 (9 %)	29	72 (16 %)	35
Number of healthy teeth				
25—32	130 (35 %)	29	68 (15 %)	14
17—24	131 (36 %)	34	129 (26 %)	29
9—16	68 (18 %)	13	93 (19 %)	40
0—8	32 (11 %)	36	192 (40 %)	47

Judging from these tables it appears that the people in Västerbotten have worse teeth than the inhabitants of Skåne. This is true of both men and women. The dental condition of the women in Skåne as well as in Västerbotten is inferior to that of the men. This can be gathered from the denture and the number of carious and healthy teeth.

The correlation between the secretion of gastric juice and the condition of the teeth is shown in the table on p. 97.

In women the number of cases of achylia seems to increase with a deterioration in the quality of the denture and in the number of sound teeth. The smaller the number of healthy teeth the higher the percentage of Congo negative cases. There is no evident correlation between the incidence of caries and the occurrence of achylia. In men there does not seem to be, judging from the table, any correlation between the condition of the teeth and the incidence of achylia. Thus, as far as the men are concerned, there is probably an additional factor which does not so much effect the teeth but increases the percentage of achylia. This factor is probably snuff-chewing, which, as mentioned above, is comparatively common among the men. The cause may, however, be something else, the diet for instance. The figures

Incidence of achylia in the B diet group in relation to the condition of the teeth.

	Men		Women	
	No. of cases	% Congo neg	No. of cases	% Congo neg.
Denture				
Good	59 (41 %)	8	49 (24 %)	10
Medium	59 (41 %)	8	80 (39 %)	14
Bad	26 (18 %)	15	75 (37 %)	20
Number of carious teeth				
0	63 (44 %)	8	69 (34 %)	7
1—4	46 (32 %)	11	54 (26 %)	17
5—8	26 (18 %)	15	45 (22 %)	27
>8	9 (6 %)	(0)	36 (18 %)	17
Number of healthy teeth				
25—32	53 (36 %)	11	29 (13 %)	7
17—24	50 (34 %)	10	66 (31 %)	17
9—16	32 (30 %)	0 8	40 (19 %)	10
0—8	13 (30 %)	38 8	80 (37 %)	25

for the different forms of diet were, as already shown, different for men and women. The composition of the diet possibly influences both the incidence of achylia and the condition of the teeth. In order to consider this question still more closely a comparison has been made between the frequency of achylia and the condition of the teeth in the B diet group (mixed diet), the snuff-chewers being excluded. The condition of the teeth in snuff-chewers is shown in a special table below.

In spite of the comparatively small number of cases there is here a tendency in both men and women to an increase in the number of the Congo negative cases with a deterioration in the condition of the teeth. This deterioration, however, does not seem by any means to be of such a degree as to explain by itself the high incidence of achylia in the Norrland material (Table p. 98).

The relation between the condition of the teeth and the incidence of achylia in the L diet group will be discussed later.

Condition of teeth and snuff-chewing.

Denture	Snuff-chewers	Non-snuff-chewers
Good	102 (77 %)	105 (68 %)
Medium	20 (15 %)	21 (13 %)
Bad	10 (8 %)	30 (19 %)
Carious teeth		
0—4	102 (73 %)	90 (59 %)
5—8	20 (14 %)	45 (29 %)
>8	18 (13 %)	19 (12 %)
Missing teeth		
0—8	106 (76 %)	96 (62 %)
9—16	30 (21 %)	48 (31 %)
17—24	4 (3 %)	7 (4 %)
25—32	—	5 (3 %)
Healthy teeth		
0—8	8 (6 %)	14 (9 %)
9—16	20 (14 %)	18 (12 %)
17—24	38 (27 %)	61 (39 %)
25—32	74 (53 %)	63 (40 %)
Gingivitis		
+	84 (67 %)	68 (50 %)
—	41 (33 %)	67 (50 %)

From the above table it seems to be clear that snuff-chewing protects the teeth to a certain extent but at the same time increases the incidence of achylia, as we have already shown.

The composition of the diet and the snuff-chewing explain the fact that no definite relationship could be demonstrated in the table between the condition of the teeth and the incidence of achylia.

It is a well-known fact that teeth deteriorate with increasing age, a fact illustrated also by the preceding tables (pp. 96—97) showing the condition of the teeth in Västerbotten and Skåne. The incidence of achylia increases also in the more advanced ages. It might therefore be supposed that age is the cause of the apparently increased frequency of achylia. For that reason the age-group 20—39 years has been analysed especially with respect to the condition of the teeth and the incidence of achylia. The result of this analysis shows a certain increase in the incidence of achylia with a deterioration of the teeth.

(d) *The influence of helminthic infection on the incidence of achylia.*

In the discussion which preceded these investigations several workers expressed the view that the high incidence of achylia was undoubtedly due largely to the high incidence of intestinal worms in some parts of Norrland. Observations made at the Umeå Hospital certainly did not lend support to the assumption that helminthic infection is a causal factor in the incidence of achylia. Nevertheless the scheme of the investigation included an inquiry into the occurrence of intestinal worms and their significance in the incidence of achylia.

During the years 1924—1930 only 75 cases infected with tapeworms were treated at the Umeå Hospital. In 35 cases the parasite was Dibothriocephalus, in 25 Taenia saginata, in 2 Taenia soleus, and in 5 cases the species of Taenia was not recorded. In 8 cases Dibothriocephalus and Taenia were found simultaneously.

During the year 1928—1929 the faeces of 400 patients were repeatedly examined for the presence of the ova of intestinal worms, where the patients themselves had not stated that they were infected with intestinal parasites. Ova of tapeworms were found in only 2 cases.

This result does not indicate any high incidence of tapeworms in this material, while at the same time it disproves the assertion that tapeworms play any great part in the incidence of achylia in our material.

Test meal examinations were made in 57 cases infected with intestinal worms. Of these cases 16, or 28 per cent, were Congo negative. In 27 of the cases the intestinal parasite was Dibothriocephalus latus. Of these 9, or 33 per cent, were Congo negative (one of these patients was suffering from a pernicious type of anaemia). This is, it is true, a high figure, but not higher than that of the total material. The number of the cases is too small to be of any particular significance. If the cases are weeded on the same principles as those mentioned above, there remain 34 cases of helminthic infection, 6 of which were Congo negative.

From these figures it will be seen that helminthic infection does not play any particular rôle in the incidence of achylia, at least not in Västerbotten.

It is noteworthy that most of the persons infected with Dibothriocephalus treated at the Umeå Hospital were residents of the island of Holmön, where the inhabitants live to a great extent on raw-pickled gwyniad. The incidence of tapeworms is very high among the inhabitants of Holmön, as the author found in an investigation made on the spot. It is estimated that 30—40 per cent of the adult population are infected with tapeworms.

Thus, although the incidence of tapeworms in Västerbotten, with the exception of Holmön, is low, it is exceedingly high in certain parts of Norrbotten, especially in the districts of Arjeploug and Övertorneå. The source of the infection is here »fermented» gwyniad, which is eaten very seldom in Västerbotten, but is a very common dish in Norrbotten.

(e) *The influence of the diet on the incidence of achylia.*

It appeared probable already from the results of the preliminary investigations that the great frequency of achylia in Upper Norrland was due to the composition of the diet, inasmuch as achylia was particularly associated with the L diet and the coastal district, where this type of diet was most common (v. Table p. 25).

It was shown above that in a weeded material, comprising 1215 cases examined by gastric analysis (E.-B. removed after 30 minutes), 380 cases, or 31.3 per cent, were found to be devoid

of free hydrochloric acid in the stomach contents. The degree of the functional disturbances has also been treated previously. The next table shows the distributions of the achylic cases in the various diet groups. The majority of the achylic cases occur in connection with the unvaried milk-meal diet (LIa). In this diet group no less than 250 cases out of 294 (68 per cent) are achylic. In all the L diets, comprising altogether 515 cases, there are 284 cases of achylia, or 55 per cent. Of the 515 cases belonging to the B diet group the number of achylic cases does not amount to more than 88 (13 per cent), and in the S diet the figures are 38 cases with 8 cases of achylia (21 per cent).

Consequently the cause of the high incidence of achylia in this material is undoubtedly the unvaried milk-meal diet on which a great part of the inhabitants of Norrland subsists.

Incidence of achylia in relation to composition of diet.

Diet	Number of cases	% Congo neg.
LIa	294	68 % ± 2.7
LIb	19	26 % ± 10
LIIa	160	38 % ± 4
LIIb	41	44 % ± 8
Total L diets	514	55 % ± 2
BIa	350	14 % ± 2
BIb	264	12 % ± 2
BIIb	21	19 % ± 9
BIIc	28	7 % ± 5
Total B diets	663	18 % ± 1
SIa	4	75 % ± 21.7
SIIa	34	15 % ± 6
Total S diets	38	21 % ± 7

If we group the Congo negative cases found in the district investigations in respect to the composition of the diet, we obtain the following result:—

Diet group	LIa	LIIa	BIIa	BIIb	SIa	SIIa	Not recorded
Congo neg.	21	12	31	3	2	8	8
» pos.	8	25	62	2	4	5	54
% Congo neg....	72 %	32.5 %	33 %	—	—	—	—

The figures are rather small but they nevertheless point in the same direction as the results of the hospital investigations. In the LIa diet group there are 72 per cent Congo negative cases, while all the L diets contain 50 per cent and the B diets 35 per cent Congo negative cases.

In proving the importance of the composition of the food in the origin of achylia we obtain a plausible explanation of the difference between the incidence of achylia in Västerbotten and Norrbotten and in different districts of Västerbotten. This difference is due to the varying frequency of the L diet in the different regions.

It is conceivable that the LIa diet contains some secretion-inhibiting factor, or that the B diets, on the other hand, possess a factor which stimulates secretion.

It has already been shown that achylia increases in frequency with increasing age. That the higher ages are not specially represented in the LIa diet appears from the table below, showing the distribution of the Congo negative cases among the different age-groups and diet groups.

Distribution of achylia in different age-groups and diet groups.

Diet	15—20 years	21—30 years	31—40 years	41—50 years	51—60 years
LIa	10 (44 %)	41 (60 %)	57 (73 %)	51 (77 %)	29 (73 %)
LIIa	5 (31 %)	18 (33 %)	18 (41 %)	10 (37 %)	7 (64 %)
All L diets	18 (38 %)	66 (47 %)	77 (58 %)	66 (65 %)	39 (66 %)
BIa	—	13 (10 %)	15 (17 %)	13 (22 %)	8 (22 %)
BIb	4 (12 %)	13 (12 %)	4 (7 %)	4 (11 %)	6 (32 %)
All B diets	4 (5 %)	30 (12 %)	20 (12 %)	18 (18 %)	14 (25 %)
All S diets	—	—	1	4	3

Owing to the small number of cases in the LIb, LIIb, BII diet groups and the S groups they have not been recorded separately in this table and the following. The values of these groups have been combined in the totals for the L, B and S diet groups.

As appears from the table, the increase in the frequency of achylia with advancing age is evident in all the diet groups.

The greatest number of individuals examined is found in the age-groups 21—50 years, in the same proportion in all the diet groups. In all age-groups the incidence of achylia is considerably higher in the L diet groups, especially the LIa group, than in the B groups.

In our material achylia is more common among women than among men. (p. 71). The question arises as to what extent the diet may be the cause of this difference in frequency.

The following table shows that the principal cause of the greater number of Congo negative cases among women is because the unvaried L diet is used much more by women than by men. Some 48 per cent of the women live on an L diet, but only 33 per cent of the men. It will also be seen from the table, however, that the percentage of achylia is higher among women subsisting on the LIa diet than among men. This difference (10 per cent) is not statistically established, but is nevertheless probable. The mean error is ± 5.9. For the whole L group the difference is $9.3\ \% \pm 4.5$. For the B group the difference is only $2\ \% \pm 2.6$.

Sex incidence of achylia in the different diet groups.

Diet	Men		Women	
	No. of cases	Congo neg.	No. of cases	Congo neg.
LIa	98	60 (61 %)	196	140 (71 %)
LIIa	71	29 (41 %)	89	32 (36 %)
All L diets	194	96 (50 %)	320	188 (60 %)
BIa	192	29 (15 %)	158	21 (13 %)
BIb	108	8 (7 %)	156	24 (15 %)
All B diets	320	39 (12 %)	343	49 (14 %)
SI—SIIa	37	7 (19 %)	1	1

The cause of the probably higher incidence of Congo negative cases among the women in the LIa group is that the diet of the women is much more unvaried than that of the men. Indoor life, more frequent infections and constitutional idiosyncracies may also play a part.

It has already been pointed out that coffee consumption, snuff-chewing and the condition of the teeth appear to have an in-

fluence on the incidence of achylia, an increased consumption of coffee being liable to lower the incidence, snuff-chewing and a poor dental condition, on the other hand, tending to increase it. It might then be imagined that these factors make their influence felt differently in the different diets, and that this difference, rather than the composition of the diet, is the cause of the variation in the incidence of achylia in the different diet groups.

Coffee consumption in the different diet groups.

Number of cups of coffee per day	L diet		B diet	
	Men	Women	Men	Women
0	11 %	9 %	6 %	8 %
0—4	28 %	52 %	50 %	65 %
5—8	42 %	27 %	33 %	18 %
>8	12 %	13 %	11 %	9 %

The consumption of coffee seems to be somewhat greater in the L diet group than in the B diet group. An increase in the consumption of coffee, as shown above, gives rise to an increase in the secretion of acid in the stomach and should therefore reduce the frequency of achylia. Thus the accumulation of achylic cases in the L diet group cannot be explained by the varying amount of coffee consumed in the different diet groups.

Nor can the high incidence of achylia in the L diet group be explained as being due to an excessive use of tobacco. Smoking and snuff-chewing do not occur among the women, who nevertheless show the highest incidence of achylia, and the number of snuff-chewers and smokers in the L diet group is not greater than in other diet groups. Only 14 men belonging to the LIa diet group are snuff-chewers, and of these only 5 chew snuff to any great extent. Nor does drinking spirits play any rôle in our material.

With regard to the condition of the teeth, it has already been pointed out that defective teeth to a certain extent predispose to achylia. An analysis of the condition of the teeth in the various diet groups is therefore indicated in order to ascertain the cause of achylia.

Condition of teeth in relation to composition of diet.
a) Age-group of 15—19 years.

Denture	L diet		B diet	
	Men	Women	Men	Women
Good	31 (77 %)	43 (72 %)	68 (86 %)	40 (66 %)
Medium	6 (15 %)	8 (13 %)	7 (9 %)	12 (20 %)
Bad	3 (8 %)	9 (15 %)	4 (5 %)	9 (15 %)
Carious teeth				
0—4	31 (76 %)	38 (62 %)	65 (79 %)	40 (64 %)
5—8	4 (10 %)	12 (20 %)	9 (11 %)	14 (23 %)
>8	6 (15 %)	11 (18 %)	8 (10 %)	8 (13 %)
Missing teeth				
0—4	26 (68 %)	40 (66 %)	62 (85 %)	42 (72 %)
5—8	8 (21 %)	11 (18 %)	9 (12 %)	9 (16 %)
>8	4 (11 %)	10 (16 %)	2 (3 %)	7 (12 %)
Healthy teeth				
0—8	1 (3 %)	2 (3 %)	0	3 (5 %)
9—16	5 (13 %)	20 (34 %)	5 (6 %)	14 (23 %)
17—24	16 (40 %)	13 (21 %)	28 (36 %)	22 (36 %)
25—32	18 (45 %)	24 (41 %)	45 (58 %)	23 (37 %)

Condition of teeth in relation to composition of diet.
b) Age-group of 20—39 years.

Denture	L diet		B diet	
	Men	Women	Men	Women
Good	67 (65 %)	55 (36 %)	135 (65 %)	113 (55 %)
Medium	11 (11 %)	36 (23 %)	38 (18 %)	33 (16 %)
Bad	25 (24 %)	62 (40 %)	36 (17 %)	61 (29 %)
Carious teeth				
0—4	57 (58 %)	72 (44 %)	130 (63 %)	119 (58 %)
5—8	31 (31 %)	47 (29 %)	48 (23 %)	56 (27 %)
>8	11 (11 %)	45 (27 %)	27 (13 %)	30 (15 %)
Missing teeth				
0—8	56 (61 %)	56 (37 %)	116 (62 %)	103 (47 %)
9—16	27 (30 %)	46 (30 %)	58 (31 %)	69 (32 %)
17—24	6 (7 %)	31 (20 %)	9 (5 %)	25 (11 %)
25—32	3 (3 %)	20 (13 %)	5 (3 %)	22 (10 %)
Healthy teeth				
0—8	6 (6 %)	33 (22 %)	15 (8 %)	13 (6 %)
9—16	14 (14 %)	48 (32 %)	25 (13 %)	48 (23 %)
17—24	35 (34 %)	58 (38 %)	74 (38 %)	92 (44 %)
25—32	48 (46 %)	13 (9 %)	81 (41 %)	55 (26 %)

Condition of teeth in relation to composition of diet.
c) Age-group of 40—59 years.

Denture	L diet		B diet	
	Men	Women	Men	Women
Good	33 (42 %)	10 (14 %)	43 (58 %)	21 (25 %)
Medium	15 (19 %)	10 (14 %)	10 (14 %)	6 (7 %)
Bad	31 (39 %)	49 (71 %)	21 (28 %)	58 (68 %)
Carious teeth				
0—4	55 (70 %)	31 (43 %)	61 (80 %)	48 (54 %)
5—8	11 (14 %)	21 (29 %)	6 (8 %)	15 (17 %)
>8	13 (16 %)	20 (28 %)	9 (12 %)	26 (29 %)
Missing teeth				
0—8	25 (32 %)	5 (7 %)	27 (36 %)	12 (14 %)
9—16	25 (32 %)	8 (11 %)	32 (43 %)	24 (27 %)
17—24	23 (30 %)	28 (39 %)	4 (5 %)	15 (17 %)
25—32	4 (5 %)	31 (43 %)	11 (15 %)	37 (42 %)
Healthy teeth				
0—8	19 (25 %)	44 (60 %)	17 (24 %)	15 (17 %)
9—16	15 (20 %)	20 (27 %)	5 (7 %)	30 (35 %)
17—24	16 (21 %)	7 (10 %)	25 (36 %)	38 (44 %)
25—32	26 (34 %)	2 (3 %)	23 (33 %)	4 (5 %)

Conditon of teeth in relation to composition of diet.
S-diet.

Denture	Västerbotten	Norrbotten
Good	67 (67 %)	42 (42 %)
Medium	22 (22 %)	31 (31 %)
Bad	11 (11 %)	26 (26 %)
Carious teeth		
0—4	72 (78 %)	64 (65 %)
5—8	16 (17 %)	27 (28 %)
>8	5 (5 %)	7 (7 %)
Missing teeth		
0—8	84 (98 %)	78 (80 %)
9—16	2 (2 %)	11 (11 %)
17—24	0	7 (7 %)
25—32	0	2 (2 %)
Healthy teeth		
0—8	0	9 (9 %)
9—16	3 (3 %)	12 (12 %)
17—24	16 (16 %)	25 (25 %)
25—32	81 (81 %)	53 (54 %)

The above tables show that the condition of the teeth in the L diet group is as a rule worse than in the B diet group. The forest-workers in Västerbotten have by far the best teeth. The difference in dental condition between the different diet groups seems, however, to be too small to explain the high incidence of achylia in the L diet group as compared with that in the B diet group.

Additional evidence in support of this view is obtained by comparing the condition of the teeth and the incidence of achylia in one and the same diet group. This has already been done with regard to the B diet group (p. 98). Below we give a similar comparison of the cases in the LIa diet group.

Frequency of achylia in relation to the dental condition in the LIa diet group.

Denture	Men		Women	
	No. of cases	% Congo neg.	No. of cases	% Congo neg.
Good	33 (45 %)	63	26 (17 %)	46
Medium	24 (31 %)	57	36 (24 %)	64
Bad	18 (23 %)	50	89 (59 %)	80
Carious teeth				
0	32 (42 %)	66	53 (35 %)	79
1—4	25 (33 %)	64	51 (34 %)	69
5—8	11 (14 %)	45	26 (17 %)	42
>8	9 (12 %)	56	21 (40 %)	86
Healthy teeth				
25—32	27 (34 %)	63	18 (12 %)	33
17—24	26 (33 %)	77	28 (19 %)	77
9—16	12 (15 %)	33	31 (21 %)	78
0—8	14 (18 %)	50	71 (48 %)	79

The table shows the great frequency of achylia in the LIa diet group. As far as the men are concerned, no correlation can be found between the dental condition and the incidence of achylia. This may be explained partly by the fact that among the men there is a certain number of snuff-chewers with a tendency to a relatively good condition of the teeth but a high incidence of achylia. In the case of the women, the figures for the denture and healthy teeth seem to indicate that a poor dental condition is more frequently associated with achylia than a good one. The number of examinations is, however, too small to permit any defin-

ite conclusion being drawn. If the frequency figures of achylia in the different groups are compared with the corresponding figures in the B diet group (Table p. 98) it will at once be seen that the high incidence of achylia in the LIa group is not due to the inferior condition of the teeth. The incidence of achylia is throughout much higher in the LIa diet than in the B diet.

Degree of secretory disturbance in achylics in the different diet groups.

Diet	Total acidity							
	Alkaline (bile not demonst.)	Neutral	1—4	5—8	9—15	16—20	21—30	Not recorded
LIa	7	5	24	60	63	28	5	8
LIb	—	—	—	1	2	2	—	—
LIIa	2	1	6	25	10	11	5	1
LIIb	—	1	3	8	3	2	1	—
All L diets	9	7	33	94	78	43	11	9
BIa	—	1	7	17	14	8	2	1
BIb	—	1	4	9	11	5	2	—
BIIb and c.....	—	—	—	1	1	4	—	—
All B diets	0	2	11	28	26	17	4	1
SI and SIIa	2	—	2	2	1	1	—	—

Judging from the total acidity values, both slight and severe degrees of secretory disturbances occur in all the diet groups. In the LIa group exactly half the cases showed total acidity values of 8 or under. For the other large diet groups the values are about the same. No definite conclusions can be drawn from these figures, at least not to the effect that the secretory anomaly in the LIa group is of a less severe nature than in the other diet groups.

The following table shows the degrees of functional disturbance determined by means of various methods of examination.

Of the cases examined by the histamine test no less than 26 had not been previously examined by means of a fractional test meal. Of these 26 cases, 14 belonged to the LIa group, of which 4 were Congo negative. A further 4 cases, not previously subjected to fractional analysis, belonged to the L diet groups. All gave a negative Congo result when tested with histamine. In the B group 8 cases tested with histamine had not been previously subjected to a fractional examination; 1 of

Degree of functional disturbance estimated by various methods of examination.

Diet	Fractional Congo pos.	Fractional Congo neg.	Histamine Test		Neutral red excretion	
			Congo pos.	Congo neg.	+	—
LIa	23	27	6	26	9	12
LIIa	5	4	2	5	3	2
All L diets	30	35	9	33	13	14
BIa	7	8	3	7	5	2
BIb	8	8	2	6	4	1
All B diets	15	16	5	13	9	3
S diets	—	2	—	1	1	—

Pepsin content of the gastric juice in achylias belonging to different diet groups.

Peptic digestion in mm.	0—2	2,5—4	4,5—6	6,5—8	>8
Diet group					
LIa	15	23	18	4	4
LIIa	4	6	3	4	1
All L diets	20	32	23	7	5
BIa	7	4	8	3	1
BIb	7	4	4	3	1
All B diets	14	8	13	6	2
S diets	—	—	—	—	—

these 8 cases gave a positive Congo reaction. In judging the result of the fractional examination it is necessary to include those cases which were not subjected to single fractional examinations before the histamine test. Simple fractional examinations were not made on those cases where, in view of the total acidity value, a negative result was to be expected.

The LIa group, which presents the most interesting features, comprises 64 cases subjected to fractional examination. As appears from the table, the simple fractional analysis showed free acid in 23 cases (27 if the histamine positive cases are included), corresponding to 38 per cent (41 per cent at most). For the B diet group the corresponding figure is the same, 38 and 41 per

cent respectively, and for the total material 36 per cent. In the LIa group 26 cases out of 32 (most of them Congo negative on fractional examination) manifested a histamine refractory achylia. In 21 cases examined in the group, 12 showed also an inhibited neutral red excretion. In the B group, 13 of the 18 cases examined were histamine refractory, and 3 cases out of 14 showed an absence of neutral red excretion.

These findings show that the achylia in the LIa group cannot by any means be regarded as being of a milder type than that occurring in the other diet groups.

Digestive power in achylics belonging to different diet groups.

Chymefaction	Good	Fairly good	Rather poor	Poor
Diet				
LIa	21	20	34	66
LIIa	4	6	9	13
All L diets	25	28	49	87
BIa	4	9	9	13
BIb	5	7	9	8
All B diets	10	19	19	21
S diets	- -	2	2	4

Amount of mucus in the stomach contents of achylics belonging to different diet groups.

Diet	0	+	++	+++
LIa	20	74	10	24
LIIa	6	16	4	6
All L diets	31	99	17	31
BIa	3	23	5	4
BIb	6	17	1	5
All B diets	9	43	7	9
S diets	1	1	1	2

With regard to the pepsin content there is no significant difference between the cases of achylia in the different diet groups.

In the achylic cases in the L diet group and especially in the

LIa group the digestion of the removed stomach contents is if anything inferior to that of cases belonging to the B diet group.

Mucus is present to about the same extent in the achylic cases in the different diet groups (see table on p. 111).

The subjective symptoms of the achylic cases belonging to the LIa group are, on the whole, the same as those found in the total material. Thus, 59 patients (30 per cent) belonging to the LIa group complained of slight stomach disorders. In 42 cases (21 per cent) there were severe gastric disturbances, suggestive of ulcer. The incidence of gastric ulcer in this group as well as the intestinal symptoms will be dealt with later on. Mention will only be made here that constipation is a common symptom in the achylic cases in the LIa group. It was found that 65 cases (32 per cent) had simple constipation, 20 (10 per cent) had stercoral diarrhoea and 7 (4 per cent) diarrhoea. The symptoms manifested by the Congo positive cases in the LIa group are of great interest, especially with regard to the incidence of ulcer and the disorders associated with acidism. These features will be dealt with in a subsequent chapter.

»Healthy and control cases» call for a separate description with respect to the incidence of achylia.

Incidence of achylia in »healthy» persons in the different diet groups.

Diet	Men		Women		Men + Women	
	All cases	Congo neg.	All cases	Congo neg.	All cases	Congo neg.
LIa	22	15 (68 %)	59	49 (83 %)	81	64 (79 %)
LIIa	14	5	19	5	33	10
All L diets	39	22 (56 %)	82	56 (68 %)	121	78 (64 %)
BIa	30	3	34	6	64	9
BIb	16	1	34	4	50	5
All B diets	50	5 (10 %)	72	10 (14 %)	122	15 (12 %)
S diets	48	2 (4 %)	—	—	48	2 (4 %)

From the table it will be seen that the incidence of achylia among the »healthy» individuals is exceedingly high.

Of 81 cases belonging to the LIa group no less than 64 (79 %) are Congo neg.
» 122 » » » » B » only 15 (12 %) » »
» 38 » » » » S » » 2 (5 %) » »

In the following chapter we shall consider more closely the cause of the high incidence of achylia in apparently healthy individuals belonging to the L diet group.

The low incidence of achylia in the S diet group may be explained partly by the fact that this group, as a rule, comprises only men between 20 and 50 years of age.

The data regarding this group are derived for the most part from the investigations carried out among the forest-workers by LINDGREN for another purpose.

The degree of secretory disturbance in the achylic cases belonging to the control group (»healthy») does not differ from that of the entire material estimated in accordance with the total acidity value and a fractional test meal, with or without histamine and neutral red tests.

In this connection it is of interest to make a comparison between the total acidity value in the different diet groups for »healthy» subjects and the other material.

	LIa diets	All L diets	All B diets	All S diets
Healthy and control cases	11,3	15,2	34,9	32,8
Other material	14,7	18,0	33,8	32,8

The value for the women is on the average 3 units lower than that for the men.

The table throws further light on the influence of the diet on the gastric secretion. Thus there cannot be any doubt that the cause of the high incidence of achylia in the Norrland material is to be found in the unvaried milk-meal diet.

The literature contains records of observation which lend a certain amount of support to the assumption that the L diet is the fundamental cause of the high incidence of achylia in our material. The most characteristic feature of the L diets is the small amounts of animal protein they contain (meat, fish and eggs) and the almost complete absence of vegetables and fresh fruit. This deficiency in fruit and vegetables applies to an essential agree also to the other types of diet in Norrland.

Pawlow, in his classical investigations, describes the stimulating effect of various substances on the gastric secretion, and he attempts to draw separate curves for different articles of food. Later, investigations with

the aid of a different technique (for instance, alcohol test meal + the substance examined) have been carried out by Rehfuss, Bergeim, Hawk, Miller and others. All authors consider meat to be a powerful stimulant of gastric secretion. This action is due to the extractive elements of meat (Haneborg, Popielski, Keeton, Lockhardt, Koch). Thoroughly boiled meat has therefore a less stimulating action than broth and roast meat. Cereal protein produces less secretion of gastric juice than animal protein (Monossohn, Jarotsky).

Carbohydrates have but little stimulating effect on the gastric secretion, especially porridge and gruels (Boas, v. Bergmann, Katsch). With regard to the influence of sugar on the secretion of gastric juice there is a difference of opinion. v. Bergmann, Zahn, Boas and others are of opinion that sugar solutions with a concentration of 10 per cent are indifferent, while in a concentration of 5 per cent they reduce the secretion. These authors therefore use weak sugar solutions in their treatment of peptic ulcer. On the other hand, Weitz, Mahler and Kuttner have quite a diffèrent view in that they consider that sugar increases the secretion of gastric juice.

Fat, especially butter and oil in a fresh condition, has an inhibitory effect on the secretion (Cohnheim, Petrén, Katsch and others). Decomposed fat, on the other hand, increases the secretion (Kalk, Dice, etc.).

Opinions differ widely with regard to the importance of milk. For instance, v. Bergmann, Kalk and Jarotsky find that it stimulates secretion, whereas Hunt and Rehfuss consider that it has an inhibitory effect on the secretion of gastric juice.

Vegetables and vegetable extracts, especially spinach, promote secretion (Eisenhardt, Bickel and others), even when administered other than per os. Fruit-juices, turnips and carrots have the same effect (Orlowsky, Grober).

The above data cited from the literature refer in general to examinations made on a single meal, but they lend support to the view that the L diet has an inhibitory effect on the secretion of gastric juice.

Matthes, Lüthje, Hemmeter, Koschtojanz, Cloetta, Larue and Noponen have shown by observation on both man and animals that a meat diet taken for a long period gives high acidity values, while a diet consisting chiefly of carbohydrates gives low acidity values. Of these investigations special mention should perhaps be made in this connection of those carried out by Rehfuss, Noponen and Matthes and his pupil Böttner, as they are based on human material. Noponen made examinations on 200 patients, subsisting chiefly on a meat diet, and found in an E.-B. test meal drawn off after 45 minutes the values: free HCl 30, total acidity 60. In his text-book Matthes mentions a form of achylia occurring in persons subsisting on a diet very little seasoned and deficient in protein. He finds support for this view in Böttner's observation of the high incidence of achylia among the civilian population during the war, which in his opinion was due to the deficiency in meat and condiments. Other workers have also reported a great increase in the incidence of achylia in Germany and Austria during the war both among soldiers and the civilian population. This

increase was not observed in certain occupations, such as butchers and innkeepers, who were able to procure meat.

Schaff, Elsass, Milton and Monossohn describe a form of secondary anaemia, associated with a lowered secretory capacity of the stomach, observed in persons living on a diet of cereals without meat, animal proteins, vegetables and fruit.

If the composition of the diet is the causal factor in the origin of achylia it should be expected that the achylia would disappear on a change of diet.

A number of observations were in fact made in our material, where patients with normal acidity values and living on a mixed diet had for some reason or other changed to a unvaried milk-meal diet and after the transition had become achylic; after returning to a mixed diet they again showed free HCl in the stomach. Some of the cases had previously been affected with achylia in conjunction with the L diet. On transition to a mixed diet, as a rule on the physician's advice, free HCl again appeared in the stomach contents, but a return to the usual unvaried diet resulted in the re-occurrence of the achylia. Such changes in the secretion of hydrochloric acid in the stomach after a change of diet were observed in 13 cases; in two of the cases this occurred 3 or 4 times.

Finally, there is a large number of cases, where the achylia, caused, as far as can be judged, by the milk-meal diet, improved or disappeared on treatment with a mixed diet. These cases will be dealt with below.

A sceptical reader may not consider the diet to be the cause of these changes but would attribute them to other (psychic) factors, or he may point to the fact that such changes occur normally. Against this view the objection should, however, be made that the changes in the secretion of hydrochloric acid are exactly coincident with the changes in the composition of the diet.

5. *Treatment of achylia and its results.*

Even before these investigations were commenced our attention had been directed to the influence of the diet on the high incidence of achylia in the Norrland material. Our treatment was therefore devised accordingly. In the course of our investigations we were in a position to form an idea of the result of the treatment. Before proceeding to give an account of the result

obtained, it will be appropriate to give a brief description of our method of treatment.

The principle of the treatment was a gradual transition from the unvaried milk-meal diet to a mixed diet. In those cases exhibiting pronounced symptoms this transition was made cautiously, frequently in the form of a modified ulcer treatment. On the first day the patient was given no food, then he was given a meal gruel, boiled in water, in increasing quantities, to which was added orange juice or more often carrot juice. At an early stage the diet was supplemented with fruit soups and stewed fruit, puréed vegetables, finely chopped meat and fish. No fresh milk was given. If no intestinal disorders were present the patient was often allowed to eat sour milk and ropy milk, for quite a number of the patients said that sour or ropy milk agreed with them very well, but fresh milk did not.

In the first years a supply of citric acid or hydrochloric acid, the latter sometimes combined with pepsin, was frequently added to the diet. The result was very unsatisfactory. A very large percentage of the patients complained that they felt worse after the medicine, and it had to be discontinued. The patients were then given Inf. amar. alk. (bitter tonic) together with a moderate dose of potassium bromide or sodium bromide (0.5—1 g.) and belladonna extract (1 cg.). As a rule the patients preferred Inf. alk. to Inf. gentian. Bromides and especially belladonna were added in order to counteract in some degree the rapid emptying of the stomach. It is no exaggeration to say that this medical treatment was very popular among the Norrland clientele, who ascribed to it an exceedingly beneficial effect.

With regard to the result of the treatment it may be mentioned that the subjective symptoms disappeared almost without exception. As regards the improvement in the objective symptoms, especially the restoration of the normal gastric secretion of HCl, it is unfortunate that a re-examination of the patients was very often impossible. The greater part of the material consists, as already mentioned, of out-patients often residing some fifty miles or so from the hospital and means of transit very poor. Even in the hospital cases the period of treatment, 3—4 weeks, is too short for any definite conclusions to be drawn. Katsch considers that the treatment of achylia should continue for 6—12 months.

An attempt was made above to determine the degree of functional disturbance according to the total acidity value and different types of diet. It is to be expected that the prognosis of the severe cases will be less favourable than that of the milder ones. For that reason this point view has been taken into account in the analysis of the material with respect to the prognosis.

The following table shows the therapeutic results in relation to the total acidity values.

Among the 141 cases, on which the table is based, an improvement accurred in the rate of secretion in 51 cases (36.2 per cent), the Congo reaction becoming positive on re-examination after the treatment. It will be seen from the table that Congo positive cases after the treatment are especially those, which showed comparatively high total acidity values at the first examination. In several severe cases, judging from the total acidity values, an improvement in the secretion of HCl nevertheless took place, so that free acid could be demonstrated in the repeated test meal examination (with a total acidity value of 0—4 this occurred in 2 cases out of 27; with a total acidity value of 5—8, in 9 cases out of 46).

In another 7 cases the test meal examination was repeated within 2 weeks. In 2 of these cases the Congo test was positive at the second examination. These cases are not included in the table, as it is more doubtful whether the difference in the result is to be ascribed to the treatment. Both the latter cases had a total acidity value > 10.

Among the 51 cases in which free acid could be shown after the treatment, achylia had been ascertained in 17 in at least two previous examinations. In these 17 cases the total acidity value in the first examination was 0—4 in 2 cases, 5—8 in 5 cases, 9—15 in 5 cases, 16—20 in 4 cases, and 26 in 1 case. As regards these cases at least, and also those cases of achylia which became Congo positive after the treatment but were negative in the previous fractional examination, we are justified in assuming that the functional disturbance was not due to accidental causes and that an improvement of the function really occurred. In the other cases only one test meal examination was made before the treatment was commenced.

An analysis of the prognosis in relation to the results obtained by other methods of examining the gastric function will show that of 24 cases, which were Congo positive on fractional exa-

Result of treatment of achylia in relation to the total acidity values.

Total acidity at first examination	Congo negative after treatment					Congo positive after treatment				
	2—3 weeks	3—4 weeks	1—6 months	½—2 years	Total	2—3 weeks	3—4 weeks	1—6 months	½—2 years	Total
0— 4	1	5	10	4	19			2		2 (10 %)
5— 8	2	11	14	10	37		1	6	2	9 (20 %)
9—15	3	2	12	4	21	7	4	11	1	23 (52 %)
16—20	2	2	6	1	11		1	10	1	14 (54 %)
> 20		1		1	2		2	1	1	4 (67 %)
Total	8	21	42	20	90	7	8	30	5	51 (36 %)

mination but Congo negtive in an E.-B. test, 16 (61 per cent) proved to be Congo positive on an E.-B. test made after the treatment. Of 27 cases that were Congo negative on fractional examination, 6, or 22 per cent, were found to be Congo positive on an E.-B. examination made later on (after 4—7 weeks' treatment). These results prove that the prospects of re-establishing the function are not so favourable when the Congo test is negative on fractional examination as when it is positive. Still, improvement and restitution may also occur in the Congo negative cases. In this connection it should be pointed out that the fractional examination was made simultaneously with a test meal of rusks. As mentioned above, such a fractional examination with a meal of rusks can be regarded as equivalent to a histamine test without a simultaneous test meal.

In the fractional examination the time that elapses before the appearance of free acid is also a criterion for the prognosis, as is shown by the following table:

On fractional exam.: Congo positive			
after 30 min.	9 cases.	All of them	Congo-pos. on E.-B. after treatment
» 45 »	7 »	5 »	» » » » » » » »
» longer period	8 »	2 »	» » » » » » » »

From the evidence available it is natural to suppose that the higher the titration value is on fractional examination the more favourable will be the prognosis. An analysis of the cases showed that this assumption was correct.

Of 7 cases which were Congo positive in the histamine test but Congo negative on a simple fractional examination, 3 became Congo positive after the treatment (6 weeks — 6 months). Of 25 histamine negative cases, not one became Congo positive at an E.-B. examination during the period of observation, which for many of the cases, however, did not extend for more than 3—5 weeks. There were, however, 2 histamine negative cases, one of which showed no excretion of neutral red, which became Congo positive after one month's treatment (examination could not be made later) with a free HCl value of 5 and 10 respectively on single fractional examination, thus a marked improvement in spite of the short period of treatment.

Apart from the short period of observation in many cases, we are justified in drawing the conclusion that histamine negative

cases very seldom recover their power of acid secretion. The destruction of the glandular cells of the mucous membrane has progressed too far in such cases. Nevertheless a restitution seems to be possible, even if the excretion of neutral red has ceased, as is shown by the above-mentioned cases.

An account has been given above of the prognosis in all the Congo negative cases of the material that were re-examined. The prognosis was favourable in so far that, despite the brief duration of the treatment in many cases, 36 per cent of the cases showed a reappearance of free acid in the stomach contents.

The prognosis of the achylic cases with respect to the previous diet appears from the following table:—

Diet	Number of cases re-examined	Number of cases in which free acid reappeared	improved
LIa	80	34	42,5
LIb	3	1	—
LIIa—b	23	10	43,5
B diet	35	6	17,0

It will be seen from the table that this relatively favourable progress, with a reappearance of free acid in the stomach contents, occurs chiefly among the L diet groups. (The difference in the results between the L and B diets amounts to 26 per cent ($\pm$ 8), and is therefore statistically significant.) The objection may be made that the re-examined cases in the B diet group were of a more severe nature. If we classify the re-examined cases in relation to the total acidity we shall find, however, that severe functional disturbances occur quite as frequently among the L diet groups as among the B diet group. The following table shows this.

Diet	Total acidity						
	0	1—4	5—8	9—15	16—20	21—30	Not recorded
LIa	4	6	25	28	12	4	1
LIb	—	—	—	3	—	—	—
LIIa—b	—	5	11	4	2	—	1
B diet	—	5	10	9	10	1	—

It should be emphasized that all the 11 cases having a total acidity value below 9, which became Congo positive after the treatment, belonged to the LIa diet group.

Of 6 cases that were Congo negative on fractional examination, and in which free HCl was found on repeated E.-B. test after the discontinuance of the treatment, 4 belonged to the LIa group, 1 to the LII group and 1 to the BIb group. This also shows that the result of the treatment is much more favourable in the achylic cases in the L diet group than in the achylic cases belonging to the other diet groups. This is easily accounted for, since the cause of the inhibited secretion of gastric juice in the former cases is the unvaried diet and the therapeutic treatment was adapted to meet this condition. Thus the result of the treatment, or rather the unequal results of the treatment, also indicate the significance of the diet in the etiology of achylia. That the result of the treatment is not even more unfavourable is explained partly by the fact that the period of treatment was too short to permit definite conclusions being drawn as to its efficacy, partly by the fact that the change in the gastric mucosa had developed so far that a restitution was no longer possible.

6. *The cause of the inhibitory effect of the unvaried milk-meal diet on the gastric secretion.*

With regard to the cause of a suppression of the acid secretion of the stomach two opposite views have been advanced. One is the so-called inflammation theory, which contends that the underlying cause of every protracted inhibition of the secretion is an inflammation of the mucous membrane, a gastritis. The other theory maintains that the secretory disturbance is due to neurogenous or constitutional causes. In the beginning the gastritis theory was based on a macroscopical demonstration of pathological changes in the mucous membrane with a destruction of the glandular cells, an anadenia or atrophy resulting from an inflammation (Fenwick, Ewald, Quincke and others).

Leube, Ewald, Einborn, Martius and Lubarsch, however, demonstrated the occurrence of cases with a cessation of gastric secretion but in which no patho-anatomical changes could be discovered. The authors ascribe the condition in such cases to functional or constitutional neurological factors. In support of this view some authors have called attention to the occurrence of achylia in constitutionally weak persons (Disqué, Strümpell, Schütz, Hurst, and many others).

Albu considers that achylia is either hereditary — the occurrence of achylia in children and the frequency of achylia in certain families argue in favour of this view — or acquired, being a state of exhaustion in a

constitutionally weak gastric mucosa. A characteristic of the constitutional and functional achylia is that there is no evidence of the presence of an inflammation (gastritis). The history of such cases does not suggest an inflammatory etiology, and no, or very slight, changes can be demonstrated in the mucous membrane.

With the aid of modern methods, especially the possibility of protecting the mucous membrane from post-morten changes by pouring a fixative into the stomach immediately after death (Hayem, Faber, Bloch, Larue), a more thorough examination of the gastric mucosa is now possible. According to Kalk, inflammatory changes in the mucous membrane can be shown in this way in 95 per cent of human autopsies. The same observation has been made by Puschkis and Orator and others.

Faber, on the other hand, holds the view that gastritis is the cause of achylia. According to Faber, inflammatory changes can be demonstrated in every case of achylia. In opposition to the advocates of the view of a constitutional etiology of achylia, Faber calls attention to the fact that achylia frequently occurs in children after parenteral infections. This achylia may be of a transient or permanent nature (Bloch, Ingeborg Chiewitz, Andresen, Meyer, Hertz and Jacobsen). As far as the familial occurrence of achylia is concerned, Faber asserts that it is so uncommon that it can be left out of account.

On the other hand, the degree of functional impairment does not stand in any definite relationship to the degree of the anatomical changes (Faber, Lubarsch, von Bergmann and others). An inflammation of the mucous membrane, a gastritis, produces sometimes an excessive, sometimes an insufficient, acid secretion, or none at all, without it being possible to discern any difference in the microscopical picture of the different cases. Not infrequently the varying degrees of secretory disturbance are different stages of the same process (Stuart, Hurst, Kalk).

Thus if inflammatory changes in the mucous membrane can be shown microscopically in every case of achylia, the demonstration of such changes presents great difficulties clinically. The history does not supply any definite information about the presence of gastritis. Even a severe gastritis may run its course without evident symptoms (Faber). Ewald and Leube made the diagnosis of gastritis if mucus was found in the withdrawn stomach contents. There are cases of gastritis, however, in which no mucus is present in the stomach contents. According to Faber, mucus is absent in 50 per cent of the cases of unquestionable gastritis. That mucus can be shown after mechanical irritation of the mucous membrane (Pawlow) or after an injection of pilocarpine (Egan, Kalk) is no evidence, as some investigators assert, that this admixture of mucus is not due to an inflammatory irritation. Nor is the presence of leucocytes and a positive albumin reaction (Heller) in the withdrawn stomach contents evidence of the presence of inflammatory changes. In our material no absolute difference could be observed between the frequency of leucocytes and the amount of albumin in the stomach contents of »healthy» subjects with or without free acid. To make the diagnosis after an examination of particles of the mucous membrane extracted through the tube, as was done by Martius and Lubarsch, is possible only in a small number of cases. With modern improvements

in X ray technique (Forsell, Åkerlund, Berg) it is now possible by relief radiography to show the presence of inflammatory changes in the gastric mucosa. According to von Bergmann, it is possible to show inflammatory changes in 50 per cent of the cases of gastric ulcer.

Further possibilities are offered by gastroscopy (Korbsch, Schindler) and gastro-photography (Porges), but even these methods often fail.

Thus there remains in any case the fact that it is very often impossible to decide clinically whether a gastritis is the cause of an achylia or not.

One of the etiological factors of achylia, mentioned by Faber and others, is noxae (poisons), which either directly or indirectly affect the gastric mucosa along the blood channels.

In the foregoing we have dealt with the influence a change in the mechanical composition of the food has on the gastric secretion, the importance of the condition of the teeth and mastication, and the effect of coffee, tobacco and alcohol on this secretion. It was also possible to show that these factors have but little influence on the high incidence of achylia in our material.

a. *Haematogenous toxic effects* of infectious diseases of various kinds, pronounced endocrine disturbances, diseases of the liver and bile-ducts, nephritis, etc., can be left out of account as far as this material is concerned, a material which has been stringently weeded, and consists essentially of »healthy» individuals. It is nevertheless clear that such toxic influences may have existed without manifesting any symptoms, but the question arises: Why should these injurious effects be restricted solely to that group of the material which subsisted on the unvaried milk-meal diet? There is no evidence that diet predisposes to various kinds of infection. We have not been able to prove that a person living on an L diet is more frequently affected by infections than a person living on a B diet. It is not very probable, either, that the former is more frequently affected with infections which do not manifest symptoms. No change was found in the blood picture suggestive of an infection in the shape of a leucocytosis, a question which will be discussed in a subsequent chapter. The sedimentation rate was not increased to a higher degree in achylic cases than in Congo positive cases, with the exception of severe cases of anaemia. In 79 per cent of the achylic cases the sedimentation reaction rate was less than 10 mm./1 hour.

b. It would be even more unreasonable as regards this large group of the population to assume that the cause of the achylia is a neurogenous or *constitutional disturbance*. There is no other evidence of such a disturbance, and the question arises again why such a constitutional anomaly should be confined solely to that group of the population which subsists on the milk-meal diet, but which otherwise does not differ from the rest of the population either as regards race or conditions of life. KATSCH raises the objection against CLOETTA's experiments on dogs (v. p. 114), in which he gives the dogs a food analogous to the LIa type of diet, that such a fare is not dog's food, and therefore the dogs rightly feel psychically unsatisfied, which may explain the discontinuance of the gastric secretion. But such an argument cannot be applied to the people of Norrland, who find this diet wholesome and to their taste. Nor can it be asserted that the composition of the diet is conditioned by the physical constitution of the people. The L diet is, as we have already pointed out, the outcome of quite different factors.

c. Thus it is highly probably that the unvaried milk-meal diet itself is the cause of the achylia, either because it directly influences the gastric secretion or indirectly owing to *quantitative or qualitative defects*. It can hardly be assumed that the diet has a direct injurious effect. Milk-meal diet has for many years been acknowledged and generally adopted as a protective diet for stomach diseases, possibly with a certain restriction as regards milk. The question then arises whether the cause of the inhibitory effect of the LI diet on the gastric secretion is due to its being a pronounced protective diet. This point will be discussed later.

In the discussion on the dietary conditions among the inhabitants of Norrland it was shown that as far as the L diets were concerned there was evidence of a quantitative undernutrition and that the amount of animal protein, in particular, was low. It was also pointed out (p. 114) that observations made during the war indicated that a deficiency of animal protein in the diet brought about an increase in the incidence of achylia. Similar observations, not mentioned above, were made during the Great War by TALLQVIST, BRÜGEL, BÖTTNER, JUNG, RÖMHELD and many others. But it has been pointed out by several investigators that the cause of the exceedingly high incidence of achylia during the war is not to be ascribed solely to the deficiency in animal protein and to malnutrition, even if these factors play a part. The

quality of the diet during the war predisposed to the development of gastritis, infections of various kinds, of importance in the origin of achylia, were exceedingly common. Other investigators, for instance, GROTE, CURSCHMANN, called attention to a decrease in the incidence of achylia and hypochylia and an increase in the incidence of hyperchylia during the war. CURSCHMANN shows that this hyperchylia, which occurs at a time when there is a great deficiency of animal protein, is to be attributed to the increased consumption of cabbage and turnips, which greatly stimulate the gastric secretion. Thus CURSCHMANN's observations do not by any means disprove the view that a diet deficient in protein promotes achylia. His observations, in fact, furnish an explanation of the many conflicting views advanced concerning the cause of the increased incidence of achylia during the war.

We had great difficulties in finding in the literature definite information as to how under-nutrition influences the secretion of gastric juice. Under-nutrition is most frequently associated with other factors, which may be thought to stimulate or neutralize the influence of under-nutrition on the gastric secretion.

As already mentioned, during the war the occurrence was noted of a lowered B. M., analogous to that observed in the Norrland material, which was due to decreased function of the endocrine apparatus. In the decrease in the basal metabolic rate under-nutrition and a deficiency in animal protein or some associated factor (B-hypovitaminosis) play a part. Endocrine disturbances often give rise to reduced gastric secretion. Under such circumstances it is quite reasonable to suppose that achylia arises in that way. But there is no definite correlation between the gastric secretion of acid and the basal metabolic rate. Of 30 cases with a decreased B. M., 18 were achylic, 12 gave a positive Congo reaction on a test meal analysis. Another 18 achylic cases showed a normal or somewhat increased basal metabolic rate. Thus in our material achylia occurs quite as often with as without a decreased rate of B. M. The diminished gastric function and the decreased basal metabolic rate must therefore be regarded as parallel symptoms of the L diet. There remains the fact that under-nutrition and above all a deficiency in animal protein or some associated factor are the cause of the high incidence of achylia in Norrland.

Meat supplies the organism with certain substances which may

be important for the secretion of gastric juice, e. g. salts and vitamins.

It is difficult to believe that deficiency in protein is capable of producing an under-nutrition. Under-nutrition, in so far as it applies to the population of Norrland, is not due to want of food but to a diminished need of food. Some of the forest-workers also live on a diet deficient in protein. So do diabetics who are treated by PETRÉN's method with a diet consisting of small amounts of protein and very large amounts of fat. In both these diet groups, however, the calorie intake is very high. Among the forest-workers the incidence of achylia is, as already pointed out, comparatively low. These facts appear to indicate that it is some factor associated with the deficiency in protein which exercises an important influence on the origin of achylia and under-nutrition in this material.

We have already emphasized the improbability of the LIa diet being deficient in chlorides. Opinions differ widely as to the effect of a chloride deficiency on the secretion of gastric juice. Tests carried out by ROSEMANN, LANDAU, GLASS and EIMER show that a reduction in the amount of chloride in the food has but little influence on the gastric secretion.

Besides, the inhabitants of Norrland salt their food thoroughly, and that is true also of these families belonging to the LI group.

The low iron content of the LIa diet can hardly have any great effect on the incidence of achylia. Its importance in the causation of anaemia and the correlation between anaemia and achylia will be dealt with in a later chapter.

The occurrence of a possible hypovitaminosis will also be discussed later. It need only be mentioned here that in view of the composition of the food a deficiency of vitamins B, C and D may be considered to exist in the L diet group. The possibility of a deficiency of vitamin C is, however, quite as great in the BIa and SI diet groups, among which the incidence of achylia is relatively low. Indeed, it is only in an advanced stage that a C-hypovitaminosis seems to give rise to achylia (HAUSMANN, BIERICH, NEVER). No symptoms of a deficiency of vitamin D were observed in the adult population. As regards the effects of a deficiency of vitamin D on the gastric secretion the same thing may be said as that mentioned above concerning C-avitaminosis. A latent B-hypovitaminosis has not been observed so far, but the occurrence of such a condition is not impossible. In

animal experiments at least a deficiency of vitamin B gives rise to achylia, but it is not yet established whether a B-hypovitaminosis has the same effect in human beings.

We now return to the question as to whether the L diets, especially the LIa diet, in their character of protective diets, are the cause of achylia. This implies that the gastric secretion has adapted itself to the relatively modest demands placed on it. The correctness of this view, which the author put forward even before these investigations were initiated, seems to be confirmed to a certain extent by the fact that the secretion of gastric juice was re-established in a large percentage of the cases on a change of diet, and further that the administration of hydrochloric or citric acid did not agree with these achylic persons. It is easy to understand that normal functional conditions do not always result from the treatment. The period of observation is too short. The protracted »physiological» hypofunction may also give rise to secondary organic changes with a permanent failure of secretion.

Evidence has already been adduced from the literature in support of the correctness of our interpretation. Special mention may be made of the experiments carried out by Cloetta and Hemmeter and the observations made by Elias and Böttner. Investigations on children point in the same direction. Davidsson, Salge and Hess, among others, point out that children digest egg-white and milk very well but that they do not digest meat and fish so well. After a few weeks' meat diet the secretion of gastric juice increases and the power of digesting meat is improved (Hecht, Somlo and v. Szirmay). What has been said above does not in any way argue against the assumption that some other factor (hypovitaminosis) associated with a deficiency of animal protein may also be of importance in the causation of achylia in persons subsisting on the L diet. A hypovitaminosis can cause the degeneration of the glandular structure of the gastric mucosa, which in turn can give rise to a temporary or permanent achylia, possibly owing to a secondary atrophy. An increase in the meat content of the diet causes the disappearance of this causal factor in achylia. The conditions necessary for a recovery are present.

CHAPTER IV.

Incidence of Gastric and Duodenal Ulcers and their Characteristics.

A. Ulcer in connection with achylia.

It has been possible to show that the unvaried milk-meal diet is often associated with achylia and hypochylia, and in consequence that the incidence of achylia in Upper Norrland is much higher than in South and Central Sweden, and also that the mean value of HCl, as shown by test meal analysis, is lower in the Umeå material than in the Lund and Borås materials. For this reason we should expect to find a lower incidence of ulcer in Norrland, since ulcer is as a rule associated with normal or increased secretion of hydrochloric acid.

Some writers (e. g. KALK) maintain that the combination of ulcer and achylia does not exist, and that free acid in the gastric juice is a necessary condition for the development of an ulcer. According to these workers, it is always possible to produce free acid by repeated and more stimulating forms of test meals.

Below we give some data from the literature illustrating the occurrence of the combination: ulcer and achylia.

By means of fractional analysis, HURST found only 2 cases of gastric ulcer without free HCl, but no case of duodenal ulcer. PALMER declares that repeated histamine tests are necessary to determine whether free acid is absent or not. In his material of 1,004 established and 465 suspected cases of gastric and duodenal ulcer he found only one absolutely sure case of ulcer with complete absence of acid secretion, autopsy revealing that this ulcer had healed. CRISPIN, after a single titration in a test meal examination, found only 1 per cent Congo negative cases in a large material of duodenal ulcers. Among 300 cases of gastric and duodenal ulcer, half of them verified on operation,

KELLING found, by means of a single alcohol test meal, a negative Congo reaction in 15 cases (5 per cent), after eliminating cases of tuberculosis, syphilis and cholecystitis. In 215 cases of gastric and duodenal ulcer STRAUSS found 7.5 per cent Congo negative, while NELKEN found 5.2 per cent Congo negatives among 210 cases of gastric and duodenal ulcer (including, however, 4 cases of gastro-enterostomy). In a large material from South Sweden (Lund and Malmö) MATTISSON did not find any case of Congo negative reaction, after the withdrawal of an E.-B. test meal, in »pylorusferne» ulcer, but in 1.92 per cent of the cases of »pylorusnahe» ulcer. In these cases the diagnosis of ulcer was confirmed at autopsy. In 146 cases of radiographically established ulcer the Congo test was negative in 5.08 per cent of the cases with »pylorusferne» ulcers, but in no case with »pylorusnahe» ulcer.

ABRAMSON has classified the author's material (11th July 1924—1st September 1930) of ulcer cases with achylia. Only cases with a radiologically revealed niche are included. The cases were selected on the same principles as those already mentioned.

The material comprises 86 cases of ulcer of the stomach, of which 19, or 21 per cent, were Congo negative on E.-B., and 277 cases of duodenal ulcer, 37, or 13.3 per cent, of which were Congo negative. In his material from the Umeå Hospital (operated cases), comprising 38 gastric ulcers and 41 duodenal ulcers, BOHMANSSON found respectively 21.1 per cent and 5 per cent Congo negative cases. In the Borås material, comprising 116 cases of gastric ulcer and 191 of duodenal ulcer, achylia was revealed in only one case (duodenal ulcer) on an E.-B. test. In this case the total acidity value was 20.

Thus the incidence of ulcer in combination with achylia is strikingly high in the Norrland material.

Before proceeding to the discussion of the cause of this condition we shall briefly describe the degree and symptomatology of the »achylic ulcer».

The following table shows the degree of functional disturbance and also gives a survey of the total acidity values of those cases in which repeated E.-B. examinations were made.

In about 50 per cent of the cases the total acidity value is 8 or less. Fractional analysis was made in 7 cases of gastric ulcer, 6 of which were continually Congo negative. In 4 of these cases a histamine test + fractional analysis were performed; 3

cases proved to be histamine refractory and all three showed no excretion of neutral red. In 5 cases the peptic digestion was considerably lowered.

In the cases with duodenal ulcer fractional analysis was also made in 7 instances, 5 of which continually showed a Congo negative reaction. A histamine test + fractional analysis were made in 2 of the latter, but both gave a negative result. Neutral red excretion occurred in 1 case, but not in the other. One case, in which a simple fractional analysis had not been made, gave a positive Congo reaction after a histamine injection + fractional analysis. Another case showed a negative Congo reaction on simple fractional analysis. The excretion of neutral red in this case was somewhat uncertain. No histamine test was made. The peptic digestion in this case was only $^1/_2$—1 mm.

If, on the basis of the total acidity value, the probable number of negative cases on fractional analysis found in our material is calculated in accordance with the principles laid down in Chapter III A, we obtain 14 (16.4 per cent) cases of gastric ulcer and 25 (9 per cent) cases of duodenal ulcer. Approximately the same figures are obtained if we estimate the probable number of fractionally negative cases at 36 per cent of those which were Congo negative on E.-B. test. This corresponds to the figure for the percentage of Congo negative cases on fractional analysis in the entire material. On the same basis of calculation the probable figures for histamine refractory cases would be 6 and 12 respectively.

Thus it is evident from what has been said above that achylia combined with gastric or duodenal ulcer is more frequent in the Norrland material than elsewhere, judging from the data available in the literature, and that the secretory disturbance in about 50 per cent of the cases is of a serious character, and, further, that this secretory disturbance in both gastric and duodenal ulcers may advance so far that no secretion of hydrochloric acid can be produced even by the most potent stimulant.

Further evidence that the achylia present in the great majority of the cases of combined ulcer and achylia was a true achylia and not a heterochylia is furnished by the fact that all the 21 cases (6 gastric and 15 duodenal ulcers), in which repeated E.-B. was made, were always Congo negative on re-examination.

The ulcers mentioned above did not in any way differ symptomatologically from the usual picture. It is worthy of

Degree of functional disturbance in cases of ulcer with achylia.

Total acidity on E.-B. exam.	Number of cases	Examined with E.-B. 2 or more times. Total acid. on repeated exam.	Fractional analysis		Histamine + fract. analysis		Excretion of Neutral Red		Max. peptic digestion
			Congo +	Congo —	Congo +	Congo —	+	—	mm.
Gastric ulcer:									
0	2	—	—	1	—	1	—	1	2
1—4	2	1	—	1	—	—	—	—	—
5—8	5	2	—	3 (1 examined twice)	1	2	—	2 (1 exam. twice)	9, 5
9—15	6	2	1	—	—	—	—	—	—
16—20	2	1	—	1	—	—	—	—	—
>20	2	—	—	—	—	—	—	—	—
Duodenal ulcer:									
0	6	5 (of these: 1 exam. twice, 1 thrice)	—	2	—	1	—	1	46
1—4	1	—	—	—	—	—	—	—	—
5—8	11	3 (1 exam. 4 times)	1	2	—	1	—	—	6
9—15	8	4	1	1	—	—	1	1	6
16—20	7	3	—	—	1	—	—	—	11,5
>20	4	—	—	—	—	—	—	—	—

note, however, that no less than 15 patients with duodenal ulcers declared that the pains commenced immediately or shortly after eating. This may perhaps indicate the presence of inflammatory changes (gastritis).

Judging from the histories, the duration of the symptoms varied considerably, from one month to many years. It is of interest to note that in 7 cases of gastric ulcer the period of disturbance varied from 1 month to 8 months at most, and that in 3 of the 6 cases which were Congo negative on fractional analysis, the period of disturbance was of the same short duration; 2 of these 3 cases were also histamine negative. These ulcers must therefore be characterized as comparatively recent. Among the cases of duodenal ulcer there are also, judging from the period of disturbance, some comparatively fresh ulcers, the duration of the disturbance in 6 cases being less than 1 year and at the least 1 month.

A possible disturbance in the emptying of the stomach might perhaps be thought to be the cause of the inhibition of the gastric secretion. Examinations, X ray to estimate the emptying time and the usual retention meal, showed a slowed rate of emptying in 5 cases of gastric ulcer and in 7 cases of duodenal ulcer, but the delay was slight. Thus retention cannot account for the large number of cases of ulcer with inhibition of the gastric secretion. In achylia the stomach generally empties very rapidly.

According to recent investigations, inflammatory changes frequently occur in conjunction with ulceration (CONGETZNY, BOHMANSSON and others). But in ulcer gastritis there is, as a rule, abundant secretion of gastric juice, a hyperacidity. This condition, however, does not exclude the possibility of an ulcer gastritis also leading to atrophy and cessation of gastric secretion. There is, however, hardly any reason to suppose that an atrophy of the mucous membrane has occurred in all these cases, most of which are young persons, and the clinical symptoms often only of short duration. X ray examination (by means of modern relief radiography) did not demonstrate atrophy in any case. A swollen mucous membrane with ridged rugae, indicating a hypertrophic gastritis, was on the other hand revealed in 4 cases of gastric ulcer and in 7 cases of duodenal ulcer. In 5 cases, 2 with gastric ulcer and 3 with duodenal ulcer, the entire stomach exhibited inflammatory changes on screen examination. In 6 cases, 2 of gastric ulcer and 4 of duodenal ulcer, the

changes were mainly localized to the lowest part of the stomach, the canalis portion.

In addition to the cases of ulcer described above, the presence of the ulcer established by radiological demonstration of a niche, our material also contains 2 Congo negative cases of gastritis in the canalis region with suspected ulcer, although no niche could be demonstrated.

B. The Frequency and Character of Ulcer in Relation to the Composition of the Diet.

With regard to the cause of the high incidence of gastric and duodenal ulcers combined with achylia in the Norrland material, we are naturally inclined to ascribe it to the same factors as those which give rise to the great frequency of achylia without simultaneous ulceration, that is, the composition of the diet.

The following table shows the frequency of ulcer in the various diet groups.

Frequency of ulcer in different diet groups.

Type of Diet	Number of cases in the diet group	Number of cases with ulcer		Percentage ulcers
		Congo negative	Congo positive	
LIa	294	9 (3 v. + 6 d.)	22 (2 v. + 15 d. + 5 v. a. d.)	10.5 % ± 1.8
LIb	19	—	3 (— 3 d.)	(15.8 %) ± 8.4
LIIa	160	2 (1 v. + 1 d.)	16 (4 v. + 10 d. + 2 v. a. d.)	11.2 % ± 2.5
LIIb	41	—	11	(26.8 %) ± 6.9
All L-diets	514	11	52	12.3 % ± 1.4
BIa	350	7 (5 v. + 2 d.)	53 (13 v. + 38 d. + 2 v. a. d.)	17.1 % ± 2
BIb	264	3 (1 v. + 2 d.)	46 (10 v. + 36 d. —)	18.6 % ± 2.4
BIIb—c...	49	1 (1 d.)	9 (1 v. + 7 d. + 1 v. a. d.)	(20.4 %) ± 5.8
All B diets	663	11	108	17.9 % ± 1.5
SI—IIa...	38	—	4 (1 v. + 3 d.)	(10.5 %) ± 5

It will be seen from the table that the frequency of ulcer (the presence of a niche shown by radiological examination) increases as the diet becomes more varied, from the most un-

varied diet, LIa, to the best balanced diet, BIIc. The lowest frequency of ulcers occurs in the extreme milk-meal diet, LIa, with 10.5 per cent (± 1.8) ulcer cases. In the BIa group ulcer occurred in 17.1 per cent (± 2) and in the BIb group in 18.6 per cent (± 2.4) of the cases. The difference in the frequency of ulcers between these diet groups is statistically significant. The difference between the frequency of ulcer in the different groups in the L diets and in the B diets is, it is true, not statistically significant, but the difference is so regular that its probability is increased. In all the L diet groups together the incidence of ulcer is 12.3 per cent (± 1.4) and in the B diet groups 17.9 per cent (± 1.5). The difference here is also statistically significant.

Thus the L diet appears to offer a certain amount of protection against ulcer.

A still more interesting feature is that the ulcers seem to be more frequent in the Congo positive cases in both the L diet groups and the B diet groups. In spite of the small number of Congo positive cases, especially in the LIa group (94 out of 294), there are among them no less than 22 cases of ulcer (nearly 25 per cent), while among the 200 Congo negative cases there are only 9 cases of ulcer (4.5 per cent). Among all the Congo positive cases in the L diet, 230 in number, there are 52 ulcer cases (23 per cent), whereas among the 284 Congo negative cases there are only 11 ulcer cases (4 per cent). This seems to prove that there is a tendency to increased acid secretion in the stomach when ulceration is present. However, from what has been said, it is evident that the occurrence of free hydrochloric acid is not necessary for the development of an ulcer, as assumed by Büchner, Porges, Kalk and others. By its inhibitory effect on the secretion of hydrochloric acid the milk-meal diet furnishes a certain amount of protection against ulcer, but does not entirely prevent its occurrence. In other words, ulcers occur in predisposed individuals. When this predisposition is sufficiently powerful, the milk-meal diet cannot prevent the development of ulcers.

It should be expected that the achylic ulcer cases would be most numerous in the L diet groups. But this cannot, however, be deduced for certain from the table. There are, it is true, 11 achylic ulcer cases among the 514 cases (2.14 per cent), while the frequency in the B diet groups is 11 out of 663, or 1.66 per cent. The difference, however, is hardly statistically significant. The

reason why the difference is not greater is because the BIa diet comprises a borderline group and is also a rather unvaried diet, consisting of a fairly large amount of milk and cereals. But the main cause of the difference is the low frequency of ulcers in the L diet groups. A greater difference will be evident if a comparison is made between the frequency of achylic ulcer cases in the LIa, LIIa and B groups (3.06, 1.2 and 1.66 per cent respectively). If the number of achylic cases is calculated in relation to the frequency of ulcers in the different diet groups, the result will also be different. In the LIa group there are 9 Congo negative and 22 Congo positive ulcer cases, i. e. the achylic cases amount to 29 per cent of the number. If we combine all the L diet groups the proportion will be 11 Congo negative and 53 Congo positive = 17 per cent, and for the combined B diet groups 11 and 108 = 9 per cent.

The ulcer cases in the L diet group, and especially in the LIa group, are thus more frequently associated with achylia than those in the B diet group.

The fact that the cases of gastric ulcer in the LIa group are principally found among those cases which showed a positive Congo reaction on E.-B., accounts for the greater frequency of Congo negative cases among the »healthy» subjects, i. e. those cases which did not manifest any subjective symptoms. In ulcer disease normal or hypernormal values of hydrochloric acid are generally found on gastric analysis. The extensive occurrence of ulcer in the »affected» portion of the material, that is the group of examined individuals who as a rule manifested symptoms from the digestive organs, increases the frequency of Congo positive cases in this portion of the material. If the ulcer cases are eliminated from this material, the percentage of achylia will be 70, i. e., the same as for the »healthy» subjects.

In this connection it should again be pointed out that here we have only been dealing with roentgenologically established ulcers. In all probability there are, especially in the group with gastric symptoms, several gastric ulcers not revealed by X ray examination.

Thus we have been able to establish that, just as the frequency of achylia and hypochylia is very high in Norrland, so is the frequency of the combination of achylia and ulcer. The unvaried milk-meal diet predisposes to achylia and thereby offers a certain

amount of protection against ulcer. The ulcer cases in this group were not infrequently affected also with achylia.

It should therefore be expected that the incidence of ulcer in Norrland would be lower than in southern and central Sweden, where the milk-meal diet is relatively uncommon. No reliable statistics are available. The author firmly believes, however, that to be the case. The statistical data for the number of ulcer cases treated at the hospitals of Umeå, Lund and Borås are misleading in this respect, since this number depends on the provision for treatment, the regulations for admission to the hospital, the size of the area from which patients are admitted, etc. A certain amount of guidance may be obtained, however, from the figures from the hospitals of Umeå and Borås, as the author has been the head of the medical department at both hospitals and was therefore responsible for the admission of the patients. Thus generally speaking the same principles for admission to the hospital were applied in all cases, except that, owing to the great distances in Norrland, patients had to be admitted more freely at Umeå than at Borås, where a greater percentage of the patients can be nursed at home. In comparing the figures from these two places it must also be taken into account that the medical department at Umeå Hospital was larger than that at Borås, that the area from which patients were admitted to Umeå Hospital was also more extensive than that of the Borås Hospital, and moreover that the accommodation available at Borås Hospital is less adequate than at Umeå Hospital. The average number of ulcer cases admitted yearly to the hospitals were 154 at Borås and 173 at Umeå. In view of the facts, mentioned above, that the medical department at Umeå is larger and the district more extensive, these figures seem to indicate that gastric ulcer is more common in the Borås material.

Still more striking is the difference in the character of the ulcers in the Umeå and the Borås materials. The following table, comprising all ulcer cases treated at the Umeå Hospital from 1928 to 1931 and at the Borås Hospital from 1931 to 1932, shows this difference. The table shows the number of ulcer cases, the incidence of haemorrhages and perforation, the number of deaths due to ulcer, cause of death, and, finally, the average values of free acid and total acidity found in test meal analysis.

It will be observed that the gastric and duodenal ulcers in the Borås material are of a much graver nature than those in

the Umeå material. The number of haemorrhages in the Borås material is 5 times greater than in the Umeå material. In the Borås material, haemorrhages occurred in 52 per cent of the cases, as against 10 per cent in the Umeå material. Among 307

Ulcer cases and their complications in Borås and Umeå.

		No. of cases	Minor haemorrhages	Gross haemorrhages	Dangerous haem.	Op.	Perf.	Deaths
Borås 1931—1932								
Gastric ulcer	M.	57	30	22	15	9	9	5
» »	W.	59	8	6	6	2	2	5
Duodenal »	M.	152	16	14	9	25	15	3
» »	W.	39	14	12	11	10	—	1
Total		307	68 (22 %)	54 (17 %)	41 (13 %)	46 (15 %)	26 (8 %)	14 (4 %)[1]
Umeå 1928—1931								
Gastric ulcer	M.	153	5	9	12	37	5	2
» »	W.	157	4	3	9	17	1	2
Duodenal »	M.	257	10	7	4	54	7	4
» »	W.	125	3	3	4	14	1	—
Total		692	22 (3 %)	22 (3 %)	29 (4 %)	122 (18 %)	14 (2 %)	8 (1,2 %)[2]

[1] 9 with haemorrhage, 5 after operation, none of them operated for haemorrhage).

[2] 1 with haemorrhage, 1 with perforation, 6 after operation (2 of them operated for haemorrhage).

Minor haemorrhage denotes Weber's test repeatedly positive, Weber ++

Gross » » black-coloured stools or bloody vomitus, Weber +++

Dangerous » » pronounced collapse after haemorrhage and very pronounced signs of anaemia, Weber +++.

Acidity values in ulcer cases.

	Gastric ulcer				Duodenal ulcer			
	Free Hcl		Total acidity		Free Hcl		Total acidity	
	Men	Women	Men	Women	Men	Women	Men	Women
Borås.....	30	22	54	45	39	32	64	61
Umeå.....	20	20	47	38	30	24	49	41

ulcer cases in the Borås material 9 died from haemorrhage, as against 3 deaths from the same cause among 692 ulcer cases in the Umeå material; 2 of the Umeå cases died after operation. Perforation is also more common in the Borås material than in the Umeå material, the figures being 8 and 2 per cent respectively. Of 46 cases operated on at Borås, 26 were for perforation, the corresponding figures for Umeå being 122 and 14.

Thus at Borås operation was in most cases indicated owing to perforation, at Umeå on account of retention and persistent or recurrent symptoms.

The table also shows that the acidity of the gastric juice in ulcer is considerably greater in the Borås material.

The principal cause of the difference in the character of the ulcers is to be found in the composition of the food. The correctness of this view is obvious if we compare the occurrence of haemorrhages with the composition of the food. Of 32 cases with gross or dangerous haemorrhages in the Umeå material, 31 belonged to the B diet groups, most of them to the BII diet group. Only one case belonged to the LIa group. Of 18 cases with minor haemorrhages, 17 belonged to the B diet groups and 1 to the LIIa group. With regard to the cases with perforation no record of the diet is available. There are therefore definite reasons for assuming that the L diet not only offers a certain amount of protection against the development of ulcers but also influences the character of the ulcer. If ulcers arise with the L diet, they seem to be of a less severe nature, haemorrhage and perforation occurring less frequently.

CHAPTER V.

Occurrence of Intestinal Disturbances and their Characteristics.

A. Material and Methods of Examination. Classification.

When the arrangements for these investigations were being made the author called attention to the prevalence of intestinal catarrh (colitis) in Norrland, chiefly in the form of constipation, which was apparent from the preliminary examinations. Attention was also called to the noteworthy feature that the decreased secretion of gastric juice was, contrary to expectation, frequently associated with constipation. Microscopical examination of the faeces, with or without a test meal, showed practically always normal conditions. Thus there could be no question of any dyspeptic intestinal disturbance, that is, a disturbance arising from a defective digestion of the food (STRASSBURGER).

In diagnosing the intestinal disorders, consideration was in the first place paid to the information supplied by the patient with regard to the consistency of the stools and the occurrence of subjective troubles in the form of abdominal pains, flatulency and discomfort before and after defecation. Demonstration of mucus or blood in the faeces and examination of the digestion call for special methods of examination, and can as a rule be performed only in hospitals.

The material on which the present study is based is mainly derived from the out-patient department of the Umeå Hospital in 1929 and from the medical department of the same hospital from September 1928 to August 1930. Examinations of intestinal digestion, mucus, blood and pus in the faeces were only possible in cases undergoing treatment at the hospital. The cases have been so stringently selected that the material does not contain diseases (except achylia) which can be considered to have any

influence on the intestinal function. All the various forms of secondary colitis due to tuberculosis, nervous diseases, Basedow's disease, tumours, pronounced neurosis, etc., were therefore eliminated. The material may thus be regarded as fairly comparable, apart from the gastro-intestinal symptoms, to a healthy material.

A hospital material, made up of patients trying to find a remedy for their ailments, is not suitable for an estimation of the incidence of intestinal disturbances in a population. In this connection, however, a comparison between the number of cases with intestinal disorders attending hospitals in various parts of the country, affords certain points of interest. Comparisons were therefore made between the frequency of intestinal diseases in the hospital materials of Umeå, Lund and Borås. Of greater importance for forming an estimation of the incidence of intestinal disturbances are the district investigations, where the medical officer has investigated the state of health and the dietary conditions of the inhabitants of entire villages. Such district investigations, however, were carried out only in Norrland and are based entirely on anamnestic data. For obvious reasons, no other investigations could be undertaken, but they are supplemented by hospital examinations.

The material in this investigation has been divided into 2 groups. The first group comprises cases in which no signs of inflammatory changes in the intestines could be found. No subjective or objective symptoms of intestinal disorder, apart from constipation in a few cases, occurred. Thus this group consists of »healthy» cases. This does not of course exclude the possibility that the group includes a certain percentage of cases with intestinal diseases, which manifested no other symptoms. This group is divided into 2 subdivisions: cases with normal evacuation and cases with constipation. The latter comprises cases in which the consistency of the stools was hard, defecation did not as rule take place daily, but otherwise the patient did not experience any discomfort. The second group consists of cases with more pronounced intestinal disturbances both with respect to the consistency of the stools and the presence of other subjective and objective symptoms.

Whether the existing intestinal symptoms are due to an organic disease, an inflammatory process in the intestine, a colitis, or whether they are of a purely functional nature, atony or spasm, is open to question and very often impossible to determine. STRASSBURGER wants to limit the conception of colitis to include only cases in which a diffuse mixture of mucus can be shown

in the faeces. Thus the thin layer of mucus covering hard clumps of stool, or the large shreds of mucus in so-called mucous colitis are not included in this category. v. NOORDEN, on the other hand, includes under the designation of colitis also cases without mucus in the stools, provided other clinical symptoms indicate colitis. For the most part the second group of our material corresponds to v. NOORDEN's conception of colitis.

This second group has been divided into 3 subdivisions in respect to the nature of the disorders and the consistency of the faeces: (1) cases with constipation, (2) cases with stercoral diarrhoea and (3) cases with diarrhoea. The first of these subdivisions comprises cases where the stools were very hard, with intervals of several days between the evacuations of the faeces (in one case 2—3 weeks). In most cases no evacuation of the bowels was possible without a laxative. Besides, other symptoms were present simultaneously, such as abdominal tension and flatulence, pains and tenderness on pressure. The disorders were of such a nature that the patient had as a rule consulted a physician. The second subdivision, stercoral diarrhoea, consists of cases in which the faeces were alternately hard or soft in consistency, or, as in the severest cases, always fluid but at the beginning composed of one or two hard lumps covered with mucus. As a rule defecation was attended with pain and tenesmus. The cases belonging to the third subdivision, diarrhoea, had invariably fluid stools, often associated with pronounced subjective troubles.

B. **Intestinal Function in »Healthy» Subjects** (Group I).

The result of the examination of intestinal function in »healthy» subjects is shown in the following table.

	Normal evacuation		Constipation	
	Men	Women	Men	Women
Borås	202 (80 %)	326 (71 %)	49 (20 %)	135 (29 %)
Lund	436 (76 %)	559 (68 %)	135 (24 %)	267 (32 %)
Umeå	532 (66 %)	631 (52 %)	257 (34 %)	572 (48 %)

It will be seen that constipation occurs more frequently in Norrland than in southern and central Sweden. It is natural to assume that the cause of this difference in frequency is the composition of the diet. The unvaried milk-meal diet with its finely ground cereals is not in use either among the Borås material or the Lund material. The Umeå material was therefore analysed with respect to the composition of the diet.

	Normal evacuation		Constipation	
	Men	Women	Men	Women
L diet	99 (55 %)	150 (49 %)	79 (45 %)	154 (51 %)
B diet	201 (73 %)	227 (61 %)	75 (27 %)	146 (39 %)
S diet	16 (79 %)	—	9 (28 %)	—

Constipation is thus more common in the L diet group than in the B diet group, but even among those subsisting on a mixed diet the frequency is somewhat higher in Norrland than in southern and central Sweden. All the examinations seem to prove that constipation is more common amongst women than amongst men.

The consumption of coffee is greater in Norrland than in Skåne and Västergötland. But a greater consumption of coffee cannot explain this difference in intestinal function between the two groups of the population. A comparison between the consistency of the stools and the rate of coffee consumption shows that the faeces becomes softer in consistency with an increased consumption of coffee.

Judging from our material, the condition of the teeth does not appear to have any influence on the consistency of the stools in »healthy» subjects, as was shown by investigations carried out for that purpose. For want of space tables showing the results of these examinations have been omitted here.

In view of the high incidence of achylia in Norrland an increased frequency of diarrhoea should *a priori* be expected here. But, as will be shown later, this is not the case. The following table shows the defecation in persons with and without achylia.

	Normal evacuation		Constipation	
	Men	Women	Men	Women
Congo neg.	45 (62 %)	59 (49 %)	32 (38 %)	61 (51 %)
Congo pos.	211 (68 %)	164 (56 %)	100 (32 %)	134 (44 %)

Thus constipation is rather more common among the Congo negative cases than among the Congo positive.

But, even among the Congo positive cases, constipation is more frequent in Norrland than in the materials from Borås and Lund. Thus, the cause must be some other factor. A sedentary life and lack of physical exercise are also considered to be a causal factor in the occurrence of constipation. But this factor plays a much smaller rôle in the Norrland material, which is made up of a population, both male and female, employed in active work to a much greater extent than the population of southern and central Sweden.

von Bergmann calls attention to what he calls »Domestikationserscheinung» as being a causal factor of irregular evacuation and constipation. Normally the necessity of defecation arises once or twice a day, the first time, as a rule, after rising in the morning. If this need is not satisfied, it gradually wears off and the result will be constipation. Here we seem to have a plausible explanation of the common occurrence of constipation in the Norrland material, the cold climate and the uncomfortable, cold privies. A proof of the correctness of this interpretation is the frequent finding of large clumps of faeces in a greatly distended ampulla recti on palpation per rectum. Yet, in spite of the palpation findings, the patients often declared that they had not felt any need of defecation for several hours.

C. Occurrence of Pronounced Intestinal Disorders (Group II).

The frequency of pronounced intestinal disorders has already been mentioned in the discussion of the gastric symptoms observed in the district investigations. The following is a summary of the results of the examinations. Subjective evidence of intestinal trouble was found in 20 per cent of the cases,

comprising 1690 examinations. Of these affected cases, 6.1 per cent were cases of diarrhoea (including stercoral diarrhoea). In the material from Skåne, the number of examinations being unfortunately not more than 40, intestinal trouble was found in 2 cases. From the results of the district investigations in Upper Norrland the sex incidence of intestinal disorders was found to be as follows: —

Men:	735	with diarrhoea	in	48	cases	(6,5 %),	constipation	in	22	cases (3 %
Women:	955	»	»	61	»	(6,4 %),	»	»	74	» (7 %

The diarrhoea group includes also stercoral diarrhoea, as the records of the examining physicians made no distinction between these two groups. Diarrhoea is about as common among men as among women, constipation (only cases with pronounced troubles are included here) is more common among women than among men.

Among school children, 3220 examinations, intestinal disorders were found in 7.2 per cent, diarrhoea in 4.2 per cent. Also among the children examined, constipation was more common in girls than in boys.

The above figures show that intestinal symptoms are exceedingly prevalent in the Norrland material. More than 10 per cent of the adult population suffer from pronounced intestinal disorders. As far as the author is aware, no corresponding investigations have been carried out elsewhere.

According to the annual reports, on the average 94 cases per year were treated at the Umeå Hospital during the period 1927—1931 under the diagnosis of chronic colitis, chronic enterocolitis, and constipation. At the medical clinic of the Lund Hospital, with 50 per cent more beds available, an average of 37 cases per year were treated under the same diagnosis during the last 8 years. These figures, although for divers reasons they are not quite comparable, give convincing evidence of the high incidence of intestinal disorders in Norrland as compared with Skåne.

The frequency of intestinal disorders in the hospital materials (out-patient and in-patient departments) during the period these investigations were being carried on is shown in the following table.

Even if these figures cannot be directly compared, they nevertheless suggest, too, that intestinal disorders are more common in Norrland than in southern and central Sweden.

	Men	Women
Umeå	20 %	22 %
Lund	9 %	11 %
Borås	11 %	13 %

The nature of the intestinal symptoms will be seen from the next table.

	Constipation		Stercoral diarrhoea		Diarrhoea	
	Men	Women	Men	Women	Men	Women
Umeå ...	68 (35 %)	129 (45 %)	74 (38 %)	107 (37 %)	53 (27 %)	53 (19 %)
Lund ...	14 (36 %)	18 (34 %)	10 (26 %)	15 (28 %)	15 (38 %)	20 (38 %)
Borås ...	12 (31 %)	36 (36 %)	11 (28 %)	25 (25 %)	16 (41 %)	38 (38 %)

It will be noted that diarrhoea is most common in the materials from Borås and Lund, while constipation and stercoral diarrhoea occur more frequently in the material from Umeå.

In the Umeå material the frequency distributions of the intestinal disorders in the various diet groups are as follows: —

	Number of cases			
	Men	% of exam.	Women	% of exam.
L diet	62	28	120	30
B diet	90	21	116	22
S diet	16	19	4	—

The percentage incidence of intestinal disorders seems to be about the same in the different diet groups in the hospital material, slightly higher in the L diet group than in the other two groups.

The incidence of the different intestinal symptoms in the various diet groups is shown in the following table:

Chronic diarrhoea seems to be most frequent in the B diet group, stercoral diarrhoea in the L diet group.

	Constipation		Stercoral diarrhoea		Diarrhoea	
	Men	Women	Men	Women	Men	Women
L diet ...	18 (29 %)	52 (43 %)	30 (48 %)	44 (37 %)	14 (23 %)	24 (20 %)
B diet ...	31 (34 %)	46 (40 %)	31 (34 %)	36 (31 %)	28 (31 %)	34 (29 %)
S diet ...	6	2	3	1	7	1

It is an old-established fact that the function of the stomach plays an important part in the functional activity of the intestines. It often happens that both stomach and intestines are affected simultaneously. It is generally supposed that the disturbance of the gastric function is the primary affection (Oppler, Einhorn, Schmidt-Strassburger). The following table shows the correlation between achylia and the occurrence of intestinal disorders. In more than half the cases the diagnosis of achylia was established by means of repeated test meal analyses. The emptying time of the stomach was not taken into consideration, although a rapid evacuation has the same effect as a decreased hydrochloric content (Matthes). As a rule a decreased acid secretion is associated with a rapid evacuation.

	Constipation		Stercoral diarrhoea		Diarrhoea	
	No. of cases	% of exam.	No. of cases	% of exam.	No. of cases	% of exam.
Congo neg.	108	20	45	9	28	5
Congo pos.	94	11	47	5	28	3

Thus the achylic cases show on the whole a greater frequency of intestinal disorders than do the Congo positive cases. This seems to be incompatible with what was shown above with regard to the difference in the frequency of intestinal disorders in the L diet and the B diet groups, achylia being by far more frequent in the L diet group. The cause of this apparent discrepancy must be the fact that the cases of intestinal disorders in the B diet group are more frequently associated with achylia than those in the B diet group. That is indeed the case, as is evident from the following table:

	Achylia in the L group				Achylia in the B group			
	Men		Women		Men		Women	
Constipation	12	12,5 %	42	22,4 %	4	12,6 %	20	40,8 %
Sterc. diarrhoea ...	13	13,6 %	18	9,5 %	5	12,8 %	10	20,4 %
Diarrhoea	5	5,2 %	3	1,6 %	12	30,8 %	11	22,4 %
Total	30	31 %	63	35 %	21	56 %	41	84 %

In 34 per cent of the cases in the L diet group achylia is associated with intestinal disorders, while the corresponding figure for the B diet group is 70 per cent. There are two possible explanations of this difference. It was mentioned above that a disturbance of the gastric function, achylia, is frequently the primary cause of the intestinal disorder, but the latter may occasionally be the primary cause of the disturbance and thus give rise to an impairment of the gastric function. There is evidence in support of both possibilities in our material. In achylia the intestines are subjected to an increased functional strain, peptic and mechanical. In a mixed diet this strain on the intestines is more intense and intestinal troubles may arise. On the other hand, the diet itself is a causal factor in the origin of achylia in the majority of the cases belonging to the L diet group. This factor is not present in the B diet group. In that case colitis must be one of the causes of achylia in the B diet group. The same factor seems to be operative also in a number of the cases in the L diet group, but plays a minor rôle in the high incidence of achylia in this diet group.

There remains the fact that in both the L diet group and the B diet group intestinal disorders are more common in Norrland than in southern and central Sweden. As far as the L diet is concerned, this is partly explained by the fact that this diet is very often connected with achylia. Other contributory causes are the composition of the diet, its stimulating effect on the functional activity of the intestines being slight, the »Domestikation» syndrome and possibly other deficiencies in the food (hypovitaminosis) — a question to which we shall return later.

Among various other factors which may have an influence on the relatively high incidence of intestinal disorders in Norrland are the use or abuse of coffee and snuff and the bad condition

of the teeth. The following table shows the correlation between the consumption of coffee and intestinal disturbances.

Cups of coffee per day Hospital cases	Constipation		Stercoral diarrhoea		Diarrhoea	
	No. of cases	% of total material	No. of cases	% of total material	No. of cases	% of total material
0—4	63	10	66	9.3	37	5.6
5—8	49	8.4	57	9.8	36	6.5
>8	12	3.6	16	8	16	9.8
District investigations						
0—4	27	6.2	—	—	63	8.3
5—8	30	3.8	—	—	75	5.6
>8	4	0.5	—	—	39	11.4

The greater the consumption of coffee the lower is the frequency of constipation, whereas the frequency of diarrhoea is increased. On the whole coffee seems to have but little influence on the incidence of intestinal disorders in our material.

The condition of the teeth is somewhat poorer in the Umeå material than in the material from Skåne. This may explain the difference in the incidence of intestinal disorders.

The frequency of intestinal disorders in relation to the condition of the teeth for the Umeå material is as follows: —

	Constipation		Stercoral diarrhoea		Diarrhoea	
	No. of cases	% of total material	No. of cases	% of total material	No. of cases	% of total material
Denture						
Good	56	9.5	45	8.6	29	5.2
Medium ...	38	9.3	41	9.5	23	5.4
Bad	38	9.0	44	10.2	41	9.1
Car. teeth						
0—4	82	8.3	78	9.2	50	6.2
5—8	32	12.1	32	11.2	21	9.5
>8	16	9.1	20	10.3	21	13.2
Gingivitis						
—	72	9.7	68	9.2	44	7.1
+	58	10.5	62	11.3	48	10.8

The frequency of diarrhoea becomes higher in proportion as the condition of the teeth, judged by the character of the denture, grows worse, and the number of carious teeth and the occurrence of gingivitis increase. On the other hand there does not seem to be any positive correlation between the condition of the teeth and the frequency of constipation and stercoral diarrhoea. Tobacco-chewing is said to be a cause of intestinal disorders (STRASSBURGER, STEPP). Tobacco-chewing is relatively common among the men in the Norrland material, 42 per cent in the district investigations and 26 per cent in the hospital material. The incidence of intestinal disorders is possibly somewhat higher among snuff-chewers than among those who do not use snuff.

The frequency of intestinal disturbances in 120 cases of snuff-chewers in the hospital material is as follows: —

Constipation		Stercoral diarrhoea		Diarrhoea	
No. of cases	% of cases	No. of cases	% of cases	No. of cases	% of cases
14	11.7	12	10	3	2.5

The incidence of intestinal disorders is not very high among snuff-chewers. The number of cases is also small. Thus snuff-chewing cannot explain the difference in the frequencies in the materials from Skåne and Umeå. As already mentioned, tobacco-smoking is not very prevalent in Norrland and cannot therefore have any influence on the incidence of intestinal disorders.

What was said of smoking applies also to the use of alcoholic drinks. The consumption of spirits is undoubtedly greater in southern and central Sweden than in Norrland.

It was pointed out above that the cases classified here as severe intestinal disorders consist partly of functional disturbances and partly of organic, inflammatory changes in the intestines. For the diagnosis of colitis STRASSBURGER requires the demonstration of mucus in the stools. This view is not generally accepted, however, even if the presence of mucus in the faeces supports the diagnosis of colitis.

The faeces of patients nursed at the hospital were examined for mucus and the results were as follows:

Constipation:	77	cases	examined;	mucus	found	in	28	cases (36 %)
Stercoral diarrhoea:	75	»	»	»	»	»	49	» (65.3 %)
Diarrhoea:	43	»	»	»	»	»	33	» (76.7 %)

Thus the presence of mucus could be shown in about three-fourths of the cases of chronic diarrhoea, in about two-thirds of the cases of stercoral diarrhoea and in fully one-third of the cases of constipation. A positive catalase reaction was obtained in approximately the same proportion. Weber's test for blood in the stools was always negative, except in 3 cases of ulcerative colitis.

X ray examinations were made in 82 cases, 44 of which showed pronounced colitic changes. These cases are fairly evenly distributed among the different groups.

From what has been said it appears that organic changes indicative of colitis are very frequent in the cases with pronounced intestinal disorders, and that the diagnosis of colitis could be established objectively in the great majority of the cases, especially in the groups of stercoral diarrhoea and diarrhoea.

Examinations of the intestinal digestion following the ingestion of SCHMIDT-STRASSBURGER's test meal for a period of 3 days, and microscopical examinations of the faeces were made in 189 cases, mostly belonging to the groups of stercoral diarrhoea and diarrhoea. The digestion of muscle constituents as well as fat and carbohydrates was remarkably good. Only 6 cases showed an abundance of undigested muscle fibres with preserved transverse striation and rounded ends, indicating an impairment of the protein digestion. In all the other cases only solitary muscle fibres or none at all were found in the entire mixture. This is rather surprising as a large percentage of the subjects were affected with achylia. The same results were obtained in 42 examinations with SCHMIDT-STRASSBURGER's test meal on achylic patients without intestinal symptoms. In only 3 cases could any evidence of a poor digestion of muscle fibres be shown.

The digestion of fat was also normal. Only one case showed signs of a disturbance of fat digestion.

This applies also to the digestion of starch. Only in 9 cases, 4 men and 5 women, was it possible to demonstrate a moderate increase of iodine-stainable starch and iodophile bacteria in the stools. One of these gave a positive fermentation test. This in the only case in the entire material that ran a clinical course analogous to fermentative dyspepsia.

Thus the result of the examinations of the intestinal digestion does not lend support to the view that the intestinal disorders, in most cases consisting of colitis, are of a dyspeptic nature.

The treatment consisted mainly in an appropriate diet, rest and localised application of heat. In cases where spasm was suspected belladonna extract was administered in a dose of 1—1 $^1/_2$ cg. three times daily, supplemented with Carlsbad salt and liquid paraffin in obstipation.

In 332 cases the symptoms disappeared or a marked improvement was manifest, in 31 cases no improvement took place during the period of observation. With regard to the other cases no record of the result of the treatment is available. No marked difference could be demonstrated between the therapeutic results in the different forms of intestinal disorders.

CHAPTER VI.

The Occurence of Anaemia, its Etiology and Characteristics.

Blood examinations were made to the same extent as gastric examinations for the purpose of ascertaining whether anaemia occurred in the Norrland population, and especially in Västerbotten, and, if so, its incidence, degree and character.

As it was of primary importance to form an idea of the blood condition of the healthy portion of the population, a very rigorous selection of the material had to be made (about 50 per cent of the hospital material was eliminated), every disease or symptom of disease tending to produce anaemia being excluded. Further, for reasons to be discussed later pregnant and lactiferous women are treated separately, and so are all men under 19 and women under 16 years of age. Cases over 65 years of age were eliminated.

A. Methods of Examination.

All blood examinations in the Umeå Hospital material were made by two skilled female laboratory technicians. The examinations included estimations of the haemoglobin content (SAHLI, Hellige's type), counting the number of red corpuscles and leucocytes (by BURKER's method), differential counts (in a small number of cases a more thorough analysis of the blood was made). In the Lund and Hälsingborg material only estimations of the haemoglobin content were made.

All the Sahli's haemoglobinometers were calibrated before and after use at the Umeå Hospital. Two Autenrieth apparatuses were controlled in Stockholm (at the Physiological Institute, Dr. Stenström) and at the Umeå Hospital (Odin) with blood of a known haemoglobin content. The haemoglobin content was determined by estimating the oxygen absorption capacity. The value obtained in Stockholm and Umeå was practically the same. All the Sahli's instruments employed in the examinations were calibrated by means of these two standardized Autenrieth's haemoglobinometers. As a rule 5 tests were made on the same blood specimen and with the same apparatus. In these tests it was found that the Sahli instruments frequently showed deviations, sometimes up to 30 per cent.

No apparatus with a deviation of more than 4 per cent was accepted. In some of the haemoglobinometers the standard colour disc was of a different tint from that of the blood specimen, which made the reading much more difficult. On that account 6 haemoglobinometers out of 30 had to be discarded.

Every time pipettes or diluting tubes were changed a new calibration was made.

The accuracy of the haemoglobinometers thus gauged was further controlled by determining the blood index of healthy persons (20 cases). It was found that cases with a normal haemoglobin content had an average index of 0.997, which goes to prove the accuracy of the calibration.

The osmotic resistance of the red blood corpuscles was examined by the method described in »Hämatologisk Teknik» (MEULENGRACHT, GRAM) after HAMBURGER.

The sedimentation rate was determined by FÅHRÆUS-WESTERGREN's method. Only the 1 hour value was read off.

Differential counts were made on specimens prepared on cover-glasses. The samples were prepared in accordance with the directions given in »Hämatologisk Teknik» (MEULENGRACHT, GRAM). GIEMSA's stain was invariably used. 200 cells were always counted on each film. The results are given in percentages. It would have been a good thing if more cells had been counted, but that was not possible owing to the large number of examinations. To offset this no great importance was attached to the individual case, unless it deviated greatly from the normal value. Inferences were drawn on the average values obtained in different groups of material.

All slides were prepared from specimens taken in the morning on a fasting stomach.

Blood specimens for the leucocyte counts were also invariably taken at the same time in the morning.

Examinations of the leucocytes by ARNETH's method were made in a number of cases, in accordance with the directions given in »Hämatologisk Teknik» (MEULENGRACHT, GRAM).

Vital staining of the red corpuscles was made by placing a small quantity of brilliant cresyl blue mixed with a drop of blood on a cover slide and then spreading it evenly over the slide. Differential counts were made of 500 erythrocytes and the reticulocyte frequency is given in ‰. Also with regard to the results obtained by the vital staining method only the average values of the different groups of the material were taken into consideration.

Thrombocyte counts were made on capillary blood by KRISTENSSON's method.

The bilirubin content in the serum was determined by the VAN DEN BERG method.

The coagulation time of the blood was determined by FONIO's method, the bleeding time by DUKE's technique.

The urobilin content of the urine was determined qualitatively by SCHLESINGER's method. Before the test was made a drop of LUGOL's solution was added to the urine. The grading of the result was made subjectively by means of the symbols: —, (+), +, and ++, the last symbol denoting a yellowish red colour and marked fluorescence in the specimen.

Capillary resistance tests were carried out at the Lund and Umeå hospitals with the aid of a special method, a description of which will be given later.

The Personal Bias in Calorimetric Haemoglobin Estimations.

When working up the material collected we were struck by the curious fact that adjacent districts situated at the same altitude above sea-level, having the same climate and natural surroundings and inhabited by the same race of people with the same customs and habits, exhibited a fundamental difference in the percentage of haemoglobin, a difference which amounted to more than 10 per cent for certain districts. This difference must be due to some bias in reading the results. In order to obtain a general idea of this personal source of error, we sent out to each investigator 4 carefully closed tubes containing blood, to which had been added 0.5 per cent benzoic acid and some sodium citrate to prevent putrefaction and coagulation. This addition did not make the readings more difficult. The investigators were requested to make 5 estimations of the amount of haemoglobin in these blood samples, which had already been tested at the Umeå Hospital. The results of the examinations pointed to the existence of an observer's bias. Some of the workers invariably obtained too high values, others too low, while the readings of the majority were fairly accurate.

As these examinations presented several possibilities of misinterpretation (the samples of blood may not have been taken by the customary method, some of the tubes may not have been shaken thoroughly, the blood may have »changed» during transport, etc.), one of the laboratory assistants at the Umeå Hospital and one of the medical staff (Dr. WERDINIUS) were sent out to visit each of the investigators and control their Hb estimations. About 4 or 5 blood specimens were taken and as a rule 5 estimations were made on each specimen, the average value of which was calculated. By this means some idea was obtained of the »personal bias» of each investigator. This has nothing to do with the degree of the investigator's skill in making blood tests. The reliability of an examiner with a great »personal bias» may be just as great as or even greater than that of an examiner who reads off correctly. On the other hand, an expression of the technical ability of the worker is shown by the dispersion, σ, in a series of tests on the same blood specimen. In order to include practically all observations it is customary to reckon with 3 times the value of σ. The simple value of σ covers only 68 per cent of all observations.

After making a correction for the »personal bias» the values would theoretically be equivalent to those obtained by the laboratory technician in the Umeå Hospital. The mean error of the values obtained at Umeå is so small that it can be left out of account.

The demonstration of the »personal bias» is of great importance. It shows that a Hb value cannot be accepted without reservation, even if it has been obtained by means of a standardized Sahli apparatus. The Hb values found by different examiners are not strictly comparable. The »personal bias» of the examiner must first be determined and the

values corrected accordingly. Not only the apparatus, but also the examiner must be »calibrated».

The »personal bias», as the author and Dr. WERDINIUS have been able to show, depends on 1) the time the examiner takes in performing the test, 2) the examiner's individual reading, and 3) his attitude to the apparatus.

The value of these haemoglobin studies is greatly increased by the correction made for the »personal bias». This factor has not been taken into consideration in the majority of earlier investigations.

B. The Haemoglobin Content and Number of Red Corpuscles in Children.

The blood undergoes certain changes during the development of the individual. These changes take place progressively for years until they result in the formation of the blood picture characteristic of adults.

According to OPITZ, the Hb value in new-born babies is 100—140 per cent (Sahli), and the number of red corpuscles 5—8 million. In infants the Hb values is 75—85 per cent and the number of red corpuscles 5 million, in older children the respective values are 80—90 per cent and 5 million, and in adults 100 per cent and 4.5—5 million.

GRAM does not give any exact figures for the haemoglobin content and the number of red corpuscles in children, but we get the impression that the values in question were not lower than those for adult women before the climacterium.

NÆGELI states that young children (not new-born infants) show on the average lower values for both haemoglobin content and the number of red corpuscles than children of 10 years and above.

STIERLIN and WILLIAMSON and others point out that the haemoglobin level falls rapidly during the first months of life and subsequently rises progressively up to the age of puberty.

NYLIN found in children aged 5—6 years an average oxygen capacity of 16.5 cc. per 100 cc. of blood and in school children 16.82 cc. This corresponds to an average Hb value of 89 per cent in children of 5—6 years and 91 per cent in school children (elementary schools). These values are somewhat higher than those obtained by earlier investigators, and may be due to the small number of children examined (8 and 6 in each age-group).

No data is found in the available literature with respect to the number of the red blood corpuscles in the different ages. GRAM states that before puberty the number of red corpuscles in both sexes tends to approach the average of the ultimate value for the two sexes.

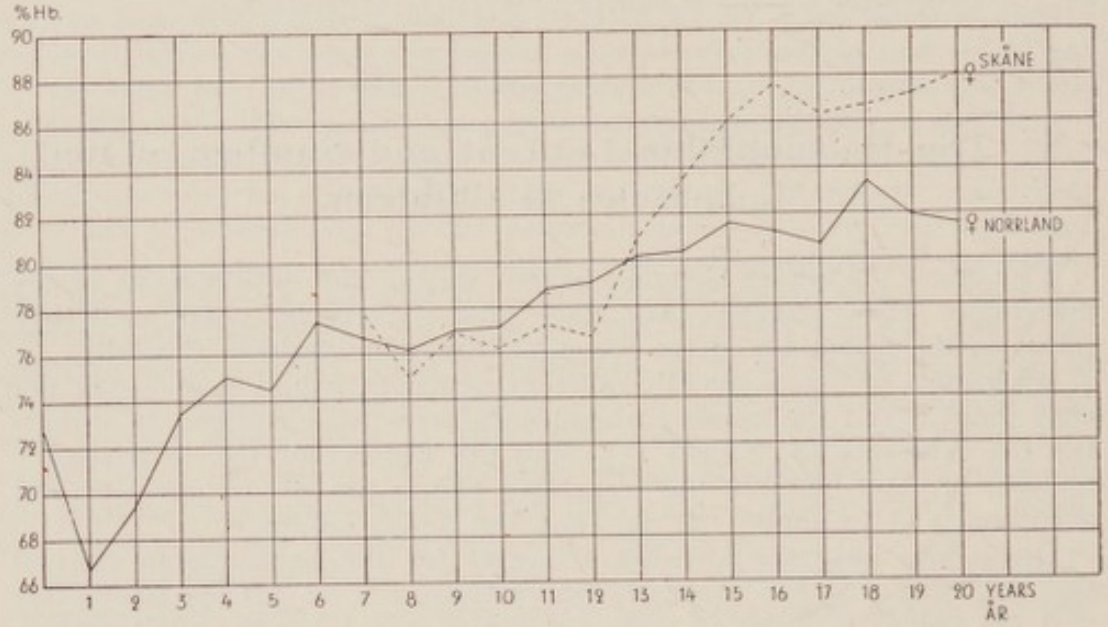
NÆGELI seems to assume a normal index in all ages. In that case the number of red corpuscles can be calculated from the figures already cited, provided that 5 million red corpuscles correspond to 100 per cent haemoglobin.

The leucocytes also go through certain developmental changes during the growth of the child, but we shall not discuss them here.

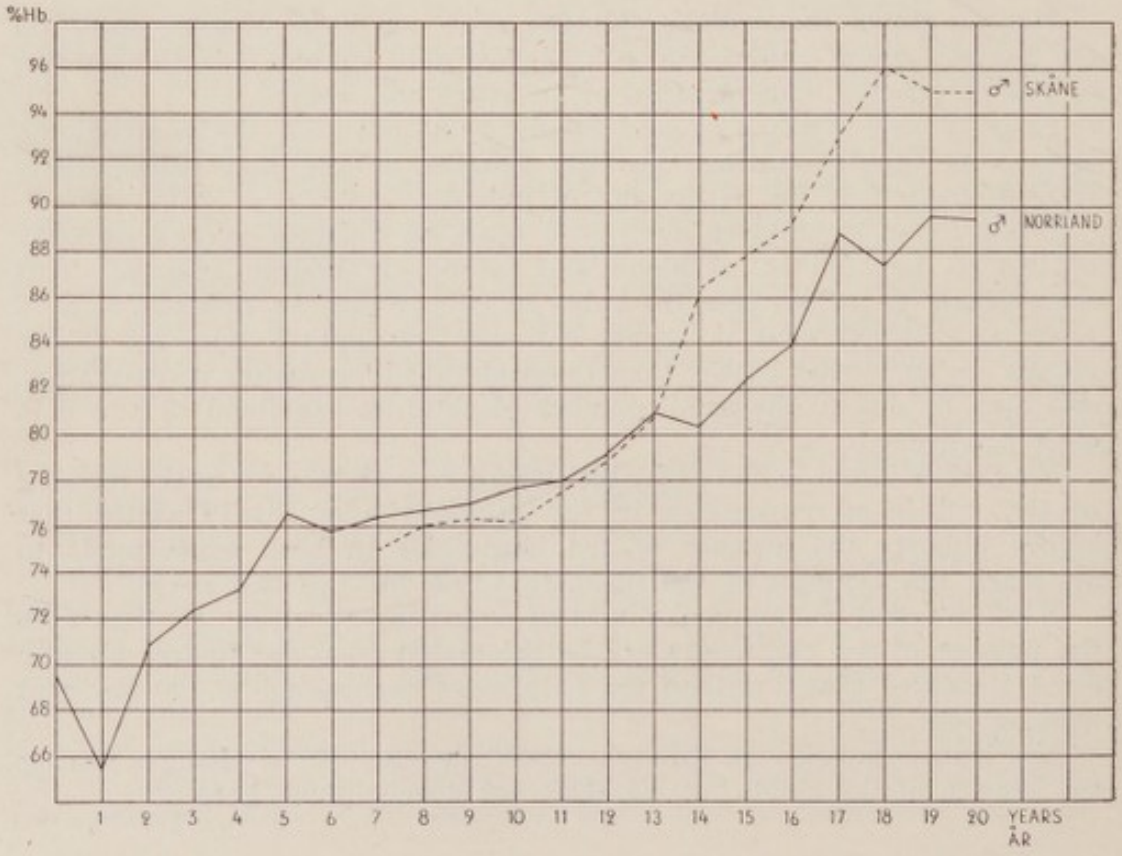
The following curves, based on the Norrland material of 2808 boys and 2916 girls and the Skåne material of 236 boys and 267 girls, show how the haemoglobin level and the number of number of red corpuscles vary between the ages of 0—20 years.

The Hb value in different ages.

Boys.



Girls.



The curves for the Hb value in children in Skåne and Norrland agree rather well up to the age of 12 years, but after that age the curve for the Skåne children runs about 4—8 per cent higher than the curve for the Norrland children. This difference is undoubtedly due to the same factor as that which causes the difference in the Hb values for adults in southern and northern Sweden, as will be shown later on.

The difference in the course of the Hb curves for boys and girls is probably due to sex characters.

The curves show that the Hb level falls in infancy, which agrees with the results obtained by other investigators. That the curve does not fall so abruptly as is often asserted in the literature (Pfaundler, Opitz and others) is due to the fact that this material does not include any child under 1 month of age and only a few children aged 2 to 6 months, for the greatest changes in the Hb level take place during the first months of life. From the age of 1 year the Hb level begins to rise, rapidly at first, then (after the age of 5—6 years) more slowly. From the age of 13 in the Skåne cases and from the age of 14 in the Norrland material the level rises rapidly again, reaching its maximum at the age of 18 in the Skåne material and one year earlier in the Norrland material. The Hb level for the girls in the Skåne district rises rapidly until the age of 16, after which the curve runs a horizontal course. In the Norrland material this rise takes place more slowly up to the age of 15 years. In the case of girls of 17 years there occurs a temporary rise due to accidental(?) causes. The Hb value for the later ages is the same as for youths of 19 years and girls between the ages of 15 and 16 years, whence it can be assumed that after these ages the haemoglobin value remains constant.

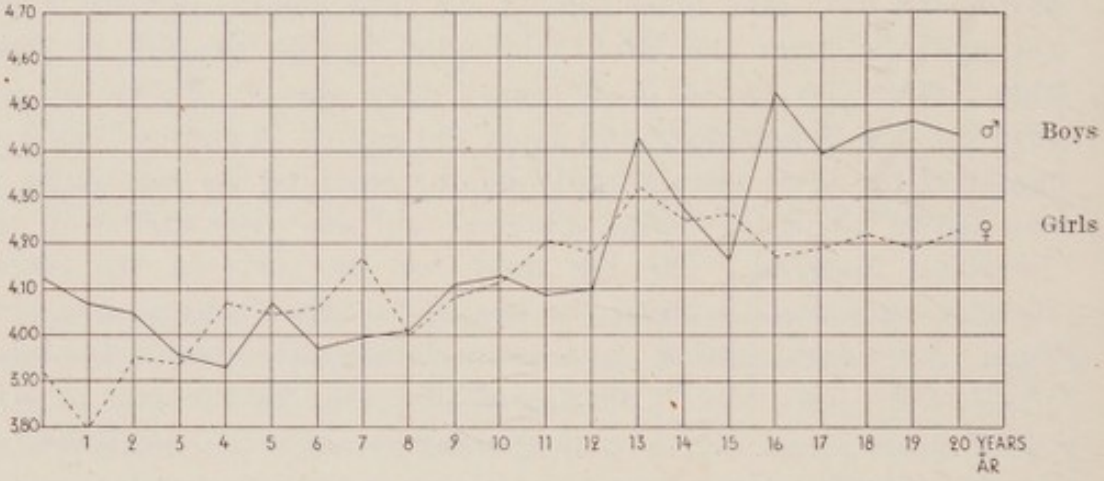
It is noteworthy that the curves do not show any marked difference between the Hb values of the two sexes. It has often been asserted that after the age of 14—15 years girls have a somewhat higher Hb value for one or two years than boys. This is not evident in our curves. For boys after the age of 14 years in the Skåne material and after 15 years in the Norrland material the haemoglobin level is higher than that for girls.

A great many blood counts were made simultaneously with the estimations of the amount of haemoglobin on children at the Umeå Hospital, but no blood examinations could be carried out on the other children in the investigation. The latter material

has been selected on the same principles as the adult material and is therefore comparable to normal material. After elimination, it comprises 411 boys and 544 girls.

The following curves show the number of red corpuscles at different ages. The decrease in the first year or life is much less marked than the corresponding fall in the Hb level. In the case of the boys there is a slight progressive decrease up to the age of 4 years. Afterwards the curves for both boys and girls run fairly parallel up to the age of 15, as in the Hb value, when the curve for the boys rises above that for the girls, in analogy with our findings concerning the Hb value. In the girls the definitive number of red corpuscles is reached at the age of 12 years, but this does not occur in the boys until the age

The number of red corpuscles at different ages.



of 16. The somewhat jagged line of the curve is probably due to accidental circumstances. From the values of the amount of haemoglobin and the number of corpuscles obtained it is easy to calculate the colour-index. At the age of 2 years the colour-index is normally about 0.8, which is in agreement with the opinion of Pfaundler, Opitz and others. In the next two or three years the index changes rapidly, and from the age of 5 up to 14—15 years the index remains rather constant at about 0.9. After the latter age the curves approach each other rapidly, though in different ways. In the boys the Hb level rises more rapidly than the increase in the number of red corpuscles, in the girls the number of red corpuscles seems to decrease a little, a fall also taking place in the haemoglobin level, but a little later. It appears

as if the stimulation of the blood-formation associated with puberty brings about an excessive increase in the amount of haemoglobin and the number of red corpuscles. A balance is restored later. This is noteworthy and does not appear to have been observed previously.

C. The Haemoglobin Value in Adults.

Before discussing the results obtained in the present investigation it is necessary to define what is meant by the expression normal Hb value, i. e. the limits of the normal variations. The requirements placed by different investigators on a normal Hb value vary considerably, largely because they employ different standard values, so that what is 100 per cent to one is not 100 per cent to another. The Sahli values obtained in these examinations have been corrected in accordance with HALDANE's standard, which means that 100 per cent Hb corresponds to an oxygen capacity of 18.5 cc., which is equivalent to 13.8 g. of haemoglobin per 100 cc. of blood and 5 million red corpuscles per cm.

HALDANE states that adult men have on the average 100 per cent haemoglobin, the values varying between 96 and 118 per cent. According to the same author, the average haemoglobin value for women is 94 per cent, the range of the normal value lying between 88 and 102 per cent. A glance at the series recorded in the following table will at once show that HALDANE's normal values do not apply to a Swedish population; they are much too high.

NÆGELI asserts that men normally have on the average 100 per cent haemoglobin and 5 million red blood corpuscles. By 100 per cent haemoglobin he means 15 g. of haemoglobin per 100 cc. of blood, values which differ considerably from HALDANE's, although both investigators consider 5 million red corpuscles to correspond to 100 per cent haemoglobin.

Further, NÆGELI states that women have 10 per cent lower values than men; the normal value for women will thus be 90 per cent. He also asserts that the physiological variation is ± 10 per cent of the average value. Thus the normal values for men vary between 90 and 110 per men and for women between 80 and 100 per cent.

For the statistical treatment and classification of the data it will be appropriate to assume that the normal Hb value for men is 91—110 per cent and for women 81—100 per cent.

The following tables (p. 161) show the Hb values for the provinces of Norrland, Västergötland and Skåne obtained in the hospital examinations.

It will be observed that the frequency of low Hb values is definitely much greater in the Norrland material than in the Skåne and Västergötland materials, subjected to the same principles of elimination, and, accepting the standards mentioned

above, 44.6 per cent of the men and 42.1 per cent of the women in the Norrland material have too low a Hb content as compared with 17.5 and 9.8 per cent, and 11.9 and 3.9 per cent respectively in the Skåne and Västergötland materials. On the other hand, the relative frequency of hypernormal cases seems to be about the same in the three regions, with the exception of the women at Borås, of whom no less than 13.8 per cent show a hypernormal Hb value.

If we calculate the average percentage of haemoglobin in the Norrland material we obtain the value 90.2 ± 0.38 per cent for men and 80.1 ± 0.37 per cent for women. The respective values for men and women in the Lund series, after correction for the personal bias, are 95.1 ± 0.40 and 88.2 ± 0.43 per cent. The corresponding figures for Borås are 98.2 ± 0.31 and 92.4 ± 0.29 per cent.

Thus, the difference between the average percentage of haemoglobin in Lund and Umeå is 5.2 ± 0.55 per cent for men and 8.1 ± 0.57 per cent for women, while the difference between the figures for Borås and Umeå is 8.0 ± 0.51 per cent for men as compared with 12.3 ± 0.47 per cent for women. The differences are thus statistically significant.

In the district investigations in Norrland the average value was found to be 88.6 per cent for men (400 cases) and 82 per cent for women (383 cases). At Boden (in Norrbotten) the average value was 94.4 per cent for men (34 cases) and 78.5 per cent for women (38 cases).

The results found in the district investigations agree fairly well with those obtained at the Umeå Hospital. On the other hand, the average Hb value for the men in Boden is more in agreement with the value found in Skåne, while the average value for the women agrees more closely with that found at Umeå. The cause of this will be discussed more closely below.

The fact that the average values in Norrland are lower than those in Skåne is no definite evidence that the incidence of anaemia is higher in Norrland. It is perhaps possible that the population in Norrland has physiologically a lower haemoglobin level than the population in Skåne. This is hardly probable however. If the Hb values were physiologically lower in Norrland than in Skåne it should be expected that the dispersions about the means in the Norrland material would be the same as in the Skåne material, but that is not at all the case. The relatively

Comparison between the haemoglobin values in Umeå, Lund and Borås.

% Hb.	Men			Women		
	Umeå No. of cas.	Lund No. of cas.	Borås No. of cas.	Umeå No. of cas.	Lund No. of cas.	Borås No. of cas.
116—120	3	—	—	—	—	—
111—115	10	1	1	1	—	—
106—110	22	13	4	3	1	—
101—105	60	51	12	12	8	3
96—100	97	141	32	23	12	14
91—95	208	231	109	102	128	48
86—90	158	68	124	193	180	127
81—85	91	24	148	220	120	195
76—80	33	1	42	191	32	140
71—75	20	—	8	95	13	53
66—70	7	—	—	31	3	11
61—65	1	—	—	27	1	—
56—60	2	—	—	21	—	—
51—55	3	—	—	15	—	—
46—50	1	—	—	11	—	—
41—45	4	—	—	10	—	—
36—40	1	—	—	4	—	—
31—35	1	—	—	2	—	—
26—30	—	—	—	1	—	—
Total	722	530	457	962	498	591

Haemoglobin values after correction.

M (% Hb.)	90.2 ± 0.38	95.4 ± 0.40	98.2 ± 0.34	80.1 ± 0.37	88.2 ± 0.43	92.4 ± 0.29
σ	10.1 ± 0.27	5.1 ± 0.16	7.3 ± 0.24	11.4 ± 0.26	5.7 ± 0.18	6.9 ± 0.20
V	11.2 ± 0.30	5.3 ± 0.16	7.4 ± 0.24	14.2 ± 0.33	6.5 ± 0.21	7.5 ± 0.22

	Men			Women		
	Umeå	Lund	Borås	Umeå	Lund	Borås
Hypernormal	1.8 %	0.6 %	6.1 %	1.6 %	2.3 %	13.8 %
Normal	53.5 %	88.1 %	82.0 %	56.0 %	91.3 %	82.3 %
Hyponormal	44.6 %	11.3 %	11.9 %	42.4 %	6.4 %	3.9 %

low average Hb value in Norrland is due, as is evident from the table, to the large number of anaemic cases found in the material.

The adequate measure of the incidence of anaemia in such a comparison is the variation coefficient, which denotes the standard deviation of the mean value.

The variation coefficient of the Hb value for men in Skåne is 5.3 ± 0.16 per cent and for women in Skåne 6.5 ± 0.21 per cent. For the Borås material the corresponding figures are 7.4 ± 0.24 and 7.5 ± 0.22 per cent.

In the Umeå material the variation coefficient for men is 11.2 ± 0.30 per cent and for women 14.2 ± 0.33 per cent. In this connection it may be mentioned that in the Boden material the respective figures are 8.3 ± 1.01 per cent ($\sigma = 7.8$ per cent) and 15.3 ± 1.79 per cent ($\sigma = 12$ per cent). The difference between the variation coefficients for the men in Umeå and Lund is 5.9 ± 0.34 per cent and for the women 7.7 ± 0.39 per cent, and is therefore statistically significant.

The corresponding figures for Umeå and Borås are 3.8 ± 0.38 and 6.7 ± 0.40.

Thus there is a fundamental difference in the incidence of anaemia in the various places. The dispersion about the means is much greater in the material from Umeå than in the Skåne and Västergötland materials.

A comparison between the variation coefficients of the values for the Boden, Lund and Borås cases points in the same direction, even if the difference is not so marked.

On the other hand, no difference can be shown between the variation coefficients for the female material from Boden and Umeå. If a comparison is made between the values for men from these two places it will be seen that there is a probably greater significant variation in Umeå than in Boden. The difference between these variation coefficients is 2.9 ± 1.05 per cent. The same peculiarity was found in a comparison between the average haemoglobin values, a point to which we shall return later on.

The dispersion about the means is, throughout, greater for women than for men, not only relatively (the variation coefficients) but also absolutely (σ, see Table p. 161). This is not due to the fact that women during the climacteric have a somewhat higher haemoglobin value than before that time, as asserted by GRAM and others. In our material the haemoglobin value for women during the climacteric is the same as in earlier years.

The mean values of the haemoglobin content in the Norrland material, 90.2 per cent for men and 80.1 per cent for women, are lower than HALDANE's standard values, though his values are generally considered to be too low.

D. Etiology of the Anaemia.

1. *The Haemoglobin Value in relation to the Composition of the diet.*

Even before these investigations were started the author had expressed the view, based on observations made at the Umeå Hospital, that the main cause of the high incidence of anaemia was to be found in the diet and also in climatic factors, the long dark winters, etc. Let us first examine the significance of the diet in this respect. We refer the reader to the description already given of the various types of diets and their classification.

Owing to the relatively small number of cases belonging to the LIb and LIc groups, as well as those belonging to the LIIb, LIIc and BIIb groups, the c groups were combined with the corresponding b groups before the first treatment of the material, in the same manner as in the study of the gastric symptoms. The first examination of the results showed, as a rule, a slight increase of the haemoglobin value, although not statistically significant, in favour of the b component in the LIa and LIb groups, that is, where fruit and vegetables form part of the dietary. But as the b group in the L diet and the a group in the BII diet are very small, despite the combination made, they are left out of consideration in the following discussion. The BIb group, on the other hand, is retained on account of the relatively large number of cases it contains. The values of the S diet agreed with those of the BII diet. Owing to the small number of cases in the S diet group it does not call for separate analysis. Thus in the following discussion the diets have been divided into the following groups: LIa, LIIa, BIa, BIb and BIIb.

Owing to the small number of cases in the Boden material all the L diets have been combined into one L group and all the B diets into one B group.

For the same reason the district investigations have been combined in such a manner that only the average results for the coastal district, outer and inner forest districts and mountainous district are given. For reasons which will be explained later, Tärna is treated separately. With regard to the school investigations, only those districts in which 2 or more diet types are represented by 10 or more cases have been included.

The following tables show the results of the examinations of the Hb value in relation to the composition of the diet.

It will be seen from the tables, especially from the results obtained at Umeå, that there is an evident, uniform rise in the haemoglobin level as the diet becomes more varied, i. e., when the intake of animal protein is increased. With but few exceptions, the differences are statistically significent. However,

The Haemoglobin value in relation to the composition of the diet. The material from Umeå.

% Hb	Men				
	LIa	LIIa	BIa	BIb	BIIb
116—120	1	—	2	—	1
111—115	1	1	6	2	—
106—110	1	1	16	10	1
101—105	3	10	35	24	3
96—100	10	17	45	18	9
91—95	30	26	110	43	5
86—90	29	30	67	39	7
81—85	20	19	30	9	—
76—80	14	6	3	1	1
71—75	2	3	6	3	—
66—70	3	1	3	—	—
61—65	4	—	1	—	—
56—60	—	—	—	—	—
51—55	—	—	—	1	—
46—50	1	—	—	—	—
41—45	1	—	—	—	—
36—40	1	—	—	—	—
31—35	1	—	—	—	—
26—30	1	—	—	—	—
Number of cases	123	114	324	150	27

	LIa	LIIa	BIa	BIb	BIIb
M (% Hb.)	85.0 ± 1.21	89.9 ± 0.73	92.7 ± 0.46	93.3 ± 0.68	94.9 ± 1.46
σ	13.4 ± 0.85	7.8 ± 0.52	8.2 ± 0.32	8.3 ± 0.48	7.6 ± 1.04
V	15.8 ± 1.02	8.6 ± 0.58	8.8 ± 0.35	8.9 ± 0.52	8.0 ± 1.10

even those tables in which the differences are not statistically significant frequently show numerical differences pointing in the same direction, as for instance the difference between men belonging to the BIIb and BIa groups in the Umeå material. An addition of fruit and vegetables (b) to the diet also seem, as a rule, to bring about a slight increase in the Hb value, except in the case of the boys attending the Elementary School at Umeå. This difference is not statistically significant, but it is so constant that it must be taken into account.

An examination of the variation coefficient (this can only be calculated successfully for the hospital material) will reveal in the case of the women a steadily, although not uniformly, declining series, with the maximum value in the LIa group and the minimum value in the BIIb group. The variation coefficients

Haemoglobin value in relation to the compositon of the diet.

% Hb	Women				
	LIa	LIIa	BIa	BIb	BIIb
111—115	—	—	—	—	1
106—110	—	—	—	1	—
101—105	—	—	3	8	1
96—100	1	3	8	4	2
91—95	7	15	48	27	8
86—90	27	26	70	55	14
81—85	52	26	66	52	12
76—80	59	36	51	29	1
71—75	29	24	12	11	1
66—70	10	12	6	2	—
61—65	8	6	3	2	—
56—60	5	1	3	—	—
51—55	4	3	2	1	—
46—50	7	1	—	—	—
41—45	3	—	2	—	—
36—40	6	1	—	—	—
31—35	2	—	—	1	—
26—30	2	—	—	—	—
Number of cases	222	154	274	193	40

	LIa	LIIa	BIa	BIb	BIIb
M (% Hb.)	74.5 ± 0.91	78.7 ± 0.80	83.5 ± 0.52	84.5 ± 0.62	87.9 ± 1.06
σ	13.5 ± 0.64	9.9 ± 0.57	8.7 ± 0.37	8.6 ± 0.44	6.7 ± 0.75
V	18.1 ± 0.89	12.6 ± 0.73	10.4 ± 0.44	10.2 ± 0.53	7.6 ± 0.96

in this respect lend support to the view that the lack of animal protein in the diet lowers the haemoglobin value in this material. The reason why this does not apply to all cases is undoubtedly due to the fact that different individuals for varying reasons are more or less »sensitive», either constitutionally or owing to other factors, for instance, endocrine (especially in women). As a rule there is a significant difference between the variation coefficients. In the BIa and BIb groups the values for both men and women agree relatively well (there is, as mentioned above, a slight increase in the Hb value on addition of fruit and vegetables to the diet). This indicates, as already pointed out, that an addition of fruit and vegetables to the diet plays a much smaller rôle for the Hb value than does an addition of animal foodstuffs.

By demonstrating the influence of the diet on the haemaglobin content of the blood we have also, at least partly, found the

Haemoglobin value in relation to the composition of the diet.

The material from Boden.

Diet	Men		Women	
	L	B	L	B
Number of cases..	7	23	10	22
M (% Hb.)	89.2	94.9	77.6	79.2

School children.

Diet	Boys				Girls			
	LIa	LIIa	BIa	BIb	LIa	LIIa	BIa	BIb
Umeå	8 66	31 74.7	43 76.3	76 74.6	4 74	22 70.5	43 73.1	49 73.7
Bureå	27 72.8	29 75.3	22 77.1	0 —	15 78.3	28 76.9	18 77.6	0 —
Lycksele	30 79.9	14 80.2	8 80	0 —	24 76.7	29 80.2	12 79.4	0 —
Dorotea	6 80	16 85.9	14 88.0	0 —	4 85	3 83	5 84	0 —
Stensele	20 82.8	10 82.0	16 79.7	0 —	19 81.5	5 83	11 82.4	0 —
Sorsele	4 77	23 77.8	14 80.4	0 —	1 90	25 77.6	10 77.9	0 —
Jukkasjärvi.....	11 73.9	51 75.5	23 77.8	18 83.3	9 74	57 78.3	28 80.3	18 82.3
Tärna	9 89.5	30 89.9	39 91.7	0 —	9 85	32 91.6	31 89.9	0 —

District investigations.

	Men				Women			
	LIa	LIIa	BIa	BIb	LIa	LIIa	BIa	BIb
Coastal district	5 79	25 80.7	22 83.7	10 89.9	9 77	38 78.2	30 81.1	12 83.1
Outer forest district...	7 82	16 74.4	22 83.8	8 93	9 75	16 73.4	24 78.2	3 82
Inner forest district...	8 94	12 90.2	58 93.4	0 —	5 75	11 82.8	40 85.1	0 —
Mountainous district, excl. Tärna	11 82.6	10 81.0	73 86.7	1 87	6 76	12 78.7	68 81.6	1 87

explanation of the difference in the haemoglobin values in the populations of Skåne, Västergötland and Norrland. The customary diet in Skåne, as shown in the investigations on the subject made at the Lund clinic, is most closely comparable with the BIIb diet, and the diet in the Borås district is still richer in animal protein. The diet commonly in use amongst the population in both Skåne and Västergötland contains meat, fish, eggs, fruit and vegetables to a much greater extent than the diet of the Norrland population.

The average Hb content in the BIIb group at Umeå was:

for men ..... 94.9 % ± 1.46 %, the variation coefficient 8 ± 1.10 %,
» women ..... 87.9 % ± 1.10 %, » » » 7 ± 0.96 %.

The average Hb content in the Lund material was:

for men ..... 95.4 % ± 0.40 %, the variation coefficient 5.3 ± 0.16 %,
» women..... 88.2 % ± 0.43 %, » » » 6.5 ± 0.21 %.

Thus there is a rather close agreement between the figures for the Skåne and the Umeå materials. The Borås material has a somewhat higher average Hb value, the figures being

for men ..... 98.2 % ± 0.34 %, the variation coefficient 7.4 ± 0.24 %,
» women..... 92.4 % ± 0.29 %, » » » 7.5 ± 0.22 %.

The Borås diet is richer in meat than the Lund diet.

Thus the composition of the diet is an important factor, perhaps the only one that explains the difference in the Hb values for the populations of Norrland, Västergötland and Skåne. Below we shall deal with a few more points which may be of importance in this respect.

2. *Other factors which may influence the haemoglobin content.*

(a) *Coffee consumption.*

The following tables show the influence of the consumption of coffee on the Hb content.

In the same manner as in our examination of the influence of coffee on the gastric secretion, it is essential in studying the effect of coffee drinking on the haemoglobin content in children that the grouping of the children must be different from that of the other material. Only a very small number of children fall under the group consuming more than 3 cups of coffee a day. In most districts practically all children belong to the group 1—3 cups a day. These districts are therefore omitted in the table.

Coffee consumption and Hb content.

Number of cups of coffee a day	Men				Women			
	0	1—4	5—8	>8	0	1—4	5—8	>8
Hospital material.								
Umeå. Number of cas.	32	203	114	61	37	342	116	41
M % Hb	87.7	89.6	92.2	89.6	82.1	81.3	81.8	76.8
Lund. Number of cas.	34	216	258	13	26	275	175	9
M % Hb	96.4	94.7	95.9	96.9	90.7	88.3	88.4	89
District material.								
Coastal district	0	35	49	5	1	60	49	3
	—	84.5	84.9	86	73	79.8	82.9	81
Outer forest district	1	13	25	14	0	17	24	12
	76	81.9	77.6	91.0	—	75.6	77.3	77.6
Inner forest district	0	15	71	13	0	14	50	5
	—	92.6	93.1	90.7	—	79.0	85.7	78
Mountainous district	0	20	58	51	2	24	59	33
	—	94.2	89.4	88.4	87	84.8	84.2	82.8

Coffee consumption and Hb content.

	Boys			Girls		
	0	1—3	>3	0	1—3	>3
School examinations.						
Umeå elementary schools	102	138	1	76	95	2
	73.7	75.5	73	72.0	74.4	70
Bureå	92	37	2	21	31	0
	72.6	76.4	82	76.2	76.6	—
Byske	14	26	0	17	38	1
	70.9	74.0	—	67.6	73.0	73
Kalix	33	111	3	35	119	0
	77.4	72.9	83	73.8	72.9	—
Jukkasjärvi	39	225	57	46	281	34
	83.4	82.8	74.1	81.6	82.8	75.1

It will be seen from the table that the Hb values are not infrequently a little higher when the consumption of coffee is moderate than when no coffee at all is consumed. It would, however, be rather too rash to infer from this observation that

a moderate use of coffee has a favourable effect on the Hb content. The explanation is probably to be found elsewhere. A great many of these persons who consume only small quantities of coffee are suffering from gastric disturbances. Among such persons there is a wide-spread and certainly well-founded opinion that coffee is the cause of their ailments and they have therefore reduced their consumption of coffee. Others perhaps are more susceptible to the effects of coffee, they develop nervous symptoms, suffer from insomnia and palpitation and for that reason have reduced their consumption of coffee. These symptoms are most prevalent in sensitive, delicate persons. Here we have perhaps the explanation of the apparently favourable effect of coffee on the Hb value. The consumption of coffee is a little higher in the L diets than in the other diets. But even in the L diets the number of cases consuming excessive amounts of coffee is so small that this factor cannot explain the difference between the Hb value in the L diet group and that in the B diet group. On the other hand, excessive coffee-drinking, more than 8 cups a day by adults and more than 3 cups a day by children, often seems to decrease the Hb value. As far as children are concerned, the figures for Jukkasjärvi certainly point in that direction.

(b) *Use of tobacco.*

The district investigations show a haemoglobin content of 88.1 per cent (200 cases) among »snuff-chewers». Non-snuff-chewers have an Hb amount of 88.9 per cent (200 cases). The hospital material (115 cases) shows an average Hb value of 91.2 per cent amongst snuff-chewers and 92 per cent amongst non-snuff-chewers (49 cases). Thus no definite correlation can be demonstrated between snuff-chewing and the Hb value.

In a comparison between smokers and non-smokers in the district investigations the Hb content varied without any tendency in either direction. At the Umeå Hospital smokers (all men) had an average haemoglobin content of 92.3 per cent (125 cases), non-smokers 92.2 per cent (38 cases). Thus, judging from these examinations, tobacco-smoking does not seem to have any influence on the amount haemoglobin.

(c) *Consumption of spirits.*

As already mentioned, the consumption of spirits in Västerbotten is very moderate. The Hb values found in the various

district investigations show no variation in relation to the consumption of alcohol. The material shows an average Hb value of 94.3 per cent for those who drink spirits (47 cases) and 94.5 per cent for abstainers (20 cases). Hence no anaemic effect can be ascribed to the use of alcohol in this material.

(d) *Influence of certain hygienic factors on the Hb value.*

Among the factors which might be supposed to influence the general state of health and the condition of the blood, housing conditions are one of the most important (cf. the »Stubenanämi» of the Germans). Overcrowding is attended not only by foul air, etc. but also by an increased risk of infections, which frequently bring about anaemia. For that reason investigations were carried out in order to ascertain, a) the occurrence of overcrowding, and b) its influence on the condition of the blood. As far as possible we have followed the principles laid down by Prof. ALFRED PETTERSSON for estimating the housing conditions. Special importance was attached to 1) the window area in percentage of the total floor area, 2) the floor area per occupant of the rooms used for sleeping, 3) the average number of persons sleeping in the same bedroom, and 4) the average number of school children sleeping in the same bed. The results of the investigations showed that in more than two-thirds (72.5 per cent) of the cases 3 or more persons slept in the same room. Overcrowding is especially prevalent in the case of school children. In about 50 per cent of the cases 4 or more slept in the same room, while in 46—47 per cent of the cases examined 2—3 children occupied the same bedroom. Only 2—3 per cent of the children had a bedroom of their own. A further indication of the degree of overcrowding is obtained by examining the number of persons sleeping in the same bed. Such an examination was made respecting school children. Only 27 per cent of the children had a bed of their own, 46.5 per cent shared their bed with another child, 23 per cent with 2 and 0.5 per cent with 3 other children. Overcrowding, judged by the same principles, is in general less marked in the towns than in the country. Overcrowding seems to be particularly marked in the districts of Degerfors, Lycksele, Malå, Stensele and Sorsele.

The figures (p. 171) show very plainly the rate of overcrowding in Norrland. This overcrowding, however, is not due to lack of rooms, but to the cold climate and deep-rooted habit. Only one or two of the rooms are used as bedrooms, while one or, not infrequently, more rooms are unused. As a rule the bedroom serves also as kitchen and dining-room.

Attempts to estimate the rate of morbidity amongst adults with respect to the rate of overcrowding gave negative results. The rate of morbidity was not greater among adults having scanty house-room than among those with sufficient accommodation.

The following records may be given of the haemoglobin value in relation to the *rate of overcrowding* judged by the principle mentioned above (no tables are given owing to lack of space):

No positive influence could be ascertained in the case of men. In 7 districts the Hb value was somewhat reduced in proportion to the rate of overcrowding, but in another 7 districts the Hb value was somewhat increased. An anaemic effect was found in healthy women in 11 districts, whereas no such effect was observed in 4 districts. The difference in the Hb values is, however, very small. Thus it is possible that overcrowding causes anaemia in women, who, owing to indoor work, are more subjected to the possible deleterious effects of overcrowding than men, whose outdoor occupations possibly neutralize this effect.

With regard to school children, the Hb values are as a rule lower in those living under the worst housing conditions. This is exemplified by the figures for Umeå and Jukkasjärvi, where the number of cases examined is highest. In tabulating the results the degree of overcrowding is indicated by the number of persons sleeping in the same room.

Hb values in school children in relation to the degree of overcrowding. Healthy children.

	Sleeping in the same room					
	Boys			Girls		
	1	2—4	>4	1	2—4	>4
Elem. schools in Umeå	14 (5.8%)	161 (66.8%)	66 (27.4%)	15 (8.7%)	102 (59.0%)	56 (32.4%)
Hb %	75.9	74.6	73.4	71.3	73.4	72.4
Jukkasjärvi	21 (6.5%)	176 (54.3%)	127 (39.2%)	26 (7.0%)	214 (57.5%)	132 (35.5%)
Hb %	86.3	82.9	78.2	87.2	82.9	79.3

If the rate of overcrowding is calculated on the basis of the bedroom area per person, the result does not seem to be so discouraging as the result of the examination of the number living in the same room. The rooms are generally large, which diminishes the disadvantages to a certain extent, whereas they are augmented by the fact that the same room does duty as bedroom, kitchen and dining-room. Employing PETTERSSON's system of grading, we find that only 40 per cent of the homes have a bedroom floor area less than 5.6 square metres, and 37 per cent less than 7.3 square metres. The window area in proportion to the floor area also seems to be sufficient. In about 60 per cent of the cases the window area amounts to 12 per cent or more of the floor area, and in about 27 per cent it varies between 9 and 11 per cent of the floor area. In only 1 per cent of the cases was the window area as low as 3—5 per cent of that of the floor. Attempts made to show a correlation

between the Hb value and the bedroom and window areas established that the Hb value was approximately the same in all the groups.

The distance from the children's homes to the schools. The question has very often been discussed among School Medical Officers as to whether the distance the child has to walk to school has any influence on its health. One is readily inclined to believe that the general condition and the blood of a child is impaired if it has to walk a long distance to school, for if the distance is rather long the child is unable to go home for the midday meal and is therefore compelled to eat the dry food it brings with it from home. It was of certain interest to try to ascertain the effect of this factor on the children in Norrland, where the population is scattered over wide areas. The investigation gave the surprising result that 63.6 per cent of the children had less than one kilometer to go to school, and 36 per cent between 1 and 5 kilometers; only 0.4 per cent had a distance of more than 5 kilometers. A still more surprising fact is that children living in the forest and mountainous districts have as a rule shorter distances to school than the children in the coastal district. The probable explanation of this is that in the former districts the children when attending school are boarded in homes in the vicinity. An examination of the Hb value in relation to the distance the child has to walk to school furnished no positive evidence of any causal relationship existing between them.

Assisting in house work. The question as to whether the employment of children at home assisting in house work has any influence on the Hb value was also examined. It was found that on an average 66.8 per cent of the boys and 67.9 per cent of the girls had to assist in the house work. As a rule the Hb value was found to be slightly lower for children *who did not assist in the house work.* This may be explained by the fact that the children generally assist in the outdoor work, which to a certain extent counterbalances the drawbacks of an inactive, indoor life.

(e) *Influence of helminthic infection on the Hb value.*

As already mentioned, the incidence of helminthic infection is very high in certain parts of Norrland. In the official reports of the District Medical Officers infection with tapeworms is regarded as an important factor in the causation of anaemia. For that reason one of the objects of this investigation was to obtain information regarding the incidence of helminthic infection and its influence on the condition of the blood. Estimations of the haemoglobin content were made for this purpose, in addition to the hospital material, especially in the district of Arjeploug, where infection with tapeworms, as already shown, is very common.

Thus the Hb values in persons affected with tapeworms are not appreciably lower than in unaffected persons, even if all affected persons belonged to the BIa diet group, in which the average Hb

Effect of tapeworm infection on the Hb value.
Hb content in affected persons
Umeå hospital.

	Men		Women	
Species of tapeworm	Dibothrioceph.	Taenia (sag. or sol.)	Dibothrioceph.	Taenia (sag. or sol.)
Number of cases	17	8	21	36
M (Hb %)	90.4	90.6	82	81.8

Arjeploug

	Dibothrioceph.	
	Men	Women
Number of cases	20	12
M (Hb %)	84.1	82.0

value for men is 92.7 per cent and for women 83.5 per cent. The average Hb value for persons not affected in the district of Arjeploug is 84.1 per cent for men and 77.4 per cent for women. Thus no reduced Hb values.

(f) *Pregnancy and lactation.*

Even before these investigation were started the author had observed that pregnancy and lactation often cause a very marked fall in the amount of haemoglobin. The following table shows the Hb values found in one year at the lying-in department of the Umeå Hospital, grouped according to the number of childbirths in each case.

Hb in relation to pregnancy.

Number of childbirths	I	II	III	IV	V	VI	> VI
Number of cases ...	292	106	58	24	19	12	29
M (Hb %)	66.5	66.5	69.6	62.5	62.8	59.2	58.5

In a material collected from Skåne, JERLOW found an average Hb value of 71.1 per cent after childbirth.

It will be seen from the table that a very high degree of

anaemia develops during pregnancy (the average Hb value for women being 80.1 per cent), and that the degree is about the same in primiparae, secundiparae, tertiparae, but later tends to increase with each additional pregnancy.

At the lying-in department at Umeå the women were usually examined on the first day they were admitted to the hospital, but frequently shortly after parturition. Cases with severe haemorrhage were omitted.

In addition, 115 pregnant women examined at the out-patient department at Umeå showed an average Hb value of 71.7 per cent. Several of these cases were in an early stage of pregnancy. The corresponding figure for 38 cases examined at Borås is 82 per cent (the everage Hb value for women is 92.4 per cent). Thus it appears that the Hb value is also lower during pregnancy in the Borås cases, but not so low as in Norrland women.

Thus pregnancy causes a marked decrease in the Hb values. At the out-patient department of the Umeå Hospital 43 lactiferous women were examined 3—12 months after childbirth. The average Hb values was found to be 69.9 per cent, thus a low value. Owing to the small number of cases no conclusions could be drawn with regard to the different values of the haemoglobin during the months of lactation.

The results of the district investigations coincide on the whole with those of the hospital material, as shown in the table on p. 175.

(g) *Seasonal factors.*

Examinations of the haemoglobin content of the blood in different seasons of the year have been carried out by several investigators, and many contributions have been made by Scandinavian workers. Finsen's investigations dating from 1893 are classical. He showed an increase in the amount of haemoglobin from December—January to the maximum level in June—September, with a difference of not less than 15 per cent in women and 19 per cent in men. Finsen's work has been continued by numerous investigators, among whom we may mention Heerup, Borchardt, Grimsgaard and Koettlitz. Studies on the haemoglobin content in children have been made, among others, by Häberlin and Nylin. All these authors found the same tendency to an increase in the amount of haemoglobin in summer. However, the point of time at which the maximum increase takes place and the greatest rise attained vary considerably in the records of the various authors. On the other hand, Smit and Scott were unable to discover any rise at all.

Most investigators regard this rise in the haemoglobin level as being due to the influence of the utra-violet rays on the formation of haemoglobin. Kestner and Nylin call attention to the agreement between the rise in the haemoglobin level and the increase in the basal metabolic rate during the different seasons.

Haemoglobin content during pregnancy and lactation.

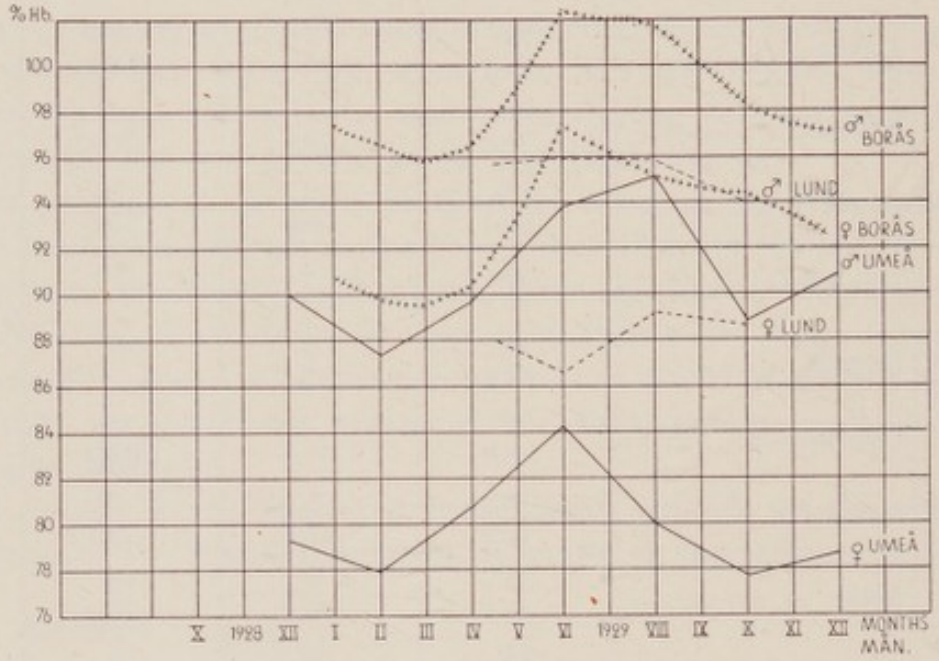
District	»Normal cases» Number of cases and average Hb-value	Pregnancy Number of cases and average Hb-value	Lactation Number of cases and average Hb-value
Sävar, Bygdeå	30 77.9	2 69.9	0 —
Bureå	39 82.7	5 69.8	12 61.1
Byske	22 77.2	2 68.1	6 59.8
Öjebyn	26 85.5	4 73.8	4 70.1
Bjurholm	14 65.1	2 55.5	5 58.0
Degerfors	17 78.7	3 60.2	0 —
Norsjö.....	14 81.7	2 71.7	0 —
Övertorneå.....	8 88.2	2 61.3	6 68.8
Lycksele.....	18 78.3	1 75.2	3 78.5
Malå	51 85.7	2 65.0	13 71.3
Stensele	24 82.3	0 —	5 77.4
Arjeploug	23 79.4	1 76.6	3 76.6
Jukkasjärvi	34 79.4	0 —	8 75.2
Tärna	39 93.4	3 92.2	4 92.7

The following curves are intended to show the average Hb values in the different months of the year for cases examined at the Umeå, Lund and Borås hospitals. The material has been stringently selected so as to exclude all pathological cases and the average values for three months have been combined in order to obtain larger series. The district and school investigations are not included in this material, as most of them were carried out in

April and May. Owing to the small number of cases, the Boden material has also been omitted.

The curves show that the amount of haemoglobin increases during the spring months, the maximum level being reached in June in the case of the women and between May and August in the case of the men, while the lowest level is reached in January—February. In the Lund material the same variations seem to occur in the men but is not quite so evident in the case of the women. Unfortunately the examination at Lund could

Seasonal variations of the Hb value.



be continued only for a short time. In the Borås material the seasonal variations are quite evident, the lowest value occurring in February—April, the highest in June—August.

The difference between the maximum and minimum values for men and women in the Umeå material is 7.7 ± 1.04 per cent and 6.3 ± 1.35 per cent respectively. The reason why the seasonal variations are greater at Umeå than at Lund is not far to seek, they are due to the long winter nights in Norrland. The Borås material shows about the same difference between the maximum and minimum values as the Umeå material; the winters in the Borås region are also very dark and foggy, without any snow.

It is rather striking that the Hb curves for Umeå show a slight rise in November—December, this rise is not found in the curves for Borås. This is probably due to the fact that snow

begins to fall in Upper Norrland in the middle of October while the sun is still comparatively high. Sunlight is reflected by the snow and the intensity of radiation is thereby increased.

The seasonal variations in Umeå exhibit essentially the same features in the L and B diet groups. No certain deviation could be established. We are not justified, however, in concluding from this fact that sunlight is the only factor causing the seasonal variations in the haemoglobin level. If that were true the haemoglobin level would be highest in September—October, but that is not the case. The long winter darkness is also accompanied by a more intense cold, which compels the inhabitants to stay indoors and to live a more sedentary life. Further, it is not improbable that the dietary during the dark period of the year is different from that taken during the summer months.

Thus it is probable that the difference between the Hb values in Norrland and Skåne is to a certain extent due, as already pointed out by the present writer, to climatic conditions. But this is not the only factor, nor is it the main factor. The most important factor, as we have shown in the foregoing, is the diet.

The variation coefficient for men in Umeå belonging to the BII group was greater than that in the Skåne material in spite of the fact that the average Hg values were equal. This may be due to the fact that the Umeå material comprises cases examined in all months of the year, whereas the Lund records refer to only a part of the year.

The relatively small number of examinations of the basal metabolism made in our material shows, like the Hb level, a rise in spring and summer. The minimum rate occurs in February, but the maximum, in contradistinction to the Hb level, does not occur until August—November, that is, when the average Hb level has already passed its maximum rise and is relatively low. Thus it is not correct to attribute the seasonal variations of the Hb level solely to the degree of basal metabolism — a view maintained, for instance, by WERDINIUS.

(g) *Highland climate.*

It has already been mentioned that the altitude in Norrland rises rather steadily from the coast up towards the Norwegian boundary. It is well known from the investigations made, for instance, by VIAULT, JAQUET, BÜRKER, ABDERHALDEN, MÜLLER, MAJOR HINGSTON, J. RICHARDS and BARCROFT, that a mountain

climate brings about an increase in the amount of haemoglobin and the number of red corpuscles. One should therefore expect to find a rise in the Hb level the farther one gets into the interior of a country. It has been shown, in particular by KESTNER, that two factors, radiation of light and rarefaction of the air, contribute to the effect of highland-climate. Both these factors become more potent with increasing altitude. The following table shows the average Hb value for the various districts.

	Towns		Coastal distr.		Outer forest distr.		Inner forest distr.		Mountain distr.	
	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.
Hospital investigations.										
Number of cases	228	394	228	382	126	123	67	58	18	(5)
M (Hb %)	91.3	81.0	88.6	78.5	90.4	80.2	91.8	83.1	94.4	(93.5)
District investigations.										
Number of cases	—	—	92	117	53	53	99	69	156	144
M (Hb %)	—	—	85.0	81.1	82.1	76.7	92.8	83.8	90.1	83.3
School investigations.										
Number of cases	247	196	543	513	199	190	215	216	705	711
M (Hb %)	74.8	73.3	75.2	74.0	78.2	77.9	78.7	78.1	81.2	81.5
BI diet. Hospital investigations.										
Number of cases	—	—	95	93	52	33	42	25	11	(2)
M (Hb %)	—	—	92.5	82.4	93.5	85.8	93.9	88.7	95.4	(92)
BI diet. District investigations.										
Number of cases	—	—	22	30	22	24	58	40	93	86
M (Hb %)	—	—	83.7	81.1	83.8	78.2	93.4	85.1	90.2	84

It will be observed that if the towns-people in the material are not included there is an evident tendency to an increase in the Hb value the farther one gets into the interior of the country. This difference is very plainly seen in the hospital and school investigations, which were as a rule carried out by the same examiner. The only exception to the rule is the adult urban population (in the hospital material), to which we shall return

later. The difference in the Hb content between the coastal district and the interior of the country is statistically significant.

But this difference between the Hb values of the coastal district and the interior of the country is largely due to the diet. It has already been shown that the L diet is predominant in the coastal district and decreases in frequency in the interior. The question then arises whether the increase in the Hb value is not due to the dietary factor. In order to exclude this factor we shall examine only one diet group, the BI group, which is the largest and most suitable for the purpose. The result shows a similar increase in this diet group to that found in the total material, although it is not quite so marked. The farther one gets into the interior of the country the higher the Hb value.

School children as a rule have a more uniform diet, usually the L diet. Here the diet factor plays no part in the difference between the Hb values for the coastal district and the interior of the country.

The following table shows the difference between the Hb values in Tärna, the district with the highest altitude above sea-level, in the coastal district, in the towns in Norrland and in Skåne.

	Adults		School investigations		
	Men	Women	Boys	Girls	Boys and girls
Tärna.....	44 103.2	39 93.4	95 90.1	88 88.9	183 89.5
Coastal districts	283 88.6	182 78.5	543 75.2	513 74.0	1056 74.5
Towns in Norrland...	228 91.3	394 81.0	247 74.8	196 73.3	443 74.1
Skåne.....	530 95.4	498 88.2	222 76.7	178 76.5	400 76.6

Between the average values in Tärna and in the coastal district there is a difference of 14.6 per cent and 14.9 per cent for adults and 14.2 per cent for children.

If a comparison is made between the average Hb values in Tärna and the average values obtained from Skåne we shall find a difference of 5 and 8 per cent respectively for men and women and 13.4 per cent and 12.1 per cent respectively for boys and

girls. The difference in the case of the children is noteworthy and will be discussed later. Tärna is the only place in Norrland that shows higher Hb values than South Sweden. As already mentioned, Tärna is situated at a greater altitude above sea-level than any other district covered by the investigation.

The adult population of the towns has a higher Hb value than the rest of the coastal district. The difference is 2.7 ± 0.84 per cent for men and 2.5 ± 0.80 per cent for women. The variation coefficients show a difference of 2.7 ± 0.78 per cent for men and 4.5 ± 0.73 per cent for women. Both differences are statistically significant. This difference in the Hb content between town and country is undoubtedly due to the fact that towns-people mostly subsist on a mixed diet, corresponding to the BI and BII types of diet.

Thus the increase in the Hb content, shown in the above tables, is due to a considerable extent to the influence of the mountain climate. The magnitude of this influence can be calculated with a certain degree of probability. Bürker states that the Hb value increases in proportion to the altitude above sea-level. According to Barcroft, an elevation of 13000 feet corresponds to 40 per cent haemoglobin. Tärna is situated between 2000 and 2300 feet above sea-level. This would correspond to a rise of 8 per cent in the amount of haemoglobin. There must therefore be another factor present to account for the high Hb value found at Tärna, especially in the case of the children, where the diet factor is not of the same importance as in the case of the adults. Then the question arises whether the explanation is not to be found in race-biological factors.

(i) *Race-biological factors.*

A particularly noteworthy feature is, as pointed out above, the great difference in the Hb values found in children in Tärna and those in children in the coastal district, this difference amounting to 15 per cent. It has also been mentioned that in contradistinction to the population of the coastal district, which is of purely Teutonic race, the population of the mountainous region contains a mixture of Lapps, who belong to the Mongol race. This mixture of Lapps is especially extensive in Tärna. There is no reason to suppose that the blood picture of the Mongols or of a mixed race differs from that of Teutons. Nægeli, from data supplied by Japanese investigators, gives the normal number of red corpuscles in Japanese at 5 million for men, 4.5 million for women and the index 1, that is, the same values as for Teutons. It was pointed out above, however, that during childhood the Hb content shows a progressive rise up to the age of 17—19 years in males and up to the age of 13—15

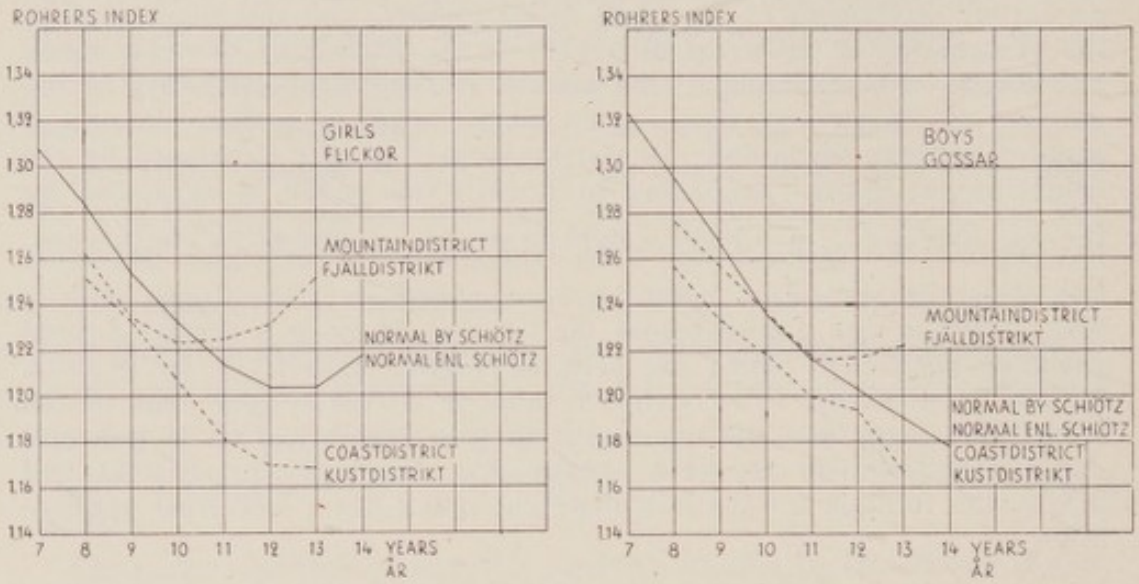
years in females. It might then be thought that Lappish or a mixture of Lappish blood would bring about an earlier maturity and thereby an earlier attainment of the adult blood picture, and this might supply the explanation of the great difference in the Hb values between Tärna and Umeå. A comparison of the growth and the proportionality of the children in Tärna and Umeå or in Skåne lends a certain amount of support to this assumption. Proportionality is usually expressed by the height/weight index. According to Rohrer this index is expressed by the formula: $i = \frac{v}{l^3}$, v = body weight in grams, l = height in centimetres. Deviations from normal values are expressed in percentages with a plus or minus sign placed before the figures. There is a certain normal variation coefficient which has been calculated statistically by Schiötz. If this is calculated by a simple ± value it covers 68 per cent of the cases. In a large material one may therefore expect to find 16 per cent underweight and 16 per cent overweight. As shown by Schiötz and others, the formula for the height/weight index has a universal applicability.

In the calculation of the height/weight index of the children in Tärna not a single case of pathological underweight was found, but on the other hand more cases of overweight than was expected. This shows that the proportionality among the children in Tärna, a large percentage of which are of Lapp origin, differs from that among children of purely Teutonic descent. The physical condition of the children in the mountainous district differs from the normal curve of development in that already at the age of 10—11 years they become more thick-set in stature. Thus, owing to this mixture of Lappish blood, this population follows different laws of development from those of the inhabitants of the coastal and mountainous districts and of the province of Skåne. This is probably due to an earlier sexual maturity, which brings about a change of index in this direction. The following curves (p. 182) illustrate these points. The rapid rise in the Hb curves for Tärna and their horizontal course after the age of 12 years argue in favour of the correctness of the assumption that race-biological differences are to a certain extent the cause of the great difference between the Hb content of children in the coastal district and that of children in the mountainous district.

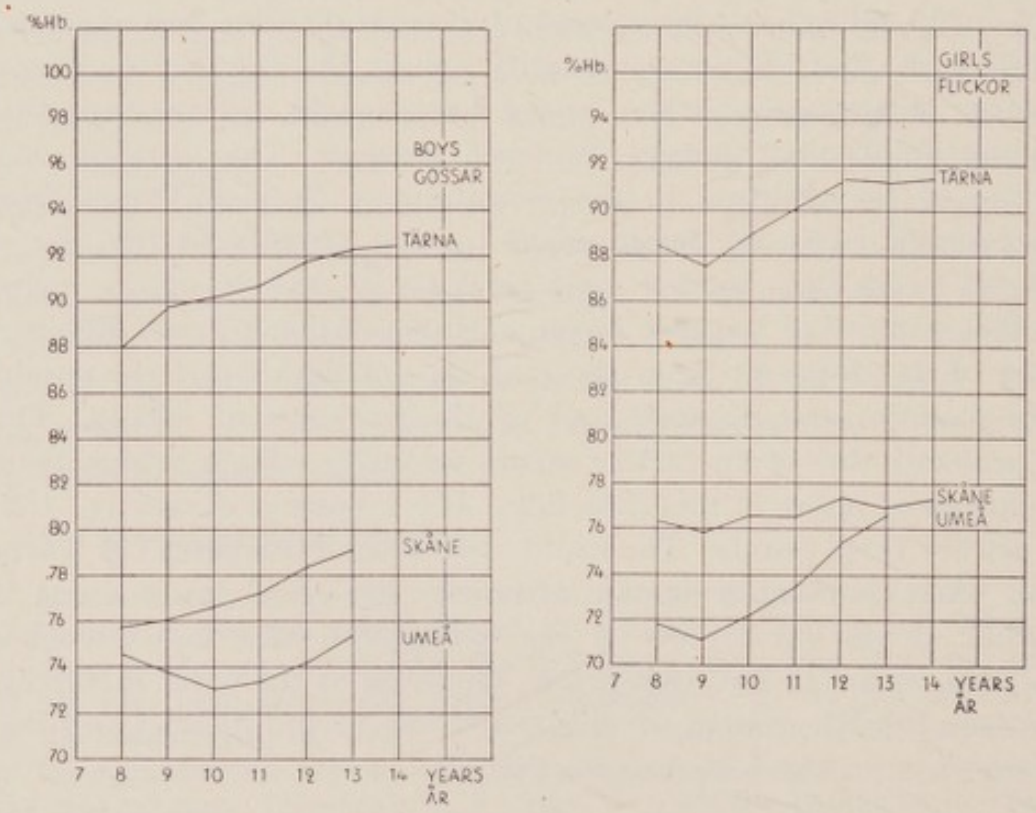
(j) *Gastric disorders, especially achylia.*

It has already been shown that the incidence of achylia and colitis is very high in the Norrland material. It was also established that gastro-intestinal disturbances, and above all achylia, were mostly associated with the L diet. It is possible that the Hb content is a sequel of the gastro-intestinal disorders.

Length weight index for schoolchildren.



Hb values in schoolchildren.



The following table, based on examinations made at the Umeå Hospital, shows the correlation between the Hb value and the incidence of gastric disorders. The grouping is the same as that adopted previously. The Hb values agree very well with each other and with the values found for the total material.

Character of disorders	Men			Women		
	Mild sympt.	Severe sympt.	Ulcer (X-ray)	Mild sympt.	Severe sympt.	Ulcer (X-ray)
Number of cases	134	84	58	160	72	28
M (Hb %)	90.0	90.4	89.7	81.4	80.1	82.3

Owing to the comparatively small number of cases with gastro-intestinal disorders in the various districts and the difficulty of grouping the cases with respect to the symptoms, the results of these examinations cannot be expected to show any definite influence on the Hb value.

The Hb value in relation to the incidence of achylia is shown in the following table. The achylic cases have been divided into two groups, a total value of 8 being fixed as the borderline between mild and severe cases.

Hb value in relation to the gastric secretion.

	Men			Women		
	Congo — T. a. 0—8	Congo — T. a. > 8	Congo +	Congo — T. a. 0—8	Congo — T. a. > 8	Congo+
116—120	—	—	3	—	—	—
111—115	—	—	2	—	—	—
106—110	2	1	5	—	—	—
101—105	5	3	28	1	—	6
96—100	5	5	27	—	2	2
91—95	17	10	113	5	3	32
86—90	15	12	86	5	21	72
81—85	7	8	37	12	21	81
76—80	5	5	9	11	25	52
71—75	—	2	5	8	7	17
66—70	3	1	2	4	7	5
61—65	—	1	1	6	3	2
56—60	—	—	—	2	2	—
51—55	—	—	—	6	—	—
46—50	—	1	—	4	—	—
41—45	—	—	—	1	—	—
36—40	—	—	—	1	—	1
Total	59	49	318	66	91	270
M (% Hb.)	89.3 ± 1.12	86.7 ± 1.50	90.9 ± 0.42	72.3 ± 1.76	79.8 ± 0.84	83.4 ± 0.44
σ	8.6 ± 0.79	10.5 ± 1.06	7.5 ± 0.30	14.3 ± 1.24	8.0 ± 0.59	7.2 ± 0.31
V	9.6 ± 0.89	12.1 ± 1.23	8.3 ± 0.33	19.8 ± 1.80	10.0 ± 0.75	8.6 ± 0.37

It will be seen from the table that achylic anaemia in this material is not a rare occurrence also in men. It is not, however, by any means so common or so pronounced as in women.

The Congo positive cases exhibit the highest haemoglobin values in both men and women. In the Congo negative groups the men with the lowest total acidity values have the highest Hb values, but these values are quite the reverse in the case of the women. The figures for the men, however, are not statistically significant, but those for the women are so. The variation coefficient increases with a diminution of the Hb value, which is to be expected and lends support to the view that there is a correlation between the Hb values and the gastric secretory activity.

The variation coefficient for the severe cases of achylia among the men is lower than for the milder cases. This seems to indicate that the frequency of anaemia is really lower in the former group. The cause of this is to be found in the fact that the severe forms of

Hb value in relation to diet and acidity.

M e n.

	Congo neg.				Congo pos.	
	T:a 0—8		T:a > 8			
	LIa	B	LIa	B	LIa	B
116—120	—	—	—	—	—	1
111—115	—	—	—	—	1	1
106—110	—	1	—	—	1	5
101—105	—	3	2	1	2	22
96—100	3	—	5	3	4	16
91—95	2	5	7	3	5	46
86—90	6	4	4	2	8	39
81—85	5	1	4	5	5	19
76—80	2	1	2	—	2	3
71—75	1	1	—	—	—	2
66—70	—	—	—	1	—	—
61—65	—	—	—	—	—	—
56—60	1	—	—	—	—	—
51—55	—	—	—	—	—	—
46—50	—	—	1	—	1	—
41—45	1	—	1	—	—	—
36—40	—	—	1	—	—	—
31—35	—	—	1	—	—	—
Total	21	16	29	15	29	154
M (% Hb.)	83.2 ± 2.75	91.3 ± 2.25	83.7 ± 3.47	88.5 ± 2.20	89.4 ± 2.12	92.2 ± 0.60
σ	12.6 ± 1.94	9.0 ± 1.59	18.7 ± 2.45	8.5 ± 1.55	11.4 ± 1.50	7.5 ± 0.43
V	15.2 ± 2.39	9.9 ± 1.76	22.3 ± 3.08	9.6 ± 1.77	12.8 ± 1.70	8.1 ± 0.47

Hb value in relation to diet and acidity.

W o m e n.

	Congo neg.				Congo pos.	
	T:a 0—8		T:a > 8			
	LIa	B	LIa	B	LIa	B
101—105	1	—	—	—	—	4
96—100	—	—	1	—	2	3
91—95	1	—	1	2	4	12
86—90	2	4	5	3	13	45
81—85	7	—	9	5	19	31
76—80	10	2	17	4	20	28
71—75	5	1	7	—	10	5
66—70	3	2	7	—	5	2
61—65	4	—	2	3	2	2
56—60	2	—	5	—	—	—
51—55	4	1	2	—	—	—
46—50	4	—	3	—	—	—
41—45	2	1	1	—	—	—
36—40	2	—	—	—	2	—
31—35	—	—	1	—	—	—
Total	47	11	61	17	77	132
M (% Hb.)	68.4 ± 2.23	73.4 ± 4.34	72.2 ± 1.64	79.9 ± 2.23	79.0 ± 1.13	84.1 ± 0.61
σ	15.3 ± 1.58	14.4 ± 3.07	12.8 ± 1.16	9.2 ± 1.58	9.9 ± 0.80	7.0 ± 0.43
V	22.4 ± 2.43	19.6 ± 4.35	17.7 ± 1.66	11.5 ± 2.00	12.5 ± 1.02	8.3 ± 0.51

achylia occurring among the men are of a different nature, have a different cause from that of the forms of achylia prevalent among the women. We were also in a position to prove that the significant factor in this respect is snuff-chewing.

It therefore seems probable that the anaemia occurring in the L diet group is due to »achylia», that is, it is an »achylic anaemia». (Faber, Gram, Reimann and Weiner, Kaznelson, Waugh, Davies, Watkins, Mills, Mettier and Minot, Salvesen, Meulengracht.) The tables (pp. 184—185) elucidate this point.

It will be noted that although an impairment of the gastric secretion brings about a decrease in the Hb value, both the achylic cases and the Congo positive cases in the L diet group regularly have lower Hb values than the corresponding cases in the B group.

Examinations of the Hb value in relation to the degree of acidity were also made on the Congo positive cases in the different diet groups. No correlation could be found. The Hb value showed no variations at different degrees of acidity.

This implies that the cause of the difference in the Hb values for the different diet groups is partly due to a gastric secretory anomaly present but also partly to other factors. In women the Hb value, as shown in the preceding table, seems to be correlated to the degree of the functional disturbance of the stomach. That is not the case with the men, however, in whom snuff-chewing appears to cause a severe achylia without any anaemia.

Quite a number of the cases with achylia exhibit comparatively high Hb values, but some of the cases in the L diet group have a low Hb value with a normal secretion of gastric juice. This furnishes certain evidence that the two phenomena, both sequels of the L diet, are independent of each other. The variation coefficent is the same as that mentioned above.

The number of cases was comparatively small, owing to the fact that a stringent selection was made and only »true» cases were included.

The results of the examinations of the Hb value in relation to the gastric secretion carried out at Boden are shown in the following table. The results agree with those obtained at Umeå. Owing to the small number of the cases no division into different groups was made.

Boden material.

	Men			Women		
	Congo neg.		Congo pos.	Congo neg.		Congo pos.
	T:a 0–8	T:a > 8		T:a 0–8	T:a > 8	
No. of cases	3	11	19	10	13	14
M (Hb %)	92	93.0	98.8	70.0	82.5	85.7

(k) *Intestinal disorders.*

The next table shows the Hb value in relation to the incidence of intestinal disorders in the hospital material. The material has

Symptoms	Constipation		Stercoral diarrhoea		Diarrhoea	
	M.	W.	M.	W.	M.	W.
No. of cases	68	129	74	107	53	53
M (Hb %)	89.0	78.9	89.8	79.6	90.2	79.9

been divided into 3 groups: constipation, stercoral diarrhoea and diarrhoea.

It will be seen from the table that no significant difference in the Hb value can be shown in cases with intestinal disorders of different kinds. Nor is there any marked difference between the average Hb value and that for the material as a whole. It corresponds closely to the average value for the achylic cases in the B diet group. The number of cases with intestinal disorders was so small that a division into different diet groups would be of no value. An analysis of the district and school materials along similar lines also proved rather valueless on account of the small number of cases.

(1) *Condition of the teeth.*

The following table shows the influence of the dental condition on the Hb value in different diet groups, estimated from the

Hb value in relation to the dental condition and different diets.

Denture	L diet				B diet			
	Men		Women		Men		Women	
	No. of cases	Hb. %	No. of cases	Hb. %	No. of cases	Hb. %	No. of cases	Hb. %
Teeth good	150	88	165	78	298	93	221	85
Medium	39	89	60	77	88	93	83	83
Bad	55	86	100	76	46	91	88	83
Carious teeth								
0—4	163	89	199	77	338	94	255	85
5—8	37	89	73	76	65	92	67	83
> 8	41	84	53	74	28	91	66	81
Missing teeth								
0—8	154	88	167	76	285	93	213	85
9—16	51	88	69	77	112	93	116	82
17—24	20	87	59	76	13	89	43	81
25—32	11	82	30	76	13	86	19	84
Whole teeth								
0—8	34	86	93	76	33	91	79	82
9—16	41	88	76	78	76	91	96	84
17—24	80	89	101	79	167	92	119	85
25—32	89	89	55	77	154	93	97	85
Gingivitis								
+	105	87	177	79	140	89	124	84
−	88	87	147	80	210	94	167	84

number of carious teeth, the denture and the occurrence of gingivitis. It will be observed from the table that a slight but evident decrease in the Hb value sets in with a deterioration of the dental condition in both the L diet group and the B diet group. The cause of this is probably to be found in repeated infections from carious teeth. It is obvious that the dental condition cannot explain the difference in the average Hb values in the various diet groups, even if the cases in the L group have on the average inferior teeth to those of the cases in the B group, as was shown in the tables on pp. 96—97. The correlation shown is too slight to explain the differences in question. It is quite evident from the table that the difference between the average Hb values of the different diet groups is too great to have been caused by a poor dental condition. Further, the cases with the poorest dental condition in the B diet group have, as a rule, higher Hb values than those cases with the best dental condition in the L diet group.

E. **The blood picture, especially in L diet anaemias.**

In a previous section a detailed analysis was given of the haemoglobin content and of the cause of the increased incidence

The number of red corpuscles in relation to the composition of the diet.

Number of red corpuscles	Men				Women			
	LI	LII	BI	BII	LI	LII	BI	BII
5.76—6.00	—	—	1	—	—	—	—	—
5.51—5.75	—	—	4	—	—	—	—	—
5.26—5.50	1	—	16	1	—	—	3	1
5.01—5.25	3	5	30	2	—	1	3	—
4.76—5.00	12	14	86	6	2	8	27	2
4.51—4.75	17	20	84	5	11	10	55	8
4.26—4.50	21	33	45	3	33	37	119	14
4.01—4.25	16	6	13	—	43	41	86	6
3.76—4.00	6	2	5	—	47	12	32	1
3.51—3.75	3	—	—	—	19	10	6	—
3.26—3.50	2	—	—	—	20	6	7	—
3.01—3.25	—	—	1	—	5	1	—	—
2.76—3.00	1	—	—	—	2	—	—	—
2.51—2.75	—	—	—	—	1	—	—	—
2.26—2.50	4	—	—	—	3	—	—	—
2.01—2.25	—	—	—	—	1	—	—	—
Total	86	80	285	17	187	126	338	32
Average r. blood count	4.290	4.540	4.733	4.772	3.925	4.187	4.325	4.438
σ	0.5925	0.2700	0.3450	0.2725	0.4625	0.3650	0.3275	0.2750
V	13.8	6.0	7.3	5.7	11.8	8.7	7.6	6.2

of anaemia in Norrland. We shall now attempt to elucidate the other characteristics of the existing anaemia, especially with respect to the different diets. The composition of the diet is of course the most important factor in the causation of anaemia.

The number of red corpuscles in persons belonging to the different diet groups are tabulated in the table on p. 188.

It will be noted that a decrease in the number of red corpuscles is common. This applies in particular to the L diet groups, and especially to the LI group, and to the women.

If this table is compared with the Hb values found in the different diet groups (pp. 164—165) it will be seen that the decrease in the number of red corpuscles is relatively smaller than the decrease in the Hb content. In conformity to this the dispersion and the variation coefficient of the number of red corpuscles are also lower than those of the Hb values.

The mean colour-index for men in the L diet groups is greater than that in the B diet groups.

Colour index in relation to the composition of the diet.

Colour index	Men				Women			
	LI	LII	BI	BII	LI	LII	BI	BII
1.35—1.44	1	—	—	—	—	1	—	—
1.25—1.34	1	1	—	—	1	—	—	—
1.15—1.24	3	1	1	—	4	2	4	—
1.05—1.14	11	21	47	3	22	8	35	2
0.95—1.04	54	37	166	9	78	41	163	22
0.85—0.94	10	18	61	5	50	52	111	7
0.75—0.84	3	3	8	—	12	16	19	1
0.65—0.74	1	—	2	—	7	3	3	—
0.55—0.64	1	—	—	—	9	3	3	—
0.45—0.54	1	—	—	—	4	—	—	—
Total	86	80	285	17	187	126	338	32
Average index	0.995	0.999	0.988	0.988	0.937	0.929	0.962	0.978
E. M.	0.0124	0.0087	0.0041	0.0154	0.0102	0.0097	0.0046	0.0095
σ	0.115	0.078	0.069	0.064	0.139	0.109	0.084	0.054
V	11.5	7.8	6.9	6.4	14.9	11.7	8.7	5.5

This circumstance is noteworthy. It indicates that in men the anaemia is more frequently of a hyperchromatic character than in women. In fact, as shown by the table, a hyperchromatic blood picture is by no means rare either in men or women, especially in the LI group.

The range of variation of the colour-index calculated by the formula $M \pm 2\,\sigma$, is as follows: —

Range of variation of colour index.

Diet	Men	Women
LI	0.77—1.23	0.66—1.22
LII	0.84—1.16	0.71—1.15
BI	0.85—1.13	0.79—1.13
BII	0.86—1.12	0.87—1.09

This agrees very well with the previous findings of the present writer that both hyperchromatic and hypochromatic anaemias are common in the Norrland material. As seen from the table, this is especially the case amongst the men in the LI group. In the women the anaemia is generally of a hypochromatic and more severe type, although the hyperchromatic type also occurs rather frequently.

An analysis of the material with regard to the relation of the colour index to the degree of anaemia, estimated on the basis of the Hb value, indicates that the lower the Hb value the less frequent is the hyperchromatic type of anaemia. Still it is not infrequently met with. As the B diet becomes more predominant, i. e., when the diet contains more meat, the number of hyperchromatic cases decreases: the index falls.

Size and morphology of the red corpuscles. Poikilocytosis and anisocytosis are not infrequent phenomena in the Norrland material, generally increasing with the degree of the anaemia. It seems, however, as if these symptoms appear comparatively late, especially in the L diet anaemia. Special examinations showed that this change in the red corpuscles occurs in the L diet group when the Hb content has decreased to 70 per cent, while it was observed in the B diet group, as a rule, when the Hb content was not lower than 80 per cent. This seems to indicate that the anaemias due to the L diet had a lower regenerative capacity than anaemias due to the B diet.

Estimations of *the size of the red corpuscles* by Gram's method were made in a small number of cases. However, owing to the limited number of estimations no definite conclusions can be drawn. The examinations were made for a differential diagnostic purpose so as to exclude the diagnosis of pernicious anaemia.

The sizes of the cells differed widely from those in pernicious anaemia. Macrocytes occur, it is true, but they are by no means so frequent as in pernicious anaemia. In none of 12 cases examined, most of them belonging to the LIa group and exhibiting evidences of pronounced anaemia, does the number of macrocytes ($D > 8.5\ \mu$) exceed 11 per cent.

The *volume of the cells* was determined in 6 cases in the L diet group. All of them showed a rather high volume index, on the average 1.08, which also indicates the not infrequent hyperchromatic character of the anaemia, since, according to NEAGELI, the red corpuscles are normally saturated with haemoglobin. Thus an index above 1 signifies an increase in the size of the red corpuscles.

Vital staining of red corpuscles. The number of vital stained red corpuscles (reticulocytes) is to be regarded as a sign of regeneration of red corpuscles. Even at the beginning of the investigation the observation had been made (ODIN) that a striking feature of the dietary anaemia was the absence of regenerative forms. This view proved to be correct. Reticulocytes in any noteworthy number could be observed only in the most advanced cases of anaemia due to the L diet. With a Hb value of 70 per cent or less they amounted to 12 per cent, and with a Hb value below 60 per cent they rose to 25 per cent. A comparison with the B diet anaemia, only 4 cases with a Hb value below 60 per cent being examined, showed 33 per cent reticulocytes. Nucleated red corpuscles were never met with.

Signs of *increased blood destruction* in the form of higher bilirubin values in the blood (HIJMANS V. D. BERGH) and an increased amount of urobilin in the urine (SCHLESINGER's test) were not found in any case.

Osmotic resistance of red corpuscles. The resistance of red corpuscles to the action of hypotonic saline solutions is somewhat increased both with respect to complete haemolysis and incipient haemolysis, if the limit is fixed, according to MEULENGRACHT and GRAM, at 0.30—0.38 and 0.48—0.52. There is no evident difference between the results obtained for the different types of diet.

Leucocytes. The number of leucocytes in cases with normal Hb values is 5453 in men belonging to the L diet group (15 cases) and 5388 in women (33 cases). In the B diet group the number amounts to 6229 in men (7 cases) and 5736 in women (11 cases). Lower haemoglobin values are often associated with a slight

decrease in the number of leucocytes, but on the average this decrease amounts only to 500 when the Hb value is below 60. In a few isolated cases the decrease is much greater. There is no marked difference in this respect between cases of anaemia belonging to the L diet groups and those belonging to the B diet groups.

Differential leucocyte count. The number of neutrophiles is regularly lower in the L diet group than in the B diet group. This difference exists irrespective of the Hb value. It is not great, amounting to only 4.1—7.7 per cent for different groups of Hb values. In a decrease in the Hb value the number of neutrophiles sometimes shows a slight increase, sometimes a slight decrease. The average number of these cells in men belonging to the L group is, irrespective of the Hb value, 58.1 per cent and in women 59.5 per cent. The figures for men and women belonging to the B diet group are 63.6 and 61.9 per cent respectively.

The average number of eosinophile leucocytes does not exceed 2.5 per cent in any diet group. No evident variation in the number can be observed in varying Hb values.

In 104 cases belonging to the L diet group examined, the average number of basophile cells was found to be less than 1 per mille. The average number in the B diet group was 2 per mille.

The average number of monocytes is 5—5.7 per cent. No evident difference can be observed with respect to the different types of diet and the varying Hb values.

The average number of lymphocytes in men belonging to the L diet group (26 cases) is 31.4 per cent, and in women (83 cases) 32.7 per cent. The average values for men (10 cases) and women (24 cases) belonging to the B diet group are 27.7 and 30.4 per cent respectively, that is, a relatively slight lymphocytosis in the cases belonging to the L diet group. In an increase in the degree of the anaemia there is frequently a reduction in the number of lymphocytes in proportion to the number of leucocytes, but never to such an extent that the number of lymphocytes falls below 25 per cent, on the average. In a very few instances the decrease was greater.

Classification of the leucocytes in accordance with ARNETH's index made in 9 cases belonging to the LI diet group showed a slight shift to the right in all cases, indicating that the regeneration of leucocytes is slow.

Further, determinations of the *bleeding time*, by DUKE's technique, and the coagulation time of blood, by FONIO's technique, were made in a number of cases. The results obtained showed normal conditions and no difference between the various diet groups.

The *retraction of the blood clot* (FONIO), which is considered to be comparable to a thrombocyte count, in that a diminution of the retraction takes place when the number of thrombocytes decreases, is less in the L diet group than in the B diet group, thus corresponding to a reduced number of thrombocytes. When the anaemia increases, the retraction of the blood clot is also increased, as expected.

The *coagulation valency*, by Fonio's technique, is higher in the L diet cases than in the B diet cases. The coagulation valency falls when the anaemia increases.

F. Prognosis and treatment.

The prognosis of the anaemia, both *quo ad vitam* and *quo ad valitudinem*, is very favourable. The patients do not die of their anaemia, and the treatment, in spite of the relatively short period of observation (about 1 month in more than 95 per cent of the cases), brought about a considerable improvement or a return to normal values. This applies to both the number of the red corpuscles and the amount of haemoglobin.

The treatment consisted of: 1) in the cases of the L diet group and when no contra-indication existed, a change of diet to the BIIc type; 2) administration of iron, mostly in the form of ferrum reductum in a dose of 1 gr. 3 times daily, sometimes smaller doses were given: Sol. citr. ferric. chin. 4/300 one tablespoonful 3 times daily. A few patients, in whom the desired effect was not obtained by treatment with ferrum reductum, were given instead ferrostabil, 1 gr. 3 times a day; 3) treatment with quartz and carbon arc lamp; 4) some patients with a lowered B. M. rate were given thyroid tablets, 0.3 gr. 3 times a day, provided this relatively large dosage was tolerated; 5) liver preparations in the form of raw liver or hepatotal were also given occasionally.

In the great majority of the cases several of the above-mentioned methods of treatment were employed simultaneously. It is therefore difficult to draw any definite conclusions concerning the value of any of them. It was in the interest of both patient and hospital that recovery was effected as soon as possible, because the hospital was overcrowded with patients, a state of things which greatly hampered the progress of these investigations. Nevertheless, in working up the data, we endeavoured to

obtain an idea of the value of the various therapeutic measures from the comparatively small number of cases where only one method of treatment was employed. Fortunately there are cases of that kind and also cases where one method was replaced by another, when the former proved ineffective.

The greatest interest is attached to those cases of anaemia in the L diet group in which the only method of treatment employed was the change of diet mentioned above. In these cases, 30 in number, an improvement was observed in 19 of them. In 2 cases the improvement was considerable, a gain of 4—5 per cent weekly. No improvement occurred in 11 cases on change of diet alone.

Light treatment alone (9 cases) brought about some improvement in 6 cases but none in the other 3 cases.

All the 22 cases treated only with iron showed an improvement, which was quite considerable in 10 of them, a gain of 3—5 per cent weekly.

In 2 cases out of 8 with a lowered basal metabolic rate the thyroid treatment seemed to have had a favourable effect also on the treatment of anaemia.

In the other cases a combination of various methods of treatment was employed, and it is therefore impossible to draw any definite conclusions as to which method was the effective one.

One thing, however, is clear, that when iron administration formed part of the treatment, the effect was more rapid and potent than in a combined diet and light treatment without iron. No marked difference could be shown in the results of the iron treatment in the various diet groups. In a few cases no effect at all, or only very little, was obtained by using ferrum reductum, even when combined with diet and light treatment. But the administration of ferrostabil in such cases always produced good results. In the great majority of cases, however, ferrum reductum, possibly combined with light treatment and a change of diet, gave good effects.

It was frequently observed during the treatment of these cases that the administration of iron produced good results in the early stages, but afterwards failed or became less effective. This occurred as a rule in cases with a Hb content of 70—80 per cent and a red corpuscle count of 4—4.5 million. We feel almost certain that there was a causal factor in the anaemia in question on which iron medication has no effect.

G. Analysis of the causal relationship between the unvaried milk-meal diet and the occurrence of anaemia.

In the same manner as it influences the gastric function, the diet may also have a toxic effect on the blood, either direct or indirect, owing to quantitative or qualitative deficiencies.

1. *Toxic factors.*

It is inconceivable that the L diet, which consists chiefly of milk, flour, potatoes and butter, introduces into the organism any substances which, owing to their direct toxic effects, cause anaemia. The ingredients are of the best possible kind. The toxic factor should in that case be the character of these ingredients.

Injuries due to the use of cereals is practically unknown in adults, and the so-called »Mehlnährschaden» in infants are at present considered to be phenomena of inanition (FINKELSTEIN). The theory of alimentary anaemia in children advanced by CZERNY, which created such a stir among pediatricians, and according to which it is contended that milk has a toxic effect, has also been discarded. With regard to this so-called milk anaemia, the existence of which is hitherto unknown in adults, two essentially different interpretations have been advanced. According to one interpretation the anaemia is due to the milk being deficient in biologically important accessory nutritive substances (FINKELSTEIN, HOFMEISTER, ARON), while the other interpretation is that milk causes a toxic decomposition of the blood. According to the former interpretation there is thus present a form of hypovitaminosis. This possibility will be discussed later. These dietary anaemias exhibit no signs of increased blood destruction with enlargement of the liver and spleen due to haemosiderosis as the result of a toxic action, nor has there been shown any increase in the amount of bilirubin in the blood or of urobilin in the urine or any urobilinogen in the faeces.

There is no reason for interpreting the anaemia in our material as a result of repeated infections or a constitutional weakness. There is nothing to indicate that infections are more common in the L diet group than in the other diet groups. To suggest the presence of a constitutional weakness in the large group of population subsisting on the L diet would be absurd.

2. *Quantitative under-nutrition.*

As shown above, a certain degree of quantitative under-nutrition is not infrequent in persons living on the L diet. The blood picture in a moderate degree of quantitative under-nutrition generally exhibits no changes. On the other hand, anaemia is not uncommon in under-nutrition, at least it is not inconceivable. JANSEN has shown that inanition anaemias have a high colour index. In some cases of inanition there is no anaemia, but the Hb value is abnormally high (JAKOBSTHAL, ZUNTZ and LOEWY). On the other hand, BENEDICT and co-workers have shown that a decrease in the Hb content and in the number of red corpuscles occurs in under-nutrition. The fall in the Hb level is relatively greater than the diminution in the number of red corpuscles. Hence it must be a question of a secondary anaemia. Further, in under-nutrition the blood picture shows a leucopenia with a relative or absolute lymphocytosis. Thus the L diet anaemia present features analogous to those found in inanition anaemia, but they are not so pronounced.

The cases in the L diet group often showed a decreased basal metabolic rate, and there were definite reasons for assuming that this was due to a reduction in the internal secretory activity. According to NAEGELI, BÜRKER and ASHER, haematopoiesis is regulated by the action of hormones. The regeneration of red corpuscles is slow in the L diet anaemia. It is therefore possible that an explanation may be found along these lines not only of the anaemia in the L diet group but also of the anaemia due to under-nutrition. On the other hand, the degree of anaemia does not by any means always correspond to the decrease in the basal metabolic rate, and in a great many cases no under-nutrition is demonstrable.

As already pointed out (p. 57), under-nutrition cannot be regarded as a primary symptom, but rather as a secondary symptom due to certain deficiencies in the diet.

In 13 men, or 39 per cent of the cases examined, belonging to the L diet groups, chiefly the LIa group, the basal metabolic rate was decreased. These showed an average Hb value of 84 per cent. All men belonging to the L diet groups had an average Hb value of 87 per cent, while the LIa group, to which most of the cases with a decreased basal metabolic rate belonged, had an average value of 85 per cent. Of the women, 37 (49 per cent

of all cases examined) showed a lowered basal metabolic rate with an average Hb value of 80 per cent, while the average value for women belonging to the L diet group was 78 per cent. The women in the LIa group, to which most of those examined belonged, had an average Hb value of 75 per cent.

This seems to indicate that the decreased basal metabolic rate and the anaemia are to be regarded as parallel symptoms due to the same cause, but relatively independent of each other.

3. *Qualitative under-nutrition.*

It has already been shown that the nitrogen content of the LIa diet is low. Records in the literature lend support to the view that the Hb value is reduced in a diet poor in nitrogen (Albertoni-Rossi, Nasse, Verdeil, Subbortin, v. Hoesslin and Grawitz). Animal food increases the regeneration of the blood (Morawitz and Kühl). Davies suggests that the anaemia of persons suffering from gastric diseases is due to the fact that they refrain from eating meat, which puts a greater strain on the stomach, and therefore change to a lactocereal diet, which is poor in iron. This deficiency of nitrogen thus seems to be a contributory factor in the origin of anaemia.

Another characteristic feature of the L diets is their deficiency in iron. According to an analysis of the diet, the average iron intake of men is 17.5 (10.4—23.4) and women 11 (8.4—12.3) mgr. The amount of iron which the organism requires daily to maintain a normal haemoglobin level is said to be 6—12 mgr. From this we infer that the iron content of the diet is often too small. This relative iron deficiency is further accentuated by the fact that the resorption of iron is greatly reduced by the frequent occurrence of achylia (Reimann and Fritsch). Here is perhaps one explanation of the anaemia. Opinions differ widely with regard to the influence of an iron deficiency on the origin of anaemia. Bunge's classical investigations should be mentioned in this connection. Goett claims to have shown that Bunge's theories also apply to later ages. The results obtained in these studies by the administration of iron may be adduced as proof that a deficiency of iron is one of the causes of anaemia, whether we assume that the iron administered makes up for an existing deficiency, or, in the same manner as Nægeli and v. Noorden, we consider that the iron stimulates the haematopoietic apparatus to a greater activity.

In the foregoing it was shown that anaemia is more common and much more advanced in cases with achylia than in those with gastric acid juice. The L diets, especially the LIa diet, bring about an increased frequency of anaemia. Anaemia is more common and usually of a more severe degree among women than among men. It is generally established that achylic anaemia occurs especially in women, and many authors are of opinion that generally speaking men never have achylic anaemia. It is evident, however, from our material that achylic anaemia is not infrequent in men, although not so frequent or so severe as in women (cf. Tables on pp. 183—184). Most investigators are of opinion that anaemia in achylia is due to deficiency of iron, owing to the fact that achylia greatly inhibits the resorption of iron. OTTENBERG contends that achylic anaemia occurs more commonly among women because they are more subject to losses of blood owing to menstruation and pregnancy. In the same way we might be able to explain the more frequent occurrence of the L diet anaemias in women than in men.

Opinions differ, however, as to the relationship between anaemia and achylia, whether the achylia is the primary factor or not. Most investigators are of opinion, in conformity to the view that the cause of the anaemia is a deficiency of iron, that the achylia is the primary process, that it existed before the anaemia (MEULENGRACHT). In our material anaemia frequently occurs alone, without any association with achylia, while on the other hand there are several cases of achylia without any evidence of anaemia. Therefore achylia and anaemia seem to be concurrent symptoms of the same cause. That anaemia is most frequent and most pronounced when it occurs simultaneously with achylia can be explained by the fact that the iron deficiency becomes more pronounced owing to the achylia. It is also possible that in cases where achylia is associated with anaemia the dietary factor becomes more effective. These persons live on a more unvaried L diet than do the others.

All investigators are agreed that the picture of achylic anaemia is of a hypochromatic type. This type is also the most common one in the L diet anaemias, but the hyperchromatic type is found in quite a large percentage of the cases. The colour index, however, remains mostly at about 1.

The following table shows the correlation between the colour index and the gastric acidity and the composition of the diet.

Colour index	Men				Women			
	L diet		B diet		L diet		B diet	
	Congo −	Congo +	Congo −	Congo +	Congo −	Congo +	Congo −	Congo +
1.3	—	1	—	—	—	—	—	—
1.2	—	1	—	—	—	1	—	—
1.1	1	2	1	6	—	—	2	9
1.0	17	15	10	47	26	4	4	41
0.9	17	7	6	17	22	33	12	30
0.8	1	3	1	4	17	6	3	4
0.7	—	1	1	1	8	3	1	2
0.6	1	1	—	—	5	1	1	1
0.5	—	—	—	—	1	1	—	—
Total	37	31	19	17	79	72	23	87
Mean index	0.94	0.96	0.95	0.97	0.87	0.94	0.90	0.96
Index below 1 %	51	39	42	29	67	47	74	43
» above 1 %	3	13	5	8	0	7	9	10

From this table it appears that hypochromatic anaemia is more frequent in the achylic cases than in the Congo positive cases and more common among women than among men.

In the hyperchromatic cases the position is reversed. Hyperchromasia is less common among the achylic cases than among the Congo positive cases and the material in its entirety, due to the better resorption of iron in the Congo positive cases.

The blood picture in the L diet anaemia otherwise agrees very closely with the achylic anaemia. This applies to the anisocytosis and poikilocytosis, the osmotic resistance, the haemolysis and the number of blood platelets. The leucocyte picture, the predominance in women, the age, the course and the result of the treatment also agree very closely with the picture of achylic anaemia. On the other hand, it must be pointed out that the blood picture described in achylic anaemias cannot be considered characteristic enough to permit the diagnosis of achylic anaemia on the blood findings alone. A noteworthy feature is the colour index, as a rule about 1 in the L diet group (p. 188), frequently a little above 1. This feature, and above all the occurrence of the hyperchromatic cases, point to another origin than a deficiency of iron. This causal factor is found in the L diet itself, in which, as mentioned above, under-nutrition and lack of nitrogen or some correlative factor play a part in the genesis of the anaemia. It

can also be considered established, however, that achylia is of a certain importance in the origin of anaemia and its degree. Achylia alone, on the other hand, does not explain the anaemia, nor does the iron deficiency of the L diet explain it fully. True anaemias due to a deficiency of iron, to which the achylic anaemias belong, are characterised by a pronounced hypochromatic blood picture.

The question of hypovitaminosis will be discussed in a separate chapter. The composition of the diet predisposes to a B, D and possibly C hypovitaminosis. All these types of hypovitaminosis may give rise to anaemia, provided they otherwise produce pronounced symptoms. The hyperchromatic feature of the picture may be explained by the occurrence of a B hypovitaminosis, since, as far as we know, neither a C nor a D hypovitaminosis without any manifest symptoms gives rise to anaemia.

CHAPTER VII.

The Occurrence of Haematuria (Erythrocyturia) minima.

When the author moved from Skåne to Västerbotten he was surprised to find that microscopical examinations of the urine of patients in Västerbotten, contrary to his experience in Skåne, frequently revealed the presence in the sediment of small quantities of red blood corpuscles, although there were no other signs of renal disease evident. Investigations were therefore carried out in order to study this condition and if possible to find out its cause.

In 1914 CASTRO drew attention to the comparatively frequent occurrence of a mild haematuria, »erythrocyturia minima», in children. The cause of the disease was considered by CASTRO to be primarily an infection by some unknown agent, secondarily to be due to a constitutional disposition.

The material examined in the present investigation comprises patients admitted to the hospitals of Umeå and Lund. The age of the subjects varies between 16 and 45 years. Careful selection was made and great care was taken to exclude all diseases and morbid conditions which might be thought to give rise to the presence of red corpuscles in the urine, particularly disorders of the kidneys and urinary tract, cardiac diseases, diabetes, arteriosclerosis, all febrile diseases, leukaemia and haemorrhagic diatheses.

The urine was repeatedly examined after the patient's confinement to bed, not only for the presence of albumin but also microscopically after centrifugalization. The examination of the Umeå cases also included determination of the blood pressure and estimation of the blood urea and STRAUSS' functional test. Apart from the presence of red corpuscles and a few solitary leucocytes in the sediment no signs of renal injury could be discovered. The material was divided into the following groups:

1) cases in which no red corpuscles could be detected in the field of the microscope; 2) cases with an average of 0—1 red corpuscle per field; 3, etc.) cases with respectively 1—3, 4—6 and 7—12 corpuscles per field. In no case did the number of corpuscles per field exceed 12. As a rule at least 20 fields were counted, the total number of corpuscles added and then the average number of red corpuscles per field was calculated. A medium size Zeiss' microscope was used with a × 7 eyepiece and objective D. 40, corresponding to a magnification of × 280.

The following table gives the average number of red corpuscles per visual field found in the cases belonging to the Umeå and Lund materials.

Average number of red corp. per field	0	0—1	1—3	4—6	7—12
Umeå No. of cases ...	545	98	65	7	7
Lund » » » ...	393	32	7	0	0

It will be seen from the table that the frequency of mild haematurias (with more than 1 red corpuscles per field) is much higher in the Norrland material, 10.9 per cent of 722 cases examined, than in the Skåne material, 1.6 per cent of 432 cases examined. The difference, 9.3 per cent, cannot be due to chance, and is statistically significant. This accords with the general opinion that the present writer had formed, even if the difference is less than expected.

The table also shows that the number of red corpuscles found in the sediment is greater in the Umeå material than in the Lund material.

Owing to the small number of cases of mild haematuria in Lund, the material will not be subjected to a further analysis.

The sex incidence of haematuria in the Umeå material is as follows: —

Of 384 men 37 (9,6 %) had mild haematuria (> 1 red corp. per field).
» 338 women 39 (11,5 %) » » » (> 1 » » » »).

Thus the difference in frequency between the two sexes is small and is not statistically significant.

The frequency distributions among the different diet groups are shown in the next table.

In 181 cases belonging to the L diet groups, a mild haematuria with more than 1 red corpuscle per field was found in 12.5 per cent, in the B diets the number of affected amounted to 10.7 per cent of the cases. This possibly signifies a slightly higher frequency in the L diet groups. The percentage figures for the LIa and BIa groups are 11.5 and 8.7 respectively. For the BIIb diet group the figure is 12.5 per cent. We are therefore not

The frequency of haematuria in relation to the various diet types.

Diet	Red corpuscles per field of vision					
	0	0—1	1—3	4—6	> 6	Percentage of cases with > 1r. c. per field of vision
LIa	100 (75.8%)	17 (12.9%)	13 (9.9%)	1 (0.8%)	1 (0.8%)	11.5
LIIa	64 (73.6%)	11 (12.6%)	11 (12.6%)	0	1 (1.1%)	13.7
Total L diet	181 (73.2%)	35 (14.2%)	27 (10.9%)	1 (0.4%)	3 (1.2%)	12.5
BIa	144 (73.5%)	35 (17.9%)	15 (7.7%)	2 (1%)	0	8.7
BIIb	136 (70.5%)	33 (17.1%)	17 (8.8%)	4 (2.1%)	3 (1.6%)	12.5
Total B diet	280 (71.9%)	68 (17.5%)	32 (8.2%)	6 (1.5%)	4 (1 %)	10.7
Total S diet	10 (59 %)	3 (17.6%)	4 (23.5%)	0	0	23.5

justified in assuming that there is a definite correlation between the frequency of mild haematuria and the composition of the diet. Nor does there appear to be any definite correlation if regard is paid to the amount of fruit and vegetables in the diet.

The a-diets comprise 432 cases with mild haematuria in 48 (11.1 %).
The b- and c-diets » 211 » » » » » 28 (12,5 %).

We should expect to find a definite correlation between the incidence of haematuria and the general tendency to haemorrhage as it appears from the bleeding test in venous stasis. The following table, however, shows that there is no correlation between the two.

According to Castro, one of the causes of erythrocyturia minima is infection. As far as our material is concerned, all cases of infectious diseases were excluded, also those who had recovered from a recent infection. It is obvious, however, that slight infections are easily overlooked.

Number of haemorrhages	Red blood corpuscles					
	0	< 1	1—3	4—6	> 6	Haematuria min. %
< 6	233	67	15	1	1	5.4
7—9	38	5	5	—	1	12.3
> 9	57	13	2	1	1	5.4

In the first place one suspects infectious processes from the mouth cavity. Cases affected with tonsillitis were therefore excluded as far as possible. Careful attention was, however, paid to the condition of the teeth and the gums. Examinations of the teeth and gums were made on 449 patients. The results are shown in the following table. With regard to the condition of the gums, only severe gingivitis is noted, which is recorded by means of a plus sign; a minus sign denotes that no gingivitis was present.

Correlation between red blood corpuscles in the urinary sediment and condition of teeth and gums.

	0	0—1	1—3	4—6	> 6	haematuria %
Gingivitis						
+	160 (74.1%)	34 (15.7%)	20 (9.3%)	1 (0.5%)	1 (0.1%)	10.3
—	184 (79%)	35 (15%)	11 (4.7%)	1 (0.4%)	2 (0.9%)	6
Carious teeth						
0	146 (75.6%)	32 (16.6%)	15 (7.7%)	0	0	7.7
1–8	242 (74%)	51 (15.6%)	28 (8.6%)	4 (1.2%)	2 (0.6%)	9.4
> 8	69 (71.1%)	13 (13.4%)	14 (14.4%)	1 (1%)	0	15.4
Prothesis.....	69 (84.1%)	2 (2.4%)	6 (7.3%)	2 (2.4%)	3 (3.7%)	13.4

Generally speaking, the same results were obtained in recording the frequency of haematuria in relation to the number of healthy teeth. The frequency of haematuria increases in proportion to the decrease in the number of healthy teeth. Thus it seems clear that the condition of the gums and of the teeth has an influence on the incidence of haematuria. The presence of a severe gingivitis increases the incidence of haematuria. The incidence is also increased in proportion to the number of carious teeth. Cases with false teeth are grouped separately, and even in this group

the incidence of haematuria is relatively high. As regards these cases it may be assumed that extensive caries as well as gingivitis had been present previously.

The results of these examinations thus show that haematuria minima, at least in a great percentage of the cases, is to be considered as a slight renal infection, originating from an inflammatory process in the teeth and gums.

CHAPTER VIII.

The Occurence of Deficiency Diseases (Hypovitaminosis).

In an earlier chapter a brief account was given of the occurrence of hypovitaminosis due to the composition of the diet. It was found that none of the diets showed a total vitamin deficiency, but that a partial deficiency is possible in the LIa diet, especially in respect to vitamins B, C and D, while the B diet and particulary the S diet are deficient in vitamins C and D. The fact that there is no total absence of vitamins explains, as was expected, why no pronounced symptoms of deficiency diseases are manifested, or are at any rate very rare, in the Norrland material, at least as far as adults are concerned. The vitamin requirement of children is relatively greater, and they are also more susceptible to a comparative deficiency. Hence the most pronounced symptoms should be expected in children.

A relative vitamin deficiency, particularly in adults, is therefore of importance, and may quite conceivably result in some form of ill-health as an expression of a latent hypovitaminosis. Such a diagnosis is, however, difficult to make, as the symptoms are by no means always characteristic. The symptoms possibly existing may also be stationary, the primary or secondary sequelae of a hypovitaminosis, as for instance, dental changes in a deficiency of vitamin D or C. Hence in these cases we are unable to submit the only reliable evidence of their being due to a hypovitaminosis, viz. that the symptoms disappear when food rich in vitamins is supplied.

It is also possible that in a given case there is a relative deficiency of more than one kind of vitamin, and that the symptoms observed are due to a combination of factors, which renders the interpretation still more difficult. The problem of the symptoms of latent hypovitaminosis still remains to be solved.

Mellanby and Green have shown that a latent hypovitaminosis is possible and is not merely imaginary. These investigators have also produced evidence to show that the margin between the optimal dose of vitamins and the protective dose necessary to prevent acute symptoms is very wide. The optimal dose is several times greater than the protective dose. Evidence in support of the view that a latent C hypovitaminosis occurs has been furnished also by Swedish investigators, such as Höjer, Westin and Öhnell, whose important investigations have contributed to the solution of this problem.

After these general remarks we shall now proceed to a discussion of the symptoms in various forms of hypovitaminosis. The deficiency diseases occurring in man are A, B, C and D hypovitaminoses; as regards the B group chiefly B_1 and B_2 hypovitaminosis.

As far as could be judged, the various types of diet contain an amply supply of vitamin A, and no case of xerophthalmia, keratomalacia or hemeralopia was observed. Nor could it be shown for certain that infections are more common in the Norrland material. No nervous symptoms suggestive of ergotism, characterised by Mellanby as a form of A avitaminosis, could be found in this material. Symptoms of a latent A vitaminosis are scarcely known.

The amount of vitamin B (B_1 and especially B_2) in the LIa diet is relatively small. Beri-beri, which is endemic among rice-consuming peoples and which is considered to be typical of a B_1 hypovitaminosis, is certainly not a pure form of deficiency disease (Stepp). Its principal symptoms, paralysis, oedema, exudate in the serous cavities, cardiac hypertrophy and heart failure, gastric and intestinal disorders, are not noted in this country.

In addition to polyneuritic symptoms, which are considered to be pathognomonic of a B_1 hypovitaminosis, Hopkins, Drummond and co-workers, Stepp and others have reported a disturbance of the metabolism in purely experimental B_1 hypovitaminosis. Loss of appetite and inanition seem to be practically always present. According to Drummond and co-workers, most of the symptoms discernible in a deficiency of vitamin B_1 are to be ascribed to inanition. One of these symptoms is the decrease in the basal metabolic rate (Abderhalden and others) and another is the frequently observed disturbance of the carbohydrate

metabolism (Randoin and Simmonet). The atrophy and cellular degeneration demonstrated in most parenchymatous organs may be explained in this way. A decrease in the secretion of gastric juice due to a deficiency of vitamin B_1 has been shown to occur in dogs (Miyadera). In guinea-pigs pepsin is entirely absent in this condition (Danysz-Mickel, Koskowski), and even the secretion of pancreatic juice is reduced (Tsukiye and Okada). These disturbances may perhaps also be attributed to the undernutrition due to a B_1 avitaminosis.

Degeneration and atrophy of the endocrine glands in B_1 avitaminosis have already been demonstrated by Funk and Douglas. Exceptions to this rule are the suprarenals and the pituitary body, which are enlarged up to 2—3 times their normal weight.

Anaemia is a frequent symptom in guinea-pigs fed on a diet deficient in B_1 vitamin (Abderhalden, Weill and co-workers, Palmer and Hoffmann). A reduction in the number of leucocytes and the presence of old degenerated polymorphonuclear cells are also frequently occurring phenomena. Castle and Strauss have shown that pernicious anaemia is caused by deficiency diseases. The missing »anti-pernicious complex» is composed of two factors, one of which is present in meat (vitamin B_2), the other in the gastric juice. When completely formed, it is stored in the liver. Hence the extraordinary curative effect of liver treatment in pernicious anaemia. This also supplies the explanation of the effect of stomach extracts on this disease, for these preparations contain abundant quantities of muscle and also gastric juice. On the other hand, meat alone has no effect on the disease, but meat digested by gastric juice has. Thus the exogenous factor (vitamin B_2) in the anti-pernicious complex is wanting in the LIa type of diet. In spite of the presence of achylia in a large percentage of the cases — not infrequently a severe achylia — in which it is impossible to produce hydrochloric acid secretion even with the use of the most potent stimulants, the endogenous factor in the anti-pernicious complex nevertheless seems to be present. Pernicious anaemia is a relatively rare disease in Norrland. At the Umeå Hospital not more than 4—5 patients are treated annually. This indicates that the frequently very severe achylia common among cases in the LIa diet group is not analogous to pernicious achylia, or that some additional factor, as yet unknown, is necessary for the development of pernicious anaemia.

The type of anaemia occurring in the L diet groups, however, has certain features similar to those found in pernicious anaemia. It is not a typical achylic anaemia nor an anaemia due to deficiency in iron. It contains a hyperchromatic element. This element is but little influenced by administration of iron. One asks oneself whether it is not the absence of the exogenous factor in the anti-pernicious complex (vitamin B_2) which gives rise to this character of the L diet anaemias.

If we compare the symptoms produced by the L diet it will be seen that all of them can be explained as the result of a deficiency of B vitamin complex. The under-nutrition, which is difficult to account for otherwise, as there is no lack of food among this population, is given a plausible explanation. This also applies to the decreased basal metabolic rate. The anaemia is explained partly by the achylia, partly by the iron deficiency of the diet, but some of its symptoms are explained by the assumption of a B hypovitaminosis. The gastro-intestinal disorders may partly be due to the easily digestible and non-stimulative diet, but a B hypovitaminosis may also be a contributory factor in the production of these symptoms.

We have been able to show that all the symptoms are connected with the low content of animal protein in the diet. In the same proportion as the amount of meat in the diet is increased, the symptoms also disappear. The symptoms must therefore be caused by a deficiency of meat or some allied factor. Now meat contains vitamin B_2, but the vitamin B requirement depends to a great extent on the amount of animal protein in the food, the vitamin B requirement decreases as the protein content increases. Further, the L diet is also lacking in food prepared from animal viscera and eggs, which are important sources of vitamin B, and the bread is always made from wheatmeal and is unfermented. Thus the vitamin B content of the food is low, and, moreover, the composition of the diet increases the need for vitamin B. That it is not the small quantity of protein in itself which produces the symptoms is evidenced by the fact that a certain percentage of the forest-workers live on a diet, the protein content of which is as low as or even lower than that of the L diet, without manifesting these symptoms. But the protein in the diet of the forest-workers, however, is not infrequently made up of meat and food prepared from animal viscera. Diabetics who have been treated for many years with Petrén's diet do not exhibit these

symptoms, although this diet contains very small amounts of protein. The protein in this diet, however, is mostly made up of eggs, cereals and fish. Further, this diet consists of large amounts of vegetables, many of which are rich in vitamin B.

Thus if the symptoms due to the L diet in the Norrland material can in all essentials be explained by the presence of a B hypovitaminosis, and there is much evidence to support such an assumption, it is quite remarkable that in this material polyneuritis, oedema or cardiac symptoms were not observed, and these are considered to be the principal symptoms of a B_1 hypovitaminosis. No instance of erythematous eruption suggestive of pellagra has been observed. Pellagra sine pellagra, that is, a B_2 avitaminosis without the characteristic eruption, may occasionally occur. The exceedingly pronounced symptoms of gastro-enteritis, especially diarrhoea, so common in this disease, are not found to any great extent in our material. No morbid changes of the tongue or pronounced psychic symptoms were observed. There is nothing, however, that argues against the assumption that these »typical» symptoms are late manifestations. The early and latent symptoms of a B hypovitaminosis are, as already mentioned, unknown as yet. However, there is nothing that argues against but much in favour of the assumption that most of symptoms associated with the unvaried milk-meal diet are caused by a B hypovitaminosis.

The typical symptoms of a C hypovitaminosis (scurvy) are mucocutaneous haemorrhages, changes in the bones and teeth. Cases with acute symptoms of scurvy were comparatively seldom met with in our material. During the 2 years in which these investigations were in progress only 6 cases of scurvy in adults were observed. In addition, 1 case of vitamin C deficiency (Barlow's disease) in a child was recorded. This cannot be regarded as a high incidence, considering that about 20,000 persons were examined and that special attention was paid to the occurrence of C hypovitaminosis. The cases of scurvy in adults observed by us are of particular interest. Three of these cases were forest-workers living on food brought with them from home, and the other three were female teachers, who had been prescribed a special diet on account of colitis. This seems to suggest that cases of C hypovitaminosis should be sought for among forest-workers, where, according to the dietary records, they are also most likely to be found.

During the last few years attention has been drawn, especially since the publication of the investigations of WESTIN and ÖHNELL, to the occurrence of a latent scurvy, the principal symptoms of which are said to be an increased tendency to capillary haemorrhages and changes of the teeth. GÖTHLIN devoted his attention chiefly to the tendency to haemorrhages, and believes that it is possible to determine the vitamin standard of the food by means of his »capillary resistance test». We have made a close study of the technique and the value of different tests on the tendency to capillary haemorrhages, and an account of these studies will be given in the following chapter. Here it need only be mentioned that the method we employed seems, as far as the results are concerned, to be quite on a par with GÖTHLIN's test. A positive result of the test cannot, as the examinations show, by any means be regarded as pathognomonic of a C hypovitaminosis. Under different physiological and pathological conditions it becomes positive, and it is not always positive even in pronounced scurvy. Nevertheless, the bleeding test is undoubtedly of value in the diagnosis of scurvy, even if it has been greatly overrated, not least by GÖTHLIN.

According to WESTIN, the dental changes in C hypovitaminosis consist in the transformation of the odontoblasts into osteoblasts, which gives rise to the formation of compact bone instead of dentine. In addition a calcification of the predentine takes place. Inner dentine (denticles) is formed between the predentine and the layer of odontoblasts. By demonstrating these with the aid of radiography or still better by microscopical examination of decalcified teeth it is possible with a high degree of certainty to show a deficiency of vitamin C.

WESTIN analysed his material in this respect and arrived at the conclusion that latent scurvy is not uncommon in the Norrland material. In this connection a curious feature of the teeth, especially in the forest-workers, is worthy of note. Caries are very seldom present. The teeth are exceedingly hard and very firmly fixed in the jaw. The surfaces are greatly attrited and even. Often only a half or a third of each tooth is left. This type of teeth, in striking contrast to the brittle, highly carious teeth of the coastal population, seems to have a certain connection with a C hypovitaminosis.

The changes found in advanced scurvy, pronounced swelling and congestion of the interdenticular papillae, which bleed

spontaneously or on pressure, and a subsequent pronounced hypertrophic gingivitis with haemorrhages, were seldom met with in our material. An aspecific gingivitis is, on the other hand, frequently found in connection with caries.

The relatively frequent occurrence of haematuria minima in this material does not seem to have any connection with scurvy, but is due to infection from the teeth and gums.

In the following chapter a description will be given of the technique employed in the capillary bleeding test and its diagnostic value, especially in the diagnosis of scurvy.

The following table shows the results of tests made on persons belonging to the different diet groups. For the sake of simplicity, only cases with more than 9 haemorrhages are recorded as »positive» (cf. pp. 222—224).

255	cases	with	LIa	diet	show	more	than	9	haemorrhages	in	14	%
31	»	»	LIb	»	»	»	»	»	»	»	10	»
188	»	»	LIIa	»	»	»	»	»	»	»	8	»
61	»	»	LIIb	»	»	»	»	»	»	»	11	»
328	»	»	BIa	»	»	»	»	»	»	»	7	»
335	»	»	BIb	»	»	»	»	»	»	»	7	»
65	»	»	BIIc	»	»	»	»	»	»	»	12	»
101	»	»	SI and SII	»	»	»	»	»	»	»	3	»

If the L diets are compared with the B and S diets, and the a diets with the b and c diets, we find that:

535	cases	with	L diet	show	more	than	9	haemorrhages	in	13	%
728	»	»	B »	»	»	»	»	»	»	8	»
101	»	»	S »	»	»	»	»	»	»	3	»
771	»	»	a »	»	»	»	»	»	»	10	»
492	»	»	b or c diet	»	»	»	»	»	»	9	»

It will be noted that the LIa diet group shows the greatest number of positive cases, and next comes the BIIc diet group, which has the richest supply of vitamin C, since fruit and vegetables form part of the diet almost daily. The a diets have one feature in common in that they contain practically no fresh fruit or fresh vegetables. The most important supply of vitamin C is derived from milk and potatoes. Milk and potatoes are important ingredients in the L diets. Persons belonging to this group consume about one litre of milk a day, and the supply of milk is, as far as can be judged, greater than in the Ba group. Hence it follows that the La diets must possess a greater possibility of maintaining an adequate supply of vitamin C than

the Ba diets, and still more than the S diets, which have a smaller supply of vitamin C but nevertheless exhibit the lowest tendency to haemorrhages.

There is another fact, however, which may furnish an explanation of the greater tendency to haemorrhages in the LIa diet group, and that is the great frequency of achylia, as appears from the following table.

No. of haemorrhages	Congo neg.	Congo pos.
0—3	126 cases 66 %	87 cases 78 %
4—6	28 » 12 %	31 » 9 %
7—9	14 » 7 %	20 » 5 %
> 9	29 » 15 %	28 » 8 %

Thus the tendency to haemorrhages seems to be more prevalent among the achylic cases than among the Congo positive cases. More than 9 haemorrhages occurred in 15 per cent of the Congo negative cases as compared with 8 per cent of the Congo positive cases. The difference, 7 % ± 3, is not statistically significant, but is probable. This difference may be due to several causes. Several investigators point out that the need for vitamin C is greater in achylia than in a normal secretion of hydrochloric acid in the stomach. This may imply that the achylic cases have a less favourable vitamin C standard than the Congo positive cases. But it may also be possible that the same factor which gives rise to achylia also gives rise to an increased tendency to haemorrhages. Still, the difference in the bleeding tendency between Congo negative and Congo positive cases and between Congo negative and »healthy» cases with an adequate supply of vitamins in the food (p. 223) is comparatively small. The majority of the achylic cases do not exhibit any increased tendency to haemorrhages. This does not indicate the presence of a C hypovitaminosis in any particularly large number of the achylic cases, and still less that the hypovitaminosis is the cause of the achylia. The greater bleeding tendency in the L diet group, however, seems to be explained, at least in part, by the high incidence of achylia in this group.

In the dietary anamnesis special stress was laid on the vitamin C content of the food in the form of fresh fruit and vegetables, and the varying amounts of vitamins are denoted by the letters

a, b and c. An a diet contains practically no fruit and vegetables, b signifies that fruit and vegetables are eaten 1—3 times a week and c implies that fruit and vegetables form part of more than 3 meals a week. But these designations do not convey any information about the amount of vitamin C supplied to the diet by other ingredients, such as milk and potatoes, etc. Some idea of this may be gathered, however, from the designations L, B and S diet, the meaning of which has already been explained. There is therefore some justification in our taking the designation b, and still more c, to imply that the diet contains a greater amount of vitamin C than the a diets.

The following table shows the frequency of achylic cases in relation to the amount of fruit and vegetables in the diet.

Diet	a		b		c	
	No. of cases	Congo neg.	No. of cases	Congo neg.	No. of cases	Congo neg.
LI	294	68 %	19	26.1 %	—	—
LII	160	38 %	41	44 %	—	—
BI	350	14 %	264	12 %	—	—
BII	—	—	21	19 %	28	7.1 %
S	38	21 %	—	—	—	—

As seen from the table, there is no significant difference between the frequencies of Congo negative cases in the different diet groups, with the exception of LIa and LIb. But as the latter group comprises only 19 cases no conclusion can be drawn. The fact that there is no significant difference between the frequencies of achylia in the LIIa and LIIb groups and the BIa and BIb groups also argues in some measure against ascribing the secretory disorder to a C hypovitaminosis.

It has already been shown (p. 164) that the haemoglobin content is but little influenced by increasing the amount of fruit and vegetables in the diet.

The following table shows the haemoglobin value in relation to the results obtained in the capillary bleeding test.

It will be noted that there is no definite correlation between the haemoglobin value and the result of the bleeding test.

This also indicates that the frequency of anaemia is not due to C hypovitaminosis, in so far as the capillary bleeding test can be regarded as an indicator of the vitamin C level.

No. of haemorrhages		0	1—3	3—5	6—9	> 9
Men	No. of cases	289	40	50	12	23
	M (Hb %) ...	91.8	92.3	91.2	90.8	90.1
Women	No. of cases	222	38	83	45	57
	M (Hb %) ...	81.3	78.0	82.1	81.3	79.5

The condition of the teeth and the gums in the different diet groups has been discussed already (pp. 106—107). Gingivitis is used here in a general sense; changes in the gums, specific of scurvy, were observed in but a very few cases. As shown by the result of the examination, gingivitis is very common. This is undoubtedly due partly to the great frequency of caries and the nature of the food, partly to the almost total lack of dental treatment in our material.

Gingivitis, like caries, is common in the L diet group, and persons belonging to the S diet group have much better teeth than persons belonging to the other diet groups, especially the LIa group. Characteristic of the dental condition of the forest-workers are the firmly fixed teeth with deeply worn chewing surfaces.

The following tables show the correlation between the dental condition and the results of the examinations of the tendency to capillary bleedings.

Denture	Good	Medium	Bad
Capillary bleeding			
< 6	241 (86 %)	191 (80 %)	297 (78 %)
7—9	16 (6 %)	23 (10 %)	32 (8 %)
> 9	24 (9 %)	25 (10 %)	53 (14 %)

Carious teeth	0	1—4	5—8	> 8	Artificial gums
Capillary bleeding					
< 6	190 (85 %)	231 (81 %)	147 (88 %)	118 (74 %)	99 (68 %)
7—9	(6 %)	23 (8 %)	9 (5 %)	16 (10 %)	19 (13 %)
> 9	(9 %)	31 (11 %)	12 (7 %)	25 (16 %)	27 (19 %)

Gingivitis	+	−
Capillary bleeding		
< 6	316 (82 %)	460 (82 %)
7—9	29 (8 %)	41 (7 %)
> 9	40 (10 %)	60 (11 %)

It will be seen from the tables that an increased tendency to haemorrhages, more than 9 haemorrhages, is possibly more common when the denture is poor and the incidence of caries high and when artificial gums are used than when the denture is good and the percentage of caries low. On the other hand, an increased tendency to haemorrhages does not seem to occur to a greater extent in cases with gingivitis than in cases not affected with gingivitis. This can hardly be said to lend support to the view that the gingivitis in these cases is due to a deficiency of vitamin C.

Dental caries is not a definite feature of scurvy, we are rather inclined to believe that the type of teeth, described above, frequently found among forest-workers, is a characteristic of this disease. The question may therefore be asked whether the great frequency of caries is not due to a deficiency of vitamin D. The composition of the diet makes this more than likely.

Rickets is very common among children in Västerbotten. From the reports of the district and school investigations it appears that in some districts from 33 to 67 per cent of the children exhibit signs of previous rickets. The dietary anamneses concerning the children are naturally incomplete, but the LIa diet seems to the most prevalent one among the children. Climatic conditions compel the children to spend a great part of the year indoors and they cannot enjoy the beneficial effect of sunshine. It is noteworthy, however, that symptoms of a vitamin D deficiency in adults in the form of late rickets, osteomalacia and ostitis fibrosa are very rare phenomena.

Mellanby and his co-workers have demonstrated the influence of D hypovitaminosis on the frequency of dental caries in older children.

In his analysis of the material, Westin, to whose work we refer the reader, was able to show the extensive occurrence of a deficiency in vitamin D, even among the cases subsisting on the LIa diet. The abundant amount of cereals in the diet might

be thought to play a certain rôle. But, according to WESTIN, a deficiency of vitamin C does not explain the inferior dental condition of cases in the L diet group. One of the causes may be found in the fact that the diet is composed of food elements finely broken up, which require very little mastication. It is not altogether improbable that the afunction or hypofunction in question may have a similar effect on the teeth as on other organs, that is, atrophy and decay. Further, cereal food is apt to undergo fermentation. This results in the production of acid products, which attack the teeth, which is all the more true of this material, where care and treatment of the teeth are very much neglected.

The dental condition in this material is of minor importance in the occurrence of achylia and anaemia. It is hardly possible that a deficiency of vitamin D in adults, with no demonstrable skeletal changes, impairs the secretion of gastric juice and gives rise to an anaemic condition. In this connection attention should be called to the very striking circumstance that the haemoglobin level rises rapidly and the capillary bleeding tendency diminishes quickly in the months of April—June, due probably to the influence of sunlight. We shall recur to this point later. On the other hand, no seasonal increase in the incidence of achylia was observed in our material.

Thus the clinical examinations indicate that hypovitaminoses with pronounced symptoms are very rare in the Norrland material. Only a few cases of scurvy were met with among the forest-workers or patients who had been put on a strict diet (see p. 210).

With regard to latent forms of hypovitaminosis, the clinical examinations furnish a certain amount of evidence of the occurrence of B hypovitaminosis and possibly D hypovitaminosis, especially in the LI diet group. A latent C hypovitaminosis does not appear in the clinical picture, apart from the dental condition, which appears from WESTIN's investigations (Part III). The composition of the diet also suggests that a latent C hypovitaminosis may be a not infrequent phenomenon.

CHAPTER IX.

The Capillary Bleeding Test in Venous Stasis.

The capillary bleeding test, especially the RUMPEL-LEEDE test and HESS' test for ascertaining the tendency to haemorrhages, has been considered to be very useful in the diagnosis of scurvy. This question was brought to the foreground by GÖTHLIN's investigations. He has devised a new, »physiologically based» method, by means of which he considers that he is able to draw definite conclusions concerning the vitamin C level of the subject examined. When the present Norrland investigations were started we suspected the wide-spread existence of a latent scurvy in Norrland and that this latent affection was the cause of the prevalent symptoms of disease in that part of the country. On that account the plan of the investigation included a special study of this problem. A new method of examining the tendency to haemorrhages was introduced. In addition, comparative studies were made later between our method and GÖTHLIN's test.

We call this test here »the capillary bleeding test in venous stasis». The name is rather long and cumbersome. The most commonly employed designations, capillary resistance test, capillary fragility test and endothelial test, do not seem to us to be adequate, since there is no proof that the haemorrhages are due to ruptures of the blood vessels. They can just as easily arise from diapedesis. Nor do these designations furnish any information as to the manner in which the capillaries were strained in the test.

RUMPEL and LEEDE introduced the capillary bleeding test for the purpose of diagnosing scarlet fever. If the result of the test was positive it was considered to indicate the diagnosis of scarlatina. RUMPEL and LEEDE point out, however, that the test may also give a positive result in other diseases than scarlatina, and occasionally even in healthy persons. They carried out the test by applying a rubber bandage upon the upper arm for some minutes (5—20) so tightly that a marked venous stasis was produced. If a large number of capillary haemorrhages appeared the test was looked upon as positive.

Hess considered the test to be especially valuable for the differential diagnosis between haemophilia and purpura. By means of a bandage or a blood-pressure cuff applied for 3 minutes on the upper arm, he attempts to compress the blood vessels sufficiently to stop the venous blood flow, but not the arterial. The radial pulse must be easily palpable. According to Hess, this generally requires a pressure of 100 mm. Hg in adults and 80 mm. in children.

Boye and Öhnell recommend a pressure midways between the systolic and diastolic pressures, but later they seem to have determined the pressure at 90 mm.

Stephan, who has made a close study of the capillary bleeding test and also carried out extensive experiments with a cupping glass instead of a stasis bandage, has recommended the following technique for the test with a compression bandage: A stasis bandage, 5 cm. in width, is applied 4 fingers' breadth above the elbow so tightly that the veins feel quite filled and the radial pulse easily palpable. He asserts that no definite pressure can be fixed. It will depend on the blood pressure. The duration of the stasis should be 5 minutes and the reading should be made after another 5 minutes. He is of opinion that the appearance of numerous haemorrhages on the hand and forearm is undoubtedly pathological. Haemorrhages on the upperarm, on the contrary, are of no importance.

Finally, Bayer applies a pressure which is 10—20 mm. Hg below the systolic pressure, and fixes the stasis period at 5 minutes.

As appears from the above brief survey of the different technique employed in performing the capillary bleeding test, there does not seem to be a uniform method. The inherent defect of most of the methods practised is that the pressure applied is not uniform. The pressure depends on the existing systolic pressure and possibly also on the diastolic pressure. To be able to form conclusions of universal applicability and especially to obtain comparable results from the capillary bleeding test, performed in these different ways, it is necessary that the bleeding tendency varies with the rise and fall of the blood pressure so that, for instance, cases with high blood pressure should just as easily tolerate a static pressure of, let us say, 70 and 140 mm. But this is by no means the case. The strain on the capillaries will vary considerably at different static pressures, and therefore the results of the tests will also be different. It was this fact that made it clear to us, at the outset of these investigations in the spring of 1928, that our first task was to find a suitable method for clinical use, with a constant static pressure, over- or under-pressure. We persevered with this task during the whole of the latter half of 1928 at Umeå Hospital. I shall not enter into the details of all the experiments made

with stasis bandage and cupping glass, variation of the stasis period, over- and under-pressure, various places of applying the stasis, etc. The subjects employed in the experiments were all healthy individuals of both sexes, who subsisted on a mixed and, as far as could be judged, vitamin-rich diet. The results of these experiments proved that the most suitable and simplest precedure was the following: —

A sphygmomanometer cuff, Riva-Rocci type, is applied at least 5 cm above the elbow. The cuff is connected to a standardized manometer. The arm must not be washed or massaged before the test. By means of a rubber ball, air is pumped rapidly but steadily into the cuff until the pressure reaches 80 mm. Hg and is kept there for exactly 3 minutes. During the test, the arm is held slightly bent, supported horizontally if the patient is lying down, or on a level with the heart if the patient is sitting. After the test, the arm is rubbed lightly from below upwards in order to remove the hyperaemia, and then a count is made of the number of haemorrhages within a circular area (4 cm in diameter) at the place where the haemorrhages are most numerous. The reading should be made in daylight or equally good illumination. The whole of the forearm should be examined very carefully. According to Aschoff and Kock, Bierich, Feig, Salle and others, the hair follicles are predisposed sites of the haemorrhages in scurvy. After a few minutes the result of the reading is controlled, for it sometimes happens that the haemorrhages are more conspicuous after the lapse of a few minutes. Haemorrhages at the lower edge of the cuff, which are very common, are not taken into account.

In making the test on children a lower pressure, 60 mm., should be applied and the stasis time should be a little longer, 5 minutes.

The reasons why the technique described above is the most satisfactory one are briefly the following: — A protracted time of stasis renders the test less suitable as a clinical method of examination. The duration of the stasis should therefore be as short as possible. This implies a higher static pressure. On the other hand, the duration of the stasis should not be too short, for the pressure in the veins and capillaries requires a certain time to rise to its maximum level. The time required for this rise depends in a certain measure on the difference between the systolic pressure and the static pressure. The time of the rise should be approximately the same in different cases and should

not be too long, as under such circumstances the pressure in the capillaries will not remain effective for a sufficiently long period or perhaps be unable to produce any effect at all. Nor should the static pressure be too high, as in that case the difference between the systolic pressure and the static pressure will be too small. A suitable balance between the duration of the stasis and the static pressure with a comparatively short period of duration characterizes the test we employed. By simultaneously measuring the venous pressure (by means of a cannula introduced into one of the large veins of the forearm and connected to a manometer) it was possible to demonstrate a relatively constant venous pressure in different cases, on the average 70 mm., with a relatively constant, not too long, rising time (= the length of time that elapses before the venous pressure becomes constant) of 75—105 seconds. With a higher pressure the rising time is considerably prolonged and shows a greater range of variation, owing to the fact that the difference between the systolic pressure and the static pressure is reduced to less than 25—30 mm., which proved to be the minimum pressure for obtaining a maximum venous pressure in a relatively short time. A static pressure of 80 mm. is therefore adequate in most cases of adults. The results recorded here agree very well with those found by GRILL, whose method of examination does not differ very much from ours.

After the introduction of our test, which was employed thousands of times in the Norrland investigations, GÖTHLIN published a description of a new method of determining the »capillary resistance». He considers that his test satisfies all the physiological requirements of such a test.

GÖTHLIN also employs a Riva-Rocci cuff connected to a mercurial manometer. The static pressure is produced by means of a compressor, which operates a POLLITZER balloon pump of the largest size. The pressure is applied for 15 minutes. The number of haemorrhages is read with the aid of a 5 D magnifying glass within a circular area 6 cm. in diameter (4 cm. in the case of children). The test is initiated with an examination at a static pressure of 50 mm. If no haemorrhages appear, the test is at once repeated on the same arm with a pressure of 65 mm. for 15 minutes. If a pressure of 50 mm. gives rise to 1—5 haemorrhages, no further measures are necessary. If more than 6 haemorrhages appear, the test is repeated on the other arm with a pressure of 35 mm. If one or more haemorrhages are obtained in this second test, the »capillary resistance» will be approximately 35 mm. The purpose of GÖTHLIN's test is to obtain a numerical expression of the capillary resistance, which he divides into 4 groups.

1. Petechiae only with 65 mm. pressure or not even then.
2. » » 50 » » not more than 6.
3. » » 50 » » more than 6, but none at 35 mm.
4. » » 35 » » .

If the outcome of the test corresponds to Group 3, GÖTHLIN considers it to indicate an indisputable but slight decrease in the capillary resistance. Thus a test with a pressure of 50 mm. may suffice. If less than 6 haemorrhages appear, the vitamin C supply is adequate, but if the haemorrhages are more than six in number then the supply is inadequate.

The objection which must *a priori* be made against GÖTHLIN's method is that it is unsuitable for clinical use, and especially for mass examinations, because it requires a special set of instruments and in particular because it takes too long a time. GÖTHLIN disregards the significance of the first stasis test with a pressure of 50 mm., for he immediately follows it with a second test on the same arm with a pressure of 65 mm. His first group should, in our opinion, be defined as haemorrhages appearing after 30 minutes at a pressure of 50 mm. applied for 15 minutes and a pressure of 65 mm. applied for a further 15 minutes.

The reason given by GÖTHLIN for applying a lower static pressure is that, if the capillary pressure is to rise in the shortest time possible to a value which can be read directly from an excess pressure applied from the outside, this pressure must only be sufficient to stop the venous flow. If the external pressure applied is greater than the diastolic pressure, it also implies, according to GÖTHLIN, that the afflux of the blood is stopped for a part of the pulse period. In that way an individual variable is introduced unnecessarily, since the diastolic pressure differs in different individuals. To this it may be objected that the blood afflux is obstructed to a certain extent also by the application of a pressure of 50 mm. (BEXELIUS), and that even here an individual variable is present, the magnitude of which depends on the elasticity of the blood vessels, the level of systolic pressure as well as that of the diastolic pressure. It may even be possible that this variable is neutralized in some measure by the application of a superdiastolic pressure. Further, GÖTHLIN questions whether there is not a backflow of the blood in the capillaries during the pulse period at a superdiastolic pressure. Apart from the fact that such a phenomenon has not been demonstrated, it is problematic as to how it influences the tendency to haemorrhages. The best way to decide the advantages of the various methods is by actual tests and then compare the results obtained. That is what we did.

The first question in judging the value of the test is: What result does it yield when used on healthy persons whose diet contains an adequate supply of vitamin C? Another question closely connected with this is, when can the test be regarded as positive, in other words, when can a pathologically increased tendency to haemorrhages be considered to be present. In healthy persons, whose intake of vitamin C was, as far as could be judged,

adequate, the test, performed according to our technique, gave the following results: —

Of 162 men 141 (87 %) had 0—3, 19 (12 %) had 4—6, 0 had 7—9, 2 (1,2 %) > 9 petechiae.

Of 258 women 196 (72 %) had 0—3, 42 (16 %) 4—6, 10 (4 %) 7—9, 20 (8 %) > 9 petechiae.

In 35 healthy persons, whose diet contained, as far as could be judged, a sufficient supply of vitamin C, the test was made on both arms. The result was that 17 (about 50 per cent) showed no haemorrhages in either arm, 10 exhibited 1—6 haemorrhages in one arm but none in the other. The maximum difference between both arms of the same person was 6, and the maximum number of haemorrhages in a single arm was also 6 (2 cases).

The same examination performed according to GÖTHLIN's technique gave practically the same results. GÖTHLIN says that he has never found a difference of more than 2 haemorrhages between the two arms.

On account of the results obtained and especially in view of the difference in the number of haemorrhages in the two arms, BEXELIUS suggested a modification of the test in that a cuff was applied to each arm, the cuffs being connected with the rubber bulb by means of a Y-shaped tube, and the average number of haemorrhages recorded.

In 40 patients the capillary bleeding test was made on one arm, according to GÖTHLIN's method, with a pressure of 50 mm. Hg and by our technique on the other arm. The result was that in 12 cases the same number of haemorrhages was found in both arms. In 23 cases there was a difference of 1—5 haemorrhages, in 5 cases there was a difference of more than 5 haemorrhages. In 3 of the last mentioned cases, where the differences were 8, 11 and 21 respectively, the higher number was shown GÖTHLIN's test. In 2 cases with a difference of 6 and 8 haemorrhages our method showed the greater number. In 22 cases GÖTHLIN's method gave a higher number of haemorrhages than was obtained by our method. In all cases GÖTHLIN's method gave on the average a little above 1 haemorrhage more than did our method. From these examinations it appears as if GÖTHLIN's test was somewhat more strenuous than the method employed at Umeå.

Another series of comparative tests between GÖTHLIN's method and ours, carried out by another investigator, gave the following result: — The examination comprised 48 cases. In 18 cases the same number of haemorrhages was obtained by both methods, in 25 cases the Umeå method showed a greater number of haemorrhages and in 5 cases the greater number was obtained by GÖTHLIN's technique. In only 8 cases was the difference more than 6 haemorrhages. In 6 of these our method showed the greater number; 4 cases would have belonged to GÖTHLIN's Group 2, although by our method they exhibited 12, 12, 19 and 20

haemorrhages respectively. The cases examined by GÖTHLIN's method showed 0, 2, 5 and 4 haemorrhages respectively. In the two cases which with GÖTHLIN's method showed a higher number of haemorrhages, 15 and 19, our method revealed 6 and 10. In this series of examinations our method showed an average of a little above 1 haemorrhage more than the number obtained by GÖTHLIN's method (this calculation does not include a case which showed 300 haemorrhages when examined by GÖTHLIN's technique as compared with 400 haemorrhages in an examination by our method).

In 40 patients chosen at random (some of whom might thus be suspected of having an increased tendency to haemorrhages) the test was made on both arms with a stasis duration of 15 minutes and a static pressure of 50 mm. In 10 cases there was a difference of more than 5 haemorrhages between the two arms. According to GÖTHLIN's method, 8 of these cases would have shown a positive result, GÖTHLIN's Group 3, on one arm, but a negative result on the other arm, if the pressure applied in the examination is limited to 50 mm. for 15 minutes. Further, in another 3 of the cases showing a slight difference, one arm would belong to his Group 3 while the other would belong to Group 2.

A similar examination was made with our technique on another 40 patients. In 6 cases there was a difference of more than 5 haemorrhages between both arms. None had more than 9 haemorrhages on one arm. All the cases belonged to the group 7—9 haemorrhages (on the arm showing the greater number). Of the cases in which the difference in the number of haemorrhages on both arms was less, one case should also belong to this group as far as one arm was concerned, while the other arm belonged to the group 4—6 haemorrhages.

From the above it can be adduced that, as far as the results obtained are concerned, GÖTHLIN's method does not differ essentially from ours. Its superiority over ours is open to doubt. Besides, it requires a considerable time to perform, and is therefore unsuitable for clinical use, and, moreover, special appliances are necessary.

Cases exhibiting more than 20 haemorrhages are recorded separately by us and correspond, on the whole, to GÖTHLIN's Group 4.

From the above-mentioned findings in healthy persons with an adequate supply of vitamin C in their food, we are justified in recording the result of the capillary bleeding test as *negative* (normal) if the number of haemorrhages found is less than 7, *doubtful*, if 7—9 haemorrhages are counted and *positive* (pathological) if more than 9 haemorrhages are found.

The Capillary Bleeding Test with Physico-chemical Irritants.

It has been previously demonstrated that various kinds of physiological irritants cause an increase in the number of haemorrhages in the stasis test, e. g. by MAYER after cleansing the

skin with alcohol and ether, by WALTERHÖFER by means of light blows on the arm at the site of the trauma. Further, WALTERHÖFER and BAYER found that heat and irradiation enhanced the tendency to haemorrhages in venous stasis. These observations were confirmed, and also augmented, as will be shown below, by examinations made at Umeå Hospital (BEXELIUS) and at Borås Hospital (ODIN).

After a hot vapour bath there is almost regularly an increase in the number of haemorrhages.

A hot-water bath at a temperature of 38° C. does not increase the number of haemorrhages, but when the temperature of the water is raised to 40° C. the number is regularly increased.

A dessert-spoonful of pine-oil added to the bath-water causes a considerably increased tendency to haemorrhages, and the same effect is produced by brushing and rubbing the skin.

Treatment with a quartz or arc-lamp, or ultra violet rays for 10—15 minutes brings about a great increase in the bleeding tendency. Local eczema and treatment with irritating ointments, such as sulphur and resorcin, have the same effect.

All the conditions mentioned are associated with a general or local hyperaemia. As a rule the increased tendency to haemorrhages disappears in the space of 1—2 hours, at the same time as the hyperaemia decreases.

On the assumption that hyperaemia was the cause of the increased tendency to haemorrhages, a further series of tests was carried out at the Umeå Hospital. These tests showed that physical exercises and work cause an evident increase in the tendency to haemorrhages (BEXELIUS). These examinations also proved that hyperaemia brings about an increased tendency to haemorrhages, and that the test should be made after the subject has rested. With regard to school children, it should be pointed out that the test should not be made after play-time.

The Capillary Bleeding Test in Relation to Age and Sex.

BAYER and SCHUMACHER, using Rumpel-Leede's method, obtained a positive reaction in practically all infants even after 3—5 minutes' stasis; in children of 2—6 years of age the test was positive in 83 per cent of the cases, and in children 6—12 years of age it was positive in 75 per cent of the cases. On the average haemorrhages appeared more frequently in boys than in girls. In an examination of 700 children (with a stasis period of 5 minutes) with the application of a static pressure of 15—20 mm below the systolic pressure of school children in older children, and

10—12 mm below in infants, BAYER found an increased tendency to haemorrhages in 62 per cent of the cases (51 per cent for boys and 73 per cent for girls). At the age of ½—6 years haemorrhages appeared in 69 per cent of the examined cases. In new-born babes, he found the tendency to haemorrhages to be very pronounced.

Most investigators found a greater tendency to haemorrhages in adult women than in adult men (STEPHEN, VOGT, BAYER, BOYE).

At the Umeå Hospital 10.1 per cent of the 1128 persons above 15 years of age examined showed an increased tendency to haemorrhages (more than 9 haemorrhages) — 12 per cent of 579 women and 8.2 per cent of 549 men. These figures do not include cases affected with diseases which might be thought to increase the tendency to haemorrhages. Most of the cases were between 30 and 40 years of age. No marked difference was found at different ages in either men or women. No increase could be demonstrated at the menopause.

STEPHEN and VOGT have observed an increased tendency to haemorrhages in connection with menstruation and the menopause, STEPHEN also at the climacterium virile. No exact figures are available. BOYE was unable to demonstrate any increased tendency to haemorrhages in associtation with menstruation.

With regard to the influence of menstruation on the tendency to haemorrhages, the following results were obtained in our material: —

Menstruation	week	84	cases,	30	%	of	which	showed	more	than	3	haemorrhages
Postmenstr.	»	121	»	34	»	»	»	»	»	»	3	»
Intermenstr.	»	114	»	30	»	»	»	»	»	»	3	»
Premenstr.	»	137	»	39	»	»	»	»	»	»	3	»

The number of cases examined amounted to 356. As only a very small number of the cases exhibited more than 9 haemorrhages, the values given in the table are based on the occurrence of 3 haemorrhages.

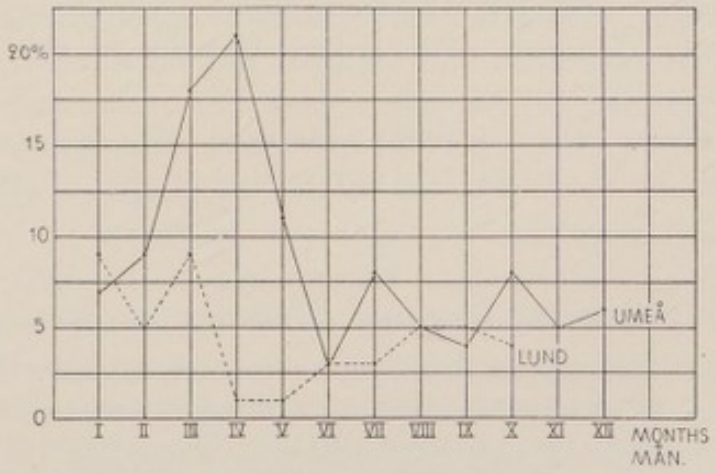
The varying number of cases in the different weeks is due to the fact that the weekly examinations, to a certain extent, cover different cases, because all the cases examined were not under our observation for the entire menstrual cycle. Thus a slight, but not statistically significant, increase in the tendency to haemorrhages is seen to occur in the week preceding menstruation.

Seasonal Variations in the Capillary Resistance.

If a positive result of the bleeding test is due to a C hypovitaminosis the frequency of such results, as far as Norrland is concerned, should be much greater during that part of the year when potatoes and milk are most poor in vitamin C and when potatoes begin to be scarce in many places, that is, in the months of May and June. In Upper Norrland the ground is still covered with snow until the middle of May, the cattle are not put out to pasture until the end of June, and new potatoes are not procurable until the end of July or the beginning of August. Fresh vegetables are hardly ever eaten, and are not ready for use until the end of July.

In view of these conditions a study was made of the tendency to haemorrhages in different months of the year. Mention has already been made of the serial examinations of patients at the hospital. The present examinations were mostly made on the same cases. As regards the influence of the seasons on the tendency to haemorrhages, it was not possible to follow the same case for several months. Instead we had to be content with recording the results obtained from different cases. In order to obtain a greater uniformity only the test made in conjunction with the first examination has been taken into account in each case. Thus each individual is represented by only one determination. The results shown in the following curve include cases with more than 9 haemorrhages. The Umeå material comprises 1156 cases, fairly evenly distributed in the different months.

Seasonal variations in the tendency to capillary haemorrhage.



The material collected at Lund consists of 1171 cases, 5 per cent of which gave more than 9 haemorrhages in the capillary bleeding test in venous stasis.

The curve for the Umeå cases shows that in April the haemorrhagic tendency is very pronounced, but afterwards there occurs a great decrease. In the Skåne curve a similar, but not so marked, decline takes place already in March. From what was said above, it is unreasonable to suppose that this decrease in the haemorrhagic tendency is due to an increase in the vitamin C content of the food. The fall in the curve takes place at a time when the supply of vitamin C in the food is lowest, that is, when there is a risk of a C hypovitaminosis. Some other factor must be involved; this is undoubtedly to be found in the insolation which is most intense, as far as Norrland is concerned, in the spring-time.

The Effect of Various Drugs on the Tendency to Haemorrhages.

Stephen and others have demonstrated that the inhalation of narcotics, the use of such remedies as trypaflavine, iodine and especially injections of salvarsan preparations bring about an increased tendency to haemorrhages.

From our investigations it appears that treatment with mercurial injections is attended by an increasing tendency to haemorrhages. On the other hand, no marked effect could be demonstrated after treatment with opium (Tinctura opii 10—15 drops 3 times daily), potassium iodide, 3—6 grams daily, potassium bromide, 3—6 grams daily, the medication being continued for a period of 2—4 weeks. It is worthy of note that a few cases with pronounced bromism and iodism did not show any increased haemorrhagic tendency. Nor did the application of salicylic acid (3—6 grams daily) produce an increased tendency to haemorrhages, not even when symptoms of salicylic intoxication were present (5 cases with heavy breathing, tinnitus, slight deafness, etc.).

Neither could any definite increase in the tendency to haemorhages be demonstrated after injections of neosalvarsan (10 cases).

The Capillary Bleeding Tendency in Diseases.

According to the reports in the literature, the capillary bleeding test seems to show an increased tendency to haemorrhages in scarlet fever (Rumpel-Leede, Beneche, Clakeson, Meyer, Feig and others), measles, influenza (Beneche), syphilis, lupus, gonorrhoea, psoriasis, eczema (Meyer, Mayr), pernicious anaemia, diphtheria, sore throat (Meyer), diseases of the endocrine organs, especially exophthalmic goitre (Stephen). In ad-

dition, STEPHEN states that the following conditions give a positive »endothelial symptom»: injury to the endothelia cells due to poisons, bacterial toxins, metabolic products and medicaments, disturbances of the capillary tonus due to disease of the peripheral sympathetic nervous system or its cerebral centre.

STEPHEN considers the test to be of no importance as an isolated symptom. Several authors have found it to be of no value as a differential diagnostic measure in children, who normally show a great tendency to haemorrhages. BOYE finds an increased haemorrhagic tendency in arterial hypertonia, in polyarthritis and disorders of the endocrine glands. He considers that there is a connection between the tendency to haemorrhages and a general diminution of the individual »psycho-physical turgor». He finds an increased tendency to haemorrhages to be common in neurosis, especially if it is associated with vasomotorial disturbances. BOGENHÖFER and BAYER record positive bleeding tests in latent morbid conditions of various etiology. BOGENHÖFER is of opinion that there is a certain familial predisposition to a positive haemorrhagic tendency. HESS, ÖHNELL, BOYE and GÖTHLIN consider the test to be of very great importance for the diagnosis of latent scurvy. Most of these authors, however, consider this symptom to be insufficient grounds for diagnosing the presence of latent scurvy, and require further anamnestic and clinical evidence. GÖTHLIN considers his test to suffice for establishing the occurrance of an inadequate vitamin C level, even if no other symptoms are present. Later his attention has, however, been directed to the influence of certain physico-chemical irritants and certain diseases on the tendency to haemorrhages and he makes reservation accordingly.

The following table shows the results of the test in 2127 cases at the Umeå Hospital, grouped in respect to the nature of the diseases.

The following observations may be made with regard to the contents of the table. In polyarthritis it is particularly the primary chronic form which shows an increased haemorrhagic tendency. In hypertonia, an increased tendency to haemorrhages is met with chiefly in that form of the disease occurring in older persons in association with arteriosclerosis (29 per cent). Younger persons affected with nephritis (16 cases) showed no increased haemorrhagic tendency.

In regard to neurosis, the tendency to haemorrhages occurs chiefly in cases with pronounced vasomotorial symptoms with marked dermographism, which agrees with BOYE's findings.

As regards the cause of the increased tendency to haemorrhages in various diseases it may be considered to arise in some of them, e. g. polyarthritis, sepsis, exophthalmic goitre, owing to a capillary hyperaemia. In jaundice and pernicious anaemia that can hardly be the cause. In these diseases the increased haemorrhagic tendency

The Capillary Bleeding Test in various Diseares.

Tumour of the brain	20	cases	of	which	0	(0 %)	showed	more	than	9	haemorr	
Gonorrhoea (urethritis) ...	20	»	»	»	0	(0 »)	»	»	»	»	»	
Tuberculosis of bones and glands.....	35	»	»	»	1	(3 »)	»	»	»	»	»	
Heart disease	59	»	»	»	2	(3 »)	»	»	»	»	»	[1]
Bronchitis, chron.	28	»	»	»	1	(4 »)	»	»	»	»	»	
Colitis, chron. (without achylia)	73	»	»	»	3	(4 »)	»	»	»	»		
Cancer of the stomach ...	23	»	»	»	1	(4 »)	»	»	»	»	»	
Diabetes	48	»	»	»	2	(4 »)	»	»	»	»	»	
Disseminated sclerosis ...	24	»	»	»	1	(4 »)	»	»	»	»	»	
Peptic ulcer	223	»	»	»	11	(5 »)	»	»	»	»	»	
Pleurisy, exudat.	84	»	»	»	4	(5 »)	»	»	»	»	»	
Pneumonia	80	»	»	»	4	(5 »)	»	»	»	»	»	
Sciatica	87	»	»	»	4	(5 »)	»	»	»	»	»	
Anaemia, secondary	67	»	»	»	5	(7 »)	»	»	»	»	»	
Erythema nodosum	14	»	»	»	1	(7 »)	»	»	»	»	»	
Neurasthenia	220	»	»	»	15	(7 »)	»	»	»	»	»	[2]
Arteriosclerosis	28	»	»	»	2	(8 »)	»	»	»	»	»	
Asthma, bronchial	26	»	»	»	2	(8 »)	»	»	»	»	»	
Influenza	11	»	»	»	1	(9 »)	»	»	»	»	»	
Tuberculosis, pulmonary	83	»	»	»	8	(10 »)	»	»	»	»	»	
Nephritis	61	»	»	»	7	(11 »)	»	»	»	»	»	
Colitis, chron. (with achylia)	23	»	»	»	3	(13 »)	»	»	»	»		
Syphilis III	17	»	»	»	2	(12 »)	»	»	»	»	»	
Polyarthritis, acute.....	46	»	»	»	6	(13 »)	»	»	»	»		
Achylia gastrica	106	»	»	»	14	(13 »)	»	»	»	»	»	
Polyarthritis, chron.	151	»	»	»	19	(18 »)	»	»	»	»		
Hypertension	116	»	»	»	26	(22 »)	»	»	»	»	»	
Jaundice (various forms)	24	»	»	»	6	(25 »)	»	»	»	»	»	
Pernicious anaemia.....	13	»	»	»	6	(46 »)	»	»	»	»		
Exophthalmic goitre	23	»	»	»	12	(52 »)	»	»	»	»	»	
Sepsis.....	12	»	»	»	10	(80 »)	»	»	»	»		
Cases with more than one disease and cases with uncertain diagnosis.....	275	»	»	»	16	(16 »)	»	»	»	»	»	

presumably arises from an injury to the endothelium, from the same cause as STEPHEN considers it to occur, for instance, in scurvy. It is also possible that this explanation applies to other diseases attended by an increased tendency to haemorrhages.

The generally accepted view is that the capillary bleeding test gives a positive reaction, above all, in scurvy.

Unfortunately we have little experience of the value of the test in scurvy, for our material does not contain more than 6 cases with an established diagnosis of scurvy. In all 6 cases there

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[1] 5 cases of aortic insufficiency, all of them with more than 9 haemorrhages are not included here.

[2] Most of the positive cases had pronounced vasomotorial symptoms.

was a history of a diet very deficient in vitamin C. All of them showed subcutaneous haemorrhages, especially on the legs, gingivitis with haemorrhages and, in one case, also haemorrhages from the kidneys and intestines. Three of the patients were forest-workers, who subsist, especially during the months of January—April, on a diet consisting of bread, butter, dumplings fried in fat, coffee and bacon. Potatoes hardly ever formed part of the diet. The other three patients were female teachers who had been put on a restricted diet owing to colitis. In two cases, one in each group, the result of the bleeding test was negative, one of them showing 3 haemorrhages and the other 5. A few days later one of them gave a very pronounced positive bleeding test, the other was not examined again. All six patients became free from symptoms when fed on a diet rich in vitamin C. Thus, judging from these few cases, it appears that scorbutic patients as a rule, but not always, give a positive reaction to the capillary bleeding test, but not in all stages of the disease.

GÖTHLIN looks upon the bleeding test, performed according to his technique, as a measure of the vitamin C standard of the food. In some quarters his view has been accepted unreservedly, and nowadays the diagnosis of scurvy is not infrequently made on the basis of his test without any other symptoms of the disease being found. The author has examined 10 cases of this kind, who, in spite of the employment of anti-scorbutic treatment, continued to show an increased tendency to bleeding. Two of these cases manifested symptoms of exophthalmic goitre, three had pronounced symptoms of neurosis with marked dermographism, three exhibited signs of hypertonia and one was affected with a slight chronic polyarthritis. In the tenth case there was no demonstrable cause of the positive reaction to the bleeding test. Thus, it can be regarded as established that the capillary bleeding test is a valuable aid in diagnosing a C hypovitaminosis, but the diagnosis should not be made on the result of the test alone, whether it be positive or negative. The diagnosis must be supported by an anamnesis of a diet poor in vitamin C and by other clinical symptoms.

In proof of the correctness of the above observations it may be mentioned that, apart from certain diseases, there are not infrequently cases with pronounced tendency to bleedings without any demonstrable cause. We have seen several such cases, all of which were carefully examined. In particular, thorough ex-

aminations of the blood were performed and exhaustive inquiries regarding the diet were made so as to rule out the possibility of a C hypovitaminosis being present.

Capillary bleeding tests were made once a week on a large number of patients, alternately on the right or left arm. The same diet, rich in vitamin C, was given all the time. It was then shown that in 126 initially negative cases (less than 3 haemorrhages) the number of haemorrhages increased to more than 9 on 12 occasions, without any demonstrable cause. Among them there were no less than 4 cases with more than 20 haemorrhages, the present writer being one of the 4. Thus there cannot be any doubt whatever that there are cases with a marked tendency to bleedings for which no cause can be demonstrated.

CHAPTER X.

Summary and Survey of the Clinical Symptoms Produced by the Unvaried Milk-Meal Diet.

On account of the extraordinary conditions under which the inhabitants of Upper Norrland live, especially the isolation and climatic factors, their diet must be very unvaried.

Broadly speaking, three different types of diet can be distinguished: 1) the unvaried milk-meal diet, the L diet, used chiefly by the agricultural population, especially in the coastal district, 2) the pork or bacon diet, the S diet, most common among the forest-workers, and 3) the mixed diet, the B diet, which is the usual diet in the more densely populated localities, towns and industrial communities.

In its extreme form the L diet consists of flour, milk, potatoes and a little butter. As a rule the flour is fine-bolted barley and wheat flour, the bread is the so-called clap-bread, thin, hard-baked bread made of barley. In addition, breakfast usually includes a small amount of boiled salt herring, and Sunday dinner is generally supplemented with fruit soup, made of dried fruit.

The S diet is chiefly made of bacon, fat American and lean Swedish bacon in about equal quantities. A very important ingredient of the S diet is flour, usually fine bolted wheat flour, bread — as a rule coarse and hard-baked — and more seldom potatoes, milk and butter.

The B diet is much more varied and consists of meat, fish, pork or bacon, potatoes, milk and butter.

Between these three main types of diet there are numerous transitional types. Among them may be mentioned the LII diet, which includes meat or fish, but only twice a week at most, otherwise this diet is the same as the LI diet. If meat forms part of the S diet 2—3 times a week it is designated SII. Of

the B diet two different types may be distinguished. If meat, bacon or fish are taken 3 or at most 4 times a week, the diet being otherwise unvaried, resembling the L diet, it is called BI, while the BII type of diet contains meat, bacon or fish at least 5 times a week.

Fresh fruit and vegetables are seldom eaten by the native population of Norrland, except the inhabitants of the towns. The addition of the letter a to the symbol of the diet signifies that fruit and vegetables are eaten once or twice a month at most, which is the most usual. To denote a more abundant supply of fruit and vegetables the letter b is employed if these ingredients are eaten once or twice a week, and the letter c if they are taken more than twice a week.

In Skåne and Västergötland, where comparative investigations were carried out, the BIIb and BIIc types of diet are the most common.

The consumption of coffee in Norrland is very great. As a rule, the forest-workers drink 9—12 cups a day, the average consumption of the rest of the population being 5—8 cups a day, 1—2 cups being drunk the first thing in the morning. Children are usually given from 1 to 3 cups a day. In Skåne and Västergötland the consumption of coffee seems to be lower, only one-fourth — one-third of the inhabitants consuming more than 4 cups a day.

Snuff-chewing is very common among the men in the rural districts of Norrland and among the forest-workers, where it occurs in 42 per cent of the cases. The figure for the hospital material is only 27 per cent, which is due to the fact that this material includes a relatively large number of people from the towns, where snuff-chewing is not so extensive. In the provinces of Skåne and Västergötland only 20 per cent of the men chew snuff.

Tobacco-smoking, on the other hand, is more common in southern and central Sweden. That is also true of the consumption of spirits, which is comparatively low in Norrland.

An analysis of the most unvaried types of diet, based on weighings of the dietary constituents, gives the following results: —

The calorie content of the L diet is comparatively low, averaging 2840 calories per day (2090—3350) for men and 1687 (1493—1876) for women. The protein content is low, being on the average 85.5 g. (59.1—110.9) for men, and 51.4 g. (49.8—60.6)

for women. The greater part of the protein is derived from vegetable sources.

The fat content is also low, but on the other hand the supply of cereals is ample. The iron content is also low, averaging only 17.5 mg. (10.4—23.4) for men and 11 mg. (8.4—12.3) for women.

The diet of the forest-workers, the S diet, has on the other hand, a very high calorie value, the average daily calorie intake being 5176 calories (3718—6966). From $^1/_3$ to $^1/_2$ of the number of calories is derived from fat.

The protein content of the diet of the forest-workers is relatively low, on the average 100 g. (42—184). It is derived to no small extent from vegetable sources, but a large part of it is derived from meat and milk.

The iron content of the diet of the forest-workers varies between 36 and 78 mg.

An estimation of the amounts of the different vitamins, based on the composition of the various diets, indicates that as far as the LIa diet is concerned there is a risk of a vitamin B deficiency and in certain months of the year also a deficiency in vitamins C and D.

The S diet shows a certain lack of vitamin C, and in winter also of vitamin D.

In conformity with the low calorie content of the food, cases of the LI diet group show a decreased basal metabolic rate. In addition to under-nutrition, the low protein content of the food or a correlated factor (B hypovitaminosis) plays a part in the decrease in the basal metabolic rate.

An increased glucose tolerance and a reduced reaction to pharmacodynamic tests with adrenaline, pilocarpine and atropine are also found in cases belonging to the L diet group, indicating a lowered tonus of the vegetative nervous system and the endocrine apparatus. This disturbance may either be secondary, an expression of a functional adaptation to the under-nutrition, or more directly produced by the low content of animal protein in the diet or a B hypovitaminosis associated with the composition of the diet. The latter explanation applies also to an under-nutrition which is not due to an insufficiency of food but to a reduced need for food. It is not improbable that the above-mentioned etiological factors cooperate.

The incidence of *achylia* is much higher in Norrland than in southern and central Sweden or any other place, judging from the records published in the literature.

According to the results of the investigations made at Umeå, Lund and Borås, the frequency figures are 39.1 per cent (4568 cases examined), 14.7 per cent (433 cases examined) and 13.5 per cent (525 cases examined) respectively.

In a selected material, from which diseases with a tendency to decreased gastric secretion were excluded, the frequency of achylia in the same three localities is 31.3, 10.9 and 9.8 per cent respectively.

The acidity values in E.-B. tests on Congo positive cases are also lower in Umeå than in Lund and Borås. The difference in the total acidity values is respectively 9 and 12 units.

The frequency of achylia is greater among women than among men and increases with advancing age.

The degree of the secretory disturbance, estimated from the total acidity value following an E.-B. test meal and other tests (fractional gastric analysis with and without simultaneous injections of histamine and neutral red) is frequently very high in the achylic cases in Norrland. In more than half the cases the peptic digestion is also very greatly reduced.

The value of the various methods of examination for estimating the degree of the achylia is considered.

In the achylic cases, an examination of the gastric contents following the ingestion of an E.-B. shows defective digestion in 69 per cent of the cases. Mucus in pathological amounts was found in 27 per cent of the cases.

The symptoms in the Norrland achylics resemble those in ulcer (acidism) in not less than 38 per cent of the cases. In the Congo positive cases such disorders are found in only 28 per cent. Nevertheless, the frequency of peptic ulcer is much higher among the Congo positive cases, 19 per cent as compared with 5 per cent. The symptoms of acidism consist of pains and burning sensations in the epigastrium shortly after a meal, especially if the food is unsuitable. The pain is generally relieved by taking food. »Sour» eructations and vomiting are not infrequent.

Mild gastric disorders, mostly in the form of a sense of fullness and oppression in the epigastric region, occur as frequently in Congo negative as in Congo positive cases, 36 and 37.5 per cent respectively.

Intestinal disorders occur in 35.5 per cent of the achylic cases, mostly in the form of very severe constipation and stercoral

diarrhoea. Permanent diarrhoea is found in 7.6 per cent of the cases. The corresponding figures for the Congo positive cases are 17.4 and 3.4 per cent respectively.

The results of the district investigations show that 30 per cent of the 1690 adults examined are suffering from gastro-intestinal disorders. In general gastric symptoms seem to be twice as common as intestinal symptoms, and are as a rule of a mild character.

Among the inhabitants of the coastal district the incidence of digestive disturbances is especially high. In some villages 40 per cent of the inhabitants have such disorders. The incidence among the forest-workers is 20 per cent.

In school children (3220 cases examined) gastro-intestinal symptoms, mostly in the form of intestinal disorders, are found in 11 per cent.

The composition of the diet is the decisive factor in the frequency of achylia in Norrland. In the various L, B and S diet groups achylia occurs in respectively 55, 18 and 21 per cent of the cases. The frequency of achylia among users of the most unvaried milk-meal diet (the LIa diet) amounts to 68 per cent.

It is of particular interest to note that in the group of »healthy and control cases», in which no gastric or intestinal symptoms were present, the frequency of achylia is still more predominant in the LIa diet group. The frequency figures for the LIa, B and S diet groups are 79, 12 and 5 per cent respectively. The cause of this is to be found in the fact that among the cases with gastric disorders, which form the great majority of all cases, there are quite a number with gastric and duodenal ulcers, which predispose to an increased secretion of acid. If the cases with ulcers are omitted, the frequency of achylia among patients suffering from »stomach troubles» in the LIa diet group will be the same as among the healthy subjects.

It can also be shown that the incidence of achylia in the L diet group, and especially the LIa group, is higher in all age-classes than in the other diet groups.

The higher incidence of achylia amongst women is mainly due to the fact that women subsist to a greater extent on the L diet than men.

The consumption of coffee is somewhat greater in the L diet group than in the B diet group. Excessive coffee-drinking, however, seems to predispose to an increased acidity and cannot ex-

plain the difference between the frequency of achylia in the various diet groups.

Snuff-chewing frequently gives rise to severe achylia, but this habit is equally common in all diet groups except among the women, who do not use snuff. Thus snuff-chewing cannot explain the high incidence of achylia in the L diet group.

Defective teeth are more common among the cases belonging to the L diet group than among those belonging to the B diet group, and are more frequent in women than in men. A poor dental condition, which is much more common among the population of Norrland than among the populations of southern and central Sweden, predisposes to a certain degree to achylia, but not to such an extent that it can alone explain the high incidence of achylia in Upper Norrland. The cases in the L diet group, both those with good and those with bad teeth, show a much greater frequency of achylia than the corresponding cases in the other diet groups.

Helminthic infection (Dibothriocephalus latus), the incidence of which is very high in certain parts of Upper Norrland, does not play any decisive part in the frequency of achylia.

Thus the causal factor of achylia is the unvaried milk-meal diet.

Achylia has been produced in a number of cases by changing the B diet to the LIa diet, and on substituting the LIa diet with the BII diet the achylia has usually disappeared, as shown by the results of the treatment. The treatment of the achylic cases belonging to the L diet group consisted of a gradual change to a mixed diet of meat, eggs, fish, fruit and green vegetables. The medicinal treatment in later years consisted in the administration of *inf. amar. alk.* 300, potass. bromide 20 and Ext. Belladonnae 0.20, 1 tablespoon X 3 daily before meals. The last-named remedy was given in cases of too rapid emptying of the stomach, otherwise tinct. nuc. vom. 0.3—0.5 X 3 was given instead. As a rule the patients did not tolerate hydrochloric or citric acid medication, which was the most usual »medicine» for achylia in the first years.

In spite of the relatively short period of observation, from 4 to 6 weeks, a marked improvement or a restitution of the gastric function occurred in 36 per cent of the cases re-examined. The achylic cases belonging to the L diet group showed a much better prognosis than those belonging to the other diet groups.

Prognosis, however, depends on the degree of the functional disturbance, estimated from the total acidity value after the ingestion of an E.-B. test meal and the result of the fractional analysis with or without the injection of histamine and neutral red. But even in the most severe degrees of functional disturbance an improvement seems to be possible, at least in cases belonging to the LIa diet group. All cases with a total acidity value below 9, where the achylia has subsided, belong to this diet group.

The cause of the achylia-promoting effect of the L diet cannot be of a toxic nature.

A constitutional etiology cannot be considered to come into the question. The population investigated belongs to the same race and lives, with the exception of the diet, under the same conditions.

The L diet is a diet which to a great extent relieves the work of the digestive apparatus, owing to the fine disintegration of the food and its deficiency of meat, fruit and vegetables. Herein perhaps lies the cause of its achylia-promoting effect.

The L diet is also characterized by certain quantitative and qualitative deficiencies, which have an influence on the secretion of gastric juice. The other symptoms associated with the L diet, especially the under-nutrition and the decreased basal metabolic rate, can hardly be explained solely as an adaptive measure. It is therefore not improbable that the frequency of achylia is due to the same factors as give rise to the above-mentioned symptoms. The impaired function of the endocrine apparatus, which is especially evident in the decreased basal metabolic rate, is of no decisive importance in the occurrence of achylia. In the achylic cases the basal metabolic rate is just as often decreased as normal, and not infrequently the decreased basal metabolic rate is associated with a normal rate of gastric secretion.

The combination of ulcer and achylia is remarkably common in the Norrland material. Achylia was found together with an ulcer, demonstrated on X ray examination in the form of a niche, in the stomach in 21 per cent of the cases, and in the duodenum in 13.3 per cent. In the Borås material, comprising 307 ulcers demonstrated in the same manner, achylia was found in only 1 case, the ulcer being localized to the pylorus. In this case the total acidity value was 20.

The achylia in the ulcer cases is often very severe. In about

50 per cent of the cases the total acidity value in an E.-B. test meal was lower than 9. Several cases also show a negative Congo red reaction on fractional analysis with and without histamine. In a few of these cases there was no excretion of neutral red either.

Ulcers are more frequent in the B diet group than in the L diet group, especially in the LIa group. In the L diet group ulcers are more common amongst the Congo positive than amongst the Congo negative cases. In 52 of the 230 Congo positive cases (23 per cent) and in 11 of the 284 Congo negative cases (4 per cent) a niche could be shown on X ray examination. The achylic cases with ulcers mostly belong to the L diet group, particularly to the LIa group. The frequency figure for the LIa group is 29 per cent, for all L diets it is 17 per cent and for all B diets 9 per cent.

It appears as if the incidence of ulcers is higher in Västergötland than in Västerbotten. At any rate haemorrhages undoubtedly occur 5 times as frequently in the Borås hospital material as in the Umeå material. More than 50 per cent of haemorrhages in the Borås material must be classified as large and dangerous. Perforations, too, are more frequent in the Borås material. The cause of this difference in the nature of the ulcers is to be found in the difference in the composition of the diets. In the Borås district the diet is a pronounced meat diet. In the coastal district of Västerbotten, from which the Umeå Hospital receives most of its patients, the diet is predominantly of a lactocereal character. In 32 cases at the Umeå Hospital with severe or dangerous haemorrhages reliable information as to the diet was available. Of these cases, 31 belonged to the B diet group, and 1 to the LIa diet group. Of 18 cases with slight haemorrhages, 17 belonged to the B diet group and 1 to the LII diet group. Thus the milk-meal diet seems to afford a certain protection against the occurrence of ulcers, and if ulcers appear in cases belonging to this type of diet, they seem to be of a less severe nature.

Disturbances of the intestinal function are also more common in Upper Norrland than in southern and central Sweden. In less than half of the material examined evacuation can be characterized as normal; most frequently there is constipation attended by subjective trouble. This is true of all diet groups, but especially of the L diet group, which is at least partly explained by the finely disintegrated elements of the food, which is poor in

cellulose. Conditions in Norrland are specially favourable for the »domestication syndrome», which seems to be of importance for the occurrence of constipation.

Pronounced intestinal disorders are also frequent in Norrland, due chiefly to the higher incidence of achylia. It is a remarkable fact that the L diet achylia is much more seldom associated with intestinal disorders than the achylia occurring in the B diet group. The intestinal disorders vary also in character in the different diet groups. In the achylic cases in the L diet group they most frequently consist of severe constipation and stercoral diarrhoea, while in the B diet group they mostly consist of chronic diarrhoea. This seems in some measure to indicate that the L diet achylia is of a different nature from that of the B diet achylia.

Bad teeth as well as abuse of coffee seem to give rise to a slight increase in the frequency of intestinal disorders, but only with respect to the frequency of diarrhoea. Therefore these two factors cannot explain the frequent occurrence of constipation and stercoral diarrhoea in the Norrland material. The cause of these disorders is the same as that of the slow evacuation of the faeces, mentioned above.

The intestinal digestion in the Norrland cases of colitis is good almost without exception. Even among the achylic cases signs of a poor digestion of muscle fibres were very rare. The digestion of fat was good in all cases. Fermentative dyspepsia was observed in only one instance.

Prognosis of the intestinal disorders was very favourable. More than 90 per cent of the cases showed improvement on dietary treatment.

Estimations of the haemoglobin content in children of various ages, based on a material consisting of 2808 boys and 2916 girls in Norrland and 236 boys and 267 girls in Skåne, show agreement between the two areas of investigation up to the age of 13 years, but after this age the Skåne children have 4—5 per cent higher values than the Norrland children. The cause of this difference will be discussed below.

In the first year of life there is a fall in the Hb level, then follows a gradual rise, which in the case of girls reaches its maximum at the age of 16—17 years and in the case of boys at 17—18 years. Up to the age of 13 years both boys and girls show corresponding Hb values. After that age the Hb level is higher

in boys than in girls, and this difference in level remains throughout life.

The changes in the number of red corpuscles follow somewhat the same lines, except that the variations are not so marked.

The average Hb values in adults in Norrland are, according to the hospital examinations, 90.2 per cent for men and 80.2 per cent for women, the corresponding values in Skåne are 95.4 and 88.4 per cent and in Västergötland 98.2 and 92.5 per cent. The difference, which is statistically significant, between the Norrland material on the one hand and the Skåne and Västergötland materials on the other is 5.2 and 8 per cent respectively for men and 8 and 12 per cent for women. The variation coefficient is much greater in the Norrland cases than in the cases from Skåne and Västergötland, which indicates a higher incidence of anaemia in Norrland.

In the Norrland material 44.6 per cent of the men and 42.4 per cent of the women show subnormal Hb values. The corresponding figures in the Skåne and Västergötland materials are 11.3 and 6.4 per cent and 11.9 and 3.9 per cent respectively.

The composition of the diet seems to have a very great influence on the Hb value. An increase of the B component, that is an increase in the amount of animal protein in the food, brings about a rise in the Hb level. The average Hb value of men subsisting on the LIa diet is 86 per cent, while that of women is 74.5 per cent. The corresponding values for the BIIb diet group are 94.9 and 87.9 per cent. The difference is 9.9 per cent for men and 13.4 per cent for women. The difference between the Hb values of the Norrland cases and those of southern and central Sweden is due to the diet. The reason why this difference is not evident before the age of 13 years is partly because the diet of children is practically the same all over the country.

If fruit and vegetables form part of the diet a slight increase seems to occur in the Hb value.

A moderate consumption of coffee, not more than 5—8 cups a day, does not seem to have an unfavourable effect on the Hb level in adults. On the contrary, a slight rise in the average Hb values seems to follow an increase in the coffee consumption up to the limit just mentioned. This rise is probably only apparent, because a decrease in the consumption of coffee to less than 5 cups a day is very often due to ill-health, and there-

fore the materials with varying consumptions of coffee are not directly comparable. A consumption of more than 8 cups of coffee daily seems as a rule to cause an evident, thought not great, fall in the Hb level.

Snuff-chewing and consumption of spirits do not seem to have any definite effect on the Hb value, nor does infection with tapeworms appear to affect the Hb level.

Overcrowding and stuffiness seem to cause a slight anaemia in children and women. On the other hand, the long distance to school or house work does not appear to have any definite effect on the Hb value in children.

Pregnancy and lactation, however, cause a considerable fall in the Hb level. With regard to pregnancy this fall is especially marked after the third and subsequent gestations.

The Hb value varies according to the season of the year, as shown by examinations carried out in different parts of the country. Seasonal variations were found in the Hb values obtained in the different areas investigated. The course of the Hb curve, however, is the same everywhere, a fall occurring during the autumn months, reaching the lowest point in January —March, and then a rise in spring, the maximum being reached in the summer months.

The Hb value for the various districts in Västerbotten increases the farther one gets inland. This difference is partly due to the composition of the diet (the L diet is less common in the interior of the country) and partly to the higher altitude above sea-level. The latter factor, however, cannot explain the great difference between the Hb value of the children in Tärna and that of the children in the coastal district. This difference amounts to no less than 14.3 per cent. As mentioned above, the dietary factor does not play such an important rôle in the case of children as in that of adults. The explanation is certainly to be found in race-biological factors. The children in Tärna are to a great extent of Lappish origin and subject to other laws of growth. The blood picture of the Tärna children already at the age of 12 years resembles that of adults.

The great frequency of anaemia in the L diet group is partly due to the high incidence of achylia in this group. Achylic anaemia occurs mostly among women but is also met with in men. Achylia is not, however, the only cause of the greater frequency of anaemia in the L diet group. Both the achylic

cases and the Congo positive cases in this diet group have considerably lower Hb values than the corresponding cases in the B diet groups.

The occurrence of intestinal disorders cannot explain the difference between the Hb values of the different diet groups. Bad teeth cause a slight decréase in the Hb value in both the L diet group and the B diet group. The effect is not so great, however, as to be able to furnish an explanation of the difference between the average Hb values of the different diet groups. The Hb value of the cases belonging to the B diet group having the poorest dental condition is higher than that of the cases belonging to the L diet group with a good dental condition.

A careful examination of the L diet anaemias shows them to be of both a hyperchromatic and a hypochromatic character. The colour-index is often lower than 1 but not infrequently above 1. When the amount of animal protein in the diet increases, the frequency of the hyperchromatic type decreases.

Anisocytosis and poikylocytosis are found relatively often. A slight increase in the size of the red corpuscles is not infrequently seen. No nucleated red corpuscles were ever found. Signs of increased destruction of the red corpuscles in the form of an increased bilirubin value in the blood and a pathological amount of urobilin in the urine could not be demonstrated in any case.

The resistance of the red corpuscles to the action of hypotonic saline solutions was fairly normal.

As regards the leucocytes, a slight degree of a relative lymphocytosis was met with.

Arneth's blood picture showed a slight shift to the right.

The prognosis of the anaemia is favourable. The administration of iron brings about a rapid improvement, the haemoglobin level rises in a short time to 76—80 per cent and the number of red corpuscles increases to 4—4.5 million. It is rather difficult to get above this value. It takes quite a long time and to attain this goal a change of diet is probably necessary. Simply a change from the L diet to the B diet brings about an improvement, but not so rapidly as the iron treatment. Treatment with liver preparations seems to have only a little effect on the Hb level, at least as far could be ascertained during the short period we had the patients under observation.

With regard to the causal relationship between the L diet

and the anaemia the following points are worthy of mention. It is hardly probable that the diet itself produces any toxic effect. The cause is to be found in quantitative and qualitative deficiencies in the L diet. Under-nutrition is present in at least part of the cases belonging to the L diet group and it may also have a certain influence on the anaemia. A decreased basal metabolic rate occurs both with and without anaemia and, like the under-nutrition, is to be regarded as a parallel symptom with the anaemia.

The L diet is poor in iron, and this deficiency becomes still more marked by the frequently simultaneous occurrence of achylia, which makes the absorption of iron more difficult. The L diet anaemia is therefore to be regarded as essentially an anaemia due to iron deficiency.

The L diet anaemia, however, presents certain features which are not compatible with the type of anaemia due to iron deficiency, in particular the not infrequent hyperchromatic feature and in a certain measure the result of the treatment. Thus there is probably another causal factor besides the iron deficiency. It seems probable that this factor is a B hypovitaminosis.

A slight haematuria is frequently found in the Norrland material without any other simultaneous nephritic symptoms. It does not seem to have any definite connection with the composition of the diet, nor did the capillary bleeding test show it to be associated with an increased tendency to haemorrhages. Infection of the teeth and gingivae, on the other hand, seems to be an important etiological factor.

The composition of the food showed that the amounts of *vitamins* B, C and D in the L diet were very small, and that the diet of the forest-workers was deficient in vitamins C and D. The assumption of a B hypovitaminosis would explain most of the symptoms of the LIa diet. The fact that no evident signs of a B hypovitaminosis were found does not exclude the possibility of its being present in a latent form.

Scurvy as an expression of a C hypovitaminosis is seldom observed in Norrland, only 6 cases being met with. Of these, 3 were forest-workers and 3 female teachers who had been put on a diet on account of colitis. However, a latent C hypovitaminosis is not infrequent in all diet groups, as shown by the dental examinations made by Westin. But it can hardly explain the symptoms of the LIa diet.

The occurrence of a D hypovitaminosis does not seem to be uncommon among children, a fact shown by the district investigations and the dental examinations (WESTIN). In adults, on the other hand, no signs of a D hypovitaminosis in the form of late rickets, osteitis fibrosa or osteomalacia were observed. Nor can a latent D hypovitaminosis alone explain the symptoms of the L diet.

As a *suitable method of testing the tendency to haemorrhages* we recommend the application of a static pressure of 80 mm. on the upper arm for a period of 3 minutes by means of a Riva-Rocci cuff. The number of haemmorrhages appearing are counted within a circular area of 4 cm. in diameter. Particular attention is paid to haemmorrhages from the hair follicles on the fore-arm. Haemorrhages occurring along the lower edge of the cuff are left out of account. Up to 6 haemorrhages appear relatively often in healthy persons whose diet contains an adequate supply of vitamin C. If the test is made on both arms a difference of up to 6 haemorrhages is not infrequently obtained, in healthy persons with a sufficient amount of vitamin C in their food. The appearance of less than 7 haemmorrhages should therefore scarcely be of any importance. A reaction with 7—9 haemorrhages is regarded as doubtful, while more than 9 haemorrhages seem to point to an increased tendency to bleeding.

Women exhibit a somewhat greater tendency to haemorrhages than men. It is most marked in the week preceding menstruation. The test gives a positive reaction (with increased numbers of petechiae) in various kinds of hyperaemic conditions in the arm, for instance, on mechanical, chemical and thermic irritation.

Certain medicinal substances, especially mercurial preparations, also produce an increased tendency to haemorrhages.

The same thing applies also to certain diseases, particularly sepsis, exophthalmic goitre, erythematous febrile diseases, pernicious anaemia, jaundice, hypertonia, due to arteriosclerosis, polyarthritis, eczema, achylia and vegetative neuroses. Scurvy seems to be very frequently, but not always, associated with an increased tendency to bleeding.

Finally, the test is frequently positive in healthy individuals with an adequate supply of vitamin C in their food. In these cases the result of the test may even vary from week to week.

Examination of an extensive material shows that the tendency to haemorrhages varies according to the seasons of the year. It

is most pronounced in March—April, diminishes greatly in April in Skåne and in May—June in Norrland. These seasonal variations cannot be associated with the vitamin C content of the food, but are due to the radiation of light. The decrease takes place when the vitamin C content of the food, especially in Norrland, is lowest, that is when signs of a C hypovitaminosis are mostly to be expected, unless the radiation of light on the skin is also to be regarded as a cause of their absence.

PART III

CONDITION OF THE TEETH AND DENTAL DISEASES IN UPPER NORRLAND

By

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and

H. Holtz and *A. Lindström*
Head-Assistants in the same Department of the College

Page

A. Extraction material 157
1. Local distribution of the material 158
2. Percentage distribution 160
3. The value of the material 161
4. Forming an estimate of the material 163
B. The diagnoses 163
C. The approximate distribution of the changes within the material 165
D. Illustrated material 173
E. Complex of causes of the »scorbutic» dental changes 196
1. General points of view 196
2. Discussion on different groups of causes 202
F. Diagnosis and complex of causes of the »rachitic» dental changes 211
G. Diagnosis and causes of the inflammatory changes 215
H. The inter-relation between the inflammatory changes and simultaneous »scorbutic» changes in the dentin and pulp 218
I. The inter-relation between the inflammatory changes and simultaneous »rachitic» injuries to the dentin 220
J. Light thrown on the problem of the calcification of the tooth by the relation between simultaneous D- and C- hypovitaminosis .. 225
K. General conclusions 228

Chap. V. General summary of the results of the dental investigation, by *G. Westin* 229

CHAPTER I.

Introduction

by

G. WESTIN.

The Preface to this work and »Antecedents and planning of the Investigation» (Chap. II of Part I and Section 1 respectively) describe the result of inquiries and the course of events which induced the Director-General of the Medical Board to take steps to extend the scope of the so-called Norrland Investigation which had been started at the Umeå Hospital by Dr. MARTIN ODIN. The aforesaid parts of the work also shed some light on the reasons for including the dental investigation. When collaborating with Dr. J. A. HÖJER, the present Director-General, in a study of scurvy in guinea-pigs (1924—1925), I had already had my attention drawn to the possibility of the widespread existence of latent scurvy in Sweden, notably in the northern parts of the country. Upon my continuing the study of the dental changes in cases of scurvy in Man, I was able to confirm my view that this assumption was justified partly by the evidence of numerous discoveries made from amongst a large body of private research material of my own, partly as a result of my collaboration with Dr. H. ÖHNELL and of his studies of latent and manifest scurvy in Sweden. During the years 1926—1929 I was afforded an opportunity of working for two periods with Dr. M. ODIN at the Umeå Hospital and collecting selected material relating to about 60 suspected cases of latent scurvy or an ascertained lack of vitamin C. Already before the Norrland Investigation began I had been able from clinical and histo-pathological studies of this material to convince myself of the presence of latent dental scurvy in Upper Norrland. However, its scope, degree of severity

and medical significance were unknown factors. No causal connection with dental caries could be traced; as a matter of fact, both ODIN and I were of the opinion that of the various pathological conditions to be found in the dentures available for study in the hospital material, latent scurvy might occur primarily in such cases from amongst the inland population as had types of denture showing the least injury from caries. The distribution and complex of causes of gingivitis were, if possible, still more uncertain than those of caries. Here a mere preliminary investigation could provide no basis for the formation of an opinion as to the significance of C-hypovitaminosis.

During these early studies of that subject there was practically no discussion of problems concerned with vitamins or diet other than the question of vitamin C. When, therefore, for reasons already mentioned here and explained in the Preface and elsewhere, the Medical Board took steps to widen the scope of the Norrland Investigation, there was assigned to the dental investigation, which it was then to include, the limited function of endeavouring, by a study in selected localities of the pathological gingival changes and the microscopical examination of the dental material, to throw further light on the distribution and significance of any existent latent scurvy. When drawing up the programme for a dental investigation along these lines I was at once confronted with serious difficulties, first and foremost the fact that an inquiry of this kind was at that date a new phenomenon in the field of odontology; I thus had no literary data of any value to serve as a basis. Further, the questions connected with the relation of the dental diseases to and their dependence upon a lack of vitamins are even now extremely complicated fields of medical research.[1] However, I very soon realized that there could be no practical advantage in confining the investigation to the problem of the distribution and nature of C-hypovitaminosis. It seemed likely that nothing less than a detailed statistical treatment of all the discoveries made in the course of recording and determining the status of dentures, combined with the final results of a simultaneous medical examination, could give to the dental investigation such authority and reliability as alone could guarantee the attainment of results

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[1] WESTIN, G., Zahnveränderungen in Fällen von Skorbut bei Homo. 1931.

compatible with the heavy expenditure of money and labour involved in collecting and examining the material. This would imply, it is true, that the inquiry into C-hypovitaminosis would form only part of the investigation, but it might be possible to set other inquiries on foot within the general scope of our immediate problems, and these inquiries might perhaps subsequently prove to be of some consequence. As it turned out, the results of the investigation as recorded in our general reports have afforded complete and gratifying confirmation of this preliminary assumption.

At about the same time much interest was shown in a discussion that was going on in odontological medical literature on the part played by vitamin C in the prophylaxy of caries. In order to enable us to form an opinion of the significance of vitamin C in this respect the dental investigation would have, on the one hand, to produce a general survey of the distribution of caries in the areas investigated and, on the other hand, to draw an individual comparison between a carious condition and the supply or lack, as the case may be, of vitamin C. In the Department of Operative Dentistry of the State Dental College my Head-Assistant Dr. H. Holtz was engaged at the time in working out the statistics of caries — a task that seemed likely to afford a means of classifying dentures and determining the status of caries with greater accuracy than had been the case hitherto.

Caries apparently occurred in the material on so large a scale that it was considered best to make a special study of this problem. It was consequently made a separate part of our investigation and Holtz was entrusted with the task of carrying it through. One question of the utmost importance in this connection was the definition of caries. In previous statistical compilations the definitions have differed widely, thus frequently giving rise to uncertainty and unreliability. I decided for the purpose of this work to draw up a definition that would only represent caries as that stage of carious affection in which the probe has established the existence of a cavity in the hard substance. Had we adopted a wider definition of caries, the investigation would have left the way open for a number of subjective opinions which might conceivably influence the results of the investigation. Moreover, it would have been necessary to undertake a far more radical examination of the dentures, such as, for instance, the complete Röntgen survey of the denture in every case, which it

would obviously have been practically impossible to carry out. Again, the investigation of caries was bound to necessitate our study of the teeth being conducted to a certain extent on different lines from those followed in the medical examinations — and this for several reasons. Caries is mainly a disease of youth and growth and has a distinct association with the period of puberty. Besides this, there arise in the later stages of the individual's life a number of other injuries to the denture, which might render it difficult to form an opinion solely on the question of caries. The consequence is that the investigation of the teeth with a view to studying caries must be devoted primarily to examining the condition of children's dentures; thus the school examinations have proved of predominant importance in the task of compiling our material. From the very outset, therefore, there existed an essential difference between the dental investigation and the general medical investigation. True, the latter was also to include an examination of school-children on a considerable scale, but the principal material for medical purposes was to be collected from adult subjects in the Umeå Hospital. It was further decided from the outset that the lines on which the material was to be collected should differ in another respect also. If the investigation of caries was to have any permanent value, it would have to be carried out on otherwise healthy subjects in order that there might be no need, in judging the results, to take into account any influence derived from general diseases and in order that the opportunity might be kept open for determining the geographical pathology of the carious picture. In the dental investigation, therefore, the most decisive importance was attached to material collected from adults in the local examinations and to that collected from children in the school examinations, whereas the hospital material played the dominating part in the medical examinations.

A special chapter, so to speak, having thus been devoted to the problem of caries in the field of our dental inquiry, there remained for investigation all the other pathological conditions observed in the clinical study of the oral cavity. It proved extremely difficult to determine the value of a statistical treatment of this material, which comprised primarily the diseases of the gums, but other affections as well, such as deficient calcification (hypoplasiae) of the enamel, accretion of tartar and materia alba, abrasion, salivary variations etc.

In the Department of Operative Dentistry of the State Dental College I had previously, with a view to studying and giving instruction in individual cases, drawn up a table of the oral status in all its aspects, but at the time I had but very little experience of the usefulness of this table for statistical purposes. I had formed the opinion that certain of the said conditions in the oral cavity were interconnected and thus characterized distinct types of denture, which in turn were determined by constitution, disposition for infection, the influence of diet etc. Whether my assumptions along these lines, if applied to the compiling of a large body of statistical material, would prove capable of confirmation in the form of reliable results, was still an unsolved problem, the study of which would to all intents and purposes be of the nature of an experiment. I succeeded in inducing the Head-Assistant Dr. P. A. Lindström to undertake this task and thus endeavour by compiling statistics derived from the material to ascertain whether they could lead to discoveries of any interest in that field; Lindström spent over a year working out detailed and complicated statistics before it was even possible to ascertain whether the inquiry would yield any positive results. Upon the work of compilation being continued it was found — as indeed was only to be expected — that the investigating chart of the status of the mouth was capable of considerable improvement as a method of collecting reliable statistical data. The investigation undertaken for control purposes in 1931 provided therefore an opportunity of drawing up a chart that was in many respects simplified and which, as it afforded a better survey of the material, yielded more valuable results. In the study of caries I had, as already mentioned, endeavoured by every conceivable means to exclude methods of examination likely to lead to subjective results, but in this other part of the investigation such a possibility was from the outset not open to me. The examinations undertaken in 1929 were carried out by several persons, with the result that, when a description was to be given, for instance, of a pathological condition of the gums, since only the first general table was available there could not fail to be a lack of conformity in judging and assessing the discoveries. When subsequently, therefore, the data were being compiled, it was only with the utmost caution that any conclusions could be drawn from the material collected in 1929 — a great many cases having

to be excluded and resort being had to the results of the control investigation.

The *general statistical study of the status of the mouth and denture*, with the exception of caries, thus constituted the second main chapter in the dental examination. Unfortunately it contained no detailed inquiry into a number of points the solution of which would have been of very great interest, notably a study of the chemistry of the saliva, the bacterial flora and the oral deposits. However, in working out the programme I found myself faced with insuperable difficulties, which prevented a complete investigation of these problems. One disadvantage of the large dimensions already assumed by the journals relating to each individual was that every case would involve a considerable time being spent in carrying out the investigation in homes and schools. The consequence of this would be that, owing to the limited number of assistants available for this part of the Norrland Investigation, the number of cases investigated would necessarily be very small. If then we had added to our tasks the study of the saliva and bacterial flora, with the immense apparatus it would have necessitated, and with the resultant considerable prolongation of the time required for the investigation, the number of cases would certainly have been too small to permit of any statistical treatment at all. It is hoped, at any rate, that it will be found possible at some future time to undertake supplementary inquiries both in these and in other respects not specifically mentioned here.

This second chapter of the work deals further with the attempt to determine the degree of association that may exist between the dental conditions and diseases recorded, including caries, and the results of the medical examinations, including first and foremost the data relating to diet. This part of the statistics is bound to prove the most valuable aid towards discovering the complex of causes responsible for the decay of the teeth (caries) and diseases of the gums, seeing that such individually determined correlations must be assumed to possess general applicability extending beyond the purely local conditions, and thus to exert a decisive influence on the questions at issue in all their bearings. Indeed, our investigations have confirmed these assumptions.

As to the third and final chapter in our dental study, I planned an account of *the histo-pathological examination of the collected material*. The primary object of this chapter was to

endeavour to ascertain whether changes that might conceivably be due to lack of vitamin C were found to occur in the structure of tooth and pulp. It was thus the third section of the investigation that was, strictly speaking, to assume the primary function of the dental investigation, viz. to solve the question of vitamin C deficiency by means of the study of changes in pulp and dentin. It was further anticipated that valuable results might also be obtained from the study of the effects of vitamin D, the problem of calcification, and dental inflammation. This section, which was compiled by me personally, follows below in the form of a third report (Chap. IV).

For particulars regarding the research programme, the number of cases examined, the localities and dates concerned, the dentists engaged, and the investigation in schools, in country districts and in hospitals etc., the reader is referred to Chap. III, Pt. 1.

The investigation has been based upon the examination of three different groups:

1) *School children*, examined in the schools by a doctor; number of cases 3220.
2) *Local inhabitants*, a doctor and a dentist visiting the homes and carrying out a joint examination of all the members of the family; number of cases 436.
3) *Hospital patients*, a dentist examining both in-patients and out-patients; number of cases 482.

The material originally collected exceeds the above total of 4138 by altogether about 300 cases, which for various reasons, chiefly on account of incomplete or faulty diagnoses, have been excluded by the authors from the subsequent statistical treatment of the data (see page 22).

It should also be pointed out that this investigation has necessarily involved dental-hygienic treatment on a large scale, so that the total number of cases dealt with has had to be cut down. The inquiry thus comprises only a small portion of the total population in the counties concerned; nevertheless, the material has been compiled in such a way as to permit of valuable conclusions being drawn from it.

The dental investigation, therefore, does not represent a study of all the inhabitants of Norrbotten and Västerbotten, nor does it depict the exact dental conditions obtaining throughout the population in each district in the counties in their entirety. It

is a typical sample test, and has been kept within those restricted limits, *inter alia* for reasons of economy.

From a statistical point of view, however, an investigation of this kind can only be of limited value; accordingly, in the present inquiry, having secured the collaboration of experts in statistical research, we have convinced ourselves that the general conclusions drawn from the statistical data we have compiled from our limited material are justified. Any reader desiring to follow further along the paths of inquiry pursued here, especially with a view to combining the material collected from small, isolated places, into larger groups, is referred to HOLTZ's and LINDSTRÖM's treatises. The body of material investigated has been of such a size, and collected in such parts of these counties, as to enable us to judge of the points of similarity and dissimilarity between Norrbotten and Västerbotten in the first place, and in the second place between three separate zones within the two counties; moreover, we have been able to draw a comparison with the results obtained from an examination of about 400 school children in Scania (Skåne).

The material on which the dental investigation was carried out, regarded as a percentage of the population, differs, as I have already said, from that which was subjected to medical examination. The latter is represented for the most part by hospital cases, either in-patients or out-patients, especially at the Umeå Hospital, whereas those who underwent dental investigation — the local population and school children — only to a small extent throw light on the pathological conditions prevailing in the districts concerned. The Umeå Hospital material, after being very much thinned out, here represents only 11 %, while the remaining 89 % consist of healthy material from amongst the local inhabitants and particularly from the schools.

An inquiry into the teeth of a »healthy material» is however only of value provided that all the cases have undergone medical examination in order to establish that they *are* healthy. It is obvious, however, that the kind of medical examination to which our material from the schools and homes in the country districts was subjected could not be so thorough and exhaustive as that carried out in an internal medical ward at a hospital. Only a medical examination under the latter conditions can sift the sick material from the healthy with any measure of certainty. The medical examination conducted in conjunction with the dental investigation was

devoted mainly to a study of the general medical status, in addition to which certain tests, such as blood tests, were carried out and note taken of any diseases discovered or otherwise known to exist. The presence of a number of unobserved cases of disease in our »healthy material» cannot therefore be deemed to be entirely out of the question (70 % of cases living on a LIa diet, for instance, show traces of achylia, and so on). Nevertheless, their number, reckoned as a percentage, can hardly be supposed to have any appreciable influence on the figures. There even seems to be justification for assuming that cases of this sort are fairly uniformly distributed within the material and consequently do not prevent comparisons being made between different districts and different zones. The chief value of the medical examination lies in its having enabled the investigation carried out amongst the local population and school children to reap the benefit of certain important discoveries made in the course of the hospital inquiry.

Our dental inquiry has constituted in the main an investigation of school children. The fact that such good results have been obtainable, which is somewhat surprising, is of considerable importance seeing that it has opened up the possibility of carrying on further extensive studies. Children at school are an easily approachable and grateful material to examine. It is far more difficult to carry out an examination of the local population, and that for many reasons. Firstly, numerous difficulties may arise when paying visits to homes in order to carry out — often under extremely primitive conditions — dental and oral inspection which to the »victims» may seem meaningless and are frequently regarded as unwarranted interference in their private affairs; secondly, an investigation of this kind, conducted in a region with long distances between inhabited districts and considerable distances even between the people's homes, is very expensive and difficult to conduct on an economic basis; and thirdly, it may yield such varying results that the number of cases must be very considerable if valuable data are to be obtained. The experiences gained from the present investigation have thus afforded us most important indications as to the lines on which any subsequent similar investigation into popular hygiene ought to be conducted.

The three papers that follow are, strictly speaking, of the nature of concentrated reports to the Medical Board on the direct results of the investigation. The first two — on the problem of caries and the pathological state of the oral cavity — will in all proba-

bility be supplemented by more comprehensive studies published in dental journals. The results of the third report have already been dealt with in my previous scientific papers.

Obviously, the authors do not by any means claim that the results published in the reports presented here have finally solved the problems under discussion. The fact is, all these problems are so complicated that we cannot expect, when our results have been subjected to scrutiny, to receive any recognition for our labours beyond the fact that we have thereby contributed to the present discussion a number of new ideas and fresh points of view.

Dr. Sven Palmi, Ph. Lic., and Filip Anger, B. A., have assisted in the statistical treatment of the recorded and controlled primary material.

CHAPTER II.

The picture and frequency of caries; also the growth of the permanent teeth and their course of development in Upper Norrland.

By

HARALD HOLTZ.

A. The material, its classification, etc.

In the course of an investigation started in 1929 to ascertain the state of health prevailing amongst the population in the Counties of Västerbotten and Norrbotten, and any factors that might conceivably influence it, the condition of the cavity of the mouth was also made the subject of exhaustive inquiry. The material collected on the spot contains, inter alia, careful notes of the condition of the different dental crowns, the shedding of the milk teeth, the eruption of the permanent teeth, carious processes in the milk teeth and permanent teeth, as well as any therapeutical interference there may have been. I contemplate publishing the results of the scientific treatment of this material in a lengthy paper; the present report is to be regarded on the whole as the result of a preliminary estimate.

The material has been collected from specially selected localities within the counties. In the »medical examinations in schools»[1] the investigators have inspected the children by classes, and in the »local medical examinations»[1] all the members of the different households have been examined. Finally, the hospital examination[1] comprises patients under treatment in the Umeå

[1] See Pt. I, Chap. II, pp. 32 et seq. In the following report the material collected from the medical examinations in schools has been compiled into a group called »school material», and that from the local medical examinations and the hospital examination into a group called »local material».

Hospital. Many of the places investigated are small, sparsely inhabited villages, so that the material relating to them, divided up according to age and sex, was bound to be very meagre. Nevertheless, the material may perhaps be regarded as being sufficiently comprehensive to be in general representative of the different localities.

In regard to the geographical position, we note first of all that a number of the places are situated in the interior of what is called the »Lappmark» or Lapp district. These places include: in Västerbotten, Tärna, Stensele, Sorsele and Dorotea; and in Norrbotten, the Kiruna district in the parish of Jukkasjärvi, some small villages in the parish of Jukkasjärvi, and Killinge in the parish of Gällivare. All these places are found in the north-western section of Lapland, within an area close to and parallel to the Norwegian frontier and bounded on the east by the Inland Railway and its extension northwards. We might term this area the *mountainous and desolate zone*. In this region Kiruna assumes a peculiar position as a cultural community out in the wilds, possessing good communications with the outer world and a population living in good circumstances. The villages of the desolate zone in Västerbotten all exhibit the same living conditions: isolation, scanty diet, poor dwellings and a rigorous climate. The villages in Jukkasjärvi, on the other hand, are, thanks to their position, in fairly lively communication with Kiruna. Killinge is exceptional in that, generally speaking, potatoes are not cultivated there, and it may therefore be described, as far as diet is concerned, as a potato-less village, but one whose standard of living is on the whole equal to that obtaining in the villages in the desolate zone of Västerbotten (here too, in parts at least, potatoes are consumed to only a small extent).

The second area in which investigations have been carried out is the coast area, the *coast zone*, embracing the stretch of coast east of the Northern Main Line. The localities examined are situated along the actual coast and comprise the town of Umeå and its surroundings, some smaller places, Bureå, Byske, Kalix and its environs, and also the district of Övertorneå, situated on the R. Torneälv. Here the population lives under very much more favourable conditions than in the desolate zone. The more important part played by agriculture and the good communications have tended in this area to create a different level of dietary and

living conditions, besides which there is the influence of the quite numerous industrial establishments. The Umeå material comprises in part an urban population, in part the inhabitants of the surrounding countryside. The population in Kalix, and especially in Övertorneå, is found to be living in far more needy circumstances than the inhabitants of the coast district in the County of Västerbotten.

Between these two zones lies, finally, the *intermediate zone*, which is represented in Västerbotten by Bjurholm and Vindeln nearer the coast, and Åsele, Lycksele and Norsjö further inland, and in Norrbotten by Arvidsjaur and Jokkmokk. These places have a population of agricultural and forestry workers.

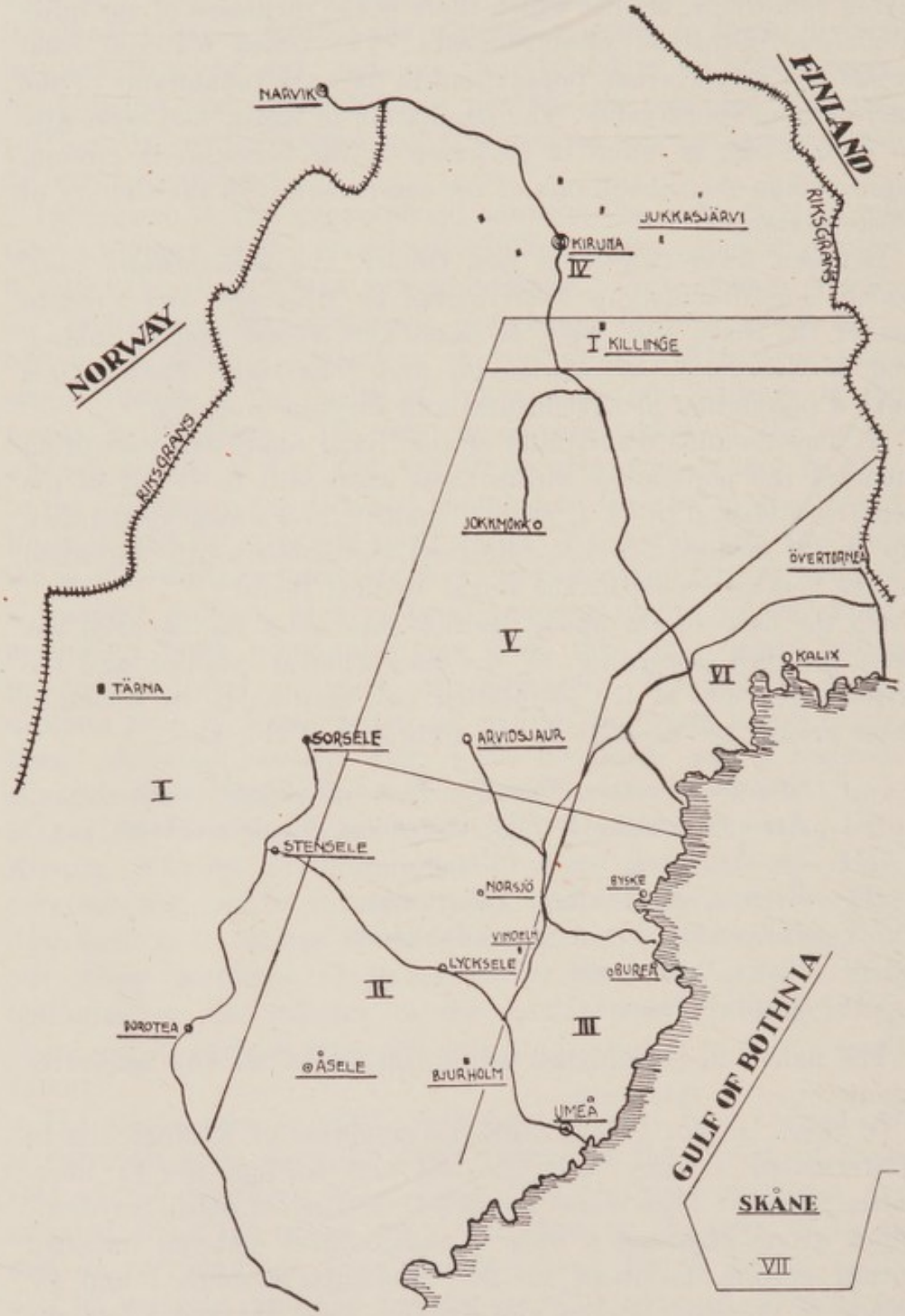
A more detailed description of the living conditions prevailing amongst the population within these areas will be found in the reports published in Pt. I, Sect. 1, chap. V, and which were drawn up by the medical officers concerned and subsequently embodied in one general report by the Royal Medical Board.

On the basis of the above division into zones the material has been grouped according to the geographical position and the living conditions of the population (see map on p. 14, in which these groups are denoted by the figures I—VII), viz.-:

I. Stensele, Sorsele, Dorotea, Tärna, Killinge (Stensele);
II. Åsele, Lycksele, Norsjö, Bjurholm, Vindeln (Åsele);
III. Umeå, Bureå, Byske (Umeå);
IV. Kiruna, Jukkasjärvi (Kiruna);
V. Jokkmokk, Arvidsjaur (Jokkmokk);
VI. Kalix, Övertorneå (Kalix);
VII. Scania (Skåne).

The names in parentheses denote the terms for the respective groups used in this work.

Of these, groups I—III, with the exception of Killinge, are in Västerbotten County, and IV—VI and Killinge are in Norrbotten County. Then comes group VII, Skåne (in South Sweden), which group embraces a body of comparative material included within certain localities in that province. Groups I and IV belong to the mountainous and desolate zone, III and VI to the coast zone, and II and V to the intermediate zone. All the groups I—VII are represented in the medical examination in schools, whereas the local examinations only comprise material from groups I—IV.



Map of the areas from which the primary material has been taken.

* * *

The actual dental pictures are shown in the form of diagrams, in which respective changes have been drawn in different colours according to a special system that has not previously been employed (see p. 19, where the investigation chart in use is illustrated). The study of the picture is facilitated by a free-hand drawing in each individual case of the milk-teeth denture and of the permanent teeth. The nature of the therapeutical treatment that has been given is also indicated.

Out of the present material, that relating to the cases derived from the medical examinations in schools is in every respect of primary interest. For there is a far larger body of material relating to them than that collected from the local medical examinations; moreover, the former deals with a relatively short age period, rendering it possible to divide the data up into such small age intervals as one-year classes. As, further, this material is collected from children in the youngest school ages (7—15 years) it has been possible to study the change-over of teeth in detail; besides which the first attacks of caries could easily be observed and distinguished. Nor has it been very difficult to determine those portions of the teeth on which primary caries has made its appearance. Even the surviving milk teeth are of importance, seeing that the pathological changes found in them represent, so to speak, an elapsed period of the disease, and, when compared with the condition in which the permanent teeth are found, afford a good insight into the individual's disposition to caries.

The material from the local medical examinations and from the hospital comprises individuals of 16—75 years of age. As this material is relatively small, the separate age groups will be inadequately represented, thus reducing the possibilities of drawing conclusions therefrom. In the adult individual, moreover, the picture is confused by the numerous changes of a non-carious nature in the dentures, besides which, any therapeutical interference there may have been tends to render the conditions difficult to interpret.

In the investigation in question, therefore, the main stress must be laid on the material derived from school children. To the results obtained from this material I have added the rest of the material merely in order to supplement and elucidate the conclusions drawn.

In the compiling of the collected primary material the first thing to note has been the influence of age on the beginning and

development of the carious changes. During the age period of 7—15 we find that as a rule all the permanent teeth erupt with the exception of the wisdom teeth. That is to say, during this age period the permanent teeth increase in number from year to year, and we thus get a rapid increase in the number of points of attack from caries. Consequently it becomes necessary to make the different age classes embrace shorter periods so as to avoid the possibility of more or less wide fluctuations in age yielding inaccurate results upon a comparison being made between the different groups. This, as mentioned above, has been feasible thanks to the comparatively abundant material covered by the medical examinations in schools. The age of 7—15 years has thus been divided into nine one-year classes. As regards the rest of the material it is unfortunately impossible to work on the basis of small differences in age. The material is far too meagre, so that we are forced to introduce classes covering a period of ten years each. But we also have to make a distinction between the sexes, owing partly to the fact that the teeth erupt at a different period of childhood (earlier in the case of girls), and partly, indeed more particularly, owing to the far higher frequency of caries occurring in women of 17—18 years of age and over than is the case with men of corresponding ages.

There are different ways of judging the frequency of caries. The easiest way is, in respect of each local group, age and sex, to reckon out relative frequency numbers showing the presence of caries, these frequency numbers being calculated by ascertaining the proportion of teeth attacked by caries to the total number of teeth. This gives a *quantitative measure* of the presence of caries. As however the disease exhibits certain qualitative dissimilarities in its nature, other methods have also been adopted for determining its distribution.

According to one of these methods the individual set of teeth has been regarded as a unit and there has been allotted to it by a special system one of the figures 0, 1, 2 or 3 (»the four-figure system»). The basis on which the different dentures are numbered has been the known existence of definite places on the teeth where there has been a predisposition to caries. These places are:

a) occlusal surface decays in pits,
b) proximal surface decays,
c) gingival third decays in labial and buccal surfaces.

The first of these groups is attacked even at an early stage of

the disease and in mild cases. The presence of caries on the proximal surfaces at once implies a more serious and frequently a more advanced case — and that too especially if these surfaces have also been attacked in the incisors and cuspids of the lower jaw. Finally, if caries has attacked the gingival thirds we generally find that the subject we are dealing with is very susceptible to caries and that the case is one of severe caries. On these lines the material has been divided according to a 4-figure system in the following manner:

0. No caries present;
1. Caries present on occlusal surfaces with fissures and pits;
2. Caries also present on the proximal surfaces in the teeth of the upper jaw as well as on corresponding surfaces in the bicuspids and molars of the lower jaw;
3. Caries present, in addition, on the proximal surfaces of the incisors and cuspids of the lower jaw as well as on the gingival thirds.

This method gives rapid results and throws definite light on the *quality* of the disease. It is however highly subjective, as, owing to the numerous border cases that arise, much depends on the investigator's ability to form an estimate of the occurrence of caries. The *second qualitative method* employed permits of more exact calculations, but it is more circumstantial. By this method the frequency of caries has been calculated for certain different parts of the teeth. The number of surfaces here in question may be fixed at 120 for the permanent set as a whole (occlusal surfaces with fissures and pits 24, proximal surfaces 64 and buccal (labial) gingival thirds 32). Of these surface systems the following have been deemed to be representative parts of the denture for characterizing different forms of carious decay, viz.:

1) The molar fissural system (12 in the entire set).
2) Proximal surfaces of the upper incisors (8 in number).
3) Proximal surfaces of the lower incisors (8 in number), and
4) Buccal (labial) gingival thirds of the teeth in the upper and lower jaws (32 in number).

The calculations made by the qualitative methods have concerned only the permanent teeth.

The investigations into caries have thus been carried out by one quantitative method and two qualitative methods, viz.:

I) Calculations of frequency figures in respect of all teeth;
II) Calculations according to the four-figure system; and

III) Calculations of frequency in respect of the four above-mentioned surface systems.

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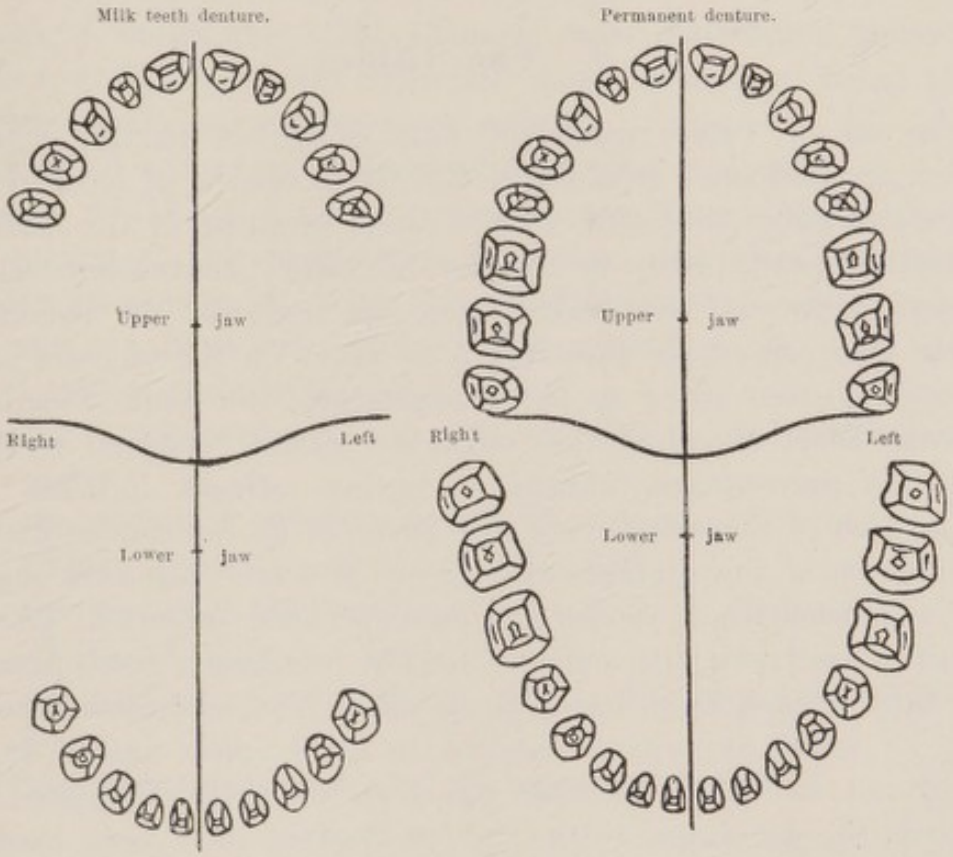
The material compiled on the basis indicated above comprises 4,413 cases, including the comparative material collected in Skåne. Of these cases, 275 have been eliminated, namely: 221 cases on account of incomplete data, and 54 cases amongst children of 15. The latter number is indeed so small that it would not be expedient in respect of the different localities and sexes to form groups for purposes of comparison; nor has it been feasible with any advantage to incorporate the 15-year-olds in the material relating to older persons, so that the only alternative was to exclude them altogether. The remaining 4,138 cases are apportioned as follows: 3,220 under the school material group (ages 7—14 years) and 918 under the local material group (ages 16—75 years).

Of the primary material collected from the Umeå district, the data relating to the milk teeth have for certain reasons proved so incomplete that it has not been found possible to make use of them for the purposes of the investigation. Consequently, all observations relating to the Umeå children's milk teeth have been omitted from the subsequent statistical summaries.

Other data regarding the material will be found under the heading B. The Tables.

Investigation chart.

Dental status.



The diagrams are filled in with blue, green and red.

Blue denotes teeth not yet erupted.

Green denotes missing teeth (milk teeth that have come out and extracted teeth).

Caries is indicated in red.

In the case of a completely carious tooth and remains of the root the entire tooth is filled in with red.

(Teeth that cannot be restored by filling are indicated by the letter R.)

In other carious states the place where the primary attack of caries took place is marked in red.

N. B. In the case of ging. third caries of the molars, a red line is drawn in a mesiodistal direction, in the case of caries in the bucc. and ling. fissures of these teeth a line is drawn along the course of the fissures.

Fillings, crowns, artificial teeth are indicated at the side of the teeth by letters: A — amalgam, S — silicate, P — porcelain, G — coh. gold, GF — gold filling, AT — artificial tooth, Gcr — gold crown, Acr — amalgam crown.

In the tooth itself the exact extent of the operation performed is carefully denoted in red.

B. The Tables.

The set of Tables published here comprises partly tables in which are indicated, in absolute figures in respect of local groups, sexes and ages, the results of the direct totalling of the different quantities, and partly a number of tables containing relative figures expressed as percentages. As regards the permanent teeth, this percentage calculation is based on the chances of infection existing prior to the examination, the method being to take as basis of calculation only the already erupted teeth, so that the percentages relating to carious attacks indicate what proportion of these teeth has been affected by the disease or what proportion of the surfaces of a group of teeth that have erupted and are sensitive to caries has actually been infected. The calculation has taken into account the lost permanent teeth provided the fate of such teeth could be deduced from available information — which it proved possible to do in most cases. If this could not be done, the case has been entirely eliminated. As regards the deciduous teeth, the calculations have been made on the basis of the milk teeth still remaining in the mouth.

1. *The medical examination in schools (ages 7—14 years).*

Tables 1—16.

Table 1 shows how the primary material is distributed according to local groups, ages and sex.

Tables 2 and 3 give the total number of permanent teeth and milk teeth, classified according to local groups and ages. They likewise show the average number of teeth per individual in respect of different groups and ages.

Table 2 comprises boys and Table 3 girls.

Tables 4 and 5 contain data showing the frequency of caries in the permanent dental system, classified according to local groups and ages and indicating both absolute and relative figures.

Table 4 comprises boys and Table 5 girls.

Tables 6 and 7 contain data showing the frequency of caries in the milk teeth system, classified according to local groups and ages and indicating both absolute and relative numbers.

Table 6 comprises boys and Table 7 girls.

Table 8 shows the 3,220 primary cases distributed according to the four-figure system explained on p. 14, account being taken however of the permanent teeth only.

Classified according to local groups, ages and sex.

Tables 9—16 are drawn up in order to afford a better qualitative survey of the distribution of caries. The absolute and the relative frequency of caries, classified according to local groups, ages and sex, have been calculated in respect of the parts of the dental system enumerated below:

a) the fissure system of the molars (Table 9, boys and Table 10, girls),
b) the proximal surfaces on the front teeth of the upper jaw (Table 11, boys and Table 12, girls),
c) the proximal surfaces on the front teeth of the lower jaw (Table 13, boys and Table 14, girls),
d) all buccal gingival thirds (Table 15, boys and Table 16, girls).

These Tables relate only to the permanent teeth.

2. *The local and hospital medical examinations (ages 16—75 years).*

Tables 17—28.

The Tables are here compiled on lines similar to those relating to the school medical examinations.

Table 17 shows how the primary material is distributed according to local groups, ages and sex. The age classes in this as in the following Tables comprise 10 years.

Tables 18 and 19 contain data regarding the total number of teeth and the absolute and relative frequency of caries, classified according to local groups and ages.

Table 18 comprises men and Table 19 women.

Table 20 is compiled on the four-figure system in the same way as Table 8.

Tables 21—28 deal with caries qualitatively in parts of the rows of teeth and are drawn up on the same lines as Tables 9—16.

Table 1. *Distribution of the primary school material acc. to local groups, ages and sex in the different cases.*

Local groups	7 years			8 years			9 years			10 years			11 years		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
I. Stensele ...	24	17	41	22	22	44	39	22	61	29	28	57	31	32	63
II. Åsele	12	19	31	32	26	58	24	25	49	26	23	49	32	25	57
III. Umeå	108	77	185	96	67	163	29	17	46	24	21	45	57	39	96
IV. Kiruna ...	61	68	129	74	66	140	62	66	128	48	51	99	25	18	43
V. Jokkmokk	2	14	16	19	18	37	28	15	43	20	12	32	28	21	49
VI. Kalix	7	14	21	11	17	28	18	30	48	22	29	51	15	25	40
VII. Skåne.....	28	19	47	33	19	52	32	30	62	27	27	54	32	24	56
Total	242	228	470	287	235	522	232	205	437	196	191	387	220	184	404

Local groups	12 years			13 years			14 years			Total 7—14 years		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
I. Stensele ...	20	16	36	28	11	39	14	19	33	207	167	374
II. Åsele	40	29	69	16	13	29	7	7	14	189	167	356
III. Umeå	68	46	114	40	39	79	9	9	18	431	315	746
IV. Kiruna ...	12	17	29	46	66	112	44	58	102	372	410	782
V. Jokkmokk	25	31	56	19	26	45	8	6	14	149	143	292
VI. Kalix	17	42	59	5	11	16	4	6	10	99	174	273
VII. Skåne	32	32	64	29	22	51	6	5	11	219	178	397
Total	214	213	427	183	188	371	92	110	202	1,666	1,554	3,220

Table 2. *Absolute and relative number of permanent teeth and milk teeth. Classified acc. to local groups and ages. Boys.*

Local groups	7 years					8 years					9 years					10 years					Total individuals
	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	
I. Stensele ...	24	191	355	8.0	14.8	22	240	263	10.9	12.0	39	493	421	12.6	10.8	29	451	236	15.6	8.1	
II. Åsele	12	93	157	7.8	13.1	32	367	329	11.5	10.3	24	334	184	13.9	7.7	26	386	196	14.8	7.5	
III. Umeå	108	937	—	8.7	—	96	987	—	10.3	—	29	401	—	13.8	—	24	403	—	16.8	—	
IV. Kiruna	61	509	799	8.3	13.1	74	773	800	10.4	10 8	62	882	418	14.2	6.7	48	752	262	15.7	5.5	
V. Jokkmokk	2	21	22	(10.5)	(11.0)	19	217	196	11.4	10.3	28	365	258	13.0	9.2	20	349	86	17.5	4.3	
VI. Kalix	7	57	98	8.1	14.0	11	105	137	9.5	12.5	18	281	128	15.6	7.1	22	387	107	17.6	4.9	
VII. Skåne	28	251	401	9.0	14.3	33	389	350	11.8	10.6	32	423	305	13.2	9.5	27	455	189	16.9	7.0	
Total	242	2,059	1,832	8.5	13.7	287	3,078	2,075	10.7	10.9	232	3,179	1,714	13.7	8.4	196	3,183	1,076	16.2	6.3	

	11 years					12 years					13 years					14 years					Total individuals
I. Stensele ...	31	537	205	17.3	6.6	20	477	36	23.9	1.8	28	670	53	23.9	1.9	14	386	1	27.6	0.1	207
II. Åsele	32	640	117	20.0	3.7	40	923	83	23.1	2.1	16	418	4	26.1	0.3	7	196	0	28.0	0.0	189
III. Umeå	57	1,123	—	19.7	—	68	1,637	—	24.1	—	40	1,023	—	25.6	—	9	229	—	25.4	—	431
IV. Kiruna	25	484	86	19.4	3.4	12	296	11	24.7	0.9	46	1,223	29	26.6	0.6	44	1,205	4	27.4	0.1	372
V. Jokkmokk	28	567	94	20.3	3.4	25	626	23	25.0	0.9	19	512	1	26.9	0.1	8	206	11	25.8	1.4	149
VI. Kalix	15	282	68	18.8	4.5	17	418	17	24.6	1.0	5	127	4	25.4	0.8	4	110	0	27.5	0.0	99
VII. Skåne	32	698	96	21.8	3.0	32	770	59	24.1	1.8	29	789	5	27.2	0.2	6	165	1	27.5	0.2	219
Total	220	4,331	666	19.7	4.1	214	5,147	229	24.1	1.6	183	4.762	96	26.0	0.7	92	2,497	17	27.1	0.2	1,666

Table 3. *Absolute and relative number of permanent teeth and milk teeth. Classified acc. to local groups and ages. Girls.*

Local groups	7 years					8 years					9 years					10 years					
	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	No. of indiv.	No. of perm. teeth	No. of milk teeth	Aver. per indiv. perm.	Aver. per indiv. milk	
I. Stensele ...	17	158	218	9.3	12.8	22	248	266	11.3	12.1	22	326	180	14.8	8.2	28	461	192	16.5	6.9	
II. Åsele	19	172	249	9.1	13.1	26	317	260	12.2	10.0	25	367	187	14.7	7.5	23	431	103	18.7	4.5	
III. Umeå	77	732	—	9.5	—	67	731	—	10.9	—	17	252	—	14.8	—	21	361	—	17.2	—	
IV. Kiruna.. ...	68	680	766	10.0	11.3	66	791	668	12.0	10.1	66	1,051	336	15.9	5.1	51	882	230	17.3	4.5	
V. Jokkmokk	14	137	181	9.8	12.9	18	222	185	12.3	10.3	15	212	128	14.1	8.5	12	231	56	19.3	4.7	
VI. Kalix	14	135	169	9.6	12.1	17	207	168	12.2	9.9	30	462	235	15.4	7.8	29	528	153	18.2	5.3	
VII. Skåne	19	171	262	9.0	13.8	19	223	213	11.7	11.2	30	447	243	14.9	8.1	27	516	122	19.1	4.5	
Total	228	2,185	1,845	9.6	12.2	235	2,739	1,760	11.7	10.5	205	3,117	1,309	15.2	7.0	191	3,410	856	17.9	5.0	

	11 years					12 years					13 years					14 years					Total individuals
I. Stensele ...	32	712	78	22.3	2.4	16	424	10	26.5	0.6	11	294	7	26.7	0.6	19	525	3	27.6	0.2	167
II. Åsele	25	547	58	21.9	2.3	29	704	46	24.3	1.6	13	348	0	26.8	0.0	7	196	0	28.0	0.0	167
III. Umeå	39	904	—	23.2	—	46	1,160	—	25.2	—	39	1,031	—	26.4	—	9	252	—	28.0	—	315
IV. Kiruna ...	18	399	11	22.2	0.6	17	443	17	26.1	1.0	66	1,805	1	27.3	0.0	58	1,602	0	27.6	0.0	410
V. Jokkmokk	21	490	33	23.3	1.6	31	803	12	25.9	0.4	26	707	8	27.2	0.3	6	163	1	27.2	0.2	143
VI. Kalix	25	521	79	20.8	3.2	42	1,081	25	25.7	0.6	11	288	9	26.2	0.8	6	163	4	27.2	0.7	174
VII. Skåne	24	546	55	22.8	2.3	32	789	44	24.7	1.4	22	605	4	27.5	0.2	5	138	0	27.6	0.0	178
Total	184	4,119	314	22.4	2.2	213	5,404	154	25.4	0.9	188	5,078	29	27.0	0.2	110	3,039	8	27.6	0.1	1,554

Table 4. *Caries in permanent teeth. Boys.*

Group	7 years			8 years			9 years			10 years		
	No. of perm. teeth	Whereof carious		No. of perm. teeth	Whereof carious		No. of perm. teeth	Whereof carious		No. of perm. teeth	Whereof carious	
		Abs.	%		Abs.	%		Abs.	%		Abs.	%
I. Stensele	191	5	2.6	240	38	15.8	493	68	13.8	451	61	13.5
II. Åsele	93	26	28.0	367	106	28.9	334	87	26.0	386	108	28.0
III. Umeå	937	237	25.3	987	306	31.0	401	113	28.2	403	115	28.5
IV. Kiruna	509	91	17.9	773	207	26.8	882	221	25.1	752	226	30.1
V. Jokkmokk	21	6	28.6	217	70	32.3	365	113	31.0	349	138	39.5
VI. Kalix	57	16	28.1	105	35	33.3	281	116	41.3	387	142	36.7
VII. Skåne	251	53	21.1	389	85	21.9	423	93	22.0	455	105	23.1
Total	2,059	434	—	3,078	847	—	3,179	811	—	3,183	895	—

	11 years			12 years			13 years			14 years		
I. Stensele	537	70	13.0	477	50	10.5	670	64	9.6	386	43	11.1
II. Åsele	640	179	28.0	923	246	26.7	418	89	21.3	196	51	26.0
III. Umeå	1,123	313	27.9	1,637	543	33.2	1,023	365	35.7	229	91	39.7
IV. Kiruna	484	145	30.0	296	66	22.3	1,223	409	33.3	1,205	406	33.7
V. Jokkmokk	567	179	31.6	626	228	36.4	512	184	35.9	206	71	34.5
VI. Kalix	282	139	49.3	418	152	36.4	127	77	60.6	110	32	29.1
VII. Skåne	698	181	25.9	770	177	23.0	789	202	25.6	165	63	38.2
Total	4,331	1,206	—	5,147	1,462	—	4,762	1,390	—	2,497	757	—

Table 5. *Caries in permanent teeth. Girls.*

Group	7 years			8 years			9 years			10 years		
	No. of perm. teeth	Whereof carious		No. of perm. teeth	Whereof carious		No. of perm. teeth	Whereof carious		No. of perm. teeth	Whereof carious	
		Abs.	%		Abs.	%		Abs.	%		Abs.	%
I. Stensele	158	16	10.1	248	29	11.7	326	40	12.3	461	46	10.0
II. Åsele	172	30	17.4	317	91	28.7	367	117	31.9	431	100	23.2
III. Umeå	732	195	26.6	731	223	30.5	252	68	27.0	361	112	31.0
IV. Kiruna	680	130	19.1	791	190	24.0	1,051	308	29.3	882	292	33.1
V. Jokkmokk	137	45	32.8	222	65	29.3	212	84	39.6	231	74	32.0
VI. Kalix	135	43	31.9	207	76	36.7	462	163	35.3	528	229	43.4
VII. Skåne	171	51	29.8	223	51	22.9	447	103	23.0	516	111	21.5
Total	2,185	510	—	2,739	725	—	3,117	883	—	3,410	964	—

	11 years			12 years			13 years			14 years		
I. Stensele	712	83	11.7	424	37	8.7	294	56	19.0	525	89	17.0
II. Åsele	547	135	24.7	704	224	31.8	348	100	28.7	196	62	31.6
III. Umeå	904	301	33.3	1,160	379	32.7	1,031	453	43.9	252	74	29.4
IV. Kiruna	399	114	28.6	443	129	29.1	1,805	819	45.4	1,602	707	44.1
V. Jokkmokk	490	169	34.5	803	310	38.6	707	304	43.0	163	55	33.7
VI. Kalix	521	163	31.3	1,081	526	48.7	288	104	36.1	163	83	50.9
VII. Skåne	546	165	30.2	789	243	30.8	605	206	34.0	138	44	31.9
Total	4,119	1,130	—	5,404	1,848	—	5,078	2,042	—	3,039	1,114	—

Table 6. *Caries in milk teeth. Boys.*

Group	7 years			8 years			9 years			10 years		
	No. of milk teeth	Whereof carious		No. of milk teeth	Whereof carious		No. of milk teeth	Whereof carious		No. of milk teeth	Whereof carious	
		Abs.	%		Abs.	%		Abs.	%		Abs.	%
I. Stensele	355	72	20.3	263	76	28.9	421	91	21.6	236	48	20.3
II. Åsele	157	118	75.2	329	210	63.8	184	117	63.6	196	111	56.6
III. Umeå	—	—	—	—	—	—	—	—	—	—	—	—
IV. Kiruna	799	522	65.3	800	552	69.0	418	280	67.0	262	153	58.4
V. Jokkmokk	22	15	68.2	196	133	67.9	258	192	74.4	86	63	73.3
VI. Kalix	98	71	72.4	137	92	67.2	128	89	69.5	107	78	72.9
VII. Skåne	401	196	48.9	350	203	58.0	305	190	62.3	189	98	51.9
Total	1,832	994	—	2,075	1,266	—	1,714	959	—	1,076	551	—

	11 years			12 years			13 years			14 years		
I. Stensele	205	34	16.6	36	6	—[1]	53	13	—[1]	1	0	—[1]
II. Åsele	117	60	51.3	83	36	—	4	1	—	0	0	—
III. Umeå	—	—	—	—	—	—	—	—	—	—	—	—
IV. Kiruna	86	50	58.1	11	5	—	29	13	—	4	4	—
V. Jokkmokk	94	59	62.8	23	21	—	1	1	—	11	4	—
IV. Kalix	68	49	72.1	17	14	—	4	4	—	0	0	—
VII. Skåne	96	53	55.2	59	23	—	5	3	—	1	1	—
Total	666	305	—	229	105	—	96	35	—	17	9	—

[1] Owing to the paucity of observations, no percentages have been calculated here. The same applies to the following tables where percentages are lacking throughout a column.

Table 7. *Caries in milk teeth. Girls.*

Group	7 years			8 years			9 years			10 years		
	No. of milk teeth	Whereof carious		No. of milk teeth	Whereof carious		No. of milk teeth	Whereof carious		No. of milk teeth	Whereof carious	
		Abs.	%		Abs.	%		Abs.	%		Abs.	%
I. Stensele	218	58	26.6	266	58	21.8	180	23	12.8	192	33	17.2
II. Åsele	249	148	59.4	260	180	69.2	187	89	47.6	103	38	36.9
III. Umeå	—	—	—	—	—	—	—	—	—	—	—	—
IV. Kiruna	766	474	61.9	668	425	63.6	336	242	72.0	230	169	73.5
V. Jokkmokk	181	125	69.1	185	131	70.8	128	95	74.2	56	38	67.9
VI. Kalix	169	124	73.4	168	109	64.9	235	169	71.9	153	115	75.2
VII. Skåne	262	157	59.9	213	111	52.1	243	149	61.3	122	78	63.9
Total	1,845	1,086	—	1,760	1,014	—	1,309	767	—	856	471	—

	11 years			12 years			13 years			14 years		
I. Stensele	78	19	24.4	10	4	—	7	1	—	3	1	—
II. Åsele	58	28	48.3	46	24	—	0	0	—	0	0	—
III. Umeå	—	—	—	—	—	—	—	—	—	—	—	—
IV. Kiruna	11	9	81.8	17	8	—	1	1	—	0	0	—
V. Jokkmokk	33	27	81.8	12	9	—	8	8	—	1	1	—
VI. Kalix	79	50	63.3	25	23	—	9	5	—	4	4	—
VII. Skåne	55	42	76.4	44	27	—	4	4	—	0	0	—
Total	314	175	—	154	95	—	29	19	—	8	6	—

Table 8. *Absolute and percentage distribution of the frequency of caries in the permanent denture acc. to the »four-figure system».*

Age years	Boys								Girls							
	Absolute figures				Percentage figures				Absolute figures				Percentage figures			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
	Stensele															
7	21	3	—	—	87.5	12.5	—	—	10	7	—	—	58.8	41.2	—	—
8	6	16	—	—	27.3	72.7	—	—	9	13	—	—	40.9	59.1	—	—
9	15	20	4	—	38.5	51.3	10.2	—	7	15	—	—	31.8	68.2	—	—
10	11	17	1	—	37.9	58.6	3.5	—	13	12	2	1	46.4	42.9	7.2	3.5
11	10	18	3	—	32.3	58.1	9.6	—	4	25	3	—	12.5	78.1	9.4	—
12	5	12	3	—	25.0	60.0	15.0	—	4	9	2	1	25.0	56.3	12.4	6.3
13	7	19	2	—	25.0	67.9	7.1	—	1	6	4	—	9.0	54.5	36.5	—
14	2	10	2	—	14.3	71.4	14.3	—	2	11	5	1	10.5	57.9	26.4	5.2
	Umeå															
7	22	82	1	3	20.4	75.9	0.9	2.8	15	57	1	4	19.5	74.0	1.3	5.2
8	9	80	3	4	9.4	83.3	3.1	4.2	4	58	3	2	6.0	86.5	4.5	3.0
9	—	24	3	2	—	82.8	10.3	6.9	—	15	2	—	—	88.2	11.8	—
10	1	16	4	3	4.2	66.7	16.7	12.4	1	11	7	2	4.8	52.4	33.3	9.5
11	2	33	17	5	3.5	57.9	29.8	8.8	—	15	16	8	—	38.5	41.0	20.5
12	—	32	25	11	—	47.0	36.8	16.2	—	18	21	7	—	39.1	45.7	15.2
13	—	18	12	10	—	45.0	30.0	25.0	—	9	16	14	—	23.1	41.0	35.9
14	—	5	2	2	—	—	—	—	—	4	4	1	—	—	—	—

Age years	Boys								Girls							
	Absolute figures				Percentage figures				Absolute figures				Percentage figures			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
	Åsele															
7	5	7	—	—	41.7	58.3	—	—	5	14	—	—	26.3	73.7	—	—
8	1	26	3	2	3.1	81.2	9.4	6.3	2	20	2	2	7.7	76.9	7.7	7.7
9	1	19	4	—	4.2	79.2	16.6	—	2	13	7	3	8.0	52.0	28.0	12.0
10	3	15	5	3	11.5	57.7	19.3	11.5	1	15	7	—	4.3	65.3	30.4	—
11	2	17	8	5	6.3	53.1	25.0	15.6	1	16	4	4	4.0	64.0	16.0	16.0
12	1	26	9	4	2.5	65.0	22.5	10.0	1	11	10	7	3.4	37.9	34.6	24.1
13	—	12	4	—	—	75.0	25.0	—	—	7	5	1	—	53.8	38.5	7.7
14	—	4	2	1	—	—	—	—	—	3	3	1	—	—	—	—
	Kiruna															
7	22	38	—	1	36.1	62.3	—	1.6	18	47	3	—	26.5	69.1	4.4	—
8	8	61	2	3	10.8	82.4	2.7	4.1	6	53	4	3	9.1	80.3	6.1	4.5
9	4	48	6	4	6.5	77.4	9.6	6.5	2	39	16	9	3.0	59.2	24.2	13.6
10	2	27	9	10	4.2	56.3	18.7	20.8	—	26	14	11	—	51.0	27.4	21.6
11	—	12	8	5	—	48.0	32.0	20.0	—	9	6	3	—	50.0	33.3	16.7
12	1	6	4	1	8.3	50.0	33.4	8.3	—	7	7	3	—	41.2	41.2	17.6
13	—	14	23	9	—	30.4	50.0	19.6	—	12	24	30	—	18.1	36.4	45.5
14	—	18	14	12	—	40.9	31.8	27.3	—	9	28	21	—	15.5	48.3	36.2

Table 8. *Absolute and percentage distribution of the frequency of caries in the permanent denture acc. to the »four-figure system».*

Age years	Boys								Girls								Boys								Girls							
	Absolute figures				Percentage figures				Absolute figures				Percentage figures				Absolute figures				Percentage figures				Absolute figures				Percentage figures			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
	Jokkmokk																Kalix															
7	—	2							1	12	1	—	7.1	85.8	7.1	—	2	5	—	—	—	—	—	—	1	12	—	1	7.1	85.8	—	7.1
8	1	16	2	—	5.3	84.2	10.5	—	—	17	1	—	—	94.4	5.6	—	1	9	—	1	9.1	81.8	—	9.1	—	14	1	2	—	82.3	5.9	11.8
9	2	21	3	2	7.1	75.0	10.8	7.1	—	10	2	3	—	66.7	13.3	20.0	—	10	6	2	—	55.6	33.3	11.1	—	20	5	5	—	66.6	16.7	16.7
10	—	12	3	5	—	60.0	15.0	25.0	—	8	2	2	—	66.6	16.7	16.7	1	11	3	7	4.6	50.0	13.6	31.8	—	10	11	8	—	34.5	37.9	27.6
11	—	16	5	7	—	57.1	17.9	25.0	—	9	10	2	—	42.9	47.6	9.5	—	4	6	5	—	26.7	40.0	33.3	—	10	12	3	—	40.0	48.0	12.0
12	—	11	7	7	—	44.0	28.0	28.0	—	9	15	7	—	29.0	48.4	22.6	—	10	5	2	—	58.8	29.4	11.8	—	9	20	13	—	21.4	47.6	31.0
13	—	8	9	2	—	42.1	47.4	10.5	—	8	12	6	—	30.8	46.1	23.1	—	—	4	1	—	—	—	—	—	6	1	4	—	54.5	9.1	36.4
14	—	5	2	1	—	—	—	—	—	4	2	—	—	—	—	—	—	3	1	—	—	—	—	—	—	2	4	—	—	—	—	—
	Skåne																															
7	6	21	1	—	21.4	75.0	3.6	—	1	18	—	—	5.3	94.7	—	—																
8	5	27	1	—	15.2	81.8	3.0	—	1	18	—	—	5.3	94 7	—	—																
9	3	28	1	—	9.4	87.5	3.1	—	1	27	2	—	3.3	90.0	6.7	—																
10	3	20	3	1	11.1	74.1	11.1	3.7	1	20	6	—	3.7	74.1	22.2	—																
11	—	18	12	2	—	56.3	37.5	6.2	—	9	13	2	—	37.5	54.2	8.3																
12	2	23	7	—	6.2	71.9	21.9	—	1	17	11	3	3.1	53.1	34.4	9.4																
13	—	17	11	1	—	58.6	37.9	3.5	—	8	10	4	—	36.4	45.4	18.2																
14	—	2	3	1	—	—	—	—	—	3	1	1	—	—	—	—																

Table 9. *Frequency of caries in the permanent molars' fissure system. Boys.*

Group	7 years			8 years			9 years			10 years				
	No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	89	5	5.6	86	36	41.9	156	53	34.0	126	56	44.4		
II. Åsele	44	25	56.8	128	91	71.1	97	74	76.3	111	73	65.8		
III. Umeå	401	226	56.4	371	277	74.7	116	90	77.6	107	84	78.5		
IV. Kiruna	219	89	40.6	289	186	64.4	247	178	72.1	194	144	74.2		
V. Jokkmokk	8	6	75.0	76	64	84.2	113	96	85.0	89	84	94.4		
VI. Kalix	24	16	66.7	42	31	73.8	76	68	89.5	89	79	88.8		
VII. Skåne	111	47	42.3	132	82	62.1	128	86	67.2	116	76	65.5		
Total	896	414	—	1,124	767	—	933	645	—	832	596	—	Total	
													No. of fissure systems	Whereof carious Abs.
	11 years			12 years			13 years			14 years				
I. Stensele	143	54	37.8	123	42	34.1	183	53	29.0	109	26	23.9	1,015	325
II. Åsele	155	108	69.7	229	157	68.6	111	63	56.8	56	30	53.6	931	621
III. Umeå	267	214	80.1	425	318	74.8	266	208	78.2	63	49	77.8	2,016	1,466
IV. Kiruna	112	77	68.8	80	34	42.5	360	219	60.8	350	203	58.0	1,851	1,130
V. Jokkmokk	139	113	81.3	160	122	76.3	136	104	76.5	59	41	69.5	780	630
VI. Kalix	72	65	90.3	106	79	74.5	31	27	87.1	30	24	80.0	470	389
VII. Skåne	170	120	70.6	208	122	58.7	219	140	63.9	48	29	60.4	1,132	702
Total	1,058	751	—	1,331	874	—	1,306	814	—	715	402	—	8,195	5,263

Table 10. *Frequency of caries in the permanent molars' fissure system. Girls.*

Group	7 years			8 years			9 years			10 years				
	No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	68	16	23.5	87	29	33.3	88	34	38.6	116	35	30.2		
II. Åsele	67	29	43.3	102	74	72.5	100	78	78.0	101	73	72.3		
III. Umeå	292	170	58.2	263	203	77.2	68	61	89.7	88	75	85.2		
IV. Kiruna	261	120	46.0	260	157	60.4	262	204	77.9	204	171	83.8		
V. Jokkmokk	54	41	75.9	74	60	81.1	66	57	86.4	55	40	72.7		
VI. Kalix	54	38	70.4	67	61	91.0	123	106	86.2	125	113	90.4		
VII. Skåne	75	51	68.0	76	45	59.2	126	92	73.0	125	88	70.4		
Total	871	465	—	929	629	—	833	632	—	814	595	—	Total	
													No. of fissure systems	Whereof carious Abs.
	11 years			12 years			13 years			14 years				
I. Stensele	167	68	40.7	117	25	21.4	82	38	46.3	152	44	28.9	877	289
II. Åsele	120	83	69.2	178	118	66.3	92	61	66.3	56	38	67.9	816	554
III. Umeå	219	164	74.9	289	218	75.4	284	225	79.2	72	47	65.3	1,575	1,163
IV. Kiruna	87	66	75.9	124	68	54.8	510	361	70.8	458	319	69.7	2,166	1,466
V. Jokkmokk	116	99	85.3	214	154	72.0	198	163	82.3	45	35	77.8	822	649
VI. Kalix	118	99	83.9	279	238	85.3	79	58	73.4	48	42	87.5	893	755
VII. Skåne	126	94	74.6	208	155	74.5	169	113	66.9	39	26	66.7	944	664
Total	953	673	—	1,409	976	—	1,414	1,019	—	870	551	—	8,093	5,540

Table 11. *Frequency of caries in the permanent front teeth of the upper jaw. Boys.*

Group	7 years			8 years			9 years			10 years				
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	62	0	0.0	136	0	0.0	280	3	1.1	232	2	0.9		
II. Åsele	30	0	0.0	198	4	2.0	176	6	3.4	208	18	8.7		
III. Umeå	302	0	0.0	440	2	0.5	204	7	3.4	190	7	3.7		
IV. Kiruna	186	0	0.0	362	8	2.2	462	27	5.8	376	38	10.1		
V. Jokkmokk	10	0	0.0	106	5	4.7	200	2	1.0	158	31	19.6		
VI. Kalix	16	0	0.0	46	0	0.0	132	38	28.8	172	33	19.2		
VII. Skåne	88	5	5.7	210	0	0.0	228	1	0.4	196	9	4.6		
Total	694	5	—	1,498	19	—	1,682	84	—	1,532	138	—	Total	

	11 years			12 years			13 years			14 years			Total	
													No. of approx. surfaces	Whereof carious
														Abs.
I. Stensele	244	9	3.7	160	8	5.0	220	5	2.3	112	6	5.4	1,448	33
II. Åsele	254	46	18.1	318	57	17.9	128	7	5.5	56	10	17.9	1,368	148
III. Umeå	446	67	15.0	532	141	26.5	320	83	25.9	72	21	29.2	2,506	328
IV. Kiruna	192	55	28.6	96	22	22.9	368	135	36.7	352	120	34.1	2,394	405
V. Jokkmokk	222	41	18.5	200	55	27.5	152	39	25.7	64	18	28.1	1,112	191
VI. Kalix	120	57	47.5	136	39	28.7	40	24	60.0	32	1	3.1	694	192
VII. Skåne	250	32	12.8	256	21	8.2	232	44	19.0	48	15	31.3	1,512	127
Total	1,728	307	—	1,698	343	—	1,460	337	—	736	191	—	11,034	1,424

Table 12. *Frequency of caries in the permanent front teeth of the upper jaw. Girls.*

Group	7 years			8 years			9 years			10 years				
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	60	0	0.0	142	0	0.0	172	0	0.0	224	8	3.6		
II. Åsele	96	0	0.0	170	12	7.1	184	25	13.6	180	23	12.8		
III. Umeå	318	10	3.1	364	6	1.6	130	0	0.0	164	29	17.7		
IV. Kiruna	304	8	2.6	406	16	3.9	522	85	16.3	400	95	23.8		
V. Jokkmokk	68	6	8.8	114	2	1.8	106	14	13.2	94	22	23.4		
VI. Kalix	58	0	0.0	112	10	8.9	234	49	20.9	230	84	36.5		
VII. Skåne	64	0	0.0	126	0	0.0	222	6	2.7	212	15	7.1		
Total	968	24	—	1,434	46	—	1,570	179	—	1,504	276	—	Total	
	11 years			12 years			13 years			14 years			No. of approx. surfaces	Whereof carious Abs.
I. Stensele	256	9	3.5	128	11	8.6	88	12	13.6	152	34	22.4	1,222	74
II. Åsele	200	23	11.5	228	69	30.3	104	20	19.2	56	16	28.6	1,218	188
III. Umeå	312	66	21.2	368	80	21.7	308	119	38.6	72	15	20.8	2,040	325
IV. Kiruna	144	35	24.3	136	48	35.3	524	249	47.5	460	243	52.8	2,896	779
V. Jokkmokk	168	59	35.1	248	89	35.9	208	78	37.5	48	9	18.8	1,054	279
VI. Kalix	198	51	25.8	334	152	45.5	88	18	20.5	48	24	50.0	1,302	388
VII. Skåne	188	56	29.8	252	50	19.8	176	45	25.6	40	9	22.5	1,280	181
Total	1,466	299	—	1,694	499	—	1,500	541	—	876	350	—	11.012	2,214

Table 13. *Frequency of caries in the permanent front teeth of the lower jaw. Boys.*

Group	7 years			8 years			9 years			10 years				
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	140	0	0.0	158	0	0.0	308	4	1.3	232	0	0.0		
II. Åsele	66	0	0.0	242	10	4.1	184	2	1.1	200	18	9.0		
III. Umeå	712	9	1.3	708	16	2.3	224	6	2.7	192	13	6.8		
IV. Kiruna	366	2	0.5	542	7	1.3	496	20	4.0	384	28	7.3		
V. Jokkmokk	16	0	0.0	148	0	0.0	224	15	6.7	160	29	18.1		
VI. Kalix	48	0	0.0	76	6	7.9	142	3	2.1	176	37	21.0		
VII. Skåne	172	0	0.0	252	2	0.8	246	0	0.0	212	3	1.4		
Total	1,520	11	—	2,126	41	—	1,824	50	—	1,556	128	—	Total	
	11 years			12 years			13 years			14 years			No. of approx. surfaces	Whereof carious Abs.
I. Stensele	248	0	0.0	160	0	0.0	224	0	0.0	112	0	0.0	1,582	4
II. Åsele	256	24	9.4	320	20	6.3	128	0	0.0	56	6	10.7	1,452	80
III. Umeå	456	15	3.3	544	48	8.8	316	37	11.7	72	13	18.1	3,224	157
IV. Kiruna	200	18	9.0	96	6	6.3	368	25	6.8	352	48	13.6	2,804	154
V. Jokkmokk	224	24	10.7	200	39	19.5	152	12	7.9	64	8	12.5	1,188	127
VI. Kalix	120	12	10.0	134	13	9.7	40	3	7.5	32	0	0.0	768	74
VII. Skåne	256	9	3.5	256	0	0.0	232	2	0.9	48	4	8.3	1,674	20
Total	1.760	102	—	1,710	126	—	1,460	79	—	736	79	—	12,692	616

Table 14. *Frequency of caries in the permanent front teeth of the lower jaw. Girls.*

Group	7 years			8 years			9 years			10 years				
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	116	0	0.0	160	0	0.0	176	0	0.0	224	4	1.8		
II. Åsele	120	0	0.0	206	6	2.9	198	10	5.1	180	2	1.1		
III. Umeå	514	15	2.9	496	11	2.2	134	0	0.0	168	9	5.4		
IV. Kiruna	476	2	0.4	514	13	2.5	526	39	7.4	408	47	11.5		
V. Jokkmokk	96	0	0.0	138	0	0.0	120	16	13.3	96	14	14.6		
VI. Kalix	96	6	6.3	136	10	7.4	240	25	10.4	232	49	21.1		
VII. Skåne	124	0	0.0	152	0	0.0	240	0	0.0	212	0	0.0		
Total	1,542	23	—	1,802	40	—	1,634	90	—	1,520	125	—	Total	
													No. of approx. surfaces	Whereof carious: Abs.
	11 years			12 years			13 years			14 years				
I. Stensele	256	0	0.0	128	2	1.6	88	0	0.0	152	8	5.3	1,300	14
II. Åsele	200	27	13.5	232	33	14.2	104	2	1.9	56	5	8.9	1,296	85
III. Umeå	312	42	13.5	368	38	10.3	312	47	15.1	72	4	5.6	2,376	166
IV. Kiruna	144	19	13.2	136	14	10.3	528	140	26.5	464	81	17.5	3,196	355
V. Jokkmokk	168	11	6.5	248	44	17.7	208	33	15.9	48	0	0.0	1,122	118
VI. Kalix	200	8	4.0	336	71	21.1	88	15	17.0	48	0	0.0	1,376	184
VII. Skåne	192	8	4.2	256	16	6.3	176	21	11.9	40	4	10.0	1,392	49
Total	1,472	115	—	1,704	218	—	1,504	258	—	880	102	—	12,058	971

Table 15. *Frequency of caries in the buccal gingival thirds. Boys.*

Group	7 years			8 years			9 years			10 years				
	No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	191	0	0.0	240	1	0.4	493	2	0.4	451	0	0.0		
II. Åsele	93	0	0.0	367	1	0.3	334	2	0.6	386	4	1.0		
III. Umeå	937	3	0.3	987	19	1.9	401	5	1.2	403	2	0.5		
IV. Kiruna	509	2	0.4	773	5	0.6	882	11	1.2	752	28	3.7		
V. Jokkmokk	21	0	0.0	217	2	0.9	365	7	1.9	349	11	3.2		
VI. Kalix	57	0	0.0	105	0	0.0	281	24	8.5	387	24	6.2		
VII. Skåne	251	0	0.0	389	3	0.8	423	0	0.0	455	2	0.4		
Total	2,059	5	—	3,078	31	—	3,179	51	—	3,183	71	—	Total	
													No. gingival thirds	Whereof carious Abs.
	11 years			12 years			13 years			14 years				
I. Stensele	537	1	0.2	477	0	0.0	670	2	0.3	386	1	0.3	3,445	7
II. Åsele	640	9	1.4	923	3	0.3	418	4	1.0	196	1	0.5	3,357	24
III. Umeå	1,123	25	2.2	1,637	28	1.7	1,023	32	3.1	229	9	3.9	6,740	123
IV. Kiruna	484	8	1.7	296	6	2.0	1,223	23	1.9	1,205	33	2.7	6,124	116
V. Jokkmokk	567	14	2.5	626	13	2.1	512	11	2.1	206	5	2.4	2,863	63
VI. Kalix	282	19	6.7	418	18	4.3	127	6	4.7	110	2	1.8	1,767	93
VII. Skåne	698	5	0.7	770	4	0.5	789	3	0.4	165	0	0.0	3,940	17
Total	4,331	81	—	5,147	72	—	4,762	81	—	2,497	51	—	28,236	443

Table 16. *Frequency of caries in the buccal gingival thirds. Girls.*

Group	7 years			8 years			9 years			10 years				
	No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious			
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		
I. Stensele	158	0	0.0	248	0	0.0	326	0	0.0	461	1	0.2		
II. Åsele	172	0	0.0	317	0	0.0	367	2	0.5	431	0	0.0		
III. Umeå	732	14	1.9	731	4	0.5	252	1	0.4	361	3	0.8		
IV. Kiruna	680	3	0.4	791	16	2.0	1,051	5	0.5	882	19	2.2		
V. Jokkmokk	137	0	0.0	222	7	3.2	212	15	7.1	231	2	0.9		
VI. Kalix	135	6	4.4	207	2	1.0	462	9	1.9	528	15	2.8		
VII. Skåne	171	0	0.0	223	1	0.4	447	5	1.1	516	1	0.2		
Total	2,185	23	—	2,739	30	—	3,117	37	—	3,410	41	—	Total	
	11 years			12 years			13 years			14 years			No. gingival thirds	Whereof carious Abs.
I. Stensele	712	3	0.4	424	0	0.0	294	0	0.0	525	2	0.4	3,148	6
II. Åsele	547	5	0.9	704	8	1.1	348	5	1.4	196	1	0.5	3,082	21
III. Umeå	904	15	1.7	1,160	9	0.8	1,031	36	3.5	252	5	2.0	5,423	87
IV. Kiruna	399	3	0.8	443	7	1.6	1,805	52	2.9	1,602	47	2.9	7,653	152
V. Jokkmokk	490	5	1.0	803	25	3.1	707	17	2.4	163	2	1.2	2,965	73
VI. Kalix	521	9	1.7	1,081	33	3.1	288	10	3.5	163	7	4.3	3,385	91
VII. Skåne	546	1	0.2	789	4	0.5	605	3	0.5	138	0	0.0	3,435	15
Total	4,119	41	—	5,404	86	—	5,078	123	—	3,039	64	—	29,091	445

Table 17. *Distribution of the primary local material acc. to local groups, ages and sex in the different cases.*

Localities	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
I. Stensele.....	23	42	65	15	29	44	10	20	30	11	15	26	4	6	10	7	6	13	70	118	188
II. Åsele	31	24	55	23	17	40	11	13	24	7	7	14	2	2	4	3	—	3	77	63	140
III. Umeå.....	79	91	170	65	71	136	43	39	82	31	24	55	13	9	22	11	6	17	242	240	482
IV. Kiruna	11	24	35	7	6	13	4	13	17	10	15	25	5	6	11	4	3	7	41	67	108
Total	144	181	325	110	123	233	68	85	153	59	61	120	24	23	47	25	15	40	430	488	918

Table 18. *Caries in permanent teeth. Men.*

Group	16–25 years			26–35 years			36–45 years			46–55 years			56–65 years			66–75 years			Total	
	No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	677	115	17.0	475	130	27.4	320	101	31.6	348	77	22.1	128	17	(13.3)	224	67	(29.9)	2,172	507
II. Åsele ...	950	285	28.0	721	336	46.7	345	159	46.1	218	61	(28.0)	64	49	(76.6)	96	58	(60.4)	2,394	948
III. Umeå...	2,350	798	33.0	2,067	1,006	48.7	1,370	596	43.5	982	490	49.9	415	276	66.5	350	253	72.3	7,534	3,419
IV. Kiruna	324	99	30.6	218	91	(41.7)	127	53	(41.7)	317	130	41.0	160	113	(70.6)	119	45	(37.8)	1,265	531
Total	4,301	1,297	—	3,481	1,563	—	2,162	909	—	1,865	758	—	767	455	—	789	423	—	13,365	5,405

Table 19. *Caries in permanent teeth. Women.*

Group	16–25 years			26–35 years			36–45 years			46–55 years			56–65 years			66–75 years			Total	
	No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious		No. of teeth	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	1,233	490	39.7	919	492	53.5	637	391	61.4	480	353	73.5	188	89	47.3	192	120	62.5	3,649	1,935
II. Åsele ...	711	338	47.5	537	399	74.3	412	318	77.2	224	174	77.7	64	62	96.9	—	—	—	1,948	1,291
III. Umeå...	2,714	1,318	48.6	2,257	1,549	68.6	1,245	1,003	80.6	768	584	76.0	288	227	78.8	192	155	80.7	7,464	4,836
IV. Kiruna	722	373	51.7	188	110	58.5	416	309	74.3	476	342	71.8	186	144	77.4	94	76	80.9	2,678	1,354
Total	5,380	2,519	—	3,901	2,550	—	2,706	2,021	—	1,948	1,453	—	726	522	—	478	351	—	15,139	9,416

Table 20. *Absolute and percentage distribution of the frequency of caries acc. to the »four-figure system».*

Age years	Stensele																Åsele													
	Men								Women								Men								Women							
	Absolute figures				Percentage figures				Absolute figures				Percentage figures				Absolute figures				Percentage figures				Absolute figures				Percentage figures			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
16—25	3	18	2	—	13.0	78.3	8.7	—	1	18	15	8	2.3	42.9	35.7	19.1	2	18	7	4	6.5	58.0	22.6	12.9	—	9	8	7	—	37.5	33.3	29.2
26—35	2	8	4	1	13.3	53.3	26.7	6.7	—	9	13	7	—	31.0	44.8	24.2	—	12	7	4	—	52.2	30.4	17.4	—	1	4	12	—	5.9	23.5	70.6
36—45	—	6	3	1	—	—	—	—	—	6	8	6	—	30.0	40.0	30.0	—	3	7	1	—	27.3	63.6	9.1	—	—	6	7	—	—	46.2	53.8
46—55	1	8	1	1	9.1	72.7	9.1	9.1	—	2	5	8	—	13.3	33.3	53.4	1	3	2	1	—	—	—	—	—	—	1	6	—	—	—	—
56—65	2	1	1	—	—	—	—	—	—	3	2	1	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	2	—	—	—	—
66—75	—	4	2	1	—	—	—	—	1	—	2	3	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—

Age years	Umeå																Kiruna															
	Men								Women								Men								Women							
	Absolute figures				Percentage figures				Absolute figures				Percentage figures				Absolute figures				Percentage figures				Absolute figures				Percentage figures			
	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
16—25	3	36	20	20	3.8	45.6	25.3	25.3	1	18	50	22	1.1	19.8	54.9	24.2	—	5	6	—	—	45.5	54.5	—	—	7	9	8	—	29.2	37.5	33.3
26—35	2	6	36	21	3.1	9.2	55.4	32.3	1	6	27	37	1.4	8.5	38.0	52.1	—	3	3	1	—	—	—	—	—	—	4	2	—	—	—	—
36—45	—	11	19	13	—	25.6	44.2	30.2	—	—	12	27	—	—	30.8	69.2	—	1	2	1	—	—	—	—	—	1	4	8	—	7.7	30.8	61.5
46—55	1	7	12	11	3.2	22.6	38.7	35.5	—	—	8	16	—	—	33.3	66.7	—	6	1	3	—	60.0	10.0	30.0	—	2	1	12	—	13.3	6.7	80.0
56—65	—	1	3	9	—	7.7	23.1	69.2	1	—	—	8	—	—	—	—	—	—	2	3	—	—	—	—	—	—	1	5	—	—	—	—
66—75	—	—	3	8	—	—	27.3	72.7	—	—	1	5	—	—	—	—	—	2	1	1	—	—	—	—	—	—	1	2	—	—	—	—

Table 21. *Frequency of caries in the permanent molars' fissure system. Men.*

Group	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total	
	No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	219	88	40.2	176	96	54.5	120	66	55.0	128	41	32.0	48	13	27.1	84	28	33.3	775	332
II. Åsele ...	335	180	53.7	261	202	77.4	125	97	77.6	78	31	39.7	24	22	91.7	36	26	72.2	859	558
III. Umeå...	765	463	60.5	767	580	75.6	511	373	73.0	362	265	73.2	155	125	80.6	130	99	76.2	2,690	1,905
IV. Kiruna	103	53	51.5	78	46	59.0	47	27	57.4	117	66	56.4	60	48	80.0	39	20	51.3	444	260
Total	1,422	784	—	1,282	924	—	803	563	—	685	403	—	287	208	—	289	173	—	4,768	3,055

Table 22. *Frequency of caries in the permanent molars' fissure system. Women.*

Group	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total	
	No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious		No. of fissure systems	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	404	254	62.9	343	257	74.9	235	193	82.1	180	149	82.8	68	40	58.8	72	57	79.2	1,302	950
II. Åsele ...	231	159	68.8	197	171	86.8	152	142	93.4	84	72	85.7	24	24	100.0	—	—	—	688	568
III. Umeå ...	892	693	77.7	833	755	90.6	468	439	93.8	288	254	88.2	108	92	85.2	72	66	91.7	2,661	2,299
IV. Kiruna	245	177	72.2	68	54	79.4	152	140	92.1	176	139	79.0	66	54	81.8	34	31	91.2	741	595
Total	1,772	1,283	—	1,441	1,237	—	1,007	914	—	728	614	—	266	210	—	178	154	—	5,392	4,412

Table 23. *Frequency of caries in the permanent front teeth of the upper jaw. Men.*

Group	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total	
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	184	9	4.9	120	2	1.7	80	5	6.3	88	10	11.4	32	0	—	56	8	14.3	560	34
II. Åsele ...	244	50	20.5	184	50	27.2	88	31	35.2	56	10	17.9	16	12	75.0	24	15	62.5	612	168
III. Umeå ...	632	128	20.3	520	194	37.3	344	65	18.9	248	72	29.0	104	69	66.3	88	56	63.6	1,936	584
IV. Kiruna	88	29	33.0	56	22	39.3	32	16	50.0	80	24	30.0	40	20	50.0	32	9	28.1	328	120
Total	1,148	216	—	880	268	—	544	117	—	472	116	—	192	101	—	200	88	—	3,436	906

Table 24. *Frequency of caries in the permanent front teeth of the upper jaw. Women.*

Group	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total	
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	336	125	37.2	232	91	39.2	160	87	54.4	120	94	78.3	48	22	45.8	48	29	60.4	944	448
II. Åsele ...	192	79	41.1	136	98	72.1	104	86	82.7	56	45	80.4	16	16	100.0	—	—	—	504	324
III. Umeå ...	728	279	38.3	568	381	67.1	312	258	82.7	192	135	70.3	72	49	68.1	48	38	79.2	1,920	1,140
IV. Kiruna	192	86	44.8	48	25	52.1	104	82	78.8	120	90	75.0	48	34	70.8	24	20	83.3	536	337
Total	1,448	569	—	984	595	—	680	513	—	488	364	—	184	121	—	120	87	—	3,904	2,249

Table 25. *Frequency of caries in the permanent front teeth of the lower jaw. Men.*

Group	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total	
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	184	0	—	118	0	—	80	1	1.3	88	8	9.1	32	0	—	56	9	16.1	558	18
II. Åsele ..	248	10	4.0	184	12	6.5	88	6	6.8	56	8	14.3	16	1	6.3	24	8	33.3	616	45
III. Umeå ...	632	48	7.6	520	23	4.4	344	12	3.5	248	48	19.4	104	42	40.4	88	65	73.9	1,936	238
IV. Kiruna	88	0	—	56	0	—	32	1	3.1	80	16	20.0	40	19	47.5	32	4	12.5	328	40
Total	1,152	58	—	878	35	—	544	20	—	472	80	—	192	62	—	200	86	—	3,438	341

Table 26. *Frequency of caries in the permanent front teeth of the lower jaw. Women.*

Group	16—25 years			26—35 years			36—45 years			46—55 years			56—65 years			66—75 years			Total	
	No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious		No. of approx. surfaces	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	336	27	8.0	232	45	19.4	160	25	15.6	120	49	40.8	48	4	8.3	48	21	43.8	944	171
II. Åsele ...	192	32	16.7	136	47	34.6	104	32	30.8	56	19	33.9	16	16	100.0	—	—	—	504	146
III. Umeå ...	728	74	10.2	568	112	19.7	312	104	33.3	192	65	33.9	72	50	69.4	48	30	62.5	1,920	435
IV. Kiruna	188	35	18.6	48	3	6.3	104	34	32.7	120	43	35.8	48	21	43.8	24	14	58.3	532	150
Total	1,444	168	—	984	207	—	680	195	—	488	176	—	184	91	—	120	65	—	3,900	902

Table 27. *Frequency of caries in the gingival thirds. Men.*

Group	16–25 years			26–35 years			36–45 years			46–55 years			56–65 years			66–75 years			Total	
	No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	677	5	0.7	475	7	1.5	320	4	1.3	348	11	3.2	128	0	—	224	7	3.1	2,172	34
II. Åsele ...	950	19	2.0	721	27	3.7	345	4	1.2	218	2	0.9	64	2	3.1	96	1	1.0	2,394	55
III. Umeå ...	2,350	63	2.7	2,067	68	3.3	1,370	35	2.6	982	21	2.1	415	14	3.4	350	5	1.4	7,534	206
IV. Kiruna	324	10	3.1	218	11	5.0	127	3	2.4	317	3	0.9	160	2	1.3	119	8	6.7	1,265	37
Total	4,301	97	—	3,481	113	—	2,162	46	—	1,865	37	—	767	18	—	789	21	—	13,365	332

Table 28. *Frequency of caries in the gingival thirds. Women.*

Group	16–25 years			26–35 years			36–45 years			46–55 years			56–65 years			66–75 years			Total	
	No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious		No. gingival thirds	Whereof carious
		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.	%		Abs.
I. Stensele	1,233	29	2.4	919	38	4.1	637	35	5.5	480	19	4.0	188	4	2.1	192	1	0.5	3,649	126
II. Åsele ...	711	17	2.4	537	30	5.6	412	9	2.2	224	3	1.3	64	0	—	0	0	0	1,948	59
III. Umeå ...	2,714	65	2.4	2,257	77	3.4	1,245	47	3.8	768	32	4.2	288	4	1.4	192	0	—	7,464	225
IV. Kiruna	722	26	3.6	188	6	3.2	412	15	3.6	476	14	2.9	186	15	8.1	94	9	9.6	2,078	85
Total	5,380	137	—	3,901	151	—	2,706	106	—	1,948	68	—	726	23	—	478	10	—	15,139	495

C. The change from first to second dentition.

The shedding of the deciduous teeth and the eruption of the permanent teeth is a problem of very considerable interest to us in forming an opinion on the questions at issue. For when we have to estimate the frequency of caries in children at the ages of 7—14 we must have some knowledge of the course of this phenomenon of growth, seeing that the difference in the period when the permanent teeth erupt in the different sexes, and possibly in different localities, is bound to exercise considerable influence upon the time at which the carious processes appear and thus also on the distribution of these processes at a given age. Again, the period when the milk teeth are shed must be observed in order that an estimate may be made of the frequency of caries in the milk teeth still remaining in the mouth — even if, as is the case here, only the latter have served as a basis for calculating the milk-teeth figures.

Taking first the relative Tables 2 and 3, which give inter alia the number of erupted permanent and remaining milk teeth respectively on an average for different places and ages, we find first of all a very considerable divergence between the two sexes. In girls the milk teeth fall out earlier and the permanent teeth erupt likewise earlier than in the case of boys, this applying throughout to all the local groups. The difference is widest and most pronounced in the ages between 9 and 11. In regard to the transition from first to second dentition, it may be said that girls of 9—11 years of age are from six months to one year before the boys, as is clearly seen from the tables, especially tables 29 and 30.

The difference between boys and girls is most striking in Stensele and, in regard to the eruption of the permanent teeth, least evident in Skåne.

When it comes to gauging differences between different local groups in regard to the period when the dentition changes, there is a somewhat greater measure of uncertainty as there are only slight differences here, which might conceivably be due merely to incidental circumstances. All attempts at discovering by rough computation any definite clues to the existence of assured regional differences have failed. We should not however attempt to draw any conclusions regarding this circumstance at the present stage of our investigation.

Table 29. *Difference in the eruption of permanent teeth between girls and boys. Average number of teeth per individual.* Cf. Tables 2 and 3.

Age	Stensele			Åsele			Umeå			Kiruna			Jokkmokk			Kalix			Skåne		
	Girls (G)	Boys (B)	Girls–Boys (G–B)	G	B	G–B	G	B	G–B	G	B	G–B	G	B	G–B	G	B	G–B	G	B	G–B
7 years	9.3	8.0	+ 1.3	9.1	7.8	+ 1.3	9.5	8.7	+ 0.8	10.0	8.3	+ 1.7	9.8	(10.5)	—	9.6	8.1	+ 1.5	9.0	9.0	± 0
8 »	11.3	10.9	+ 0.4	12.2	11.5	+ 0.7	10.9	10.3	+ 0.6	12.0	10.4	+ 1.6	12.3	11.4	+ 0.9	12.2	9.5	+ 2.7	11.7	11.8	— 0.1
9 »	14.8	12.6	+ 2.2	14.7	13.9	+ 0.8	14.8	13.8	+ 1.0	15.9	14.2	+ 1.7	14.1	13.0	+ 1.1	15.4	15.6	— 0.2	14.9	13.2	+ 1.7
10 »	16.5	15.6	+ 0.9	18.7	14.8	+ 3.9	17.2	16.8	+ 0.4	17.3	15.7	+ 1.6	19.3	17.5	+ 1.8	18.2	17.6	+ 0.6	19.1	16.9	+ 2.2
11 »	22.3	17.3	+ 5.0	21.9	20.0	+ 1.9	23.2	19.7	+ 3.5	22.2	19.4	+ 2.8	23.3	20.3	+ 3.0	20.8	18.8	+ 2.0	22.8	21.8	+ 1.0
12 »	26.5	23.9	+ 2.6	24.3	23.1	+ 1.2	25.2	24.1	+ 1.1	26.1	24.7	+ 1.4	25.9	25.0	+ 0.9	25.7	24.6	+ 1.1	24.7	24.1	+ 0.6
13 »	26.7	23.9	+ 2.8	26.8	26.1	+ 0.7	26.4	25.6	+ 0.8	27.3	26.6	+ 0.7	27.2	26.9	+ 0.3	26.2	25.4	+ 0.8	27.5	27.2	+ 0.3
14 »	27.6	27.6	± 0	28.0	28.0	± 0	28.0	25.4	+ 2.6	27.6	27.4	+ 0.2	27.2	25.8	+ 1.4	27.2	27.5	— 0.3	27.6	27.5	+ 0.1

Table 30. *Difference in the loss of the milk teeth between girls and boys. Average number of teeth per individual.* Cf. Tables 2 and 3.

Age	Stensele			Åsele			Umeå			Kiruna			Jokkmokk			Kalix			Skåne		
	Girls (G)	Boys (B)	Girls–Boys (G–B)	G	B	G–B	G	B	G–B	G	B	G–B	G	B	G–B	G	B	G–B	G	B	G–B
7 years	12.8	14.8	— 2.0	13.1	13.1	± 0	—	—	—	11.3	13.1	— 1.8	12.9	11.0	+ 1.9	12.1	14.0	— 1.9	13.8	14.3	— 0.5
8 »	12.1	12.0	+ 0.1	10.0	10.3	— 0.3	—	—	—	10.1	10.8	— 0.7	10.3	10.3	± 0	9.9	12.5	— 2.6	11.2	10.6	+ 0.6
9 »	8.2	10.8	— 2.6	7.5	7.7	— 0.2	—	—	—	5.1	6.7	— 1.6	8.5	9.2	— 0.7	7.8	7.1	+ 0.7	8.1	9.5	— 1.4
10 »	6.9	8.1	— 1.2	4.5	7.5	— 3.0	—	—	—	4.5	5.5	— 1.0	4.7	4.3	+ 0.4	5.3	4.9	+ 0.4	4.5	7.0	— 2.5
11 »	2.4	6.6	— 4.2	2.3	3.7	— 1.4	—	—	—	0.6	3.4	— 2.8	1.6	3.4	— 1.8	3.2	4.5	— 1.3	2.3	3.0	— 0.7
12 »	0.6	1.8	— 1.2	1.6	2.1	— 0.5	—	—	—	1.0	0.9	+ 0.1	0.4	0.9	— 0.5	0.6	1.0	— 0.4	1.4	1.8	— 0.4
13 »	0.6	1.9	— 1.3	0.0	0.3	— 0.3	—	—	—	0.0	0.6	— 0.6	0.3	0.1	+ 0.2	0.8	0.8	± 0	0.2	0.2	± 0
14 »	0.2	0.1	+ 0.1	0.0	0.0	± 0	—	—	—	0.0	0.1	— 0.1	0.2	1.4	— 1.2	0.7	0.0	0.7	0.0	0.2	— 0.2

Nevertheless, the possibility of the existence of distinct regional differences is not out of the question; as an instance hereof we may compare out of Tables 2 and 3 the average number of milk teeth and erupted permanent teeth in respect of boys and in respect of girls in Stensele and Skåne (Table 31).

Table 31. *Comparison between the eruption of teeth in Stensele and Skåne. Number of teeth on an average per individual.*

Age	Milk teeth				Permanent teeth				Total no. of teeth			
	Boys		Girls		Boys		Girls		Boys		Girls	
	Stensele	Skåne	Stensele	Skåne	Stensele	Skåne	Stensele	Skåne	Stensele	Skåne	Stensele	Skåne
7 years	14.8	14.3	12.8	13.8	8.0	9.0	9.3	9.0	22.8	23.3	22.1	22.8
8 »	12.0	10.6	12.1	11.2	10.9	11.8	11.3	11.7	22.9	22.4	23.4	22.9
9 »	10.8	9.5	8.2	8.1	12.6	13.2	14.8	14.9	23.4	22.7	23.0	23.0
10 »	8.1	7.0	6.9	4.5	15.6	16.9	16.5	19.1	23.7	23.9	23.4	23.6
11 »	6.6	3.0	2.4	2.3	17.3	21.8	22.3	22.8	23.9	24.8	24.4	25.1
12 »	1.8	1.8	0.6	1.4	23.9	24.1	26.5	24.7	25.7	25.9	27.1	26.1
13 »	1.9	0.2	0.6	0.2	23.9	27.2	26.7	27.5	25.8	27.4	27.3	27.5
14 »	0.1	0.2	0.2	0.0	27.6	27.5	27.6	27.6	27.7	27.7	27.8	27.6

The observed series for the *total number* of teeth show a striking measure of agreement between Stensele and Skåne. On the other hand, certain divergences appear if we study the milk teeth separately and the permanent teeth separately. It is a well-known fact that the phenomenon of the transition to permanent teeth — at any rate as illustrated statistically here — consists of two different factors: the replacing of the milk teeth by permanent teeth and the eruption of new permanent teeth without any corresponding process in the milk teeth denture. No definite expression of opinion regarding existing regional differences is possible until these factors have been exhaustively studied — each one of them separately; but at the present stage we have reached in our investigation this has not yet been done. For the time being, therefore, we must content ourselves with such observations as have already been made.

D. The frequency of caries at the ages of 7—14.

Tables 4—16 have been compiled in order to throw some light on the frequency of caries in the non-adult material and on the differences existing between different local groups, ages and sexes. It is clear from the tables that there exist in many respects considerable differences both in the purely quantitative occurrence of the disease and in regard to the qualitatively distinct forms of caries. These tables will be commented upon in greater detail in the accompanying sections of the diagram.

Section I. The Quantitative Method of Investigation.

Tables 4—7 illustrate the purely quantitative appearance of caries. From these sections have been compiled the tables given below showing the percentile occurrence of caries in different places, ages and sexes in respect of the permanent teeth and of the milk teeth. The tables give an interesting idea of the quantitative occurrence of caries.

If we first study the effect of *age* we find, as regards both the permanent teeth and the milk teeth, a certain change taking place as age advances, although it is not anything like as conspicuous as might have been expected. This is no doubt due mainly to the eruption and to the shedding of the teeth that occur at these ages. The fact of increased frequency of caries as the age increases is obscured by these circumstances.

In the permanent teeth the increased frequency of caries is more or less clearly apparent. The average series for all districts rise from 21.7 % and 24.0 % at the age of 7 in the case of boys and girls respectively to 30.3 % and 34.1 % at the age of 14. The series do not however show a steady rise but move upwards in jerks. — The case is different as regards the milk teeth. Here the precentages have not been worked out beyond the age of 11 as the remaining milk teeth at the ages of 12, 13 and 14 are too few to afford any reliable idea of the phenomenon we are studying. Between the ages of 7 and 11, however, the frequency of caries tends to fall in the case of boys, just as in girls of 7—10 years old; nevertheless, girls of 11 show increased frequency of caries.

That the frequency of caries from the purely quantitative point of view differs widely in different *areas under investigation* is

Table 32. *Frequency of caries (in percentage) affecting permanent teeth.*

Age	Boys. Stensele	Åsele	Umeå	Kiruna	Jokkmokk	Kalix	Skåne	Unweighted averages for all local groups	Age	Girls. Stensele	Åsele	Umeå	Kiruna	Jokkmokk	Kalix	Skåne	Unweighted averages for all local groups
7 years	2.6	28.0	25.3	17.9	28.6	28.1	21.1	21.7	7 years	10.1	17.4	26.6	19.1	32.8	31.9	29.8	24.0
8 »	15.8	28.9	31.0	26.8	32.3	33.3	21.9	27.1	8 »	11.7	28.7	30.5	24.0	29.3	36.7	22.9	26.3
9 »	13.8	26.0	28.2	25.1	31.0	41.3	22.0	26.8	9 »	12.3	31.9	27.0	29.3	39.6	35.3	23.0	28.3
10 »	13.5	28.0	28.5	30.1	39.5	36.7	23.1	28.5	10 »	10.0	23.2	31.0	33.1	32.0	43.4	21.5	27.7
11 »	13.0	28.0	27.9	30.0	31.6	49.3	25.9	29.4	11 »	11.7	24.7	33.3	28.6	34.5	31.3	30.2	27.8
12 »	10.5	26.7	33.2	22.3	36.4	36.4	23.0	26.9	12 »	8.7	31.8	32.7	29.1	38.6	48.7	30.8	31.5
13 »	9.6	21.3	35.7	33.3	35.9	60.6	25.6	31.7	13 »	19.0	28.7	43.9	45.4	43.0	36.1	34.0	35.7
14 »	11.1	26.0	39.7	33.7	34.5	29.1	38.2	30.3	14 »	17.0	31.6	29.4	44.1	33.7	50.9	31.9	34.1
Unweighted averages for all ages	11.2	26.6	31.2	27.4	33.7	39.4	25.1		Unweighted averages for all ages	12.6	27.3	31.8	31.6	35.4	39.3	28.0	

Table 33. *Frequency of caries (in percentage) affecting milk teeth.*

Age	Boys. Stensele	Åsele	Umeå	Kiruna	Jokkmokk	Kalix	Skåne	Unweighted averages for all local groups	Age	Girls. Stensele	Åsele	Umeå	Kiruna	Jokkmokk	Kalix	Skåne	Unweighted averages for all local groups
7 years	20.3	75.2		65.3	68.2	72.4	48.9	58.4	7 years	26.6	59.4		61.9	69.1	73.4	59.9	58.4
8 »	28.9	63.8		69.0	67.9	67.2	58.0	59.1	8 »	21.8	69.2		63.6	70.8	64.9	52.1	57.1
9 »	21.6	63.6		67.0	74.4	69.5	62.3	59.7	9 »	12.8	47.0		72.0	74.2	71.9	61.3	56.6
10 »	20.3	56.6		58.4	73.3	72.9	51.9	55.6	10 »	17.2	36.9		73.5	67.9	75.2	63.9	55.8
11 »	16.6	51.3		58.1	62.8	72.1	55.2	52.7	11 »	24.4	48.3		81.8	81.8	63.3	76.4	62.7
Unweighted averages for all ages	21.5	62.1		63.7	69.3	70.8	55.3		Unweighted averages for all ages	20.6	52.3		70.6	72.8	69.7	62.7	

at once obvious from the tables. To take Skåne first, we observe that the caries series relating to the permanent teeth in boys ranges on the whole between 20 and 25 %; only at the age of 14 is the value so exceptionally high as 38.2 %. The corresponding series for girls lies between 20 and 35 %. On an average for all ages the frequency of caries in the Skåne children is 25.1 % in boys and 28.0 % in girls. Of the Norrland districts investigated, the Stensele group shows a far better caries series, and here, apparently, caries occurs only on an inconsiderable scale. The averages for all ages are less than one half of the Skåne averages. The Åsele group, and possibly the Kiruna boys group, agree quite closely in regard to caries with Skåne, but the rest of the districts of Norrland, notably Kalix and Jokkmokk, record a far higher frequencey of caries.

As to caries in the milk teeth, we find that the circumstances are similar; high frequency of caries in the cases of Kalix and Jokkmokk, low in that of Stensele. In the girls of Kiruna also the frequency of caries is marked as far as these teeth are concerned.

In order to obtain a further basis of comparison between the different local groups, we have arranged them below according to the average of the frequency of caries.

Group	Permanent teeth		Milk teeth		
	Boys	Girls	Boys	Girls	
	Frequency of caries in percentage				
Kalix.....	39	39	71	70	High frequency of caries
Jokkmokk	34	35	69	73	
Umeå	31	32	—	—	Lower frequency of caries
Kiruna	27	32	64	71	
Skåne	25	28	55	63	
Åsele.....	27	27	62	52	
Stensele ...	11	13	22	21	Low do.

Finally, as regards divergences in the frequency of caries in the different *sexes*, it is not possible at the present stage of the inquiry to express any definite opinions as to their cause: certain tendencies to lower caries frequency in the permanent system in boys as compared with girls which are specially marked between

the ages of 11 and 12 might possibly be attributed to the earlier eruption of the teeth in the case of the girls.

Section II. The Qualitative Method of Investigation No. 1.

In Table 8 have been compiled the results of dealing with the primary material according to the four-figure system, which is of course a qualitative method of calculation. In order to enable us to examine the results of this method of compilation in a comprehensive and easily surveyable form the percentage table given below has been worked out to show the percentile distribution of the observed cases as between the qualitatively distinct types of caries characterized by the figures 0, 1, 2 and 3. The following procedure has been employed in working out the percentage table. In respect of each locality and sex we have calculated for those ages that contain at least 10 observations the percentile distribution of the observations amongst the four caries classes of the four-figure system. The arithmetical mean (unweighted) of the percentages coming under a given caries class has then been calculated in respect of each local group and of each sex and indicated for each caries class. The mean values thus obtained have been incorporated in the percentage table, in which we have also indicated which ages it was possible to include (i. e. those containing at least 10 observations) in estimating the mean values.

Table 34. *Percentage table showing the distribution of the observed cases of caries according to the four-figure system.*

Group	Boys					Girls				
	Caries group acc. to the 4-fig. system				Age-groups included	Caries group acc. to the 4-fig. system				Age-groups included
	0	1	2	3		0	1	2	3	
	Percentage					Percentage				
Stensele	36	57	7	0	7—14	29	57	12	2	7—14
Åsele	10	67	17	6	7—13	8	61	22	10	7—13
Umeå	5	66	18	11	7—14	4	57	26	13	7—13
Kiruna	8	56	22	14	7—14	5	48	28	19	7—14
Jokkmokk ...	2	60	22	16	8—13	1	60	26	13	7—13
Kalix	3	55	23	19	8—12	3	55	24	20	7—13
Skåne	9	72	17	2	7—13	3	69	23	5	7—13

The table shows, on the whole, the same result as that obtained above regarding the quantitative frequency of caries. It can be said, therefore, that from the qualitative point of view also, Stensele records a low frequency of caries, Skåne and Åsele average frequency and the other localities high frequency. The divergences between the sexes are more marked in this calculation; only as regards Jokkmokk and Kalix can there be any doubt. — It should be remembered however that the method is purely subjective, so that perhaps we should not attach too much value to it as evidence; nevertheless, if taken in conjunction with the quantitative method it confirms the results obtained by the latter method.

Section III. The Qualitative Method of Investigation No. 2.

Finally, in order to enable the reader to penetrate further into the results of the qualitative investigation we have carried out, Tables 9—16 illustrate the frequency of caries in different parts of the denture (cf. p. 17—18).

1. *The Fissural System of the Molars.*

Attacks of caries solely in the fissural system of the molars occur in mild cases of the disease.

In the following table data have been compiled relating to the percentile frequency of caries of the kind just indicated, divided up according to age, local group and sex.

Table 35. *Frequency of caries (in percentage) in the fissural system of the molars.*

Age	Boys							Girls						
	Local group (Stensele = I, Åsele = II etc.)													
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
7 years	5.6	56.8	56.4	40.6	75.0	66.7	42.3	23.5	43.3	58.2	46.0	75.9	70.4	68.0
8 »	41.9	71.1	74.7	64.4	84.2	73.8	62.1	33.3	72.5	77.2	60.4	81.1	91.0	59.2
9 »	34.0	76.3	77.6	72.1	85.0	89.5	67.2	38.6	78.0	89.7	77.9	86.4	86.2	73.0
10 »	44.4	65.8	78.5	74.2	94.2	88.8	65.5	30.2	72.3	85.2	83.8	72.7	90.4	70.4
11 »	37.8	69.7	80.1	68.8	81.3	90.3	70.6	40.7	69.2	74.8	75.9	85.3	83.9	74.6
12 »	34.1	68.6	74.8	42.5	76.3	74.5	58.7	21.4	66.3	75.4	54.8	72.0	85.3	74.5
13 »	29.0	56.8	78.2	60.8	76.5	87.1	63.9	46.3	66.3	79.2	70.8	82.3	73.4	66.9
14 »	23.9	53.6	77.8	58.0	69.5	80.0	60.4	28.9	67.9	65.3	69.7	77.8	87.5	66.7

The difference between different local groups is here very marked. The Stensele group has a low frequency of caries (about 35 %), Kalix and Jokkmokk high (as much as up to 90 %).

A feature common to all the statistical series is the emergence of a more or less distinct maximum in the ages of 9—12 years; before this maximum is reached the caries series generally shows an unmistakable rise, while after the maximum value is reached the tendency is uniform insofar that the different series begin to oscillate (exceptions: Stensele, boys, and Skåne, girls; these series, after reaching the maximum at the age of 10 and 11 respectively, tend to recede during the remainder of their course). These curious variations are apparently adjusted in conjunction with the eruption of the teeth, which goes on in the interval. The trend of the series indicates that already in childhood caries is a disease connected with advancing years and one which in these ages — ceteris paribus — as a rule breaks out more frequently among older teeth than among younger teeth.

2. *Proximal surfaces of the front teeth of the upper jaw.*

The injuries found here denote cases of caries of medium severity.

The following table, relating to the parts of the teeth here under discussion, has been drawn up on the same principle as the corresponding table under 1.

Table 36. *Frequency of caries (in percentage) in the proximal surfaces of the front teeth.*

Age	Boys							Girls						
	Local group (Stensele = I, Åsele = II etc.)													
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
7 years	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	3.1	2.6	8.8	0.0	0.0
8 »	0.0	2.0	0.5	2.2	4.7	0.0	0.0	0.0	7.1	1.6	3.9	1.8	8.9	0.0
9 »	1.1	3.4	3.4	5.8	1.0	28.8	0.4	0.0	16.3	0.0	16.3	13.2	20.9	2.7
10 »	0.9	8.7	3.7	10.1	19.6	19.2	4.6	3.6	12.8	17.7	23.8	23.4	36.5	7.1
11 »	3.7	18.1	15.0	28.6	18.5	47.5	12.8	3.5	11.5	21.2	24.3	35.1	25.8	29.8
12 »	5.0	17.9	26.5	22.9	27.5	28.7	8.2	8.6	30.3	21.7	35.3	35 9	45.5	19.8
13 »	2.3	5.5	25.9	36.7	25.7	60.0	19.0	13.6	19.2	38.6	47.5	37.5	20.5	25.6
14 »	5.4	17.9	29.2	34.1	28.1	3.1	31.3	22.4	28.6	20.8	52.8	18.8	50.0	22.5

Owing to the fact that the eruption of the teeth in this part of the jaw takes place later, we get low frequency numbers amongst children of 7—8 years old. The disease spreads very rapidly, however, as the relatively strong rise of the series shows. There is a distinct difference in the frequency of caries between the Stensele, Åsele and Skåne groups on the one hand and the Kiruna, Jokkmokk and Kalix groups on the other; in this respect the Umeå group assumes an intermediate position.

The frequency of caries on these surfaces of the teeth is considerably below that in the fissural system of the molars.

3. *Proximal surfaces of the lower front teeth.*

Here the condition denotes cases of severe caries.

The following table, relating to the parts of the teeth here under discussion, is drawn up on the same principle as the corresponding table under 1.

Table 37. *Frequency of caries (in percentage) in proximal surfaces of the lower front teeth.*

Age	Boys							Girls						
	Local group													
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
7 years	0.0	0.0	1.3	0.5	0.0	0.0	0.0	0.0	0.0	2.9	0.4	0.0	6.3	0.0
8 »	0.0	4.1	2.3	1.3	0.0	7.9	0.8	0.0	2.9	2.2	2.5	0.0	7.4	0.0
9 »	1.3	1.1	2.7	4.0	6.7	2.1	0.0	0.0	5.1	0.0	7.4	13.3	16.4	0.0
10 »	0.0	9.0	6.8	7.3	18.1	21.0	1.4	1.8	1.1	5.4	11.5	14.6	21.1	0.6
11 »	0.0	9.4	3.3	9.0	10.7	10.0	3.5	0.0	13.5	13.5	13.2	6.5	4.0	4.2
12 »	0.0	6.3	8.8	6.3	10.5	9.7	0.0	1.6	14.2	10.3	10.3	17.7	21.1	6.3
13 »	0.0	0.0	11.7	6.8	7.9	7.5	0.9	0.0	1.9	15.1	26.5	15.9	17.0	11.9
14 »	0.0	10.7	18.1	13.6	12.5	0.0	8.3	5.3	8.9	5.6	17.5	0.0	0.0	10.0

The numbers for all the local groups are lower than in the preceding table.

The Stensele group shows only a slight frequency and attacks of this nature occur only in girls (1—2 %). The figures are indeed low here for all groups. Skåne is favourably placed, and the frequency of caries in Åsele is likewise moderate. In this kind of caries also, the frequency numbers for Kalix, Jokkmokk, Umeå and Kiruna are relatively high.

The occurrence of extreme values in the intermediate ages of the series is not so striking in this caries group as in previous caries series.

4. *The buccal gingival thirds.*

Attacks here indicate severe caries.

The following table, relating to the parts of the teeth under discussion here, is drawn up on the same principle as the corresponding table under 1.

Table 38. *Frequency of caries (in percentage) in the buccal gingival thirds.*

Age	Boys							Girls						
	Local group													
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
7 years	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	1.9	0.4	0.0	4.4	0.0
8 »	0.4	0.3	1.9	0.6	0.9	0.0	0.8	0.0	0.0	0.5	2.0	3.2	1.0	0.4
9 »	0.4	0.6	1.2	1.2	1.9	8.5	0.0	0.0	0.5	0.4	0.5	7.1	1.9	1.1
10 »	0.0	1.0	0.5	3.7	3.2	6.2	0.4	0.2	0.0	0.8	2.2	0.9	2.8	0.2
11 »	0.2	1.4	2.2	1.7	2.5	6.7	0.7	0.4	0.9	1.7	0.8	1.0	1.7	0.2
12 »	0.0	0.3	1.7	2.0	2.1	4.3	0.5	0.0	1.1	0.8	1.6	3.1	3.1	0.5
13 »	0.3	1.0	3.1	1.9	2.1	4.7	0.4	0.0	1.4	3.5	2.9	2.4	3.5	0.5
14 »	0.3	0.5	3.9	2.7	2.4	1.8	0.0	0.4	0.5	2.0	2.9	1.2	4.3	0.0

At this period of age the gingival thirds are infected to only a very small extent. Stensele, Åsele and Skåne exhibit but slight, and Kalix and Jokkmokk somewhat higher frequency of caries. Kiruna and Umeå assume an intermediate position.

E. The frequency of caries at the ages of 16—75.

Of the four local groups (cf. p. 11—14), Stensele, Åsele and Umeå are uniform with the corresponding children's groups as regards the regional composition of the material. The Kiruna group on the other hand is represented by the population living in a number of small places in the neigbourhood of Kiruna, while by far the greater part of the corresponding non-adult material is made up of individuals from the township of Kiruna in the parish

of Jukkasjärvi. This latter circumstance is worth special notice, as the caries curves relating to the adult Jukkasjärvi material show, in comparison with the other localities, a more favourable position than is the case in the main non-adult material, which is collected chiefly from Kiruna.

For reasons already given, and besides, as there is no comparative material from Skåne, we must regard the following estimate of the frequency of caries at the ages of 16—75 merely as supplementary to the foregoing study of the non-adult material; there can however be no doubt that here too Stensele assumes an exceptionally favourable position in regard to caries and that there is in all groups a considerable difference between men and women.

Tables 18—28 serve to illustrate the frequency of caries at the ages of 16—75. In Tables 18—19 we find the ratio between erupted and carious teeth, that is to say, the purely quantitative measure of the frequency of caries.

Stensele records in the case of men an absolutely low, and in the case of women a relatively low caries frequency. We note, too, the relatively favourable position of the Jukkasjärvi series (cf. the series for Kiruna in the children's material). The difference between men and women is very conspicuous, the caries frequency in women often being double as high as it is in men.

Table 20 is drawn up on the same principle as Table 8 and shows the qualitative frequency of caries calculated on the basis of the four-figure system. It will be seen from the table that there are extremely few cases of dentures free from caries between the ages of 16 and 75. Out of 918 individuals only 22, chiefly in the Stensele group, are free from the disease. Of this number 17 are men and 5 women. The milder cases of caries (1) are likewise concentrated mostly within the Stensele group.

Tables 21—28 are drawn up on the same principle as Tables 9—16 and are thus based on investigations into certain parts of the denture.

The frequency of the attacks in the fissures is fairly constant throughout, indicating that the diseased process sets in at a relatively early stage. The high frequency of caries in women and the favourable position assumed by the Stensele group are at once apparent from the tables. The frequency of caries rises group by group in the following sequence: Stensele, Kiruna, Åsele and Umeå.

Approximal caries in the front teeth of the upper jaw exhibits a considerable rise, indicating that attacks of caries of this nature occur in increasing numbers throughout life. In women the increase in numbers appears to be greatest up to the age of 40, in men, on the other hand, after the age of 40. Stensele shows in the case of men very slight caries, and in that of women relatively slight caries. The frequency of caries in the women is far higher than in the men.

Similarly in regard to caries in the proximal surfaces in the front teeth of the lower jaw, there is a marked difference between men and women. However, the frequency of this type of caries is lower and does not show a pronounced rising tendency until after the age of 40.

It will be seen from Tables 27 and 28, which illustrate the attacks of caries in the gingival thirds, that these attacks are here few in number and that the figures have worked out fairly irregularly.

F. **Summary.**

It is quite evident from the figures quoted here and from the tables that the dental pictures derived from the present material are in no way to be regarded as uniform. Many dissimilarities are observable, and although the differences between the various numerical series are in many cases small, it should nevertheless be possible to accept their evidence in view of their pronounced tendency to run consistently through the whole of the series. A great many observations can be made from the statistical data, but the chief points of interest at the present stage of the inquiry are, firstly, the difference in the age at which the transition from milk teeth to permanent teeth takes place, and, secondly, the origin and development of caries. The differences we note here are clearly demonstrable in regard to sex, but are found also in certain cases when we compare the population in different localities.

The transition from the deciduous to the permanent denture.

The transition is illustrated in Tables 2, 3, 29, 30 and 31. *The girls lose their milk teeth earlier and show an earlier eruption of the permanent teeth than the boys. In this respect Upper*

Norrland is in agreement with Skåne, and the same phenomenon prevails within the different local groups investigated in Norrland. On the other hand, the difference in time is slightly variable in respect of different local groups. A special study has been made of the difference in the time of the eruption of teeth in children belonging to different local groups as far as regards Stensele and Skåne (Table 31). The eruption of the permanent teeth is delayed in the Stensele group as compared with the Skåne group. This delay is most conspicuous in the case of the boys; as regards the girls the circumstance is not so obvious as to warrant any definite conclusions being drawn from it. Whether the cause of these circumstances is to be ascribed to the climate, light and darkness, diet, racial conditions or to the more frequent occurrence of diseases that tend to check development, cannot be gauged from the statistical data, but might possibly be ascertained from a comparison with other investigations carried out on the basis of the same material.

Caries.

Taking the material as a whole we find that caries is of a widely differing frequency in the two sexes, *women being exposed to attack to a far greater extent than men.* According as the investigation has been carried out by the quantitative or any of the qualitative methods the higher frequency of caries in women differs in degree. It is most evident in the adults, amongst whom we naturally find more advanced forms of caries, though the phenomenon is also observable even in the years of childhood. To take the milk teeth first (Table 33), we find no definite differences as here the figures show a good deal of irregularity, but in the case of the permanent teeth (Table 32) we find that a distinct difference between the sexes is noticeable as early as at the age of 7. *For at the age of seven the girls in all groups, with the exception of Åsele, are more subject to attacks of caries than the boys.* This is due apparently to the earlier eruption of the permanent teeth in girls. *The divergence in question is adjusted at the age of 8—11, after which (i. e. from 12—13 years of age) the difference widens to the disadvantage of the girls. The difference in the frequency of caries, which is thus already revealed here, increases throughout life and at an advanced age attains to considerable values* (see Tables 18 and 19). The

cause of this circumstance (varying predisposition or other causes) is not apparent from the statistical data. A quite considerable difference often arises already at the age of 16—20. Between the ages of 16 and 45 the women often show twice as high a frequency of caries as the men, and after 45 the divergence becomes increasingly wider. Within the different local groups we find very different pictures of the dispersion of the disease both in the quantitative and in the qualitative sense. Most students of this subject are agreed that amongst civilized nations at least 95 % of the population suffers in a greater or less degree from caries. The statistical compilations in connection therewith relate mostly to adults. In the present report the men of Stensele alone show a numerical record that falls below this generally recognized percentage. As a matter of fact, we find only a few isolated cases in which the denture is free from caries (Table 20). Amongst the children, on the other hand, those who are free from caries are more numerously represented, the best values being attained in Stensele. Then come Åsele, Kiruna and Skåne. The lowest figures are again represented by Umeå, Jokkmokk and Kalix (Table 8).

Stensele is characterized by very low frequency of caries. Non-carious cases are common, and, moreover, in the children's material only the mildest forms of caries are recorded. The figure series indicate that the disease is not even able to keep pace with the eruption of the teeth. The frequency of caries in the milk teeth is likewise relatively low. Even in the case of the adults the series are on a relatively low level, but the great divergence between men and women is striking. *Of all the areas investigated, Stensele proves to be the one that suffers least from the disease and is the only local group that is more favourably situated in this respect than Skåne.*

The children's material in *Åsele* shows conditions that are almost in entire agreement with Skåne. The frequency of caries in the permanent teeth is higher than in Stensele, but it may nevertheless be described as low. The milk teeth, on the other hand, are here far more liable to attack. In the case of the adults the disease shows a wide dispersion. In *Umeå*, already during the years of childhood caries reaches far more advanced forms. The frequency of caries is moderately high, and the disease exhibits more severe forms than it does in the foregoing groups.

In Västerbotten, for instance, the disease in the different zones

is of an extremely different degree of intensity and character. In the mountainous and desolate zone (Stensele) we find very mild forms, in the coast zone (Umeå) caries of medium severity, and in the intermediate zone (Åsele) slight caries, which however is severer and more advanced in its character than in Stensele.

The same is the case in Norrbotten. Here we find the most severe forms within the coast zone (Kalix), where the disease must be considered to be of a very severe type. Practically every single person in this zone is suffering from it — often throughout the entire denture. The circumstances are somewhat better within the intermediate zone (Jokkmokk), although here too severe caries is present. Least caries (of medium severity) is to be found in the mountainous and desolate zone (Kiruna), in which the circumstances as regards caries are similar to those prevailing in Umeå.

CHAPTER III.

The common diseases of the mouth and their connection with the dietary forms and the general health.

By

P. A. LINDSTRÖM

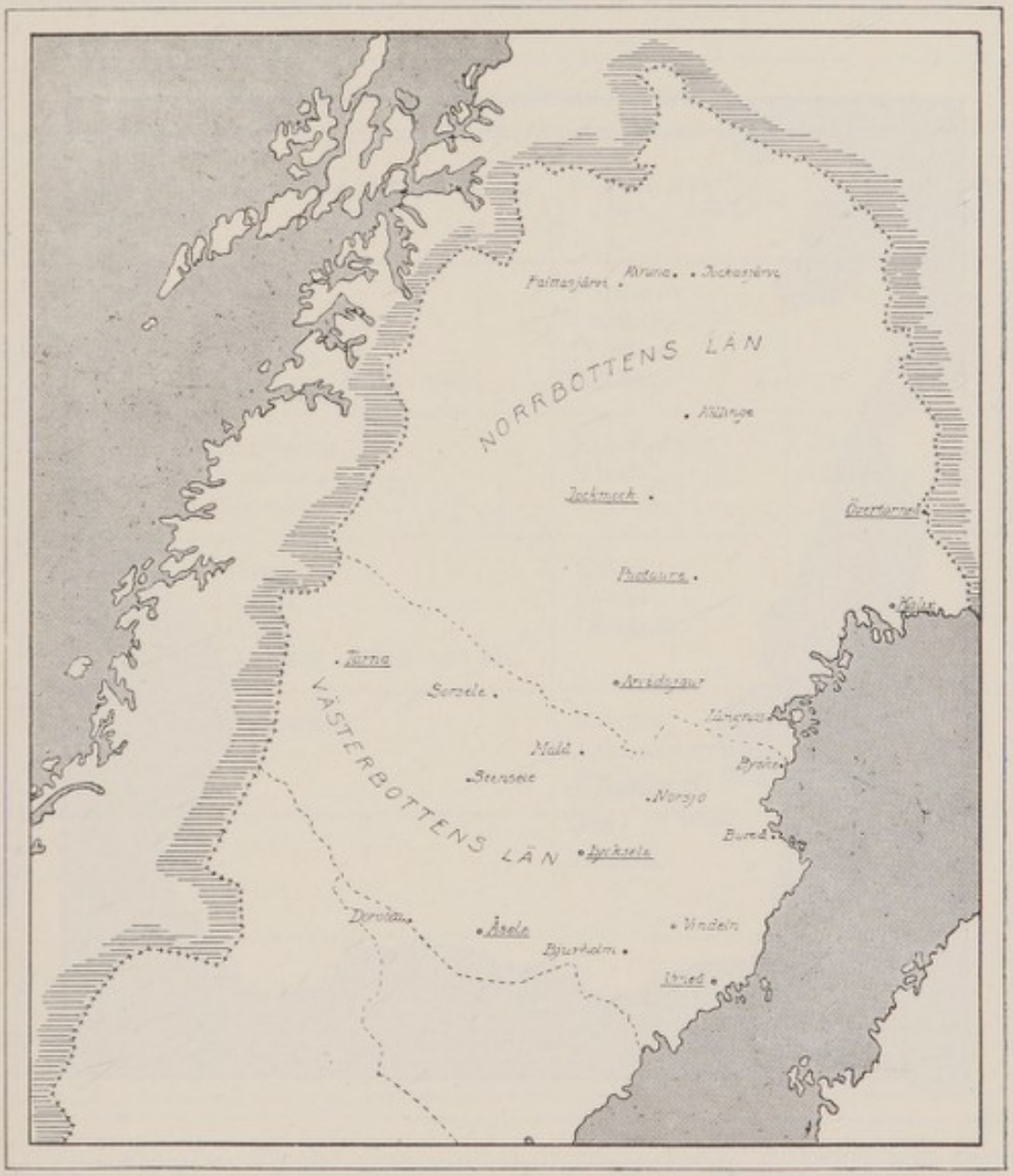
A. The material, its classification etc.

The following description of the common diseases of the mouth is based on the relevant sections of the statistical inquiry that forms part of the Royal Medical Board's report on »A social hygienic investigation in the Counties of Västerbotten and Norrbotten», or the so-called »Norrland Investigation». That is to say, the material is included partly in the hospital and local medical examinations dating from the year 1929, partly in the medical examinations in schools carried out in the same year, in which are incorporated medical records relating to school children in localities that are in the main the same as those investigated in the local medical examinations, and partly also in a medical examination in schools carried out in 1931, when observations were taken of children chiefly at other places in Norrland than those covered by the first two investigations. In this latter main group has been embodied the research material collected from a number of schools in the country parts of Skåne and likewise compiled in the year 1931.

In the following sketch-maps are marked those places in which the material was collected, the names of those covered by the 1931 investigation being underlined. (From Umeå data were collected both in the local medical examinations of 1929 and in the school medical examinations of 1931.)

As the material available does not permit of a comparison being drawn between the population in the individual places in-

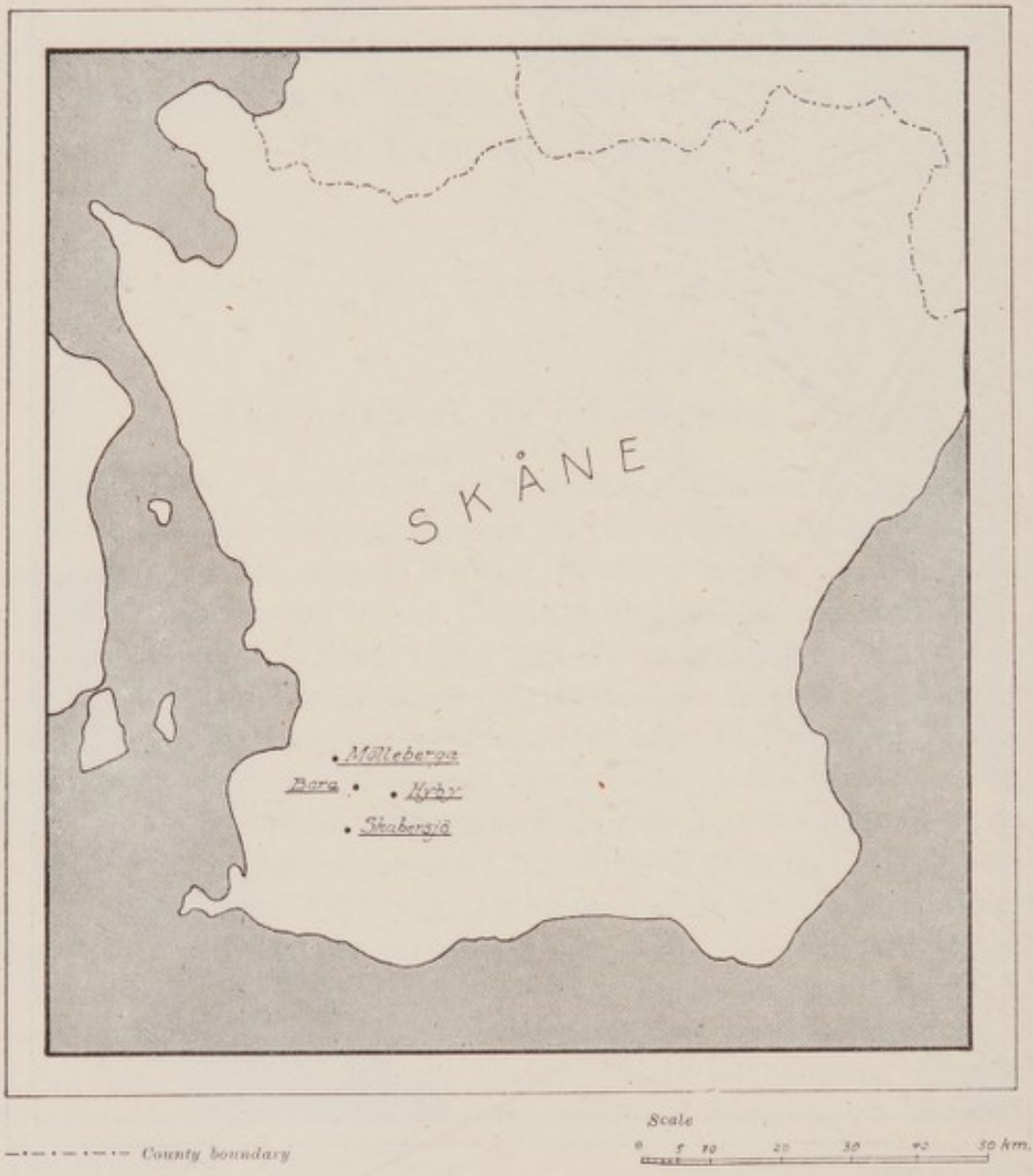
vestigated as separate units, they have been combined into a few larger geographical entities, within which the districts thus grouped together are in essentials concordant with one another from such points of view as are of decisive importance in this



case. In regard to those factors that have been of primary significance in forming the various groups, viz. the climatic features of the investigated districts and the social, hygienic and dietary conditions of the classes of the population living in the localities concerned, detailed particulars are given in Chap. I of Part I and

Sect. 1 respectively and in the itinerant investigators' reports (not published in the present work). Table A shows the geographical grouping decided upon.

The geographical division reproduced above accords with that which Holtz employed in his chapter on »Caries», based on the



same material as that with which we are here dealing. Minor divergences as regards the number of cases examined etc. between the present part of the investigation and the inquiry carried out by Holtz are due to the fact that in both these parts, in which different characteristics have been dealt with, different portions of the material have been for various reasons eliminated. For

instance, the confirmation class at Malå (comprising 80 individuals) has been included by me in some tables, whereas in the investigation of »Caries» it has been excluded altogether. The tables reproduced below show the division of the examined individuals into local groups and ages.

Table A. *Geographical grouping.*

Local groups	Local medical exam. 1929	School medical exam. 1929	School medical exam. 1931
I	Stensele, Sorsele, Dorotea, Killinge (Gällivare)	Stensele, Sorsele, Dorotea, Killinge	Tärna
II	Bjurholm, Vindeln, Norsjö	Bjurholm Vindeln Norsjö	Åsele Lycksele
III	Bureå, Byske, Umeå Långnäs (Piteå parish)	Bureå, Byske, Långnäs	Umeå
IV	Jukkasjärvi	Kiruna, Jukkasjärvi, Paittasjärvi,	[1]
V	[1]	[1]	Arvidsjaur, Jokkmokk, Puottaure
VI	[1]	[1]	Kalix, Övertorneå
VII	[1]	[1]	Skåne

The division of the material into three large sections has been called for partly by the necessity of separating the special medical examinations of children (6—16 years of age) from the local medical examinations, which were mainly concerned with adults, and partly by the fact that the two investigations of 1929 were based on an essentially different plan from the school investigation of 1931.

[1] No primary material collected.

Table 1. *Local medical examinations 1929.*

Distribution of the material according to local group, sex and age.

Age group	Local group [1]								All groups combined		Total
	I		II		III		IV				
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	
Under 1 year	—	(1)	—	—	—	—	—	—	—	(1)	(1)
1—6	16	19	2	2	1	1	17	12	36	34	70
7—12	9	11	1	2	6	16	4	4	20	33	53
13—18	15	25	9	11	32	42	3	6	59	84	143
19—30	19	33	28	19	105	125	11	20	163	197	360
31—50	23	42	17	23	108	124	16	24	164	213	377
51—65	13	14	6	3	49	32	9	14	77	63	140
Over 65	10	8	4	1	11	9	4	4	29	22	51
Total	105	152	67	61	312	349	64	84	548	646	1,194
	257		128		661		148		1,194		

Table 2. *School medical examinations 1929.*

Distribution of the material according to local group and age.

Age group	Local group [1]				Total
	I	II	III	IV	
6	3	—	—	—	3
7	29	13	112	123	277
8	38	16	95	138	287
9	56	21	38	129	244
10	52	19	45	99	215
11	54	24	26	43	147
12	30	28	17	30	105
13	31	18	21	112	182
14	26	7	4	102	139
15	5	—	—	18	23
16	1	—	—	3	4
17	—	—	—	1	1
Total	325	146	358	798	1,627

[1] See p. 69.

Table 3. *School medical examinations 1931.*

Distribution of the material according to local group, sex and age.

Age	Local group [1]												All groups combined		Total
	I		II		III		V		VI		VII				
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
6	—	—	1	—	—	—	—	—	—	—	1	—	2	—	2
7	—	—	5	11	50	39	4	15	7	13	27	18	93	96	189
8	2	2	23	18	32	18	20	18	12	18	34	20	123	94	217
9	2	1	15	15	2	4	27	16	20	30	31	29	97	95	192
10	4	2	16	11	1	—	20	12	19	30	26	29	86	84	170
11	3	5	20	13	45	27	27	20	17	23	34	23	146	111	257
12	1	2	21	19	61	34	24	32	17	42	30	32	154	161	315
13	3	2	5	5	24	28	19	26	6	11	30	23	87	95	182
14	—	1	—	—	5	2	8	6	3	6	6	4	22	19	41
15	—	—	—	—	—	—	—	1	1	1	—	—	1	2	3
16	—	—	—	—	1	—	—	1	—	1	—	—	1	2	3
Total	15	15	106	92	221	152	149	147	102	175	219	178	812	759	1,571
	30		198		373		296		277		397		1,571		

In regard to each one of the characteristics given in the recording form used in 1931 — which is reproduced in Table B — there has been entered in each individual case only a numerical figure denoting the presence or absence of alternative characteristics or the degree and type of a definite pathological picture, the figure 1 being generally given to denote a normal case. Thanks to the fact that this numerical designation, corresponding to a scheme that had been drawn up beforehand and as far as possible covered all existing cases, was consistently employed in the filling up of the primary cards in the school investigation of 1931, it has crystallized into a very rigid system and can be utilized without such amendments and attenuations as would disturb the organization as a whole.

It should be pointed out in this connection that there was never any intention to make a separate statistical compilation of the data relating to »lymphatic glands», »tonsils» and »breathing», the sole idea of these data being to throw further light on the

[1] See p. 69.

Table B.

Examination of the teeth of school children 1931.

Norrland, Skåne and Stockholm.

Parish..... Name ..... Sex ..... Age .....
Date & year of birth..... Profession of parent or guardian.....
Immigrant or native.

Status of the Mouth.	General medical data.	Remarks
1. Shape of face	I. Haemoglobin	
2. Jaws	II. Schiötz Number	
3. Palatal arch	III. Height	
4. Bite	IV. Weight	
5. Position of teeth	V. Hess's Number	
6. Size of teeth	VI. Digestive trouble	
7. Shape of teeth	VII. Housing conditions	
8. Colour of teeth	VIII. General alimental condition	
9. Proximal contact		
10. Enamel hypoplasiae		
11. Cuneiform defects		
12. Abrasion	IX. Diet	
13. Oral mucous membrane		
14. Gingiva	X. Anamnesis	
15. Materia alba (frequency)		
16. » » (location)		
17. Tartar (frequency & location)		
18. Tartar (colour)	XI. Parents' teeth	
19. Saliva (quantity)		
20. » (consistency)		
21. Lymphatic glands	XII. Diagnosis	
22. Tonsils		
23. Oral hygiene		
24. Care of the teeth		
25. Respiration		

picture in the individual cases of, in particular, inflammation of the gums and the position of the teeth.

The more exact purport of the different characteristics and the division of the sub-groups into varying types and degrees will be seen from the itemized description that follows. Nevertheless, for the purpose of clarity it is advisable at this point to enumerate some of the conditions under which the primary cards have been filled in.

The term »normal» case, which has been employed a good deal, can of course be discussed from many points of view, but if we mean by it the type that experience shows to be of most fre-

quent occurrence, and if we include within its scope those cases that do not diverge in any way, or only very slightly, from the, in the physiological sense, original and ideal picture, the term may perhaps, in spite of its subjective character, be considered acceptable under present circumstances. Certain divergent views on this point that are to be found in the school medical examinations of 1931, the results of which have been dealt with by one investigator, do not of course affect the estimate of the relative frequency of a given characteristic in respect of locality, sex and age.

It is primarily, perhaps, in regard to the gingival inflammation that there is any danger of the definitions being subject to variant interpretation. It is naturally not possible, upon a simple and brief clinical examination of the gum — that is to say merely by inspection, palpation and probing — to draw up an exact classification of the changes, as it is when making a microscopic study, or to categorize the individual cases under the great many types of gingivitis that have been tabulated, mainly on theoretical grounds.

The factors that determined the gingiva diagnosis are: 1) the colour at the edge of the gum, 2) its position and shape (hyperplastic or atrophied), 3) various forms of bleeding, 4) the depth of the gingival socket, 5) any secretions and deposits that may be found in the socket and their appearance, 6) the consistency of the gum.

At the preliminary discussions on the planning of the medical examination in schools in 1931 the nomenclature and bases of estimation were defined in exact terms and agreed upon. It was also decided that the gingival changes as well as materia alba and tartareous deposits, as far as the child material (6—16 years of age) covered by that investigation was concerned, should be judged throughout on stricter lines than is usually the case when the diagnosis relates to adults, in whom slight changes are mostly the rule, as for instance minor tartareous deposits ascertainable at any rate with a probe, and somewhat deepened sockets. Consequently, it is not possible to make a direct comparison between the diagrams of these characteristics from the school medical examinations of 1931 and those from the local medical examinations of 1929; since the application of the lines of estimation followed in the latter would result in the number of normal cases being substantially increased in the former.

The caries picture, which has been recorded on the primary cards on the page opposite to that on which the characteristics

referred to above have been entered, has only been dealt with in this work as far as regards its inter-connection with certain other factors. For this purpose there has been employed a qualitative method of grouping the cases, utilized by HOLTZ in his special study of caries, on the following lines:

0. No caries present.
1. Caries in fissures and pits.
2. Caries, besides, on the proximal surfaces of the teeth of the upper jaw and on corresponding surfaces of the bicuspids and molars of the lower jaw.
3. Caries also present on the proximal surfaces of the incisors and cuspids of the lower jaw as well as on the gingival thirds of the front and insides of the crowns.

As regards the two investigations carried out in 1929, in the respective forms used for the purpose have been entered, in respect of each characteristic, short verbal descriptions, these too based on a plan laid down in detail beforehand. Nevertheless, in these two investigations, which were carried out by several investigators, in many cases quite wide variations occur in the use of terms and recording methods. This has necessitated the exclusion of a good deal of the data on certain characteristics as being impossible to fit in with the rest, as well as the rejection of a number of particulars owing to their not being clearly formulated. In order therefore that the material from 1929 might be accurately assessed and controlled, it has been divided up into the parts contributed by each investigator. Only in those cases in which opinions have proved to be uniform has the material been incorporated in the geographical grouping for the purpose of regional comparisons. Further, no data have been dealt with which relate to patients who use prosthetic replacements — apart from isolated crowns or artificial teeth — or have had fewer than five teeth in one jaw plus corresponding antagonists, and which have to do with the characteristics abrasion, materia alba, tartar, enamel changes and the gum. As a result of all these factors, considerable variations have frequently arisen in the order of magnitude of terms and totals, both in respect of the different characteristics and between tables relating to the same characteristics. At the same time, however, the final figures have generally gained in reliability, this being especially the case with the relative distri-

bution of the diseased pictures as between local groups, sex and age. The numbers representing the absolute frequency of certain characteristics must however in several cases be considered unreliable in regard to the investigations in 1929. This nevertheless does not apply to the distribution of caries and the various forms of gingivitis, which for the most part was no less carefully and exhaustively dealt with in the material collected in the last-mentioned year.

The local medical examinations of 1929 include also a small number of adolescent individuals. As however the point was to compare those characteristics that may a priori be expected to vary considerably with age, in the comparison drawn between the local and the school medical examinations data relating to children under 12 belonging to the former category have been excluded.

It will be realized from the above that in a comparison of the results from different localities, especially in view of the fact that only one investigator collected data concerning the status of the mouth, it is necessary to attach primary importance to the school medical examinations of 1931, which in other respects also may be regarded as being more exact. In the following pages, therefore, and especially in our study of the geographical pathology of the diseases, it is primarily that investigation which will serve as a basis for our tables and to which a decisive value will be attached. On the whole it may be said that the three sections of the material collected show satisfactory agreement in those respects in which comparison is possible and the recording forms tally with one another.

In the first section of this work those characteristics are dealt with that fall under the special headings of the recording forms, the distribution of each characteristic by localities, ages and sex being shown. As regards their geographical distribution, the results obtained are applicable in the first place to the present material as such, but they also probably give an approximate picture of the absolute frequency in the individual local groups, in spite of the fact that the school medical examination of 1931 embraces only a very small proportion of the entire population in the district in question. It should be observed, however, that in Tärna for instance the total number of school children in 1931 was only 30, and that, where not otherwise stated, the corresponding tables showing the geographical pathology of the diseases

recorded from the examinations in 1929 agree in their tendency with those compiled from the 1931 material. When, for instance, the Tärna cases are stated to be in certain respects divergent from other parts of the material, this implies that, when the detailed headings on the recording forms are comparable, the other places incorporated with the Tärna district (Stensele, Sorsele, Dorotea, Killinge) likewise exhibit a picture different from the rest of the local groups.

Those particulars that are brought together under the term »general medical data» have not here been made a subject of special study but will only be discussed in the second part, in which the mutual variation between the different factors is indicated. This mutual variation can in many cases be precisely stated in numerical form by means of the so-called correlation coefficient, which usually approximates to 1 insofar as the one characteristic shows a tendency, so to speak, to attract the other. In the case of a negative association, in which definite phenomena in a greater or less degree exclude one another, the coefficient is negative. Unless expressly stated otherwise, a positive correlation is meant. Certain difficulties were encountered in determining the correlation coefficient in cases where gingival changes constituted the one factor. For this purpose, then, the various types of gingivitis were arranged in a series in which the normal gingiva formed the first step, and which under the existing circumstances may fairly be regarded as implying an enhancement of the same pathological conditions. There were excluded from the series the different forms of atrophy, and further, for the purpose of determining the correlation coefficient, the profound marginal paradentitis and the pronounced spontaneously bleeding gingivitis were combined (the two latter diseased symptoms occur only in adults). The adoption of these principles has been all the easier seeing that the atrophies and the spontaneously bleeding gingivitis are of very rare occurrence in our material. The fact that the gingivitis series indicated is regarded as implying a gradual development from the normal gingiva is not however to be taken as an assumption that the different types have necessarily arisen out of the same pathogenic factors and that the varying form merely represented a picture of the strength of these factors.

As to the data of a general medical nature, of which use has been made in the following tables, for more detailed particulars as to their significance and the method of recording them the

reader is referred to Part II, Sect. 2. It need only be added here that the original dietary divisions have very largely been combined into wider groups so as to afford a more reliable idea of the mutual variation with other factors.

The variations in length and weight have not been discussed in this work, either separately or in correlation tables, it being the intention to present the results of these inquiries later on.

In the following set of tables and diagrams we shall first of all give in summary form the statistical report on the different groups of headings, each taken separately, and then a brief survey of the connection between the individual characteristics.

B. The frequency within local groups, ages and sexes of characteristics entered under the separate headings in the recording form.

1. Bite.

Table 4. *School medical examinations 1931. Boys and girls.*

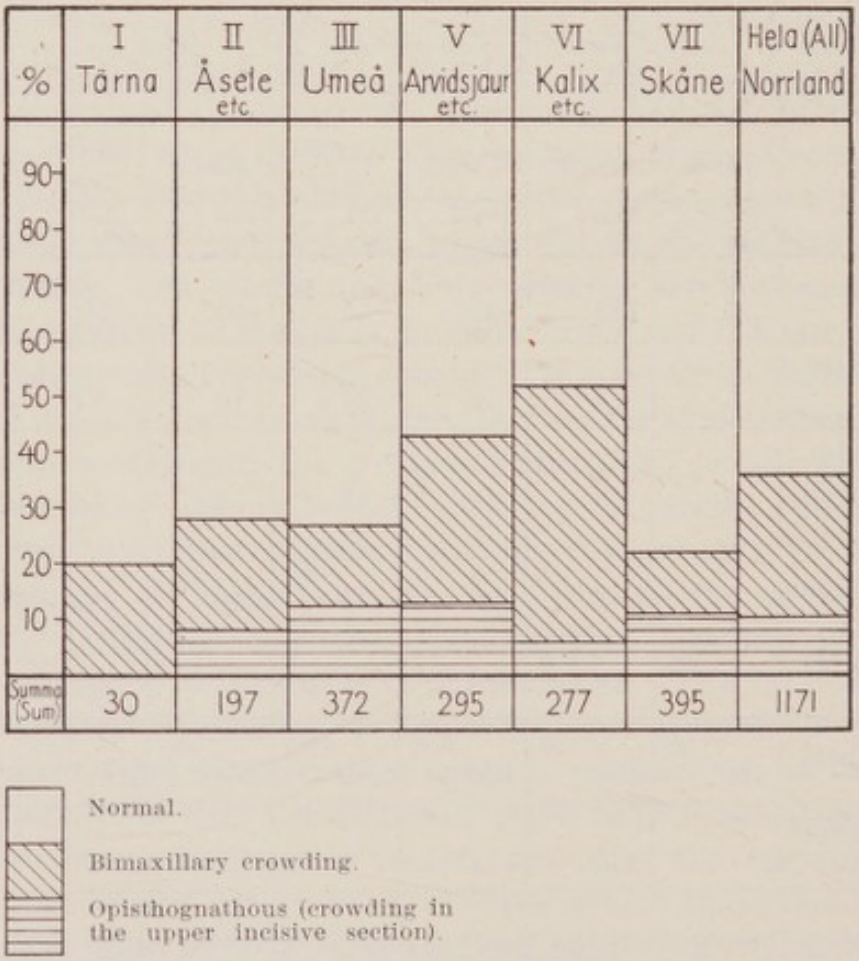
Bite	I Tärna		II Åsele		III Umeå		V Arvidsjaur		VI Kalix		All Norrland		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal	25	84	134	68	242	67	155	54	125	46	681	59	246	63
End-to-end bite	1	3	17	9	15	4	24	8	10	4	67	6	34	9
Anteroclusion (progenie)	1	3	13	7	19	5	13	4	8	3	54	5	11	3
Prognathism			15	7	23	7	77	27	109	41	224	20	41	10
Deep overbite	3	10	18	9	63	17	21	7	16	6	121	10	61	15
Total	30	100	197	100	362	100	290	100	268	100	1,147	100	393	100
Excl. observations			1		11		6		9		27		4	

In Skåne the prognathous types of bite (projecting upper jaw) appear to be less common than in Norrland. The material from the Arvidsjaur and Kalix districts indicates a normal bite in only 54 and 46 % respectively.

2. Position of the teeth.

Table 5. *School medical examinations 1931. Boys and girls.*

Position of teeth	I Tärna		II Åsele		III Umeå		V Arvidsjaur		VI Kalix		All Norrland		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal	24	80	142	72	287	77	168	57	133	48	754	64	310	78
Bimaxillary crowding	6	20	41	21	39	10.5	90	30	127	46	303	26	41	11
Opistho-gnathous			14	7	46	12.5	37	13	17	6	114	10	44	11
Total	30	100	197	100	372	100	295	100	277	100	1,171	100	395	100
Excl. observations			1		1		1				3		2	



As regards the position of the teeth, Norrland as a whole assumes a less favourable position than Skåne. In the Tärna district, where the Lapp and Finnish element is considerable, thus enhancing the number of short, broad faces, anomalies in the position of the teeth, and especially the opisthognathous bite, appear to be of less frequent occurrence.

3. Hypoplasiae of the enamel.

Table 6.

Hypoplasiae of the enamel	Local med. exam. 1929				School med. exam. 1931			
	Men		Women		Men		Women	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
None	377	91	377	90	760	94	726	96
Grooves and furrows	36	9	41	10	52	6	33	4
Total	413	100	418	100	812	100	759	100
Excluded observations	135		228					

The older generation, as recorded in the local medical examinations of 1929, shows hypoplasiae of the enamel in the teeth of close on one-tenth of the total number of individuals. The school children, according to the school medical examinations of 1929, exhibit in only 4—6 % of all those examined the presence of hypoplastic changes in the enamel of the teeth — a circumstance that may be attributed, on a conservative estimate, to the fact that in the younger generation, which has grown up under more favourable hygienic conditions, the affections of calcium metabolism, which are largely of a rachitic nature, have been of less frequent occurrence.

Table 7. *Local med. exam. 1929. Men and Women.*

Hypoplasiae of the enamel	I Stensele etc.		II Bjurholm etc.		III Bureå etc.		IV Jukkasjärvi		Total groups	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs	%	Abs. figs.	%
None	163	88	94	94	411	92	86	88	754	91
Grooves and furrows	23	12	6	6	36	8	12	12	77	9
Total	186	100	100	100	447	100	98	100	831	100
Excluded observations	71		28		214		50		363	

The interior Lapp region, represented by the Stensele group (Stensele, Sorsele, Dorotea, Killinge) and Jukkasjärvi, shows the most numerous enamel changes of a mainly rachitic nature. The agricultural districts of Bjurholm, Vindeln and Norsjö record a more favourable frequency, the figure being only half as high. The sawmilling district in the coastal area assumes an intermediate position. These circumstances apply to the older generation according to the local medical examinations of 1929.

Table 8. *School medical examinations 1931. Boys and girls.*

Hypoplasiae of the enamel	I Tärna		II Åsele		III Umeå		V Arvidsjaur		VI Kalix		All Norrland		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
None	26	87	186	94	339	90	286	96	267	96	1,104	94	382	96
Grooves and furrows	4	13	12	6	34	10	10	4	10	4	70	6	15	4
Total	30	100	198	100	373	100	296	100	277	100	1,174	100	397	100

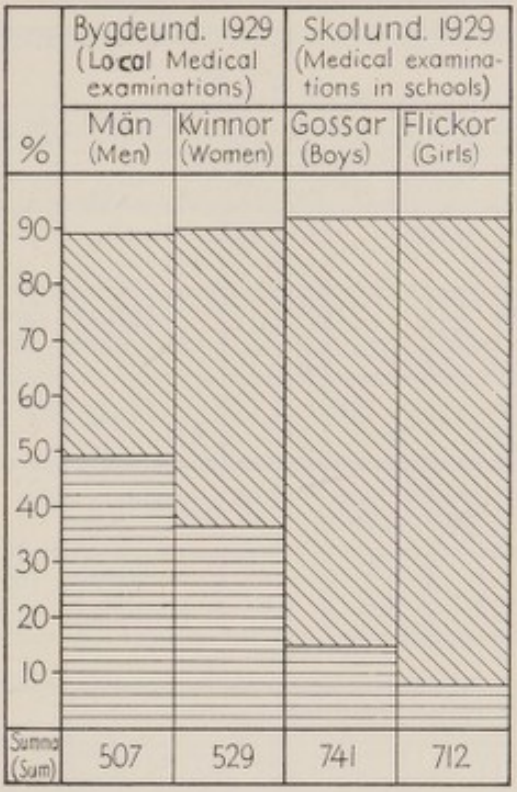
All observations included.

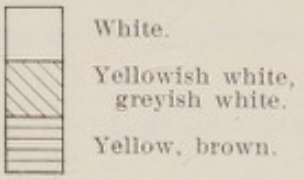
The enamel defects in the younger generation are apparent from the school medical examinations of 1931. The most numerous changes occur in the desolate Tärna district, the frequency being more than twice as high as in the district under investigation as a whole. The figures for Åsele in the Lapp district of Västerbotten and for the Umeå district are unfavourable. Arvidsjaur and Kalix are represented by figures that are on the same level as Skåne, where hypoplastic changes of a rachitic nature have been found to occur in only 4 % of the children examined in 1931.

4. Colour of the teeth.

Table 9. *The local & school medical examinations 1929.*

Colour of the teeth	Local med. exam. 1929				School med. exam. 1929			
	Men		Women		Boys		Girls	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
White	54	11	52	10	56	8	57	8
Yellowish white, greyish white	203	40	284	54	573	77	601	84
Yellow, brown	250	49	193	36	112	15	54	8
Total	507	100	529	100	741	100	712	100
Excluded observations	41		117		97		77	

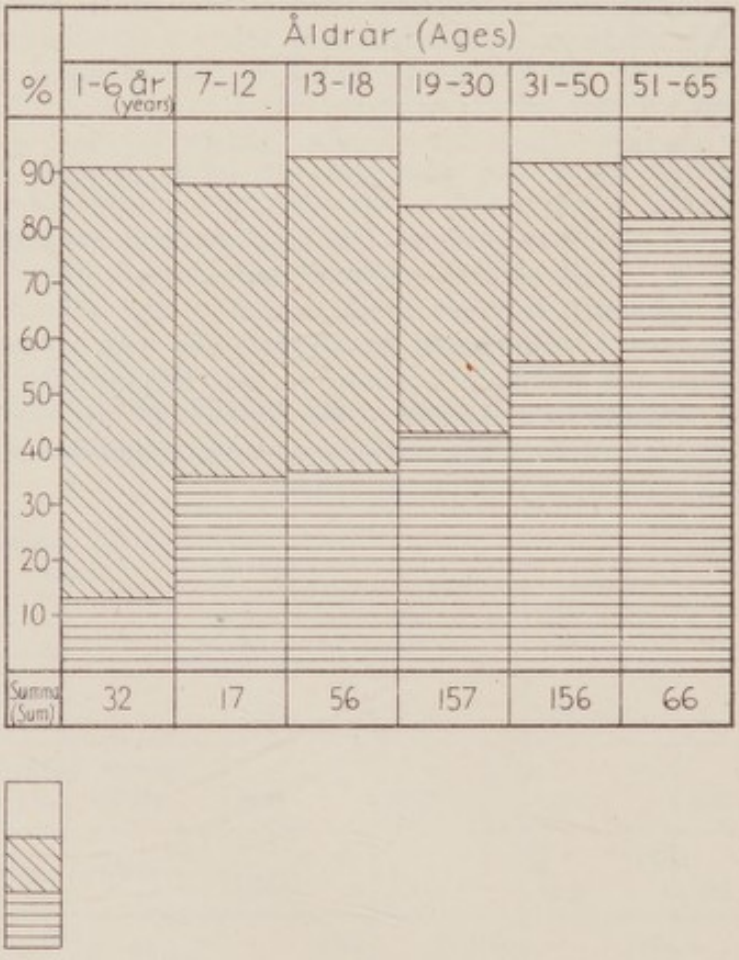




As the age advances the colour of the teeth changes to yellower shades, expressing a concretion in the form of a process of calcification undergone by the dentin substance. The local medical examinations show that in 40—50 % of all elderly persons there occurs this, in different respects more resistant, type of tooth, which in the school children is represented by only 10—15 %. In this respect the men are more favourably placed than the women, in whom — and this applies to both the older and the younger age groups — the number of the more yellowish teeth is far greater, a fact that should not be forgotten in estimating the lower frequency of caries in the men.

Table 10. *Local medical examinations 1929. Men.*

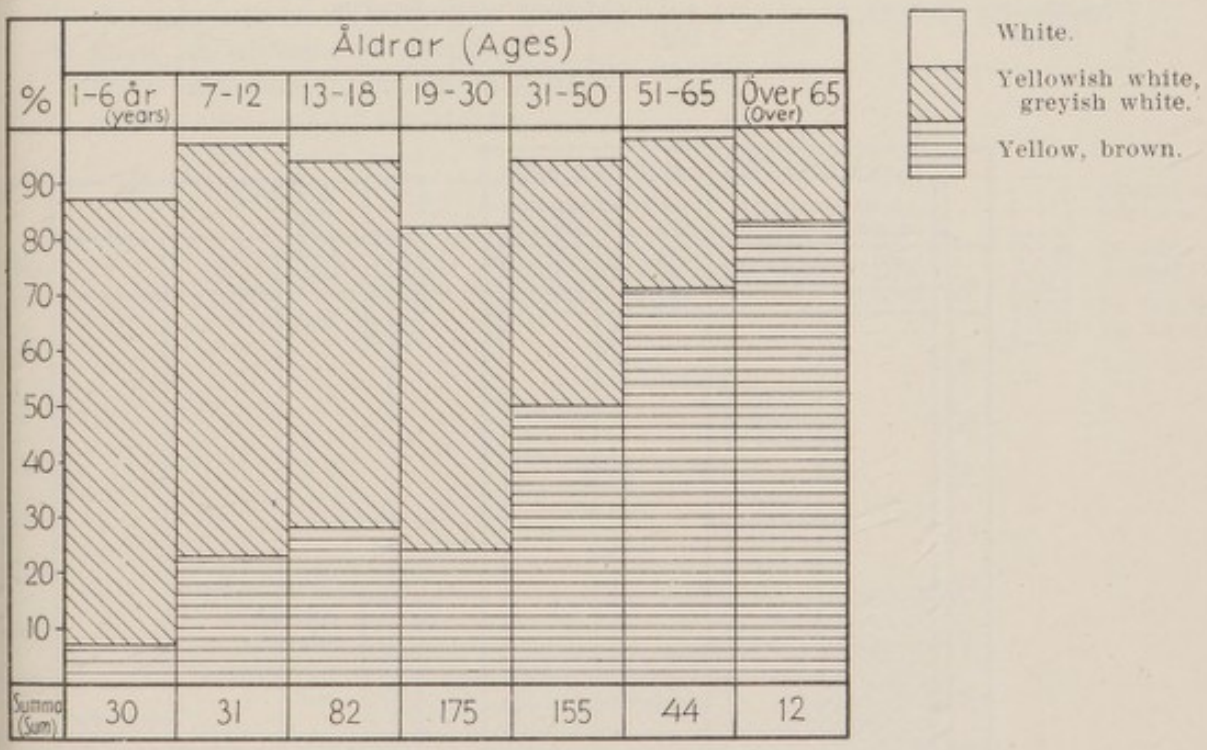
Colour of the teeth	Ages													
	1—6		7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
White	3	9	2	12	4	7	25	16	13	8	5	7	2	9
Yellowish white, greyish white	25	78	9	53	32	57	65	41	56	36	7	11	9	39
Yellow, brown	4	13	6	35	20	36	67	43	87	56	54	82	12	52
Total	32	100	17	100	56	100	157	100	156	100	66	100	23	100
Excluded observations	4		3		3		6		8		11		6	



In males the yellowness of the teeth increases throughout as age advances, indicating a gradual sclerotization of the organic dentin substances.

Table 11. *Local medical examinations 1929. Women.*

Colour of the teeth	Ages													
	1—6		7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs figs.	%	Abs. figs.	%
White	4	13	1	3	5	6	31	18	10	6	1	2		
Yellowish white, greyish white	24	80	23	74	54	66	101	58	68	44	12	27	2	
Yellow, brown	2	7	7	23	23	28	43	24	77	50	31	71	10	
Total	30	100	31	100	82	100	175	100	155	100	44	100	12	
Excluded observations	4		2		2		22		58		19		10	

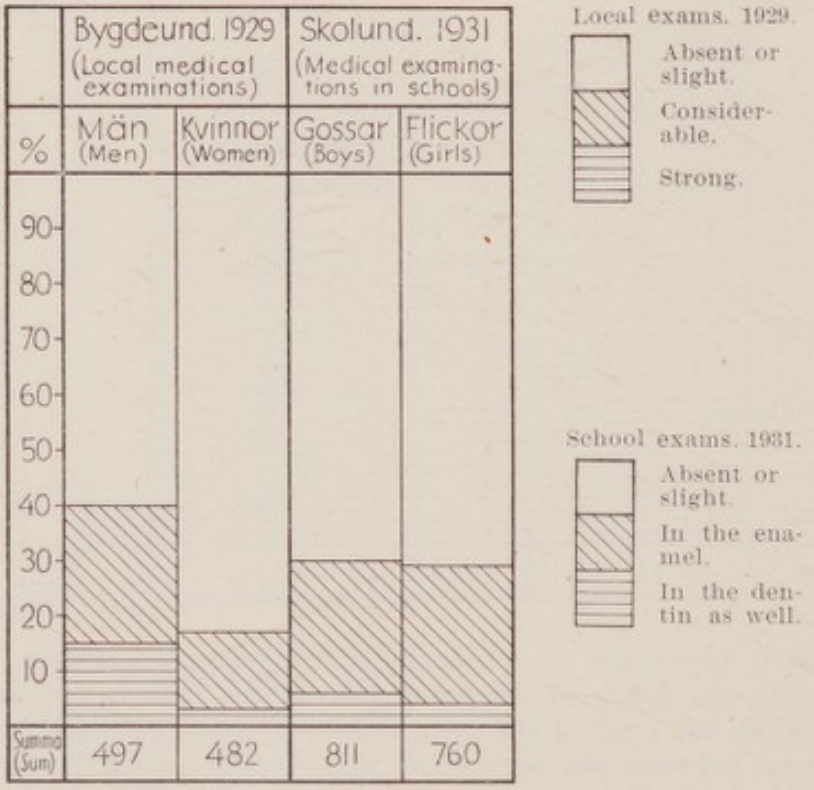


In women too there is a conspicuous tendency, as age advances, towards yellower types of colour in the teeth. This is not so marked, however, as in the case of the men, especially during woman's period of fertility, and between the ages of 20 and 30 it is actually characterized by an interruption of the process in the form of an increased frequency of the whitish types. This fact points to greater lability in the teeth of women in regard to the inorganic deposits during pregnancy and lactation, and should not be overlooked when discussing the increased frequency of caries in pregnant women.

5. Abrasion.

Table 12. *Local medical examinations 1929 and school examinations 1931.*

Abrasion	Local exams. 1929				Abrasion	School exams. 1931			
	Men		Women			Boys		Girls	
	Abs. figs.	%	Abs. figs.	%		Abs. figs.	%	Abs. figs.	%
Absent or slight	299	60	401	83	Absent or slight	571	70	537	71
Considerable	120	24	65	14	Abrasion in the enamel	191	24	190	25
Strong	78	16	16	3	Abrasion also in the dentin	50	6	32	4
Total	497	100	482	100	Total	812	100	759	100
Excluded observations	51		164		Excluded observations				

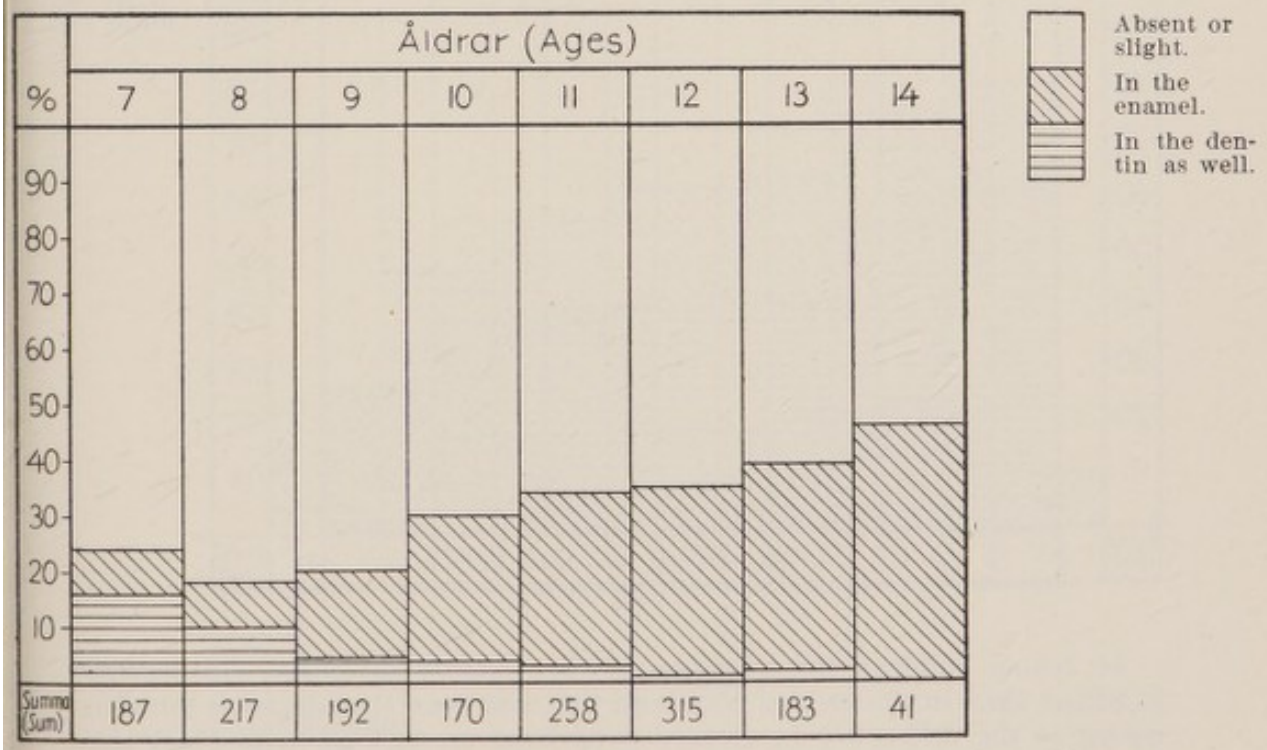


Abrasion of the teeth, which to a certain extent expresses the degree in which the masticatory organ is used for its purpose of chewing up the food, is more marked in the more muscular male.

Table 13. *School medical examinations 1931. Boys and girls.*

Abrasion	Ages															
	7		8		9		10		11		12		13		14	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Absent or slight	145	76	178	82	153	79	119	70	170	66	205	65	111	61	22	54
In the enamel	15	8	17	8	30	16	44	26	80	31	107	34	67	37	19	46
In the dentin as well	29	16	22	10	9	5	7	4	7	3	3	1	4	2		
Total	189	100	217	100	192	100	170	100	257	100	315	100	182	100	41	100
Excluded observations	—		—		—		—		—		—		—		—	

8 observations at the ages of 6, 15 and 16 are excluded, of which:
5 show an absence of abrasion,
2 show abrasion in the enamel, and
1 shows abrasion in the dentin

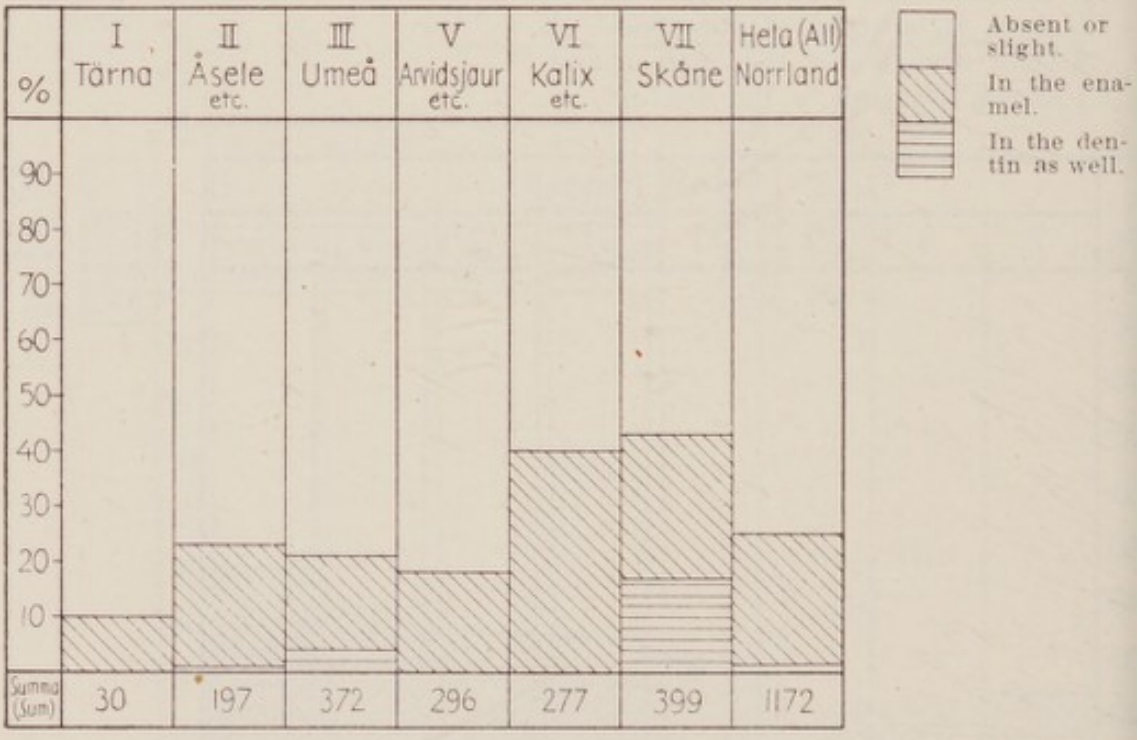


The above table and diagram show that from the age of 7 the relative number of cases of strong abrasion decreases owing to the successive shedding of the worn milk teeth: simultaneously the occurrence of abrasion in the enamel becomes more frequent.

Table 14. *School medical examinations 1931.*

Abrasion	I Tärna		II Åsele		III Umeå		V Arvidsjaur		VI Kalix		All Norrland		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Absent or slight	27	90	153	77	294	79	242	82	166	60	882	75	226	57
In the enamel	3	10	43	22	65	17	54	18	111	40	276	23.5	105	26.5
In the dentin as well			2	1	14	4					16	1.5	66	16.5
Total	30	100	198	100	373	100	296	100	277	100	1,174	100	397	100

All observations included.

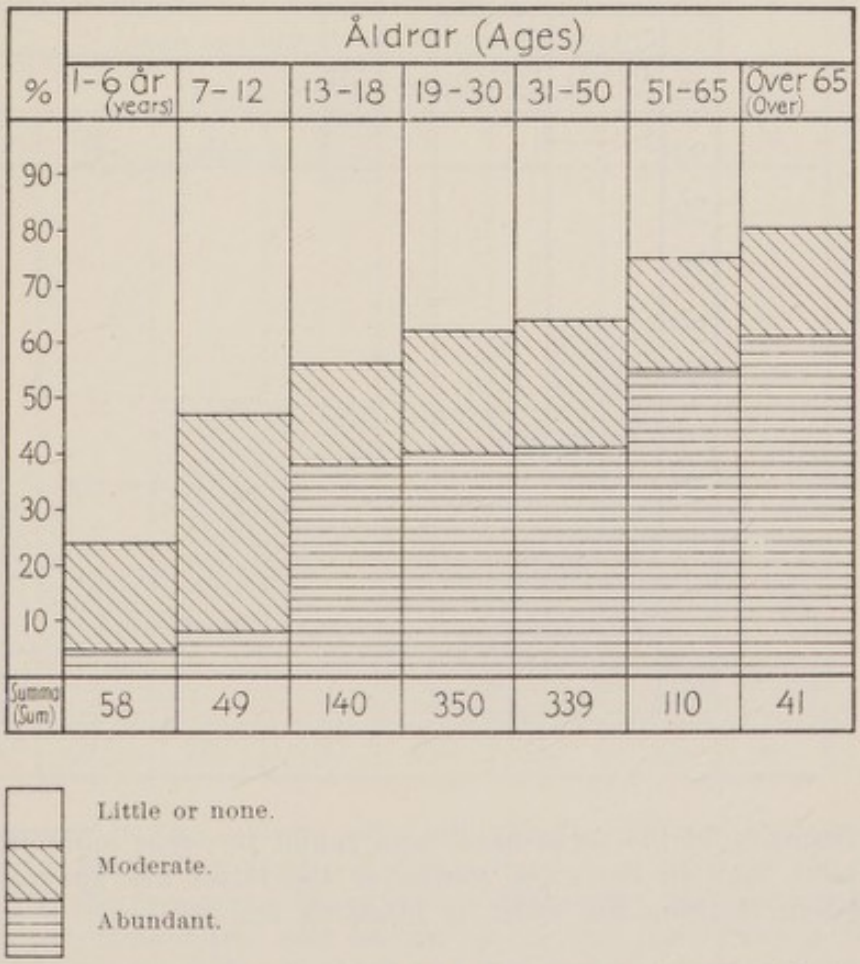


In school children the abrasion of the teeth is far more conspicuous in Skåne than in the area of Norrland that has been investigated, possibly owing to the difference in dietary conditions as well as to the fact that a bite more or less severely damaged by caries is, on account of the pain in the teeth, of less use as a means of mastication. It is highly probable, however, that the abrasion of the teeth is not only a purely mechanical problem but is also attributable to unknown constitutional factors.

6. **Materia alba.**

Table 15. *Local medical examinations 1929. Men and women.*

Materia alba frequency	Ages													
	1—6		7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Little or none	44	76	26	53	62	44	134	38	121	36	28	25	8	20
Moderate	11	19	19	39	25	18	78	22	77	23	22	20	8	20
Abundant	3	5	4	8	53	38	138	40	141	41	60	55	25	60
Total	58	100	49	100	140	100	350	100	339	100	110	100	41	100
Excluded observations	12		4		3		10		38		30		10	



Little or none.

Moderate.

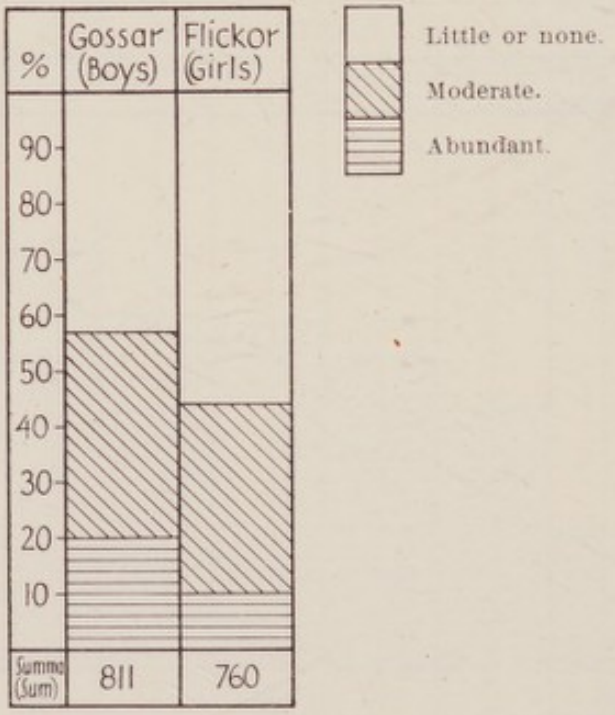
Abundant.

As age advances the soft deposits on the teeth increase in frequency and abundance amongst the population, in some measure as evidence of deficient hygiene. The relative increase is approximately the same for men as for women at the different ages.

Table 16. *School medical examinations 1931.*

Materia alba frequency	Boys		Girls	
	Abs. figs.	%	Abs. figs.	%
Little or none	349	43	420	55
Moderate	303	37	262	35
Abundant	160	20	77	10
Total	812	100	759	100

All observations included.

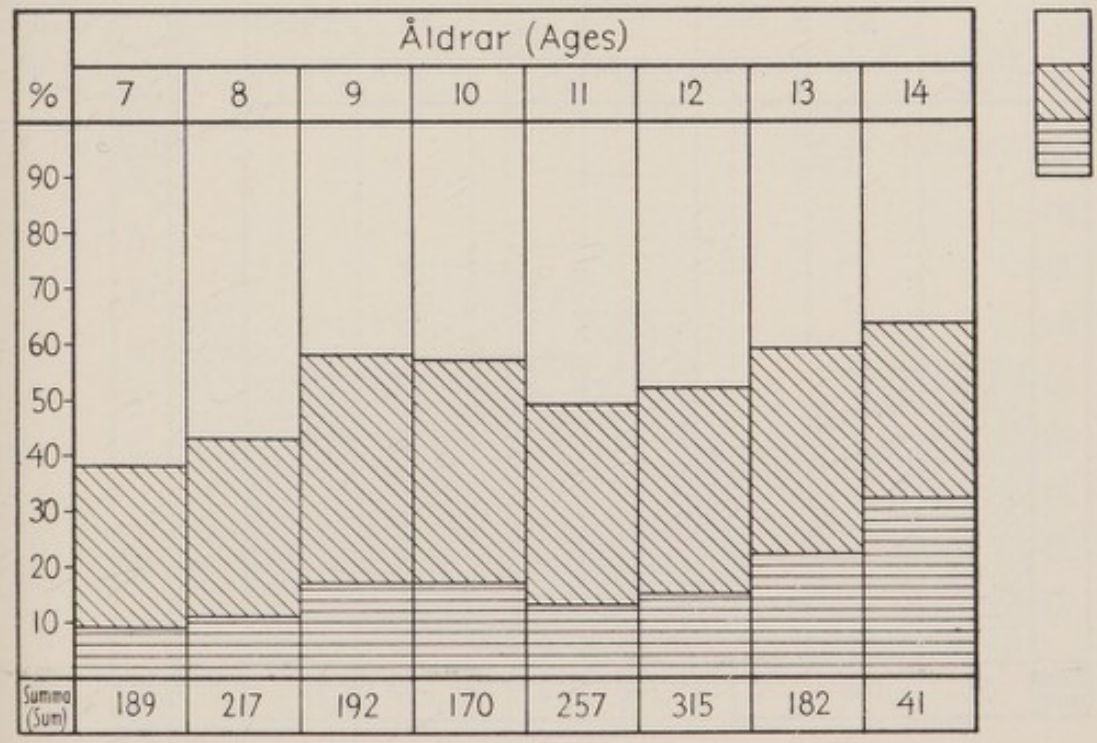


Soft deposits on the teeth have been found to occur more frequently in the boys than in the girls; moreover the latter are generally more interested in cleaning the teeth by brushing and rinsing.

Table 17. *School medical examinations 1931. Boys and girls.*

Materia alba frequency	Ages							
	7	8	9	10	11	12	13	14
	Abs. figs. / %	Abs. figs. / %	Abs. figs. / %	Abs. figs. / %	Abs. figs. / %	Abs. figs. / %	Abs. figs. / %	Abs. figs. / %
Little or none	118 / 62	124 / 57	81 / 42	73 / 43	130 / 51	152 / 48	74 / 41	15 / 36
Moderate	54 / 29	70 / 32	79 / 41	68 / 40	94 / 36	115 / 37	68 / 37	13 / 32
Abundant	17 / 9	23 / 11	32 / 17	29 / 17	33 / 13	48 / 15	40 / 22	13 / 32
Total	189 / 100	217 / 100	192 / 100	170 / 100	257 / 100	315 / 100	182 / 100	41 / 100

All observations are included in the ages given above. In addition there are 8 observations, of which 2 at the age of 6, 3 at the age of 15 and 3 at the age of 16. In the case of 2 of these the frequency of alba materia is slight, in 4 moderate and in 2 abundant.

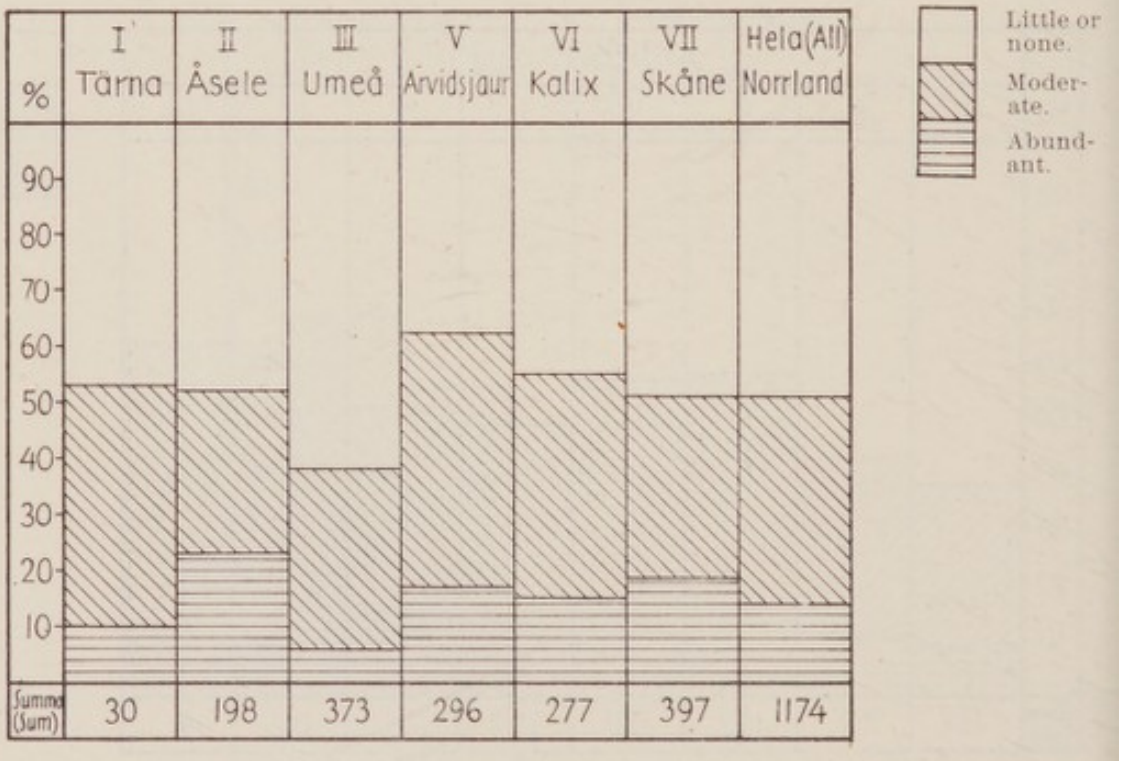


The increase in the materia alba deposits in children becomes more marked with advancing years. An exception is noticed in the 11—12 year groups, the frequency being lower, indicating that the conditions governing the metabolism and factors of growth also have a bearing on the soft dental concretions, which are thus, in point of their abundance, not entirely a function of measures of hygiene. The rise of the curve is interrupted about 1 year earlier in girls than in boys. It is to be observed, however, that the child material from the 1931 examinations has been judged with greater strictness than the material compiled from the adults.

Table 18. *School medical examinations 1931.*

Materia alba frequency	I Tärna		II Åsele		III Umeå		V Arvidsjaur		VI Kalix		All Norrland		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Little or none	14	47	94	48	231	62	111	37	124	45	574	49	195	49
Moderate	13	43	58	29	119	32	135	46	111	40	436	37	129	33
Abundant	3	10	46	23	23	6	50	17	42	15	164	14	73	18
Total	30	100	198	100	373	100	296	100	277	100	1,174	100	397	100

All observations included.

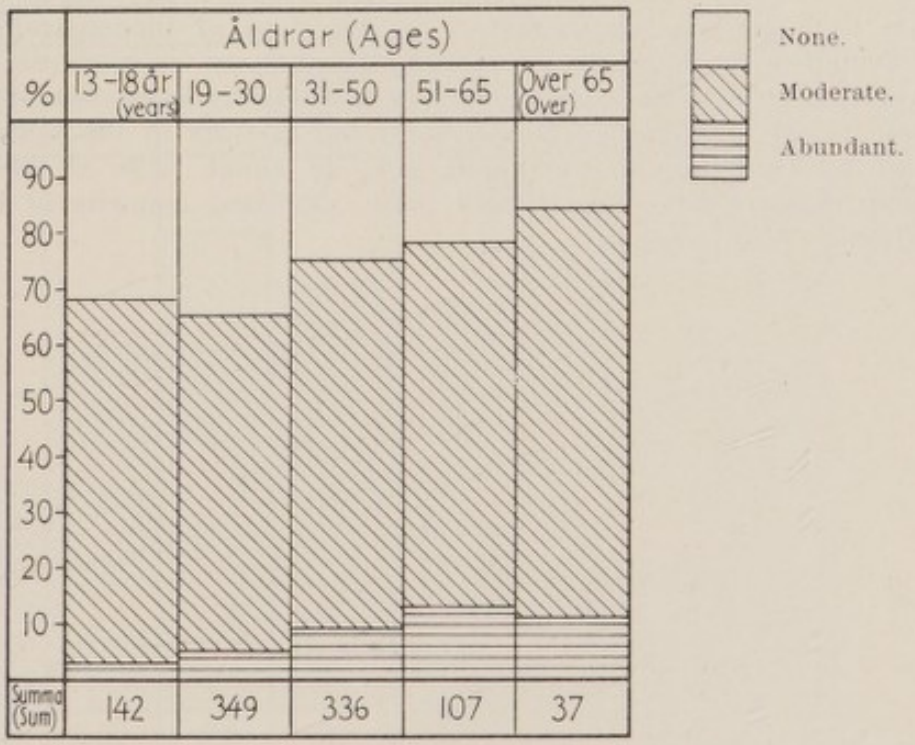


There is scarcely any difference between Norrland and Skåne in the occurrence of materia alba. The more favourable position of Umeå in this respect is chiefly to be ascribed to the higher standard of oral hygiene amongst school children in an urban community.

7. Tartar (Salivary calculus).

Table 19. *Local medical examinations 1929. Men and women.*

Tartar (frequency)	Ages									
	13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
None	46	32	124	35	85	25	24	22	6	16
Moderate	92	65	209	60	222	66	69	65	27	73
Abundant	4	3	16	5	29	9	14	13	4	11
Total	142	100	349	100	336	100	107	100	37	100
Excluded observations	1		11		41		33		14	



The clinical experience that the occurrence of tartareous deposits, as also the degree of severity of cases of tartar, increases with advancing age is confirmed by the examination of the adult population. The rise in frequency is similar in both cases. Upon a comparison with the school material it should be observed that the latter has been judged, as far as regards tartar — as in the case of materia alba and gingivitis —, far more strictly than the adult material.

Table 20. *School medical examinations 1931.*

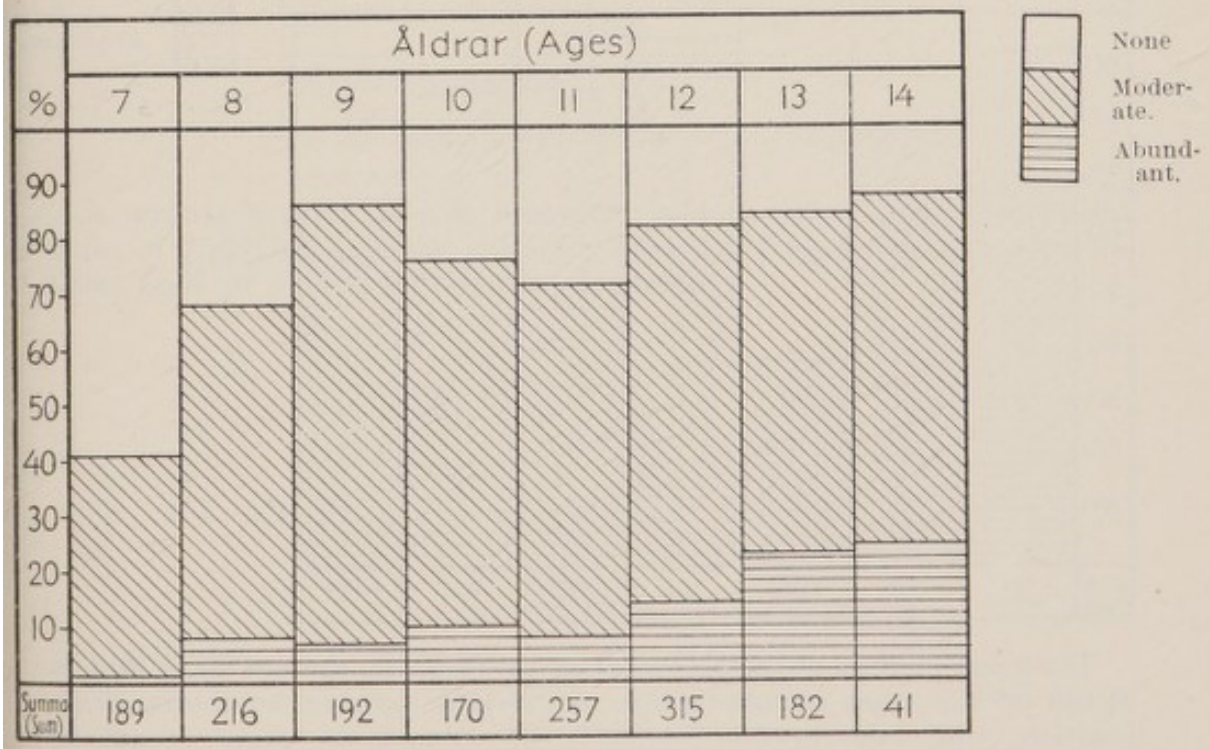
Tartar (frequency)	Boys		Girls	
	Abs. figs.	%	Abs. figs.	%
None	210	26	188	25
Moderate	518	64	488	64
Abundant	83	10	83	11
Total	811	100	759	100
Excluded observations	1		—	

Tartareous deposits occur frequently amongst school children. No less than over 70 % of those examined in 1931 were found upon careful revision to be affected with tartar. In the case of incomparably the greater number the deposits have been insignificant or moderate, i. e., upon investigation with a probe it was possible to show the presence of tartar in the gingival pockets around the incisors in the lower jaw and the 6-year molars in the upper jaw. In about 10 % of the cases investigated there have been found more abundant deposits of harder concretions.

Table 21. *School medical examinations 1931. Boys and girls.*

Tartar (frequency)	Ages															
	7		8		9		10		11		12		13		14	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
None	111	59	69	32	29	15	23	14	73	29	58	18	30	16	3	8
Moderate	76	40	130	60	150	78	130	76	163	63	214	68	111	61	28	68
Abundant	2	1	17	8	13	7	17	10	21	8	43	14	41	23	10	24
Total	189	100	216	100	192	100	170	100	257	100	315	100	182	100	41	100
Excluded observations	—		1		—		—		—		—		—		—	

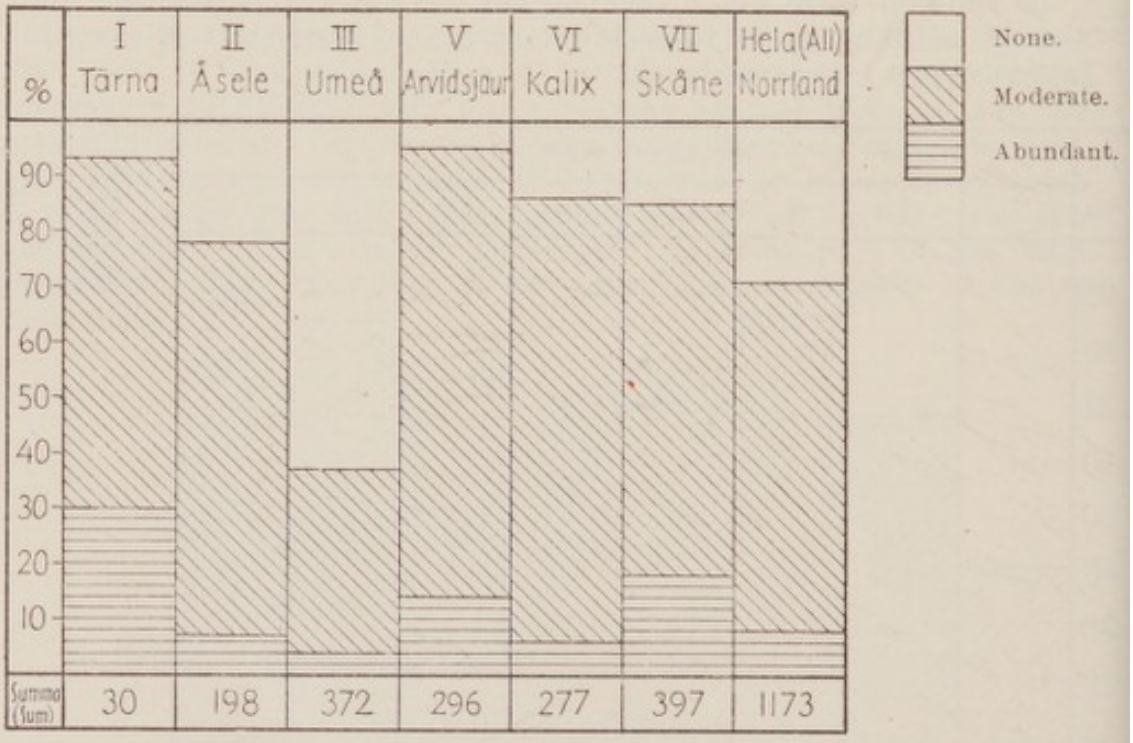
In addition there are 8 observations, of which 2 at the age of 6, 3 at 15 and 3 at 16. Of these the frequency of tartar is in 2 cases nil, in 4 moderate and in 2 abundant.



In the school children the tartareous deposits increase with advancing years not only generally speaking but also in regard to the severer forms. Just as in the case of the accumulations of materia alba, however, the intermediate age groups (10—11 years) show, as regards tartar, a decline in frequency, which emphasizes the importance of metabolic factors for the formation of concretions on the teeth. Boys and girls tally, except that the said decline in frequency starts somewhat earlier in girls.

Table 22. *School medical examinations 1931.*

Tartar (frequency)	I Tärna		II Åsele		III Umeå		V Arvids-jaur		VI Kalix		All Norr-land		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs	%
None	2	7	44	22	235	63	16	5	40	14	337	29	61	15
Moderate	19	63	141	71	121	33	239	81	221	80	741	63	265	67
Abundant	9	30	13	7	16	4	41	14	16	6	95	8	71	18
Total	30	100	198	100	372	100	296	100	277	100	1,173	100	397	100
Excluded observations	—		—		1		—		—		1		—	



The great number of tartareous cases in Tärna on the one hand and in Skåne on the other is noteworthy. Arvidsjaur assumes an intermediate position, while the lowest frequency of »abundant» cases occurs in Umeå. As a comparison with the geological map shows that Tärna and Arvidsjaur are respectively situated on and in close connection by water with the Silurian lime areas and that those parts of Skåne with which the investigation was concerned rest upon calcareous foundations, the assumption that the abundant lime content in the water has some bearing on the accretion of tartar cannot be lightly rejected. Åsele and Kalix are far removed from calcareous soil, as also is Umeå, which has no connection whatsoever by water with the Silurian lime areas. It should be added that other affections that may come into question, e. g. caries, do not exhibit in their frequency any consistent connection with the distribution of the calcareous deposits.

8. **Changes in the gums.**

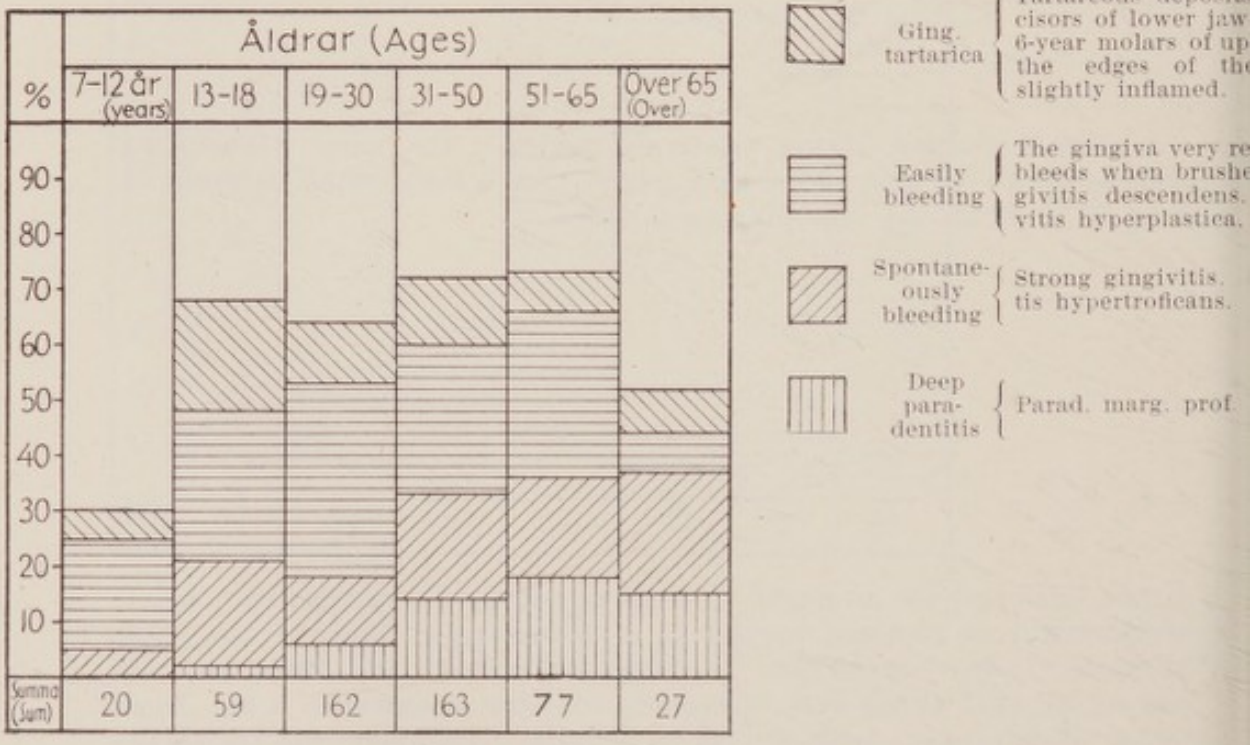
Table 23. *Local medical examinations 1929.*
Only the age groups above 7 years included.

Gingiva	Local exams. 1929			
	Men		Women	
	Abs figs.	%	Abs. figs.	%
Normal gingiva	172	34	210	34
Ging. tartarica	57	11	89	15
Easily-bleeding	145	29	174	29
Spont. bleeding	82	16	92	15
Deep paradentitis	48	10	45	7
Total	504	100	610	100
Excluded observations	8		2	

A normal gingiva occurs relatively seldom. The more pronounced forms of gingivitis amongst elderly persons have been found to occur in about 55 % of all the individuals examined.

Table 24. *Local medical examinations 1929. Men.*

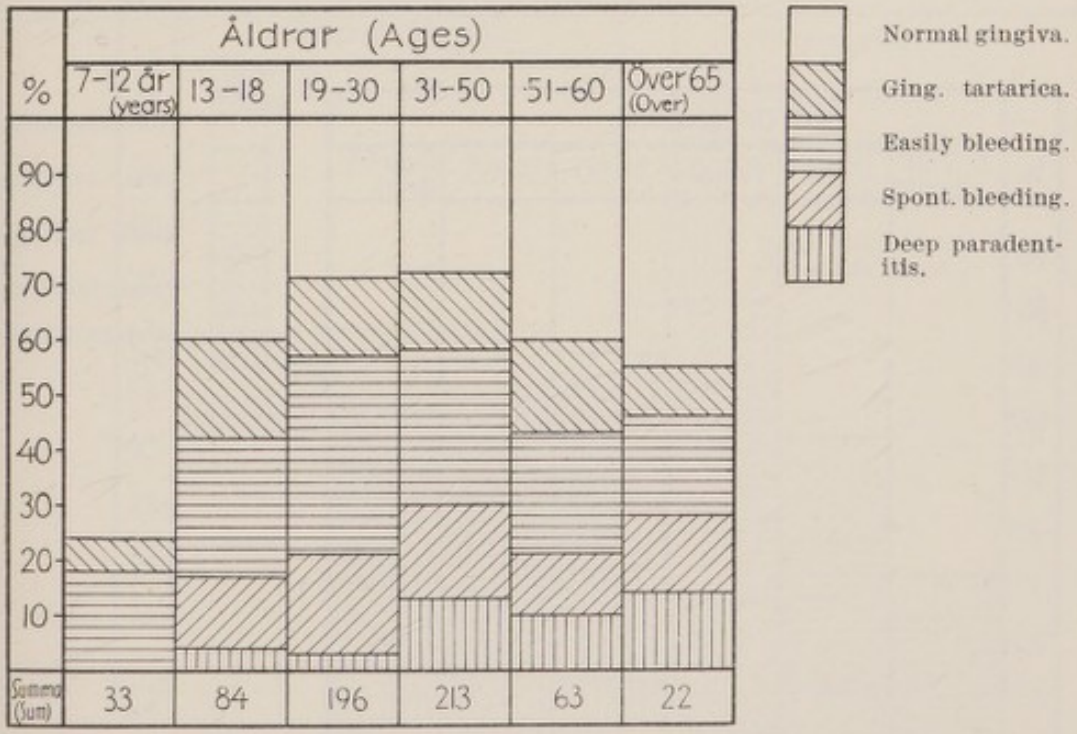
Gingiva	Ages											
	7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	14	70	19	32	59	36	46	28	21	27	13	48
Ging. tartarica	1	5	12	20	17	11	20	12	5	7	2	7·5
Easily bleeding	4	20	16	27	56	35	44	27	23	30	2	7·5
Spont. bleeding	1	5	11	19	20	12	30	19	14	18	6	22
Deep paradentitis			1	2	10	6	21	13	13	17	3	11
Total	20	100	59	100	162	100	161	100	76	100	26	100
Excluded observations	—		—		1		3		1		3	



The development of gingivitis in men is characterized by a steady increase in the severer forms up to the age of 65. From the age of 30 they become highly intensified. But in persons who have passed their 65th year (these may be considered to represent a last remnant of constitutionally stronger individuals) it can be shown that the disease tends to subside.

Table 25. *Local medical examinations 1929. Women.*

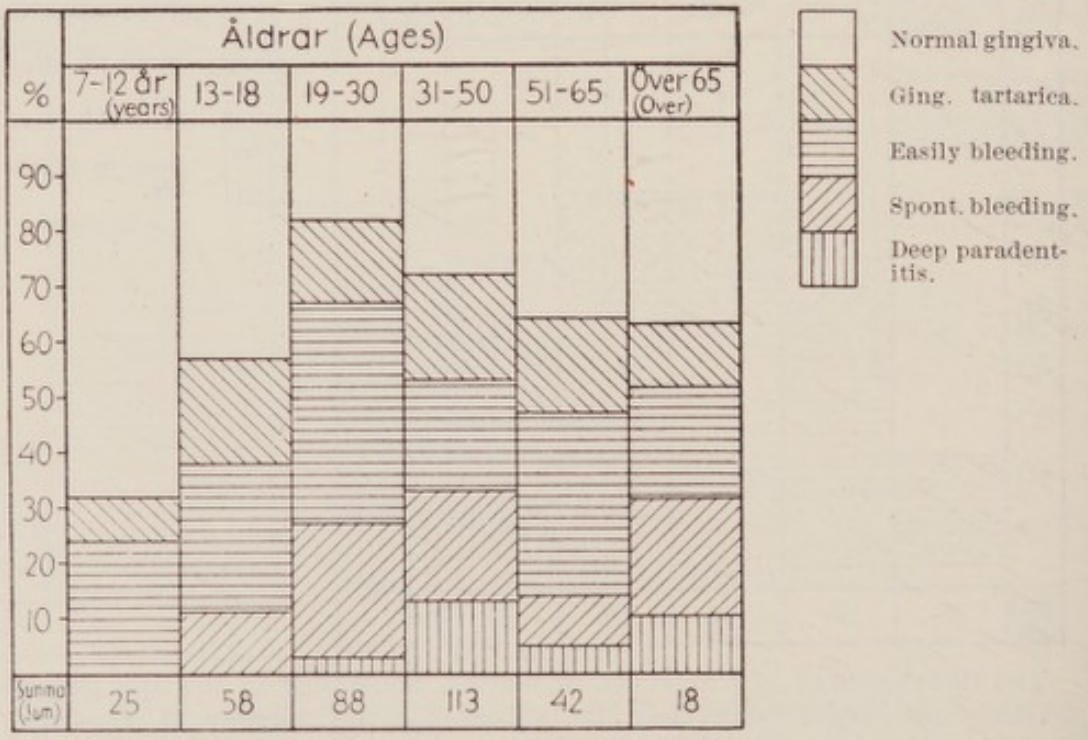
Gingiva	Ages											
	7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	25	76	34	40	57	29	59	28	25	40	10	48
Ging. tartarica	2	6	15	18	28	14	31	15	11	17	2	10
Easily bleeding	6	18	21	25	70	36	59	28	14	22	4	18
Spont. bleeding			11	13	35	18	36	16	7	11	3	14
Deep paradentitis			3	4	6	3	28	13	6	10	2	10
Total	33	100	84	100	196	100	213	100	63	100	21	100
Excluded observations	—		—		1		—		—		1	



The development of gingivitis in women according to the age groups deviates somewhat from that of the male types insofar as the ages between 19 and 50, corresponding, that is to say, to the woman's main period of fertility, show a conspicuous maximum of frequency in respect of all forms of inflammation. As in the development of the colour of the teeth, a weighty causal factor in this connection is to be found in the state of pregnancy, involving as it does readjustment of the metabolism and heavy demands upon the female organism.

Table 26. *Local medical examinations 1929.*
Norrland (Umeå and its environs excluded). Women.

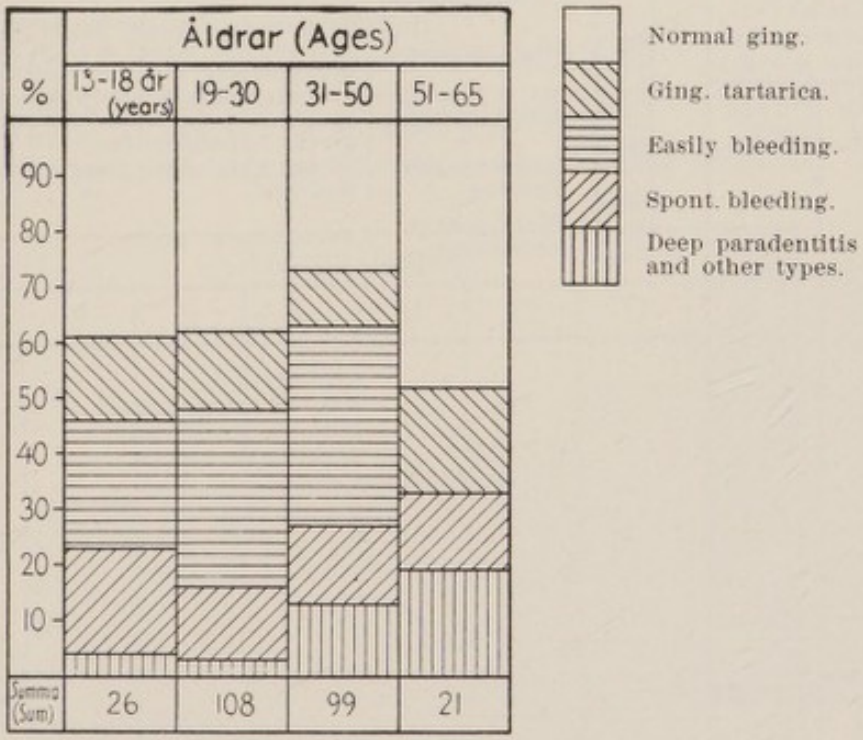
Gingiva	Ages											
	7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	17		24	41	16	18	32	28	15	36	7	
Ging. tartarica	2		11	19	13	15	21	19	7	17	2	
Easily bleeding	6		17	29	35	40	22	19	14	33	4	
Spont. bleeding	—		6	11	21	24	22	19	4	9	3	
Deep paradentitis	—		—	—	3	3	16	15	2	5	2	
Total	25		58	100	88	100	113	100	42	100	18	
Excluded observations	—		—		—		—		—		1	



In Norrland, except the Umeå district, gingivitis develops most strongly in the women at the ages of 19—30.

Table. 27. *Local medical examinations 1929. Umeå and its environs. Women.*

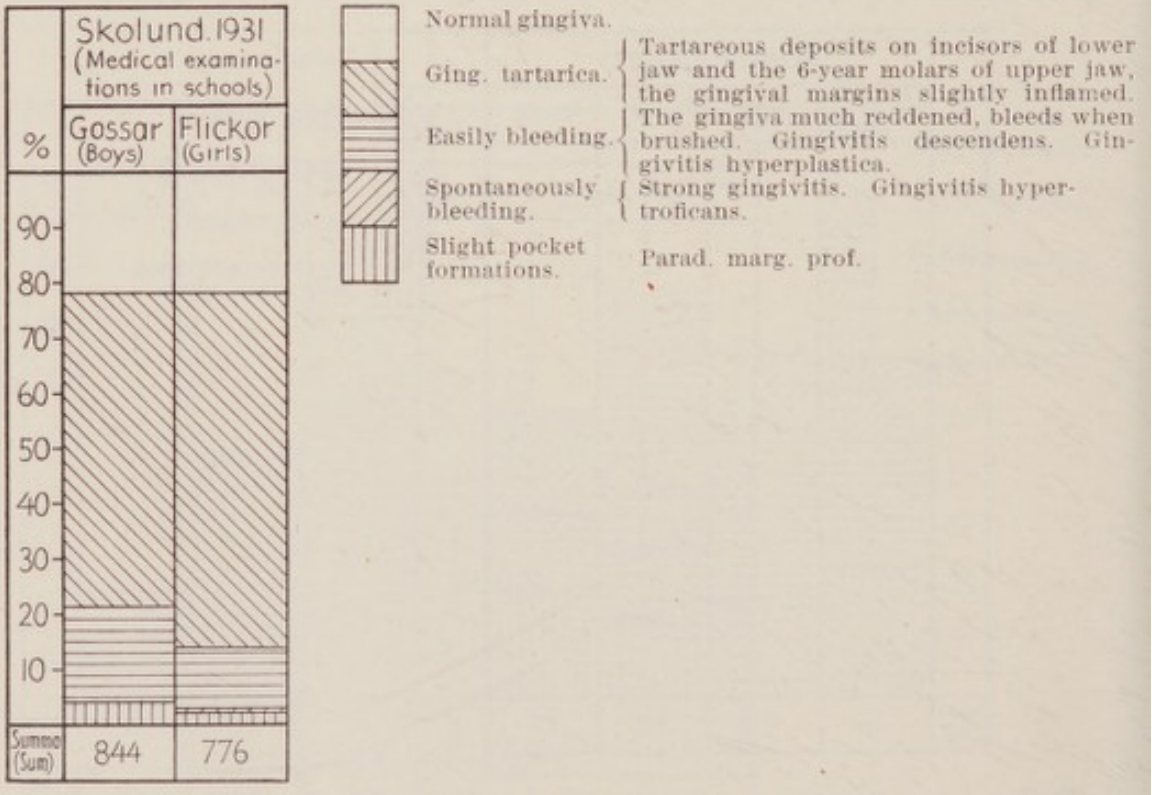
Gingiva	Ages											
	7—12		13—18		19—30		31—50		51—65		Over 65	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	8		10		41	38	27	27	10		3	
Ging. tartarica	—		4		15	14	10	10	4		—	
Easily bleeding	—		6		35	32	35	35			—	
Spont. bleeding	—		5		14	13	14	14	3		—	
Deep paradentitis	—		1		3	3	14	14	4		—	
Total	8		26		108	100	100	100	21		3	
Excluded observations	—		—		1		—		—		—	



Within the Umeå area, which is dominated by the town of Umeå, gingivitis in women reaches its maximum at a somewhat higher age than it does in the rest of Norrland, owing presumably to the higher age at which people marry and consequently the frequently later age at which pregnancy commences in the town and the urban communities. Cf. the preceding table. There seems to be no difference in respect of gingivitis amongst men from Umeå and those in the rest of Norrland such as is shown to exist amongst the women.

Table 28. *School medical examinations 1931.*

Gingiva	Boys		Girls	
	Abs. figs.	%	Abs. figs.	%
Normal gingiva	183	23	173	23
Ging. tartarica	484	60	483	64
Easily bleeding	127	16	88	12
Spont. bleeding	2		1	
Slight pocket formations	13	1	13	1
Total	809	100	758	100
Excluded observations	3		1	



The school medical examinations of 1931, in which the investigation of the gingival changes was very strictly carried out, has demonstrated the presence of such changes in close on 80 % of the children. Somewhat severer forms of gingivitis, viz. those in which brushing gives rise to bleeding, have been recorded amongst the boys in 17 % of the cases, whereas amongst the girls the figure does not go beyond 13 %.

Table 29. *School medical examinations 1931. Boys.*

Gingiva	Ages															
	7		8		9		10		11		12		13		14	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	52	55	37	30	12	12	6	7	36	25	31	20	8	9		
Ging. tartarica	34	37	74	60	68	70	62	72	84	58	92	60	52	61	16	
Easily bleeding	7	8	12	10	16	17	18	21	21	14	28	18	18	21	6	
Spont. bleeding													2	2		
Slight pocket-formations					1	1			4	3	2	2	6	7		
Total	93	100	123	100	97	100	86	100	145	100	153	100	86	100	22	
Excluded observations	—		—		—		—		1		1		1		—	

In addition have been excluded:
1 observation at the age of 6 with normal ging.
1 observation at the age of 6 with ging. tart.
1 observation at the age of 15 with ging. tart.
1 observation at the age of 16 with easily bleeding gingiva.

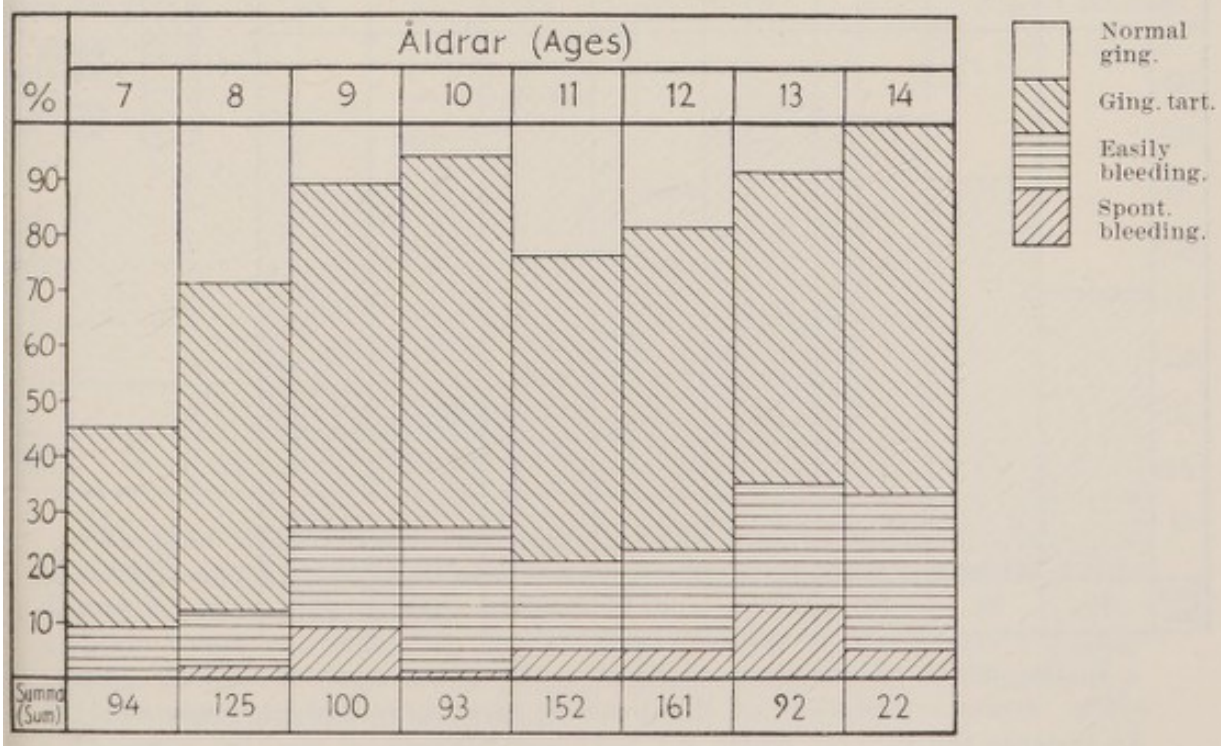
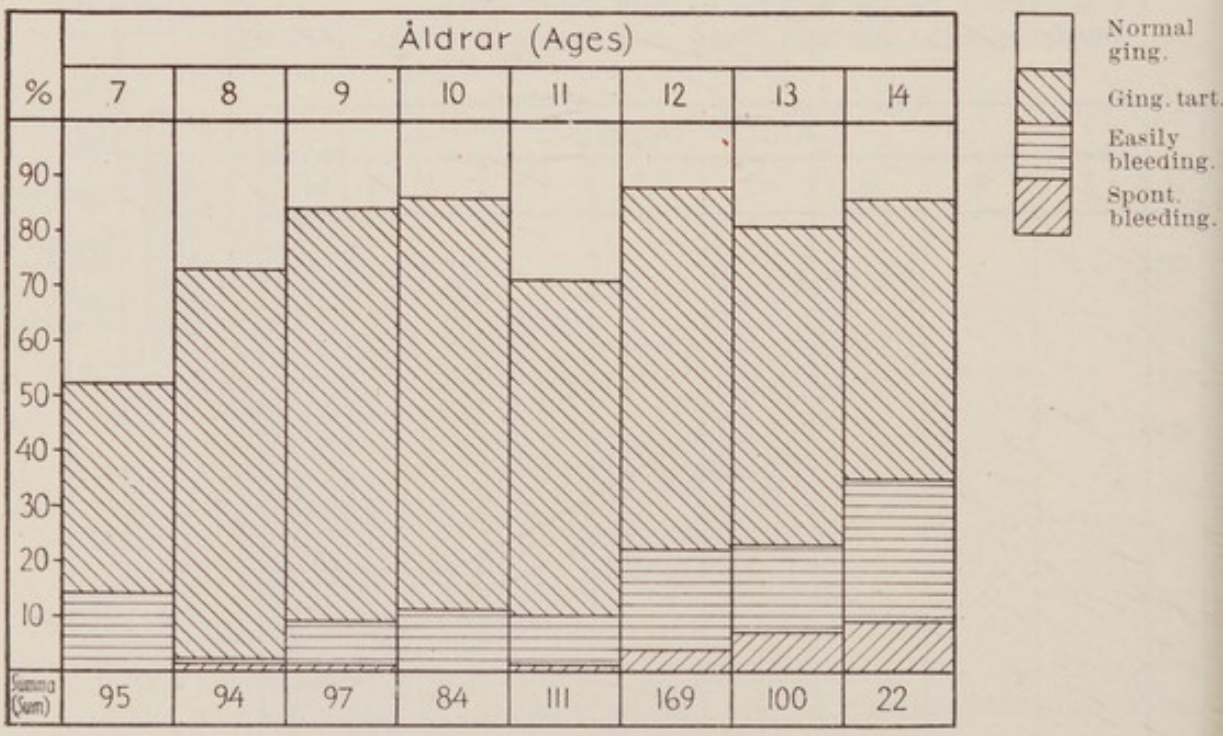


Table 30. *School medical examinations 1931. Girls.*

Gingiva	Ages															
	7		8		9		10		11		12		13		14	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	47	49	27	29	15	16	12	14	31	28	19	12	19	20	3	
Ging. tartarica	36	38	65	69	71	75	62	74	68	61	114	71	56	59	8	
Easily bleeding	13	13	1	1	8	8	9	11	10	9	22	14	16	17	8	
Spont. bleeding			1	1												
Slight pocket-formation					1	1	1	1	2	2	5	3	4	4		
Total	96	100	94	100	95	100	84	100	111	100	160	100	95	100	19	
Excluded observations											1					

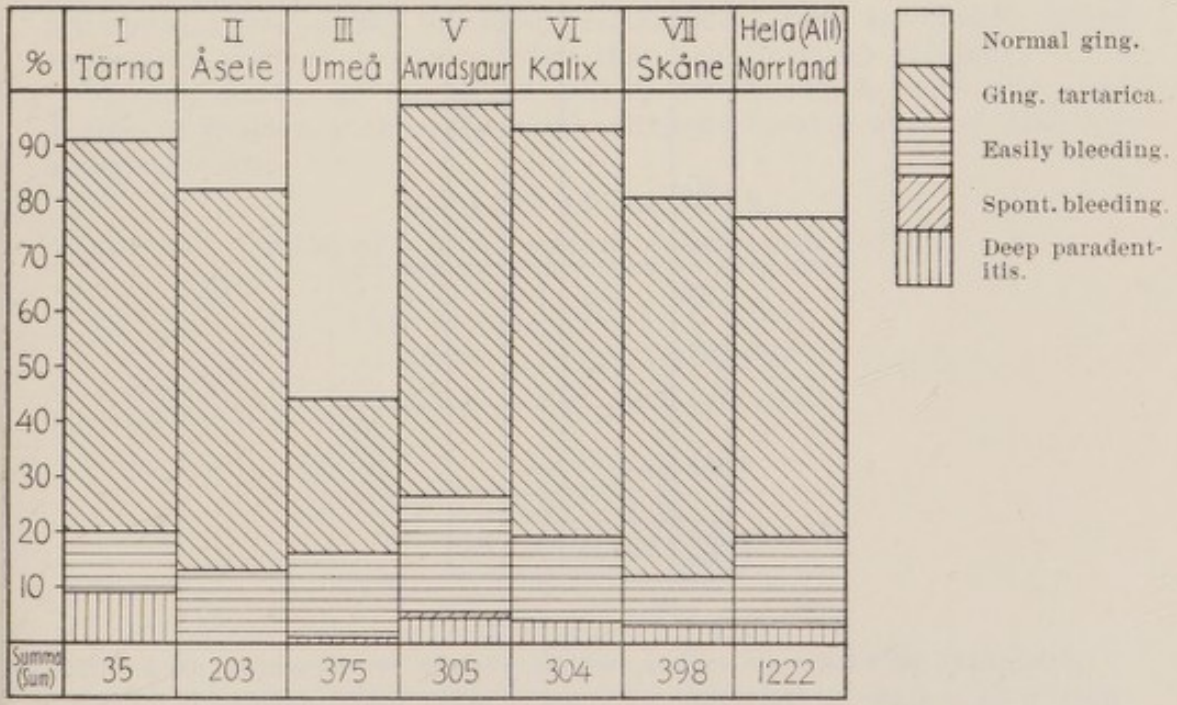
In addition have been excluded:
2 observations at the age of 15 with ging. tart.
1 observation at the age of 16 with ging. tart.
1 observation at the age of 16 with easily bleeding ging.



In the school children the changes in the gums increase as they grow older. Some retardation of the process is observed at the age of 11. As regards the severer forms the boys are throughout slightly worse off than the girls. It is noteworthy that gingival changes accompanied by a deepening of the gingival pockets were already observable at the age of 9—10. One further notices the intermittent rise in frequency caused by the change at the age of 11.

Table 31. *School medical examinations 1931. Boys and girls.*

Gingiva	I Tärna		II Åsele		III Umeå		V Arvidsjaur		VI Kalix		Hela Norrland		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal gingiva	3	10	37	19	210	57	8	3	20	7	278	24	78	20
Ging. tartarica	25	83	137	69	100	27	214	73	220	79	696	60	271	68
Easily bleeding	2	7	23	12	57	15	62	21	35	13	179	15	36	9
Spont. bleeding					1	0	2	0			3	0		
Deep paradentitis			1	0	3	1	8	3	2	1	14	1	12	3
Total	30	100	198	100	371	100	294	100	277	100	1,170	100	397	100
Excluded observations					2		2				4			



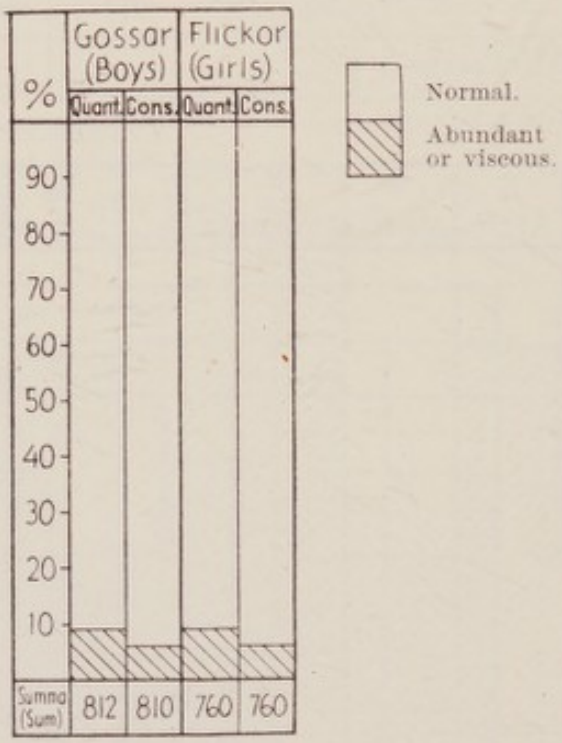
We note the frequent occurrence of the severer forms of gingivitis amongst school children in one or two of the Lapp districts investigated. Distinct forms of gingivitis arise in Tärna and Arvidsjaur in approximately every 5th child. In the country districts of Skåne the children appear to be less disposed to palpable gingival inflammation than those in the country areas of Norrland.

9. Saliva (Quantity and Consistency).

Table 32. *School medical examinations 1931.*

Saliva	Boys				Girls			
	Quantity		Consistency		Quantity		Consistency	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal	735	91	763	94	694	91	711	94
Abundant or viscous	77	9	49	6	65	9	48	6
Total	812	100	812	100	759	100	759	100

All observations included.



Abundant secretion of saliva, which should be regarded as a consequence of a state of irritation of a nervous or other nature, is found in 9 % of the school children, the frequency in boys and girls being the same. Saliva of a viscous and mucous character, which is believed to be due to excessive irritation of the glandular elements controlled by the sympaticus, could be demonstrated in 6 % of the school children investigated, the relative distribution as between the two sexes being equal.

Table 33. *School medical examinations 1931.*

Saliva	I Tärna				II Åsele				III Umeå				V Arvidsjaur				VI Kalix				All Norrland				VII Skåne			
	Quantity		Consistency		Quantity		Consistency		Quantity		Consistency		Quantity		Consistency		Quantity		Consistency		Quantity		Consistency		Quantity		Consistency	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Normal	30	100	30	100	184	93	187	94	345	92	338	91	274	93	276	93	215	78	250	90	1,048	89	1,081	92	381	96	393	99
Abundant or viscous					14	7	11	6	28	8	35	9	22	7	20	7	62	22	27	10	126	11	93	8	16	4	4	1
Total	30	100	30	100	198	100	198	100	373	100	373	100	296	100	296	100	277	100	277	100	1,174	100	1,174	100	397	100	397	100

All observations included.

Normal secretion of saliva is characteristic of all the children investigated in Tärna. This is in sharp contrast to Kalix, where hyper-secretion occurs in over 20 %. It is noteworthy that these places are poles apart as regards frequency of caries, the minimum being represented by Tärna and the maximum by Kalix. The Skåne children, who are likewise less subject to caries, are decidedly more favourably placed as regards salivary hyper-secretion than the Norrland children.

Viscous matter in the saliva occurs on the whole with the same degree of frequency throughout the different local groups as does the hyper-secretion.

10. Care of the teeth.

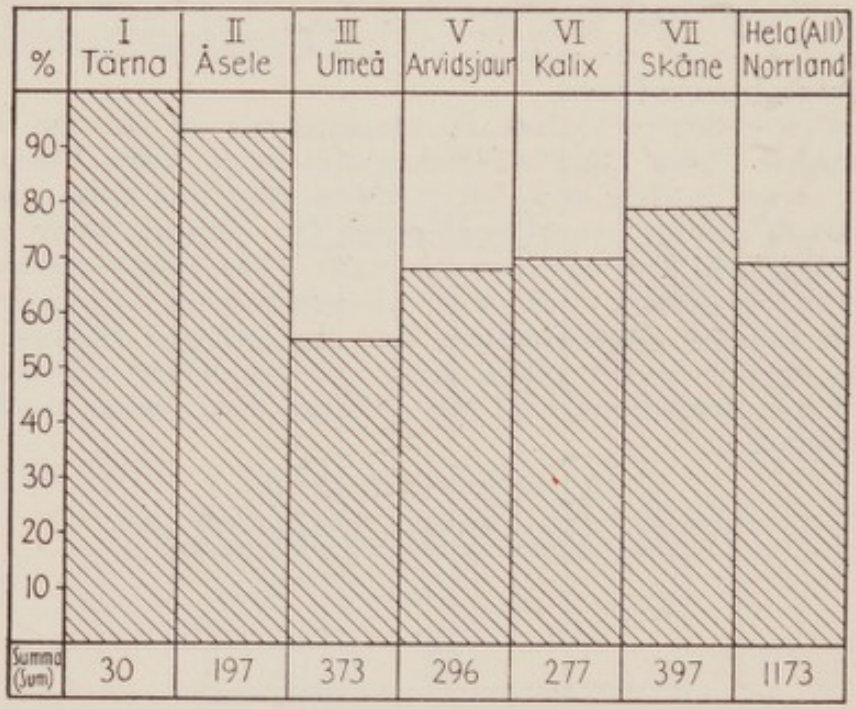
Table 34. *School medical examinations 1931.*

Care of the teeth	Boys		Girls	
	Abs. figs.	%	Abs. figs.	%
Good	167	21	275	36
Bad	644	79	484	64
Total	811	100	759	100
Excluded observations	1			

Somewhat under 30 % of all school children examined made a regular practice of cleaning their teeth. Whereas only 20 % of the boys brushed their teeth daily, close on 40 % of the girls did so. Seeing that in certain cases undoubtedly far too favourable data have been supplied regarding the daily brushing of the teeth, the results obtained must certainly be regarded as somewhat optimistic.

Table 35. *School medical examinations 1931.*

Care of the teeth	I Tärna		II Åsele		III Umeå		V Arvids-jaur		VI Kalix		All Norr-land		VII Skåne	
	Abs. figs.	%	Abs. figs.	%	Abs. figs	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Good			14	7	168	45	96	32	82	30	360	31	82	21
Bad	30	100	183	93	205	55	200	68	195	70	813	69	315	79
Total	30	100	197	100	373	100	296	100	277	100	1,173	100	397	100
Excluded observations			1								1			



Good. Teeth cleaned at least once a day.

Bad. No or irregular brushing.

Care of the teeth in the form of brushing them daily varies considerably in the different districts investigated. Thus, while in Tärna the toothbrush is quite unknown and in Åsele very nearly unknown in practice, in Arvidsjaur and Kalix about 30 % of the children brush their teeth daily. In Umeå the percentage rises to close on 50 % of all the children. It is worth noting that in Skåne only about one child in 5 made a daily use of the toothbrush, a figure that brings that province in this instance below the 30 % average for the whole of Norrland.

C. Studies based on the correlation method.

1. Some observations on the formation of the jawbone and development of the denture.

Having in the preceding pages given an account of the collected material, classified under the separate headings in the dental recording form, we propose in the following section to show in summary form the conditions applying to the various details, the intention being to endeavour to throw some light on the possible causal connections. In doing so we shall aim, as far as the material permits, at obtaining some explanation not only of such features as may be of interest with a view to intervention along the lines of social hygiene, but also of those features that are physiologically related as regards the conditions of the dental organ and the oral cavity, the idea being to endeavour to bring them into relation with the general state of health of the body and of its constitution.

It is quite true that, in the process of formation during the period of growth, the cavity of the mouth is in principle subject to the same laws as govern the rest of the organism. The process undergoes some modification, however, owing to the advent of a new factor, namely the teeth and the circumstances attending their eruption. The dental organ, which in its general character and, inter alia, as regards the size of the individual teeth has undergone, so to speak, a process of preformation at an early stage of the organic evolution, constitutes a factor that under certain circumstances may easily come into conflict with the maxillary parts, which are subject to the general laws of growth governing the skeletal parts of the body and which are influenced by disturbances arising therein.

It is in the lack of congruence between the early preformed dental organ and the circumstances attending its eruption on the one hand and, on the other, the formation of the jaws as functions of the growth of the skeleton that we have to seek the cause of the numerous anomalies in the position of the teeth. These known and intrinsic factors are demonstrated numerically in the available material by effecting a combination between the size of the tooth, the shape of the palatal arch and the enamel hypoplasia on the one hand and the position of the tooth on the other.

It will be seen from a study of the tables that the normal palatal arch largely goes with normally placed teeth. According to the medical examination in schools in 1931 (Table 36), in 70 % of all cases of children with a normal palatal arch the position of the teeth was normal. The more serious form of crowded teeth, which consists of protrusion and the consequent slanting position taken by the incisors of the upper jaw, occurs in only about one in ten of all children shown to have a normal palatal arch.

The high palatal arch is not invariably to be regarded as a pathological phenomenon, seeing that in such cases the configuration of the facial skeleton may on account of racial conditions be a factor to be considered. It is generally found that in typical dolichocephalic cases the shape of the palatal arch differs from that of markedly brachycephalic skulls — a fact that should not of course be left entirely out of account when we are concerned with the relation between different parts even of a country like Sweden, with its considerable racial homogeneity. But even subject to this reservation, a substantial measure of reliability may perhaps be attached to the expressions of quantity obtained. In the high palatal arch the divergence from the normal type is quite pronounced for the reason that in such cases the position of the teeth of nearly half of the individuals examined proved to be irregular, one-fifth of the total exhibiting the more serious opisthognathous form.

It is of interest, as throwing light on the question before us, to be able to observe how frequently a narrowly compressed palatal arch, as also a protruding upper jaw (prognathism), occurs in the masticatory organ in the Norrland area investigated as compared with Skåne, the population of which is better off in that respect owing to racial conditions as well as, probably, to physiological factors of a dietary and other nature.

We may regard as a definitely pathological factor that form of high palatal arch which occurs in combination with a compression of the premolar section of the upper jaw, for we are here confronted with a retardation of the process of skeletal calcification during the period of growth. This type of deformation is accompanied in more than two-thirds of the total number of cases by a divergence from normal in the position of the teeth. In more than a third of the examined children who had a V-shaped upper jaw the anomaly of the position of the teeth goes to the

extreme of the above-mentioned opisthognathous formation of the front-teeth section.

It is worth pointing out that bimaxillary narrowness, which is likewise observed in a preponderating degree in the Norrland material, is generally present, as in the case of prognathism, when the size, and especially the breadth, of the teeth exceeds a value that harmonizes with the rest of the face — a circumstance that stresses the conflict which arises if amongst a dolichocephalic population broader teeth are inherited as a result of an invasion of brachycephalic races (e. g. Lapp and Finnish elements).

The pathological nature of these anomalies in their relation to the development of the jawbones, attributed to alimental physiological disturbances of the metabolism, finds some confirmation if we work out a table combining the position of the teeth with the presence of hypoplasiae in the enamel. Since the conception of the enamel hypoplasiae as an expression for disturbances in the calcification of the teeth does not appear to be open to any objections, it is interesting to be able to establish statistically the following facts (Tables 37 and 38).

The tables demonstrate with adequate clearness that in those cases in which manifest defects in the dental enamel of a hypoplastic nature have appeared there have at the same time been found irregularities in the position of the teeth of a more pronounced type and to a far greater extent than in individuals

Table 36. *School medical examinations 1931.*

Palatal arch	Position of the teeth						Total	
	Regular		Bimaxillary crowding		Opisthognathous			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%		
Normal	1,016	70	312	21	132	9	1,460	100
High	37	52	20	28	14	20	71	100
Narrow, with the premolar section pressed inwards	11	31	12	34·5	12	34·5	35	100
Total	1,064	68	344	22	158	10	1,566	100

5 observations excluded.

Table 37. *School medical examinations 1931.*

Hypoplasiae of the enamel	Position of the teeth						Total
	Regular		Bimaxillary crowding		Opisthognathous		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
None	1,009	68	329	23	143	9	1,481 100
Holes and grooves	55	66	15	17	15	17	85 100
Total	1,064	68	344	22	158	10	1,566 100

5 observations excluded.

Table 38. *Local medical examinations 1929.*

Hypoplasiae of the enamel	Position of the teeth				Total
	Regular		Irregular		
	Abs. figs.	%	Abs. figs.	%	
None	551	81	129	19	680 100
Holes and grooves	35	73	13	27	48 100
Total	586	80	142	20	728 100

466 observations excluded.

who were normal in that respect. Thus, whereas no less than 17 % of children with hypoplasiae show irregularity in the position of the teeth of an opisthognathous character, among children whose teeth are free from defect this occurs in only 9 % — a fact that must be considered to confirm the author's conception of the anomalies in the position of the teeth as being essentially caused by metabolic disturbances and the effects of their reaction on the body's conditions of growth.

If we compare the different records, viz. the results of the local and of the school medical examinations of 1929, which, as mentioned above, were carried out along lines differing somewhat

from the medical examination in schools in 1931, we find that the former shows less marked divergences from the normal. But these figures are also of a nature to throw into strong relief the high frequency of anomalies in the position of the teeth amongst the younger members of the population in this country and to lay emphasis on the desirability of providing ample room for orthodontic treatment in the programme devoted to the health of the oral cavity.

2. Correlation studies of caries.

The destruction of the masticatory organ within the sphere of our present-day civilization is taking place, generally speaking, in two ways. The tooth is either destroyed by carious attacks or else it is lost as a result of processes in the apparatus by which it is attached to the jaw. In a previous section of the report on the »Norrland Investigation» (Part III, sect. 3) the occurrence and frequency of caries in the investigated area have already been discussed. In this connection, therefore, I shall deal with these conditions only insofar as they are of importance to my immediate task, that of illustrating the frequency of caries in its relation to certain exogenous and endogenous factors that may conceivably influence the emergence and development of the diseased picture.

The bearing of materia alba and tartar on the development of caries.

In the research into caries special stress has been laid hitherto upon etiological factors belonging to the first-mentioned group. For instance, much significance has been attached to the presence of deposits on the teeth of a more or less substantial character, while simple hygiene in the form of cleaning the teeth by brushing them and rinsing the mouth has been considered extremely useful as therapeutical and prophylactic aids. It may be claimed that on this point the Norrland investigation has, thanks to the results obtained, put the facts in their true perspective insofar that certain ideas which had hitherto gained currency are being abandoned, while others, to which less attention has been paid in the past, are now being brought into the foreground.

The relation between caries in its different degrees of severity and the deposit on the teeth will be gathered from the appended tables showing, on the one hand, the presence of materia alba, i. e. the common whitish-yellow coating of soft substance on the teeth, concentrated especially around the neck portions of the teeth, and on the other hand the formation of tartar in the same regions.

As to the soft substance (Table 39), the figures seem to indicate that an increase in the frequency of caries and the development of the severe types of caries are accompanied by consistently increasing accumulations of materia alba. Thus, while in the case of dentures that are immune from caries the coarser forms of deposit occur in only about 7 % of the children, the corresponding figure for the more serious forms of caries, in which the necks of the teeth are attacked, amounts to no less than 30 %. Without in the present case inferring a direct causal connection, which of course is not improbable, seeing that in these deposits there undoubtedly occur fermenting processes accompanied by acid products, which attack the enamel, this co-variation indicates the possibility that caries and the abundant presence of materia alba have a common cause, which in that case we should have to seek in some underlying disturbance of the metabolism.

There exists a connection between the presence of materia alba and tartar insofar that the more severe cases of materia alba at the same time exhibit a greater frequency of tartaric deposits. Again, as regards these latter, the appearance of which in conjunction with carious processes will be seen from Table 40, here too the figures indicate that, as the caries becomes intensified, there is some increase in the frequency of tartar. It is worth noting, however, that the parallelism we find here is far less marked than in regard to the soft deposits — a fact that fits the theory that in the harder and more calcareous deposits the fermenting processes are less active, and consequently the injurious effect upon the enamel is slighter.

Brushing the teeth.

The most common act of oral hygiene — the regular cleansing of the teeth by means of brushing — for which so much propaganda has been made hitherto as being the principal means of protecting the teeth from caries, is intended to get rid of remains

of food left in the dental organ and to remove injurious deposits. However, that the brushing of the teeth, as to the importance of which as a simple hygienic function — just like the cleaning of any other part of the body — there can be no difference of opinion, is capable of contributing towards the prevention of the emergence and growth of caries is not indicated by the results obtained from the Norrland investigation. Tables 41, 42 and 43 show that irregular brushing of the teeth or even no brushing at all is compatible with the existence of perfect rows of teeth or such as have been only very slightly attacked by carious processes, while, contrariwise, where the teeth are regularly looked after there are at least as many cases of severe caries. It is a noteworthy fact that in the more remote forest districts, where caries shows a low frequency, the toothbrush is rarely in use. For instance, of the school-children in the Tärna district, which is practically immune from caries, there is not one that makes a practice of brushing the teeth. We must however stress in this connection the unreliability of the data relating to the care of the teeth, these data being probably in many cases far too subjective.

The state of affairs described above should not of course lead us to jump to hasty conclusions as to the importance of regularly cleaning the teeth from the point of view of general hygiene, and in reference to what has been previously observed we may once more mention the importance, from the standpoint of the prophylaxis of dental caries, of removing abundant deposits of materia alba. A study of teeth-brushing and materia alba after the correlation method indicates, moreover, the existence of a quite distinct co-variation between them, whereas the frequency of tartar is apparently but slightly influenced by the personal care of the teeth. (The tables illustrating this point, Nos 70, 71, 72, 73 are given on subsequent pages.) At the same time, however, it may be pointed out that the diseases of caries certainly cannot be suppressed by such simple means as the regular brushing of the teeth.

Caries and abrasion.

The most natural way of cleaning the mouth and the teeth, and the only form of oral hygiene that has been commonly practised by uncivilized races, which have largely got rid of the disease of caries, is an intensive chewing of the food, this being accom-

panied step by step by the wearing down or abrasion of the masticatory surfaces of the teeth. The idea of abrasion as a factor that prevents caries has indeed been propounded in various quarters, and it certainly does sound quite plausible that as a result of energetically cleaning out fissures and other parts disposed to caries it is possible, by mechanical means and thanks to an abundant supply of saliva, to prevent caries. Moreover, the statistical data from our investigations (Table 44, which relates to the school medical examinations of 1931) prove that enhanced detrition of the teeth is accompanied by a decrease in the frequency of gingival caries. (The detrition referred to here is that of the milk-teeth.) On the other hand, among the older individuals examined, people over 30 years of age (only one-third as many as in Table 44), there is a distinct antithesis between the two factors. That a purely mechanical process of detrition and cleansing does play some part as a contributory cause of reduced frequency of caries in cases of abrasion is likely, but it should also be emphasized that in individuals whose teeth are subject to severe detrition the natural predisposition to caries owing to constitutional and other reasons may already be less inclined to manifest itself. It seems that the clear cases of abrasion are often found to occur in well-developed and muscular individuals possessing a sound physical construction and accordingly a masticatory organ showing a development above the average, as is

Table 39. *School medical examinations 1931.*

Caries index	Materia alba (frequency)						Total	
	None		Moderate		Abundant			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Immunity from caries	40	73	11	20	4	7	55	100
Fissural caries	524	55	326	34	107	11	957	100
Proximal caries	148	40	154	41	69	19	371	100
Gingival caries	57	30	74	40	57	30	188	100
Total	769	49	565	36	237	15	1,571	100

Correlation coefficient = **0.251** ± **0.023**.

All observations included.

Table 40. *School medical examinations 1931.*

Caries index	Tartar (frequency)						Total	
	None		Moderate		Abundant			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	25	45	24	44	6	11	55	100
Fissural caries	271	28	605	64	80	8	956	100
Proximal caries	68	18	254	69	49	13	371	100
Gingival caries	34	18	123	65	31	17	188	100
Total	398	25	1,006	64	166	11	1,570	100

Correlation coefficient = **0.145 ± 0.025.**

1 observation excluded.

Table 41. *Local medical examinations 1929.*

Caries index	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
Immunity from caries			5	100	5	100
Fissural caries	23	28	58	72	81	100
Proximal caries	32	27	85	73	117	100
Gingival caries	27	27	74	73	101	100
Total	82	27	222	73	304	100

Correlation coefficient = **— 0.013 ± 0.057.**

890 observations excluded.

revealed in the present investigation by the fact, inter alia, that in such people's teeth there is a predominance of yellow colour, accompanied by a greater capacity in the enamel and the dentin for resisting caries.

Table 42. *School medical examinations 1929.*

Caries index	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	10	21	38	79	48	100
Fissural caries	79	28	200	72	279	100
Proximal caries	27	39	43	61	70	100
Gingival caries	11	39	17	61	28	100
Total	127	30	298	70	425	100

Correlation coefficient $= -0.106 \pm 0.048$.

1,202 observations excluded.

Table 43. *School medical examinations 1931.*

Caries index	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	18	33	37	67	55	100
Fissural caries	272	28	685	72	957	100
Proximal caries	105	28	266	72	371	100
Gingival caries	47	25	140	75	187	100
Total	442	28	1,128	72	1,570	100

Correlation coefficient $= 0.032 \pm 0.025$.

Correlation summary for both the school medical examinations correlation coefficient $= 0$.

1 observation excluded.

Caries and diet.

One of the main features in the results of our investigation is the predominant influence which the constitutional factor and the

Table 44. *School medical examinations 1931.*

Caries index	Abrasion						Total
	None or slight		In the enamel		In the dentin		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	35	64	8	14	12	22	55 100
Fissural caries	686	71	207	22	64	7	957 100
Proximal caries	234	63	132	36	5	1	371 100
Gingival caries	153	81	34	18	1	1	188 100
Total	1,108	71	381	24	82	5	1,571 100

All observations included.

Table 45. *Local medical examinations 1929.*
Type of diet irrespective of vitamin content.

Caries index	Diet						Total
	Mixed diet		Lacto-cereal diet		Abundant meat diet		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	22	9	16	10	16	13	54
Fissural caries	55	24	45	28	53	43	153
Proximal caries	80	35	51	31	34	27	165
Gingival caries	73	32	51	31	21	17	145
Total	230	100	163	100	124	100	517

677 observations excluded.

state of health have on the development of caries as compared with the exogenous causal factors.

Among the latter we may include, from certain points of view, food and its suitable composition, which has in recent years been emphatically declared in several quarters both abroad and in

this country to be a primary factor governing the development of caries. These attempts at finding an explanation have appeared to be all the more gratifying seeing that they may be directly associated with the hitherto generally accepted theory as to the origin of caries — the Miller-Black theory. This, it will be remembered, regards the fermenting carbo-hydrates and the resultant lactic acid as the fundamental causes of dental caries, which thus arises, so to speak, as an immediate consequence of food that is rich in carbo-hydrates. As has already been pointed out in our introduction, in the Norrland investigation exhaustive inquiries were carried out into dietary conditions. It has been possible to draw up a comparison between these dietary data — including information about carbo-hydrates and the consumption of meat as well as the supply of, chiefly, vitamin C — and the caries groups.

The earlier views as to the injury caused to the teeth by a diet rich in carbo-hydrates (Tables 45, 46, 47) are not been contradicted. However, it may be possible to deduce from the local medical examinations (Table 45) some tendency to greater immunity from caries in the case of an abundant meat diet. It would certainly be rash, however, to draw from this not very marked agreement any definite conclusion as to the value of the meat diet as a prophylaxis of caries, since there is a possibility that this complex of causes is partly accounted for by other factors.

A similar attitude may be adopted in regard to the content of vitamin C in the food (Tables 48, 49). The school medical examinations have produced statistics that more or less distinctly show that the two factors arise independently of one another, and the results of the hospital and local medical examinations, which concern Norrland only, even show that the caries picture is in direct contrast to the standard of vitamins. More favourable carious conditions are accompanied by lower vitamin content in the diet, and the adverse types of caries are grouped far more numerously around cases showing a more abundant supply of vitamins.

Caries and Hess's Tests.

The lack of association between dental caries and the supply of vitamin C is still further emphasized if we study the correlation tables relating to the first-mentioned disease and the so-called Hess's Tests, which offer a method of gauging the fragility of

Table 46. *School medical examinations 1929.*
Type of diet irrespective of vitamin content.

Caries index	Diet						Total
	Mixed diet		Lacto-cereal diet		Abundant meat diet		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	69	22	81	14	3		153
Fissural caries	191	61	378	67	12		581
Proximal caries	28	9	81	14			109
Gingival caries	26	8	27	5			53
Total	314	100	567	100	15		896

Table 47. *School medical examinations 1931.*
Type of diet irrespective of vitamin content.

Caries index	Diet				Total
	Mixed diet		Lacto-cereal diet		
	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	11	3	9	3	20
Fissural caries	237	58	163	60	400
Proximal caries	105	26	56	20	161
Gingival caries	53	13	46	17	99
Total	406	60	274	40	680

vessels, and are also said to be capable of determining the standard of vitamins in individuals. The cases are divided up into three tables according to the strength and duration of the pres-

Table 48. *Local medical examinations 1929.*
The diet grouped acc. to the vitamin content.

Caries index	Diet (Vitamin content)				Total
	a[1]		b[1]		
	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	54	12			54
Fissural caries	146	31	3	8	149
Proximal caries	141	30	17	45	158
Gingival caries	123	27	18	47	141
Total	464	100	38	100	502

Table 49. *School medical examinations 1931.*

Caries index	Diet (Vitamin content)						Total
	a[1]		b[1]		c[1]		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	2	2	3	6	2	17	7
Fissural caries	55	53	19	37	5	41	79
Proximal caries	27	26	19	36	3	25	49
Gingival caries	19	19	11	21	2	17	32
Total	103	100	52	100	12	100	167

sure used in the experiments. No common variation between the fragility of the vessels and caries is deducible from any of the tables.

[1] a, b and c denote different degrees of supply of vitamin C; a representing the lowest (poor in C).

Table 50. *School medical examinations 1931.*

70 mm Hg. / 3 min.

Caries index	Hess's numbers (No. of punctiform bleedings)						No. observations
	0		1—3		Over 3 [1]		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Immunity from caries	31	4	11	5	2	4	44
Fissural caries	543	62	129	63	30	57	702
Proximal caries	212	24	43	21	19	35	274
Gingival caries	96	10	23	11	2	4	121
Total	882	100	206	100	53	100	1,141

Table 51. *School medical examinations 1931.*

80 mm Hg. / 3 min.

Caries index	Hess's numbers (No. of punctiform bleedings)			No. observations
	0	1	7	
Fissural caries	13	2		15
Proximal caries	11	2	2	15
Gingival caries	1	1		2
Total	25	5	2	32

The general alimental condition and caries.

The somewhat unilluminating picture offered by the figures illustrating dietary conditions in their relation to caries is in part repeated when we come to discuss the connection with the general alimental condition. There is in the very concept »alimental condition», in the case of young people, subject as they are

[1] Maximum 17 bleedings.

Table 52 *School medical examinations 1931.*

50 mm Hg. / 15 min.

Caries index	Hess's numbers (No. of punctiform bleedings)						No. of observations
	0		1—3		Over 3 [1]		
	Abs. figs.	%	Abs. figs.	%	Abs figs.	%	
Immunity from caries	6	5					6
Fissural caries	78	65	23	53	7		108
Proximal caries	29	24	13	30	2		44
Gingival caries	7	6	7	17			14
Total	120	100	43	100	9		172

Table 53. *School medical examinations 1929.*

Caries index	General alimental condition						Total
	Good		Ordinary		Bad		
	Abs. figs.	%	Abs figs.	%	Abs. figs.	%	
Immunity from caries	71	32	119	55	29	13	219 100
Fissural caries	213	25	528	61	118	14	859 100
Proximal caries	84	30	177	63	21	7	282 100
Gingival caries	33	22	103	70	12	8	148 100
Total	401	27	927	61	180	12	1,508 100

119 observations excluded.

to fluctuations in the phase of growth, a certain element of uncertainty that cannot be disregarded when it comes to interpreting the figures in the correlation tables here concerned. It may reasonably be expected that the alimental condition will be

[1] Maximum 17 bleedings.

Table 54. *School medical examinations 1931.*

Caries index	General alimental condition						Total	
	Good		Ordinary		Bad			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	31	72	10	23	2	5	43	100
Fissural caries	514	73	142	20	52	7	708	100
Proximal caries	171	66	65	25	23	9	259	100
Gingival caries	62	53	36	31	18	16	116	100
Total	778	69	253	23	95	8	1,126	100

445 observations excluded.

Table 55. *School medical examinations 1931.*

Caries index	Haemoglobin												Total	
	46—49		50—54		55—59		60—64		65—69		70			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	1	2	8	18	16	37	15	34	4	9			44	100
Fissural caries	7	1	73	10	327	46	269	38	34	5	1	0	711	100
Proximal caries	2	2	29	11	123	46	83	32	21	8	3	1	261	100
Gingival caries	1	1	21	18	69	59	18	16	5	4	2	2	116	100
Total	11	1	131	11	535	47	385	34	64	6	6	1	1,132	100

439 observations excluded.

affected and aggravated if the mouth is in a poor hygienic state which must react on the digestion either direct or through the general state of health. Indeed the school medical examinations of 1931 (Table 54) — unlike those of 1929 (Table 53) — show the existence of a distinct tendency, insofar that the more serious cases of caries occur more frequently in conjunction with a poor alimental condition, just as a sound alimental condition is less often associated with the gingival type of caries.

Tab. 56. *School medical examinations 1931.*

Lacto-cereal diet.

Caries	Haemoglobin	
	Total	Mean value
Immunity from caries	9	57
Fissural caries	174	57
Proximal caries	59	58
Gingival caries	45	56
Total	287	57

Tab. 57. *School medical examinations 1931.*

Mixed diet.

Caries	Haemoglobin	
	Total	Mean value
Immunity from caries	10	59
Fissural caries	231	59
Proximal caries	103	58
Gingival caries	55	57
Total	399	58

Caries and haemoglobin.

Haemoglobin tests have been taken from the bulk of the material (1,132 cases out of 1,521) compiled from the school medical examinations of 1931. The distribution of the material in respect of haemoglobin content and caries is recorded in Table 55.

No palpable connection is found to exist between haemoglobin content and caries, although a slight diminution of the haemoglobin is discernible amongst the gingival-carious cases as compared with the less serious types of caries.

As the haemoglobin values in the material vary somewhat according to the diet (ODIN), advantage has been taken of their being combined with the different types of caries to study them when divided into dietary groups (Tables 56 and 57).

Caries and the colour of the teeth.

There exists a distinct relation between the quality of the tissues of the hard substance, particularly that of the enamel, as revealed in the colours of the teeth, and caries as occurring in our present material, in spite of the fact that the former has been determined by a comparatively rough and subjective method. In particular, the cases that are immune from caries group themselves in a typical manner, that is to say, they diminish in number when the colour tones down from yellow and brown to white. While in the first-mentioned colour group the non-carious dentures are represented to the extent of 24 %, in the latter group they represent only 10 %.

Table 58. *School medical examinations 1931.*

Mixed diet.

Caries	Hypoplasiae of the enamel				Total	
	No defects		Grooves & furrows			
	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	10	91	1	9	11	100
Fissural caries	213	93	16	7	229	100
Proximal caries	96	93	7	7	103	100
Gingival caries	50	93	4	7	54	100
Total	369	93	28	7	397	100

Caries and disturbances in the process of calcification.

As will have been gathered from what has been said above, the Norrland investigation affords no confirmation of the idea that lack of vitamin C contributes to the emergence of caries. A number of well-known research-workers have declared, in recent years especially, that a lack of vitamin D plays a more or less decisive part in the picture of caries. Our material indicates, however, that there has been no connection between caries and those disturbances in the process of calcification of which lack of vitamin D forms one of the causes (see Chap. IV Westin). Disturbances in this process, taking place usually as a consequence of rachitis in a latent or clinically diagnosable form, at the time when the enamel is becoming calcified around most of the teeth, manifest themselves in the permanent teeth as persistent holes or transverse extensive grooves in the tooth's external deposits of hard substance, as jagged incisal edges, and in the enamel prisms assuming atypical forms and directions. Defects of this type are a symptom of past disturbances in the process of lime-fixation. At the same time it is possible by noting their position and distribution to determine the period at which the disturbance started and disappeared.

Table 59. *School medical examinations 1931.*

Lacto-cereal diet.

Caries	Hypoplasiae of the enamel				Total	
	No defects		Grooves & furrows			
	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	9	100	—	—	9	100
Fissural caries	164	94	11	6	175	100
Proximal caries	54	93	4	7	58	100
Gingival caries	44	98	1	2	45	100
Total	271	94	16	6	287	100

Table 60. *School medical examinations 1931.*

Irrespective of form of diet.

Caries	Hypoplasiae of the enamel				Total	
	No defects		Grooves & furrows			
	Abs. figs.	%	Abs. figs.	%		
Immunity from caries	34	97	1	3	35	100
Fissural caries	527	95	26	5	553	100
Proximal caries	200	95	10	5	210	100
Gingival caries	85	96	4	4	89	100
Total	846	95	41	5	887	100

For studying the correlations in respect of hypoplasiae of the enamel I have divided up the cases according to different forms of diet and combined into one group those cases in which no inquiries have been made into the diet. In the three tables

reproduced here (58, 59, 60) the column »No defects» includes also those cases, to the number of 9, 7 and 131, which are denoted in the recording form by the heading »Involutions along the incisal edge». These »involutions» are not to be confused with ordinary rachitic changes in the teeth. Under that heading in the recording form have been grouped together those dentures — interesting mainly from the evolutional point of view — which have normally developed enamel, but in which the cutting edge of the front teeth is slightly undulating, a condition that is regarded as indicating an initial lobular formation of the hard tissues.

Cases of hypoplasia, comprising 6 and 7 % of the lacto-cereal and mixed-diet groups respectively, are equally distributed within the different forms of caries, as Tables 58—59 show. It has also been observed that, if the 131 cases of »involutions along the incisal edge» mentioned above are deducted from the data in Table 60, the figures representing the frequency of the hypoplasiae will tally exactly with those in Table 58, i. e. comprise 7 % of both milder and more severe forms of caries.

It should be noticed, as constituting a noteworthy divergence from the equal dispersion of the rachitic defects, that in the cases of hypoplasia of the enamel in the lacto-cereal type of diet serious pictures of dental decay are less extensively apparent than milder fissural and approximal caries.

Although it thus appears from the results of the investigation that the character of caries is not affected either way by such disturbances in the process of calcification as are observable, inter alia, in persistent hypoplasiae of the enamel, yet this does not imply that rachitic dental changes have no influence on the denture as a whole. Apart from the fact that defective teeth spoil the appearance, we would here lay particular stress on the connection which we have shown above to exist between hypoplasiae of the enamel and anomalies in the position of the teeth. Owing to irregularities in the formation of the denture and the jaws caused by the disturbances in question, there is ample scope for the accumulation of remnants of food and deposits, thus quite conceivably to some extent facilitating indirectly the emergence of caries. But the holes and grooves that do not occur in normal cases contribute directly also towards extending those places that are predisposed to caries until they include even the surfaces that are in action during mastication

Table 60 a. *School medical examinations 1931.*
Summary of tables 58, 59 and 60.

Caries	Hypoplasiae of the enamel				All cases	
	No defects		Grooves & furrows			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%
Immunity from caries	53	96	2	4	55	100
Fissural caries	904	94	53	6	957	100
Proximal caries	350	94	21	6	371	100
Gingival caries	179	95	9	5	188	100
Total	1,486	95	85	5	1,571	100

All observations included.

Table 61. *Local medical examinations 1929.*

Gingiva	Caries index								Total	
	Caries-imm.		Fissural caries		Prox. caries		Gingival caries			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%		
Normal ging.	54	17	89	29	84	27	85	27	312	100
Ging. tart.	9	8	33	28	39	33	36	31	117	100
Easily bleeding	8	4	58	26	87	40	66	30	219	100
Spontaneously bleeding	3	2	33	25	48	37	46	36	130	100
Deep paradentitis	2	3	12	18	26	39	27	40	67	100
Total	76	9	225	27	284	34	260	30	845	100

Correlation coefficient = **0.182 ± 0.033.**

349 observations excluded.

and speaking. This latter fact is still more clearly realized if we combine all the tables relating to the hypoplasiae, for we find that, where these latter appear, dentures that are entirely immune from caries are of somewhat rare occurrence. On the other hand, as far as our material is concerned, the degree of severity of dental decay, that is to say, its tendency to superficial dispersion, to the development of secondary caries, etc., has not proved to be in any way connected with the presence of defects in the enamel. Thus, apart from fully intact dentures, the qualitative frequency types of caries are distributed in a way that is quite independent of rachitic dental changes.

Caries and gingivitis.

The school medical examinations as well as the local medical examinations, which afford still more emphatic evidence in the cases under discussion, stress the fact that between the development of gingivitis and the different types of caries the course followed is not a contrasting but a parallel one. The normal gingiva is most numerously represented in the sets of teeth that are immune from caries or in such as are only suffering from simpler forms of dental decay, whereas the cases of spontaneously bleeding inflammation of the gums, for instance, follow the types of proximal and gingival caries — indicating, that is to say, a basic cause that in certain cases is common to both (Tables 61 and 62).

3. The connection between the gingival changes and other characteristics.

The significance of the deposits on teeth.

The frequency of materia alba, which is in some measure an expression of the oral cavity's capacity for cleansing itself, proves to be frequently accompanied by gingival processes, which is in complete accord with daily clinical experience. Both the medical examinations in schools (Table 64) and the local medical examinations (Table 63) exhibit an evident correlation between the more severe cases of gingivitis and the abundance of the soft deposit on the teeth, whereas the presence of only a slight quantity of materia alba is more often associated with gums that have a healthy margin. Since it is a fact, as we have demonstrated above, that where materia alba is more or less

Table 62. *School medical examinations 1931.*

Gingiva	Caries index								Total
	Caries-imm.		Fissural caries		Prox. caries		Gingival caries		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	25	7	252	71	60	17	19	5	356 100
Ging. tart.	28	3	602	62	233	24	104	11	967 100
Easily bleeding	2	1	86	40	68	32	59	27	215 100
Spontaneously bleeding			2	67			1	33	3 100
Slight pocket formation			13	50	10	38	3	12	26 100
Total	55	3	955	61	371	24	186	12	1,567 100

Correlation coefficient = **0.286** ± **0.023**.

4 observations excluded.

Table 63. *Local medical examinations 1929.*

Gingiva	Materia alba (frequency)						Total
	Little or none		Moderate		Abundant		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	144	52	59	21	73	27	276 100
Ging. tart.	45	37	24	20	53	43	122 100
Easily bleeding	76	26	75	26	139	48	290 100
Spontaneously bleeding	24	15	31	19	106	66	161 100
Deep paradentitis	18	22	23	28	42	50	83 100
Total	307	33	212	23	413	44	932 100

Correlation coefficient = **0.317** ± **0.029**.

262 observations excluded.

Table 64. *School medical examinations 1931.*

Gingiva	Materia alba (frequency)						Total
	Little or none		Moderate		Abundant		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	279	78	71	20	6	2	356 100
Ging. tart.	451	47	406	42	110	11	967 100
Easily bleeding	35	16	71	33	109	51	215 100
Spontaneously bleeding			1	33	2	67	3 100
Slight pocket formation	4	15	12	46	10	39	26 100
Total	769	49	561	36	237	15	1,567 100

Correlation coefficient = **0.471** ± **0.020**.
4 observations excluded.

Table 65. *Local medical examinations 1929.*

Gingiva	Tartar (frequency)						Total
	None		Moderate		Abundant		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	101	47	110	51	4	2	215 100
Ging. tart.	5	5	85	89	6	6	96 100
Easily bleeding	48	20	174	73	17	7	239 100
Spontaneously bleeding	16	12	98	73	20	15	134 100
Deep paradentitis	8	10	60	74	13	16	81 100
Total	178	23	527	69	60	8	765 100

Correlation coefficient = **0.336** ± **0.032**.
429 observations excluded.

Table 66. *School medical examinations 1931.*

Gingiva	Tartar (frequency)						Total
	None		Moderate		Abundant		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	307	86	44	12	5	2	356 100
Ging. tart.	61	6	814	84	92	10	967 100
Easily bleeding	26	12	135	63	53	25	214 100
Spontaneously bleeding					3	100	3 100
Slight pocket formation	1	4	13	50	12	46	26 100
Total	395	25	1,006	64	165	11	1,566 100

Correlation coefficient = **0.569 ± 0.017.**

5 observations excluded.

Table 67. *School medical examinations 1931.*

Gingiva	Tartar (colour)						Total
	Dark, black, brown		Yellowish brown		Greyish green		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	22	40	33	60			55 100
Ging. tart.	103	11	811	89			914 100
Easily bleeding	37	20	148	79	2	1	187 100
Spontaneously bleeding	1	33			2	67	3 100
Slight pocket formation	7	27	17	65	2	8	26 100
Total	170	14	1,009	85	6	1	1,186 100

386 observations excluded.

Table 68. *Local medical examinations 1929.*

Gingiva	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
Normal ging.	60	41	87	59	147	100
Ging. tart.	17	32	36	68	53	100
Easily bleeding	49	36	86	64	135	100
Spontaneously bleeding	11	16	57	84	68	100
Deep paradentitis	13	25	39	75	52	100
Total	150	33	305	67	455	100

Correlation coefficient = **0.136 ± 0.046.**
739 observations excluded.

Table 69. *School medical examinations 1931.*

Gingiva	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
Normal ging.	141	40	215	60	356	100
Ging. tart.	259	27	707	73	966	100
Easily bleeding	34	16	180	84	214	100
Spontaneously bleeding			3	100	3	100
Slight pocket formation	4	15	23	85	27	100
Total	438	28	1,128	72	1,566	100

Correlation coefficient = **0.196 ± 0.024.**
5 observations excluded.

Table 70. *Local medical examinations 1929.*

Materia alba (frequency)	Care of the teeth (brushing)				Total
	Good		Bad		
	Abs. figs.	%	Abs. figs.	%	
Little or none	81	44	103	56	184 100
Moderate	42	34	83	66	125 100
Abundant	18	15	104	85	122 100
Total	141	33	290	67	431 100

Correlation coefficient = **0.248** ± **0.045**.
763 observations excluded.

Table 71. *School medical examinations 1931.*

Materia alba (frequency)	Care of the teeth (brushing)				Total
	Good		Bad		
	Abs. figs.	%	Abs. figs.	%	
Little or none	333	43	436	57	769 100
Moderate	99	17	466	83	565 100
Abundant	10	4	226	96	236 100
Total	440	28	1,128	72	1,570 100

Correlation coefficient = **0.393** ± **0.021**.
Correlation summary for both the school medical examinations correlation coefficient = **0.382**.
1 observation excluded.

abundant, probably in consequence of fermenting processes, this tends to stimulate the development of caries, we find on this point a factor common to both caries and gingivitis, which may in some measure explain the tendency of caries and gingivitis to occur simultaneously.

The part played by the soft deposit as a factor inducing gingivitis is far surpassed by tartar. The school medical

Table 72. *Local medical examinations 1929.*

Tartar (frequency)	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
None	40	41	58	59	98	100
Moderate	69	28	177	72	246	100
Abundant	4	19	17	81	21	100
Total	113	31	252	69	365	100

Correlation coefficient = **0.103 ± 0.052.**
829 observations excluded.

Table 73. *School medical examinations 1931.*

Tartar (frequency)	Care of the teeth (brushing)				Total	
	Good		Bad			
	Abs. figs.	%	Abs. figs.	%		
None	166	42	231	58	397	100
Moderate	250	25	756	75	1,006	100
Abundant	25	15	141	85	166	100
Total	441	28	1,128	72	1,569	100

Correlation coefficient = **0.200 ± 0.024.**
Correlation summary for both the school medical examinations correlation coefficient = **0.183.**
2 observations excluded.

examinations of 1931 (Table 66) showed that severe cases of gingivitis, i. e. the easily or spontaneously bleeding types, are often accompanied by »moderate» or »abundant» accretions of tartar, as has also been definitely, though not quite so markedly, confirmed by the local medical examinations (Table 65). On the other hand, in a normal or only slightly modified gingiva

Table 74. *School medical examinations 1931.*

Materia alba (frequency)	Diet				Total	
	Mixed diet		Lacto-cereal diet			
	Abs. figs.	%	Abs. figs.	%		
Little or none	199	65	107	35	306	100
Moderate	149	58	107	42	256	100
Abundant	58	49	60	51	118	100
Total	406	60	274	40	680	100

Table 75. *School medical examinations 1931.*

Tartar (frequency)	Diet				Total	
	Mixed diet		Lacto-cereal diet			
	Abs. figs.	%	Abs. figs.	%		
None	61	63	36	37	97	100
Moderate	314	60	210	40	524	100
Abundant	31	53	28	47	59	100
Total	406	60	274	40	680	100

the formation of tartar is correspondingly less pronounced. The considerable changes in the gingiva are generally associated with an accumulation of light or yellowish-brown tartar (Table 67), in conjunction with the fact that the latter is usually present in large quantities, which exert a direct mechanical influence on the edge of the gum, while at the same time the bacterial flora that arises in connection with this less compact form of tartar is apparently more abundant than in the case of the hard, dark tartar, which invariably occurs in smaller quantities. In severe gingivitis there has been observed in a number of cases a greyish-green tartar, which has undoubtedly taken its colour from decomposing colouring matter in the blood.

Gingiva and diet.

Table 76. *Local medical examinations 1929.*
Types of diet irrespective of vitamin content.

Gingiva	Diet						Total
	Mixed diet		Lacto-cereal diet		Meat diet		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	85	35	54	31	53	41	192
Ging. tart.	28	12	27	15	20	15	75
Easily bleeding	71	30	43	25	23	18	137
Spontaneously bleeding	35	15	32	18	24	19	91
Deep paradentitis	20	8	19	11	9	7	48
Total	239	100	175	100	129	100	543

Table 77. *School medical examinations 1929.*

Gingiva	Diet						Total
	Mixed diet		Lacto-cereal diet		Fairly abundant meat diet		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	177	56	304	54	7	47	488
Ging. tart.	36	11	64	11	4	27	104
Easily bleeding	71	23	115	20	2	13	188
Spontaneously bleeding	30	10	84	15	2	13	116
Total	314	100	567	100	15	100	896

The effect of brushing the teeth when gingivitis, materia alba, tartar are present.

Those measures of hygiene by which civilized man assists and amplifies the cleansing process in the mouth by rinsing and

Table 78. *School medical examinations 1931.*

Gingiva	Diet				Total
	Mixed diet		Lacto-cereal diet		
	Abs. figs.	%	Abs. figs.	%	
Normal ging.	42	10	20	7·3	62
Ging. tart.	307	76	196	72·4	503
Easily bleeding	51	13	50	18·3	101
Slight pocket formation	6	1	6	2	12
Total	406	100	272	100	678

Table 79. *Local medical examinations 1929.*

Gingiva	Diet vitamin content				Total
	a [1]		b [1]		
	Abs. figs.	%	Abs. figs.	%	
Normal ging.	173	36	12	29	185
Ging. tart.	69	14	5	12	74
Easily bleeding	118	24	16	39	134
Spontaneously bleeding	81	17	7	17	88
Deep paradentitis	46	9	1	3	47
Total	487	100	41	100	528

Correlation coefficient = 0.058 ± 0.043.

brushing are, as the above presentation of the facts has clearly demonstrated, of problematical significance as a prophylaxis for the development of caries. On the other hand, as affecting the

[1] a, b and c denote different degrees of supply of vitamin C: a representing the lowest (poor in C).

Table 80. *School medical examinations 1929.*

Gingiva	Diet vitamin content				Total
	a [1]		b [1]		
	Abs. figs.	%	Abs. figs.	%	
Normal ging.	324	48	164	74	488
Ging. tart.	86	13	18	8	104
Easily bleeding	152	23	36	16	188
Spontaneously bleeding	111	16	5	2	116
Total	673	100	223	100	896

Correlation coefficient $= -0.257 \pm 0.031$.

Table 81. *School medical examinations 1931.*

Gingiva	Diet vitamin content				Total
	a [1]		b [1]		
	Abs. figs.	%	Abs. figs.	%	
Normal ging.	31	9	18	11	49
Ging. tart.	250	71	120	75	370
Easily bleeding	63	18	20	13	83
Slight pocket formation	7	2	2	1	9
Total	351	69	160	31	511

Correlation coefficient $= -0.080 \pm 0.044$.

Correlation summary for both the school medical examinations correlation coefficient $= -0.156$.

gingival processes the daily care of the teeth along these lines (Tables 68, 69) is of some value, as it manifestly retards the growth of the simpler forms of gingivitis, whereas the more

[1] See note on p. 138.

Table 82. *School medical examinations 1931.*

Gingiva	Diet vitamin content						Total
	a—b [1]		b—c [1]		c [1]		
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	4	4	6	11	3	25	13
Ging. tart.	83	81	40	77	9	75	132
Easily bleeding	13	13	5	10			18
Slight pocket formation	2	2	1	2			3
Total	102	62	52	31	12	7	166

Table 83. *School medical examinations 1931.*
70 mm Hg. / 3 min.

Gingiva	No. of individuals examined	No. of punctiform bleedings average
Normal ging.	155	0.5
Ging. tart.	827	0.6
Easily bleeding	137	0.5
Slight pocket formation	22	1.1
Total	1,141	0.6

severe types of inflammational processes in the gums would appear from the available figures to be less, or even not at all, influenced by the brushing of the teeth. The fact is, probably, that the bleeding gingivites often arise and are to be regarded as symptoms of more fundamental disturbances in the state of health, so that the cause of the evil is not removed merely by mechanically cleansing the mouth. Nor should it be forgotten that, if proper care is not taken in brushing the teeth when severe

[1] See note on p. 138.

Table 84. *School medical examinations 1931.*
80 mm Hg. / 3 min.

Gingiva	Hess's numbers (No. of punctiform bleedings)		
	0	1	7
Normal ging.	12	1	
Ging. tart.	11	2	
Easily bleeding	2	2	1
Spontaneously bleeding			1
Total	25	5	2

Table 85. *School medical examinations 1931.*
50 mm Hg. / 15 min.

Gingiva	No. of individuals examined	No. of punctiform bleedings average
Normal ging.	25	0.2
Ging. tart.	120	0.6
Easily bleeding	20	1.3
Slight pocket formation	7	1.4
All combined	172	0.8

gingivitis is present, if for instance, hard, irritating toothbrushes are used which constantly damage the gum, the inflammation, instead of abating, is on the contrary stimulated and intensified. The improvement in the condition of the milder forms of gingivitis caused by the regular care of the mouth is of course attributable to the fact that these types are largely a result of soft or solid deposits on the tooth, and the removal of these deposits (Tables 70, 71, 72, 73) implies the removal of the main pathological factor. In particular, the regular care of the mouth restricts the formation of materia alba, whereas its bearing on the frequency of tartar is not so conspicuously revealed.

Table 86. *School medical examinations 1931.*
70 mm Hg. / 3 min.
Lacto-cereal diet.

Supply of vitamins	No. of individuals examined	No. of punctiform bleedings average
a [1]	210	2.4
a—b [1]	36	1.6
b [1]	15	2.7
b—c [1]	5	1.6
All combined	266	2.1

Table 87. *School medical examinations 1931.*
70 mm Hg. / 3 min.
Mixed diet.

Supply of vitamins	No. of individuals examined	No. of punctiform bleedings average
a [1]	118	1.6
a—b [1]	58	1.3
b [1]	136	1.9
b—c [1]	46	1.6
c [1]	11	1.3
All combined	369	1.5

Gingivitis and diet.

The abundant occurrence of materia alba when the diet is predominantly lacto-cereal (Table 74) may be looked upon as one of the causes of a more definite tendency under this diet for

[1] See note on p. 138.

Table 88. *School medical examinations 1931.*

50 mm Hg. / 15 min.

Cases relating to mixed and lacto-cereal diet combined.

Supply of vitamins	No. of individuals examined	Hes's test. Average
a [1]	40	1.6
a—b [1]	7	1.7
b [1]	14	2.4
b—c [1]	3	2.3
All combined	64	2.0

the development of gingivitis (Tables 76, 77, 78). Conversely, the investigation shows that in a predominantly meat diet the gingivites are somewhat less numerous. It is only to a small extent that the hard deposits that are of such importance to the development of gingival inflammation can give rise to the aggravated gingival picture in a lacto-cereal diet as compared with what takes place in a mixed diet, seeing that the frequency of tartar in the former only very slightly exceeds the corresponding values in the latter (Table 75).

It is quite evident that the proportion of the vitamin content in the food (this mainly refers to vitamin C) has a decisive bearing on the emergence of the inflammatory processes in the gingiva. The very grouping of the statistical data from the two school medical examinations (Tables 80, 81, 82) shows clearly that gingival changes are conspicuous features of C-hypovitaminosis, and that if in these circumstances the supply of vitamins is reduced, more malignant forms arise in increasing quantities. The greater sensitiveness of a child's organism in such a case will be realized if a comparison is made with the local medical examinations (Table 79), which appears to show that, as regards the condition of the mucous membrane of the mouth as a symptom of the general state of health, adults are not so essentially dependent upon food containing a more or less

[1] See note on p. 138.

Table 89. *School medical examinations 1931.*

Gingiva	General alimental condition						Total	
	Good		Ordinary		Bad			
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%		
Normal ging.	118	81	21	14	7	5	146	100
Ging. tart.	564	69	184	23	68	8	816	100
Easily bleeding	78	57	41	30	18	13	137	100
Spontaneously bleeding	1	100					1	100
Slight pocket formation	16	67	7	29	1	4	24	100
Total	777	69	253	23	94	8	1,124	100

447 observations excluded.

abundant quantity of vitamins as are those of the younger generation.

Gingivitis and tests of the fragility of vessels.

Yet another manifest transition of the gingival processes takes place, from being merely local affections to forming part of the wider pathological picture as participating phenomena in more extensive processes and symptoms of disturbances in the general state of health, if we examine the correlation between the different forms of gingivitis and the Hess numbers. These latter are supposed, it will be remembered, to be an expression of the general fragility of vessels. Whereas in a normal gingiva the Hess numbers generally keep in the neighbourhood of the 0-numbers values, it is found that if the gingival picture changes the fragility of the vessels increases (Tables 83, 84, 85), from which the conclusion might be drawn that gingivitis, and especially the severer forms thereof, has to be regarded as phenomena due to the fragility of the vessels and consequently dependent upon the general alimental condition and state of health.

The circumstances indicated are observable both by the method described by Odin, — a 70-mm. load of quicksilver for a period of 3 minutes (1,141 cases) and with a pressure of 80 mm. Hg/3

Table 90. *School medical examinations 1931.*

Lacto-cereal diet.

Gingiva	Hæmoglobin	
	Total	Mean value
Normal ging.	26	58
Ging. tart.	201	57
Easily bleeding	51	57
Slight pocket formation	8	58
Total	286	57

Table 91. *School medical examinations 1931.*

Mixed diet.

Gingiva	Hæmoglobin	
	Total	Mean value
Normal ging.	39	58
Ging. tart.	306	59
Easily bleeding	47	58
Slight pocket formation	6	57
Total	398	58

min. (32 cases) — and also from a compilation of the results obtained from the experimental device proposed by GÖTHLIN (50 mm. Hg/15 min., 172 cases). However, upon the very first examination of the primary material it was found that the variations in the results between the »Göthlin» and the »Odin» tests were striking (it may be mentioned that both the experiments were carried out as parallel tests on the same persons). For other

Table 92. *School medical examinations 1931.*

The rest (irrespective of form of diet).

Gingiva	Hæmoglobin	
	Total	Mean value
Normal ging.	79	60
Ging. tart.	313	60
Easily bleeding	41	61
Slight pocket formation	12	61
Total	445	60

Tobacco and Gingiva.

Table 93. *Local medical examinations 1929.*

Gingiva	Males over 16 years of age					
	Total abstention		Tobacco consumption			Total
			Moderate		Regular, constant	
	Abs. figs.	%	Abs. figs.	%	Abs. figs.	%	
Normal ging.	29	34	29	33	17	31	75	33
Ging. tart.	11	13	12	13	10	18	33	14
Easily bleeding	25	30	21	24	10	18	56	25
Spontaneously bleeding	13	15	15	17	5	9	33	14
Deep paradentitis	7	8	12	13	13	24	32	14
Total	85	100	89	100	55	100	229	100

reasons also it is quite clearly seen from the statistical inquiry that tests of the fragility of vessels carried out by the above methods are not applicable to individuals, or at any rate that they yield in that case highly unreliable results; they can be appreciated and are of value as diagnostic evidence only when they are carried out on larger groups of experimental subjects.

Tests of vascular fragility and vitamin standards.

If viewed in the light of the manifest, positive association between gingivitis and the Hess test on the one hand and, on the other, the connection that was previously shown to exist between the growth of gingival inflammation and the standard of vitamin C, correlation studies of vascular-fragility tests and the supply of vitamin C may prove of some interest. In the relative tables (Tables 86, 87, 88) the cases have been grouped according to the form of diet and the method of investigation employed.

It has previously been asserted (GÖTHLIN) that vascular-fragility tests might decide the issue in respect of the standard of vitamin C and C-hypovitaminosis — a view however that has met with some criticism (ODIN, WESTIN, ÖHNELL). Our present statistical material proves that in their formation the two qualities do not run a parallel course in any of the three experimental methods employed. The arithmetical characteristics indicate that the values of the Hess numbers change irrespective of the greater or less quantity of vitamin in the food.

Gingivitis in relation to the general alimental condition and the haemoglobin values.

The general alimental condition has had a typical influence on the development of gingivitis (Table 89). Both the school medical examinations show that pathological gingival changes are rarer under sound alimental conditions, whereas if the latter deteriorate the inflammation of the gums becomes intensified.

The question arises in connection herewith: how far does the diseased gum influence the general state of health? Owing to the subjective unpleasantness and pain, though compared with the extent of the destruction that is frequently caused the pain is almost invariably remarkably slight, the individual's sense of

general well-being is naturally disturbed, just as the outward and visible result of the subsequent course followed by the disease may have a somewhat distressing psychological effect on the patient. On the whole, however, it would look as if gingivitis does not contribute to, but is rather a consequence of, a decline in general health; similarly, contrary to what is generally believed, it is probably not of any very great importance as a centre of focal infection such as characterizes badly decayed teeth (see above). This conclusion was supported by an investigation into gingivitis and haemoglobin (Tables 90, 91, 92). Even if account is taken of the grouping according to age, we cannot trace any such connection between the development of gingival inflammation and variations in the haemoglobin values as has been perceptible between caries and haemoglobin-content. The explanation of this is partly to be found, no doubt, in the natural cleansing of the infected area that is effected by the efflux of secretion from the gum-pockets and the flushing by the saliva. It should be added, however, that our material does not include those more serious forms of gingivitis in which acute stages have arisen in conjunction with severe subjective symptoms, such as the growth of fistulae and the formation of alveolar abscesses etc. We are probably justified in suspecting that these latter forms are capable of causing, by way of infection, a reduction of the haemoglobin values.

The picture of the mouth in relation to tobacco and coffee.

One of the other characteristics that have been mentioned in connection with the frequency of gingivitis in that part of the Norrland investigation with which we are here concerned is worthy of comment, viz. the use of tobacco (Table 93). This factor is found in a very homogeneous body of selected material to contribute in some measure to the growth of deep-seated paradentitis. On the other hand, it appears to have no bearing on the origin of caries. It might be possible to conclude from our material that tobacco somewhat mitigates the caries picture. In all cases the data relate to *chewing* tobacco.

The effect of coffee, which may be worth while mentioning in this connection, must be judged even more cautiously than the correlations in respect of tobacco, among other reasons owing to the difficulty of rejecting predominant qualities in the available

material. If coffee in itself were to exert any direct influence on the oral picture, one would expect it to be through attacks of the absorbed tannic acids and free fatty acids on the gums. Likewise, it is conceivable that the consumption of coffee might indirectly pave the way for dental decay through the simultaneous supply of sugar and cereals. The inquiry made into the question failed however to reveal the existence of any effect on the frequency either of caries or of gingivitis.

D. **Summary.**

In view of the great number of characteristics that have been studied in that part of the Norrland investigation with which we are here concerned, any summary of the results of the investigation can only lay special stress in broad outlines on certain conditions that may be thought likely to be of general interest.

That section of the material which was collected last, that is to say in 1931, and comprises school children from both Skåne and Norrland, constitutes the most valuable part of the investigation. On the whole, however, the three main divisions, the school and local medical examinations of the year 1929 and the school medical examinations of 1931, all collected in the late winter season, tally well with one another in such particulars as are comparable.

It would have been more satisfactory if the investigational material had been more extensive, chiefly with the idea of determining the geographical frequency within the country of the characteristics in detail. Nevertheless, thanks to the individually homogeneous nature of the different parts of the country concerned, the material may perhaps be regarded as representative of the corresponding geographical areas investigated.

In drawing up our summary we are struck by the wide variations displayed by the different districts of Norrland in respect of the diseases of the mouth in their association with the general mode of life and the hygienic conditions. It is inadmissible, therefore, as has frequently been done hitherto, to make the conditions prevailing at individual places apply as if they were characteristic of Norrland in its entirety. It has been extremely valuable to be able to compare the Norrland material with the results of the school investigations made in Skåne. The

children in the country districts of Skåne appear generally to be more favourably placed as regards the common diseases of the mouth than the Norrland children. In certain points of detail, however, the relations are reversed.

The dispersion of certain characteristics in respect of sex, age and place.

The bite; the position of the teeth.

A normal bite is slightly less common in Norrland than in Skåne, owing mainly to the less frequent occurrence in the latter district of prognathism (protruding upper jaw). In Norrland the types of bite vary widely; e. g. in the Tärna district 84 % and in Kalix only 46 % possess a normal bite. The same conditions apply on the whole to the position of the teeth. Districts in which broad faces are more strongly represented exhibit fewer anomalies in the dentition and the position of the teeth.

Hypoplasiae of the enamel.

So-called hypoplasiae of the enamel are present in 4 % of the girls and 6 % of the boys dealt with in the school medical examinations of 1931. It is evident from both the local and the school examinations that the presence of defects in the enamel varies widely in different localities; for instance, in the typical desolate areas, in the Tärna-Stensele-Dorotea group and Jukkasjärvi, they occur in 12—13 %, whereas in Bjurholm, Skåne and Arvidsjaur they are found in 6, 4 and 4 % respectively. Åsele, Umeå and Bureå are also less favourably placed in that respect.

Colour of the teeth.

In all classes of age the men have yellower teeth than the women. In the former, as the age advances the teeth become steadily more and more yellow, while in the latter this tendency is interrupted at the ages of 19—30, these years representing the limits within which woman's essential period of fertility falls. It is also observed that in children a change occurs in the shade of the teeth's colours towards a lighter type at the age of 11. It is in the light of these circumstances, as also of the local distribution of the colours of the teeth, that we should regard the higher frequency of caries in women in general, and particularly during pregnancy and lactation.

Abrasion.

Abrasion is more pronounced in men than in women. Naturally enough, it increases with age, but a particularly marked increase takes place in both sexes at the age of 50. Specially striking is the wide difference in the distribution of severe abrasion, i. e. such as affects the dental bone as well; in Skåne it occurs in 16.5 %, but in the whole of Norrland in only 1.5 %. Umeå records as high as 4 %. These last data refer to the child material.

Materia alba; tartar.

Both materia alba and tartar increase with advancing years. In the case of the former the curve rises more steeply and indicates a more abundant precipitation in the boys. As regards tartar, the distribution is uniform in the two sexes. It is noteworthy that in regard to both types of deposit the frequency shows a palpable diminution at the age of 11, a fact that emphasizes the influence exerted by metabolic factors in this connection. As to the presence of materia alba in the various districts, we find that, with the exception of Umeå, where a minimum is recorded, the distribution is similar throughout. The geographical grouping of the cases of tartar according to frequency indicates that it is in striking agreement with the geological localization of the limestone deposits.

Gingivitis.

A normal gum is of comparatively infrequent occurrence. The more pronounced forms of gingivitis among elderly people have been observed in about 55 % of the total investigated. The development of gingivitis in the men shows a steady increase in the severer forms up to the age of 65. From the age of 13 healthy gums become increasingly rare, and by the age of 30 the number of cases of gingival inflammation starts augmenting rapidly. In persons over 65, however, who may be considered to represent a surviving remainder of constitutionally strong individuals, the disease may be found to assume a mitigated form. The development of gingivitis in the *women* divided into the age groups diverges somewhat from that of the male types, since in the former a maximum frequency manifesting itself in all forms of inflammation is reached between the ages of 19 and 50. In

those country districts of Norrland that have been investigated, gingivitis develops in the women most strongly at 19—30 years of age. On the other hand, in the Umeå district, the chief centre of which is the town of Umeå, a clearly defined maximum stage of gingivitis is reached at a somewhat higher age than in the rest of Norrland, owing presumably to the higher average marrying age and the consequently later period in life at which pregnancy occurs amongst women living in towns. This latter causal connection seems all the more probable seeing that, as regards the relation between the development of age and gingivitis, the *men* show no differences as between town-dwellers and country-dwellers such as have been found to exist amongst women.

In estimating the gingival changes revealed by the school medical examinations of 1931, far stricter research methods have been employed in order to enable us to work out a graduated scheme to represent the conditions prevailing in the different districts; and so even quite insignificant changes have been taken into account. Somewhat severe forms of gingivitis, for instance, those in which the gums bleed readily upon the application of a toothbrush, have been recorded in 17 % of the cases amongst the boys, the corresponding figure for the girls being only 13 %. In school children the gingival changes likewise increase with the passage of time, although the difference in earlier years is not so pronounced as it is in older people. A certain retardation and reversal of the process are observable at the age of 11—12, the phenomenon being revealed at a somewhat earlier period in Skåne than in Norrland. In regard to the severer forms of the disease, the boys are throughout somewhat worse off than the girls. As to the geographical pathology of the gums, the prevalence of severe gingivitis is noticeable in school children in some of the Lapland districts that have been investigated. Distinct gingivitis occurs in about every fifth child in Tärna and Arvidsjaur. In the country district of Skåne the children appear to be less exposed to pronounced gingival inflammation than in Norrland.

Saliva.

A normal secretion of saliva, in point of both abundance and consistency, is characteristic of all the investigated children in Tärna. In sharp contrast to this is Kalix, where the secretion is abundant in over 20 %. It is noteworthy that these two places

represent the opposite poles as regards the frequency of caries, the minimum being shown by Tärna and the maximum by Kalix. The Skåne children are better off in regard to saliva conditions.

How certain definite characteristics in the oral picture influence one another.

Irregularities in the position of the teeth often occur in conjunction with irregularities in gingival arches. A high gingival arch, and particularly one that has a narrow, compressed premolar part, is frequently associated with faults in the position of the teeth. The significance of the racial factor is emphasized by the fact that, where a tooth is of a size that exceeds a value harmonizing with the facial skeleton, we frequently find bimaxillary narrowness and progathism. Anomalies in the position of the teeth show a strong increase parallel with the appearance of hypoplasiae of the enamel — a fact that confirms the view that the former are caused by disturbances in the metabolism.

As the teeth become more and more worn down the frequency of caries decreases. The primary cause of this is not, apparently, to be sought in mere detrition or the brushing of the teeth, although these factors may have something to do with it, but the fact should be stressed that in individuals whose teeth are very much worn down even the natural tendency to caries owing to constitutional and physiological causes is less pronounced. This finds expression, inter alia, in the fact that it is predominantly persons with strong abrasion that have yellow teeth, indicating a more vigorous growth of enamel and dental bone. The more the types of colour on the teeth shift from white to yellow the lower is the frequency of caries.

Normal gums are most frequently found in a denture that is free from caries; and the spontaneously bleeding forms of gingivitis run parallel to the proximal and gingival types of caries, suggesting some common primary cause. Deposits on the teeth follow the course of development of gingivitis. In this process tartar plays a far more important part than softer deposits, and its colour also varies in a typical manner. As the frequency of tartar becomes intensified the quantity of materia alba increases.

Brushing the teeth and its effect.

The regular care of the mouth, which is apparently not a very common practice, is exercised by twice as many girls as boys. In Tärna, where there is extremely little dental decay, not a single child uses a tooth-brush. In Åsele and the neighbouring district its use is likewise very rare. Nearly half of the children in Umeå declare that they brush their teeth daily, whereas in Skåne the proportion is only one in four. The practice of brushing the teeth has been proved to be without any perceptible influence on caries, but the milder forms of gingivitis are reduced somewhat in frequency when the teeth are regularly looked after. The severer forms of gingivitis, on the other hand, do not appear to be favourably affected by the practice of daily oral hygiene in the form of brushing the teeth.

The significance of diet.

The earlier views as to the injury caused to the teeth by a diet rich in carbo-hydrates are partly confirmed. It should be emphatically pointed out, however, that no cases have been included evidencing the absorption of large quantities of sugar and »sweets» in various forms, but we refer here to a form of diet that belongs to the lacto-cereal category. The frequency of caries seems to a certain extent to decline in the case of a substantial meat diet. Gingivitis noticeably increases with a lacto-cereal diet as compared with the mixed diet, owing possibly to the fact that materia alba increases in the former dietary group. Inflammation of the gums occurs with minimum frequency in a substantial meat diet. Chewing tobacco makes the gums deteriorate, though it may possibly prevent the arising of caries. The investigation does not prove that coffee has any serious effect on the oral picture.

There is a definite connection between the standard of vitamin C and gingivitis. Elderly people do not seem to be so obviously dependent upon a supply of vitamin C so far as concerns the state of the mucous membrane in the mouth. On the other hand, caries arises independently of the content of vitamin C in the food. Hypoplasiae of the enamel of such a nature as to have been caused partially by lack of vitamin D do not appear to have any effect upon the formation of caries. It does of course happen to a certain extent that hypoplastic defects in the enamel grow

into carious injuries, wherefore we find dentures that are entirely free from caries less frequently represented among cases of hypoplasia. Nevertheless, it is a general rule that individuals exhibiting early disturbances in the process of calcification do not appear to be subsequently disposed to advanced forms of caries.

The general state of health and the oral picture.

The most severe cases of caries are more numerously represented when the general alimental condition is recorded as poor. Other types of caries, on the other hand, group themselves irrespective of the alimental condition. There is, however, a distinct covariation between the latter and gingivitis owing to the fact that a deterioration of the alimental condition goes hand in hand with a deterioration of the gingival picture.

The values obtained from determinations of vascular fragility are dispersed without any connection between them and the types of caries, though they exhibit a marked connection with the growth of gingivitis. The tests of vascular fragility carried out with our material have not enabled us to determine the standard of vitamin C, whether amongst larger or smaller groups of investigated persons. The development of severe cases of caries may possibly be accompanied by a reduction in the numbers of haemoglobin. It may however be pointed out that in the forms of gingivitis occurring amongst school-children no displacement of the haemoglobin values in any particular direction has been observable.

CHAPTER IV.

The histopathology of the teeth with special reference to hypovitaminotic changes.

By

G. WESTIN.

Introduction.

The introduction to these reports has shown how, prior to the Norrland investigation, expression had been given to an assumption that there existed widespread C-hypovitaminosis in Upper Norrland. This vitamin deficiency was presumed to be of importance to the general state of health and might perhaps prove to be a significant cause of the interesting »Norrland diseases», which have been described in the reports drawn up by the Umeå Hospital. In view of the light thrown on the subject by existing literature, it was considered that a microscopical examination of the teeth of the population in Upper Norrland would be a useful means of deciding the question of the presence and distribution of C-hypovitaminosis.

The introduction describes how the examination of teeth was planned and carried out; the reports drawn up by my collaborators and published above give particulars as to the localities covered by the investigation, the number of cases, etc. The carrying out of the microscopical examination depended of course upon the possibility of the dental surgeon's having an opportunity of treating the person under investigation for dental diseases when examining the cavity of the mouth and the teeth. No material was at our disposal for investigation other than that obtained as a result of such therapeutical action. Accordingly I am deeply indebted to the investigators for the skill with which

they have been able not only to help those under examination who were suffering from dental diseases but also to procure excellent material for microscopical study. It was realized from the outset that there would be very little suitable material derived from extractions (which for brevity's sake will hereinafter be called »extraction material»), and accordingly, acting upon my directions, the investigators endeavoured to select the typical cases in each locality and zone examined. The results of their labours show how well they have succeeded.

A. Extraction material.

Procuring and fixing of teeth. In most cases the teeth were extracted under an anaesthetic (carpule ampullae), but in the case of children many milk teeth were removed without any injection. The tooth was fixed immediately after being extracted. The fixing fluid consisted of 10 % formalin solution or else HÄGGQUIST's fixing fluid: 20 % formalin solution saturated with sublimate. The extraction material was then sent as soon as possible by post to Stockholm.

Laboratory technique. Immediately upon arrival the teeth were carefully copied in a sketchbook and each provided with a number, journal number, name of patient, name of the operator and of the locality at which the examination took place. Macroscopical discoveries of interest were noted. The sketch showed the position in which the tooth had been embedded and included a sectional drawing showing the course of the series of sectional cuts. Decalcification in 5 % trichloracetic acid. Embedding in paraffin.

For the sectional series only the pulp area was utilized. After decalcification the superficial layers of dentin and cement were cut off, so that the first cuts reached the surface layer of the pulp in such a position as was considered most suitable in each case for obtaining as entire a longitudinal section as possible. The sectioning series ceased when the pulp had been cut through to the opposite wall. Thickness of section 5—7 my.

The glasses were coloured in the following series:

1, 7, 13 etc. Htx-Eosin.
2, 8, 14 » HANSEN's connective tissue stain.
3, 9, 15 » » » » » , with ferrotrioxihaematein as counter-stain.
4, 10, 16 » Thionin stain.
5, 11, 17 » BOCK's calcium stain (modified for paraffin section).
6, 12, 18 » unstained or subsequently used for staining blood corpuscles, bacteria etc.

1. Local distribution of the material.

Västerbotten County.

Material collected prior to and in 1929.

1. *Stensele, Dorotea, Sorsele.* 1929. (Hagberg.)

Stensele:		Total no. of dental cases examined: 240; 268; aggregating 508 cases.
Skarvsjö	14 cases	
Ankarsund	5 cases	
Strömsund	3 cases	*The extraction material* represents hereof 57 cases, or 11.2 %.
Norberg	5 cases	
Sorsele:		Adult material represents 240 cases.
Ammarnäs	10 cases	
Bure village	8 cases	*The extraction material* represents hereof 51 cases, or 21.2 %.
Dorotea:		
Sörfors school	12 cases	

In all *57 cases*, whereof 6 from the examination of schools, 51 from the examination of adults.
(Total 63 teeth.)

2. *Bureå, Byske, Norsjö, Bjurholm.* 1929. (Hagman.)

Bureå	11 cases	Total no. of dental cases examined: 109; 275; aggregating 384 cases.
Byske	7 cases	
Norsjö	9 cases	
Bjurholm	5 cases	*The extraction material* represents 32 cases, or 8.3 %.

In all *32 cases*, whereof 10 from the examination of schools, 22 from the examination of adults.
(Total 51 teeth.)

3. *Umeå.*

1926—1928 (Westin)	51 cases	Total no. of dental cases examined 1929 (not the school examination, from which there is no material): 500.
1929 (Winström) ...	42 cases	
1929 (Aldeborg)....	11 cases	*The extraction material* represents 53 cases, or 10.6 %.

Total *104 cases.*
(» 126 teeth.)

Material from the investigation carried out in 1931 for control purposes.

Lycksele, Umgransele .	5 cases	Total no. of children whose teeth
Långsele	3 cases	were examined: 228 cases.
Åsele	6 cases	*The extraction material* re-
Tärna	13 cases	presents 27 cases, or 11.8 %.

Total *27 cases.*
(» 29 teeth.)

Summary:

The total number of cases of extraction from Västerbotten County: *220 cases.*

Of this total:

The author's own material collected before 1929	51 cases
the investigation carried out in 1929	142 cases
the investigation carried out in 1931	27 cases

Total no. of dental cases examined in Västerbotten in 1929 and 1931: 1620 cases (not including the examination of schools in Umeå and the Degerfors material).

Of this total *the extraction material* represented 169 cases, or 10.4 %.

If we include our own material consisting of 51 cases, which brings the total up to 1671 cases, the extraction material represents 220 cases, or 13.1 %.

Of the school material in Umeå collected in 1931, in 373 cases extraction material is entirely lacking, and of that collected in 1929 it is almost completely lacking in 166 cases.

Norrbotten County.

Material collected in 1929.

Piteå, Långnäs ..... 9 cases (117 cases, 7.6 %).

From the Kiruna investigation there was no extraction material collected in 1929.

Material collected in 1931.

Kalix	7 cases	Total no. of dental cases exam-
Nedre Kalix	5 cases	ined 573.
Övertorneå	6 cases	*The extraction material* re-
Jokkmokk	5 cases	presents 37 cases, or 6.4 %.
Kobdalis	6 cases	
Vuollerim	2 cases	
Arvidsjaur	6 cases	

Total *37 cases.*

Supplemented in 1933—1934:

Kiruna (Bäcklund) ..... 16 cases
Skellefteå (Örnkloo) ..... 28 cases
Umeå (Saedén) ..... 14 cases

Scania (Skåne).

Material collected in 1931.

Lund: Bara, Troberga, Vismarlöf, Mölleberga, Holmeja, Torup.
Svedala: Skabersjö.

Total *29 cases.*

Total no. of children whose teeth were examined: 397 cases.
The extraction material represents 29 cases, or 7.3 %.

2. Percentage distribution.

Taken as a percentage, the cases of extraction represent about 7 % of the material in cases where treatment was given and teeth extracted, and this in my view affords a good representative picture of the results under the microscope of an investigation of this kind. The microscopical examination has been unevenly distributed. Divided into the medical examination of children and local medical examinations, the percentage is about 5 % in the former and about 20 % in the latter. The reason for this divergence is obvious: in the non-adult material there was only a minor number of cases treated in which it was possible to extract milk teeth or occasionally 6-year molars, whereas amongst the adults there were a far greater number of cases in the material investigated in which the extraction of teeth was called for. The

distribution of the material amongst the adult population is likewise of a varied nature, Västerbotten being incomparably more abundantly represented than Norrbotten. The Västerbotten material covers over 20 % of the adults examined and treated in the country districts in that county, which means I have microscopically scrutinized the dental picture of approximately every fifth person thus examined. My investigation may claim on the whole to represent a sample test of the dental conditions prevailing in Västerbotten, with comparative material collected from Norrbotten and Scania. By this means dental microscopy comes to be more closely associated with the medical examination, in which the distribution of the material is similar.

3. The value of the material.

A mere summary in tabular form would be of very limited value. It would be impossible to compile statistics on that basis owing to the far too few cases of extraction in proportion to the population. True, the ratio of the number of extracted teeth to the cases investigated is high, and over 100,000 sections form a very considerable collection — but any attempt at determining associations between teeth and diet, teeth and sex or teeth and age etc. is a priori out of the question. If all the teeth extracted had belonged to a limited group of people under investigation, with all the details clearly defined, the circumstances would have been quite different. As things now are, the distribution within a number of groups of a numerically small body of material compels us to limit our conclusions in order to avoid making unreliable statistical calculations. The dental investigation as a whole represents a »sample test», from which statistical conclusions could be drawn only with the utmost caution. The extraction material does not represent a tenth of the whole dental investigation — a fact that at once demonstrates its unsuitability for statistical treatment. When however the estimate of the dental picture and the diagrams were recorded in the tables, the data thus obtained quite naturally assumed the form of summaries on the lines indicated above. They have exhibited remarkable uniformity within several groups — notably those from the Umeå Hospital and the local medical examinations in Västerbotten County — and they have inspired many fresh ideas, which I hope to be able to utilize at some future time in connection with a

larger body of material. Here I shall refrain from making any correlative calculations.

It has been stated by way of introduction that the extraction material has been collected on the principle »typical of the majority of cases» within the respective investigated areas. I have endeavoured to make this a rule by ascertaining that the material is, case for case, in accord with the results of the statistical inquiry. A check of this sort cannot possibly be exact, but I believe I may safely assert that, on the whole, the extraction material represents within each investigated area the type of denture and its pathological picture that the statistical estimate shows to be the most common and prevalent and not exceptional even in minor respects. Anyone who has been engaged in collecting extraction cases from an investigation in which teeth are only obtainable by way of therapeutical extraction in order to promote oral hygiene or to treat caries or paradentitis, as the case may be, will at once realize that the material as a whole represents the common, ordinary cases. The statistical results have shown a very large measure of uniformity prevailing in each investigated zone — a fact that in part justifies our forming our estimate of the most common of the denture's pathological pictures along geographico-pathological lines. It is not very likely under such circumstances that the extraction material should represent exceptional cases. Besides, we must take into account the fact that, except for thè cases recorded from the Umeå Hospital (which however were subjected to a process of elimination), the extraction material has been obtained from healthy groups of the population, in which no pathological affections occur of such a nature as to be determinable by doctors upon a rapid examination.

In spite of these facts, which may seem to offer evidence to the contrary, yet being anxious as critically as possible to circumscribe the field of conclusions to be drawn from my material — which, notwithstanding what has already been said, is nevertheless derived from subjectively selected cases — I propose to assume that minor, indeterminable groups of the material represent exceptional cases, which may for some reason or other have attracted the interest of the investigator. This implies that, in forming my estimate of the results, I have not drawn general conclusions from any morphological changes that have not by an overwhelming majority dominated the pictures. The aim of this

is to ensure as far as possible that the questions the inquiry set out to solve are given a correct answer.

If, then, the extraction material does not lend itself to a statistical review or calculation of individual correlations, it should at any rate enable us to form an approximate estimate of the histological picture exhibited by the dental organ within the group of material examined, provided the observed phenomena are convincingly uniform and at the same time predominant throughout the material. The problem confronting the inquiry may be stated as follows: »*Do the majority of the teeth examined show normal or approximately normal histological pictures, or are pathological disturbances and divergences present?*». If the latter is the case, then comes the decisive question: »*Are the pathological changes thus shown to exist insignificant and variable or are they strongly pronounced, easily discernible and regular in character?*».

4. Forming an estimate of the material.

The series of cuts have been investigated in the following manner: after the first scrutiny the diagnoses were noted in each case for dentin, cement and the state of the pulp. This work took over a year after the series of cuts had been completed. It was not until then that the task of statistically compiling the whole of the material collected from the investigation had proceeded so far that it was possible to draw up a tabular summary and compare it with the extraction material. It could already be ascertained from the first scrutiny that large groups of the material were dominated by uniform and easily determinable changes differing from the normal dental picture. Upon a fresh scrutiny the diagnoses within the local divisions were collected together, the grouping corresponding to that in the statistical study of the dental investigation (Holtz's and Lindström's researches) and in Odin's and Byttner's medical examinations.

B. The diagnoses.

The divergences from a normal dental picture that were found to exist in the extraction material I have divided for the sake of simplicity and easier comprehension into three groups:

1. »Scorbutic» changes.
2. »Rachitic» changes.
3. Inflammatory changes.

Of these groups of changes, those under head 2, the »rachitic», are the most easy to observe and diagnose. They consist of *dèficient calcification* of the enamel and dentin. The symptoms are: in the *enamel:* enamel hypoplasia of various kinds, ranging from deep grooves and hollows, via perichymatiae or lines of imbrication of greater depth, to diffuse, opaque spots on the surface or microscopic gaps in the cuticle; in the *dentin:* the calcified zone or the fully constructed dentin shows an abnormal distance between the lime-globules, whence arise contour bands with enlarged »inter-globular» spaces; the *pre-dentin* is proportionately far beyond its normal breadth, and, in cases of teeth apically not completely built up, the apical termination consists of uncalcified dentin. The »rachitic» changes thus represent only injuries due to deficient fixation of the calcium in the dentin. In diagnosing them no account need be taken of caries, inflammation of the pulp, abrasion, alveolar pocket-formations or the results of other external injuries and intervention. The rachitic changes are thus capable of examination, and if they are present may be diagnosed in all cases. The idea of putting the word »rachitic» within quotation marks is to denote that the changes belong to the characteristic symptoms of the disease rachitis in the hard substances but by no means invariably justify the clinical diagnosis of rachitis. (See below under »Diagnosis and complex of causes of the »rachitic» dental changes».)

The inflammatory changes are in the majority of cases not very difficult to diagnose. In respect of the hard substances, refer to this group first of all the entire carious picture and in respect of the pulp all the ordinary symptoms of inflammation: from the primary alterations in the peripheral points of irritation with the relative vascular dilatations, emigrations of leukocytes, and hydrops, to the ultimate states of phlegmon and gangrene of the pulp. For the sake of lucidity I have also referred to this group of changes such degenerations as are the result of abrasions as well as of surgical intervention, i. e. fillings. The inflammatory changes and the »rachitic» changes may be diagnosed simultaneously.

The »scorbutic» dental changes are, for reasons that will be explained in detail later, the most difficult to diagnose; not because of their being in themselves vague and uncertain — on the contrary, they are particularly pronounced — but because, when they are being diagnosed, special care must be taken to avoid confusion with presumably similar changes under the influence of injuries, infection, ageing and diseases. The »scorbutic» changes can thus only lend themselves to diagnosis in cases in which the groups of causes just mentioned are either absent altogether or else can be deprived of significance. »Scorbutic» and »rachitic» changes can be diagnosed simultaneously. To the scorbutic picture are referred the following morphological symptoms (in brief): *The pulp:* degeneration of the odontoblastema leading to structural changes or loss, reticular atrophy in the course of vascular expansion, hyperaemia and hydrops, the gradual conversion of the embryonal pulp

tissue into mature fibrillary connective tissue, degenerative calcification in vascular walls and pulp mass, haemorrhage (of earlier date) accompanied by reactions in the tissues, formations of denticles of various kinds, necrosis and cyst formations of a hydropic nature. *The dentin:* dentinolysis from the Tomes canaliculi in the old dentin; cessation of normal dentin structure in the new hard substances, which exhibit all types of irregular dentin; pulp bone and, finally, amorphous calcification of the walls. *The cement:* resorption. All these changes are bound to be present in a regular interconnection to permit of diagnosis. The healing processes go in the opposite direction to form new embryonal pulp tissue, and via osteodentin to the final building-up of normal dentin.

C. The approximate distribution of the changes within the material.

Västerbotten.

Västerbotten is the best represented area in my material. Only groups of material collected in that county afford any useful survey of the microscopical dental conditions obtaining amongst the population under investigation. The Västerbotten material is discussed below; the material from Norrbotten and that from Scania will then be used for purposes of comparison.

The material collected in 1929.

1. *Stensele, Sorsele* and *Dorotea.*

This large body of material is the most uniform of all the groups. The *scorbutic changes* are entirely predominant. Here it is not a question merely of a *majority* of cases discovered, for there is not a single tooth within the group that does not show marked and easily observable changes.

The *Dorotea* cases are in a class by themselves. The changes here are of a particularly serious character. Nowhere else within the areas investigated have such severe injuries to the pulp been discovered. They are extraordinarily similar when viewed microscopically; to judge from the appearance of the pulp, all the teeth might have come from one family or even from one single person. The general *characteristics* are as follows; *the pulp*: extraordinarily severe *hydrops*; the embryonal pulp tissue *lacerated even within the entire pulp cavity*; in places where tissue structure still exists the distended and enlarged meshes are generally filled with *degenerate remains of earlier bleedings*;

most frequently these have especially accumulated beneath the odontoblastema at the bottom of the pulp and the sides of the canal openings towards the bifurcation; the vascular structure in the centre of the pulp has the appearance of hard strings of dense collagenous bands covered with numerous phlebolith-like calcareous concretions; there is scattered degenerative calcification in compact rows in the root-canal. *The odontoblastema*: the apical third of the root-canal, the bottom of the pulp cavity and the sides of the bifurcation are generally entirely lacking in odontoblastema or possess only degenerate remains thereof, *the walls of the pulp cavity possess strongly hydropic blastema where only here and there atrophic cells remain*, the roof of the pulp cavity and the diverticula have wasted portions resembling cysts with the blastema like a wall separated from the dentin; in some cases an atrophic osteoblastema is observed here. *The dentin*: within the apical third, up towards half the height of the canal, extensive dentinolysis is observed, generally an htx-stained, gravel-like mass filling up the extensive porosities; in the other parts normal dentin, but in the majority of cases one or two bands of minor inter-globular spaces in the sides and roof of the crown. *New wall-deposits*: in cases of abrasion inside the dentin cusp remarkably slight processes of irregular dentin in the diverticula; where such do occur, they show no dentin structure but fairly normal calcification; along the predisposed places in the walls of the root-canal there are relatively narrow, secondary deposits of dentin of poor dentinal structure, varying but little in their construction but containing healing hollows and lines; in the apical third are somewhat broad bands of amorphous calcification of the wall. *The cement*: numerous resorptions or entirely healed resorption-holes.

Stensele and *Sorsele* show scorbutic changes of a somewhat milder type than Dorotea. The best pictures are found amongst the cases collected from *Skärvsjö* and in some cases from *Bure village*; the *Ammarnäs* cases most closely resemble those from Dorotea. These groups of material are likewise surprisingly uniform; one cannot resist the impression that in each locality there is something peculiar to itself in the character and extent of the dental changes. In the more favourable cases the pulp picture is better, the normal structure being specially conspicuous in the cavity. The odontoblastema is likewise better preserved on the walls of the pulp cavity. On the other hand — and this

is particularly so in the Skärvsjö and Bure cases — the new deposits of hard substance are stronger, harder calcified and of a more distinctly dentin-like character. The calcification of the pulp's central vascular system is more pronounced. The haemorrhage is extensive even in the cavity. Fine series of healing bands are found in the broader secondary dentin deposits.

There are individual cases of deficient coronal calcification. The forms assumed by the process of calcification do not as a rule exhibit the same uniformity as the other changes.

The 6 milk teeth that are found in the material — 4 second milk molars and 2 incisors — all show changes presenting precisely the same integral histopathological picture as the permanent teeth.

An attempt has been made to group the teeth from women and those from men separately. It has not proved possible with any degree of certainty to observe any common differences.

2. *Byske, Bureå, Norsjö, Bjurholm.*

The teeth extracted from adults in these districts are not quite so uniform as in the preceding localities, though they possess very close resemblances. The *scorbutic changes* are predominant; they differ however from those in the Dorotea, Stensele and Sorsele districts and are distinctly of the kind called in experimental research mitigated changes. If, for instance, a pair of molars are selected from Bureå and Norsjö, the changes, as compared with those in Dorotea, may be summarized as follows: *The pulp*: fibrillary conversion and calcification predominate in the pulp pictures, while hydrops in the tissue is not very conspicuous; the pulp cavity has a strong fibrillary area close to the vessels in the centre, besides which, the intermediate space is for the most part occupied by particularly complicated denticle structures. *The odontoblastema*: *the blastema in the cavity is well preserved along the sides* and replaced by an odonto-osteoblastema along the roof, bottom and diverticula; in the canals osteoblasts along the walls down towards the apical third, where the blastema often ceases in connection with amorphous calcification of the walls. *New structures*: the diverticula substantially filled up and elaborate systems of denticles in the pulp cavity which have in numerous places healed at points of contact with the bottom and the roof; broad deposits along the walls of the canal, particularly the upper parts thereof near the bifurca-

tion; these carry a varying structure of an irregular type of dentin and pulp-bone.

From *Risberg, Norsjö* there is material consisting of 2 milk molars, 1 six-year molar and 1 cuspid, all of which, curiously enough, exhibit somewhat serious pictures closely resembling those from Dorotea.

The five teeth from *Bjurholm* are divergent. Here the changes are far slighter than in the case of Byske and Bureå — a fact that deserves special attention.

The calcifications are clearly normal. There is no hard, degenerate scorbutic calcification.

The children's teeth are in this case distinguishable from those of the adults. The mitigated scorbutic pictures fall into the background and are no longer predominant. Instead, rachitic calcification is observable in the crowns, especially in the layer immediately beneath the enamel (presumably due to the mothers' lack of vitamin D during pregnancy).

3. *Umeå.*

The large body of material from the Umeå Hospital is divisible into two groups. The first embraces the 63 cases collected in the course of this investigation, the second the 51 cases previously examined by me (in connection with my own studies at Dr. Odin's surgery before the present investigation was started).

The first group, which is of chief interest here, has proved to be singularly valuable. It affords further proof of the already known fact that cases treated in the medical ward of the Umeå Hospital showed a marked difference after the stay in hospital compared with when first received into hospital. The difference lies in the fact that the series of scorbutic dental changes observed upon entry into the ward are in process of healing or are already healed upon discharge. Winström, who performed the extractions in these cases, has supplied material by which this can be demonstrated. On the one hand, the majority of selected cases show scorbutic changes on a more or less considerable scale, and on the other hand, in 4 undoubted cases that have undergone changes of the same nature and to the same extent as the others, I myself have observed how splendidly they have healed after the patients' stay in hospital. The healing process is characterized by new embryonal tissue, resorption of the denticles and the formation of new dentin over the scorbutic wall-deposits.

Scorbutic changes of so severe a nature as in Doretea, Stensele, Sorsele, are in this group rare. The mitigated type of change is predominant. The blastema of the pulp cavity is in most cases not seriously injured. On the pathological formations of new hard substance there are dense series of calcium-stained contour-bands alternating with parts in process of healing, marking different stages of variation over a long period of years. In 28 cases exact data regarding diet are available. 17 of these cases belong to group L; in 12 there is a record of LIa diet. The changes undergone by these 12 cases are not appreciably more serious than those undergone by the rest. An individual variation within the scope of the scorbutic changes is more common than a resemblance between teeth from cases of the same type of diet.

The second group, which is from material collected in the course of my earlier studies at the hospital, is of an entirely different character. I was then engaged in studying vitamin C in Man, and the cases for this purpose were selected partly on the basis of data relating to deficiency of C as recorded in the dietary anamnesis, and partly with the object of comparing C-hypovitaminotic cases and cases of leukemia, purpura, morbus Werlhofi, diabetes, tuberculosis etc. The primary value of these cases lies in the fact that evidence was obtained of the scorbutic changes' correlation with C-deficiency. (I would refer the reader to my monograph and to the inquiry reported under »Complex of causes governing the »scorbutic» dental changes».) A further gain derived from the study of this material was the knowledge obtained concerning the distribution of the scorbutic changes within the county. The dental investigation demonstrated that the otherwise healthy cases collected from the town of Umeå and its immediate vicinity yielded quite ordinary scorbutic dental pictures, such as I had already found to exist in previous investigations in Stockholm and elsewhere, whereas the mitigated and serious pictures were to be found in the very cases taken from more remote coastal districts and isolated localities inland, where the present investigation had established their existence.

The non-adult material collected in 1931.

1. *Tärna.*

The thirteen cases from Tärna represent perhaps the most interesting group in the whole of our collected material. All

the teeth are extraordinarily alike under the microscope. The nearest thing I can compare them with would be cases taken from an investigation into an experimental deficient basic diet, or something of that sort. If one takes haphazard out of the drawers of prepared specimens a collection of slides, one might imagine, as far as the changes are concerned, that they all relate to the same tooth.

The »rachitic» changes entirely predominate in all the pictures. The dentin structure is characterized throughout by the numerous, deficient calcified bands in the area of the crown. The broadest zones with interglobular spaces are here found in the superficial area, frequently just below the enamel, (due to deficient conditions in the mothers). Otherwise individual variation occurs only in the breadth of the succeeding non-calcified or deficiently calcified zones. Deep down in the poorly calcified dentin cusps there are extensive abrasions, the corresponding diverticula showing variations in the degree of calcification.

The »scorbutic» changes in the teeth are remarkably inconspicuous. None of the cases show destroyed tissue structure in the pulp cavity. In root canals and the bottom of the cavity, as also in the apical third, there are fine, relatively broad layers of irregular dentin with yearly variations in the canalization. No bleedings or hydrops.

Inflammatory changes are both slight and infrequent.

2. *Åsele, Lycksele, Långsele.*

If these cases are combined into one group, the material becomes extremely heterogeneous. It is impossible here to obtain uniform diagnoses from a majority of the cases: normal cases as well as scorbutic, rachitic and inflammatory changes are all represented in an irregular line. The teeth from Långsele are dominated by scorbutic changes; moreover the blastema of the cavity is here destroyed by hydrops and atrophied, but the cases are only 3 in number. Åsele is represented, inter alia, by a six-year molar with open apex, in which the dentin wall terminates in a broad and entirely uncalcified rachitic zone; the dentin body is covered with close series of annual rings and, in particular, a central zone with interglobular spaces in the middle of the crown; in the area at the bifurcation lies a composite pulpal denticle with numerous varying overgrowths of dentin. The material taken from this locality contains two cases of pulpitis,

one of them accompanied by abscesses, also two second milk molars, one of which is affected with pulpal hydrops accompanied by destruction of the blastema in the pulp cavity, whereas the other's pulpal blastema is in splendid condition and its embryonal connective tissue is dense. The Lycksele cases show an approximately similar variation; rachitic changes (milk teeth) may possibly be predominant.

Norrbotten.

Non-adult material collected in 1931

from Jokkmokk, Arvidsjaur, Kobdalis, Vuollerim, Kalix, Nederkalix and Övertorneå.

This material is inferior to all the rest, i. e. it is of less value from the investigator's point of view. HENNICHS, who collected it, gives as the cause the poor condition of the dentures, which rendered it impossible to procure satisfactory material. All the dental pictures are dominated by the inflammatory processes, but it is only in Kalix and Nederkalix that these occur to any great extent. To my great surprise the teeth from Jokkmokk, Kobdalis and Vuollerim *show remarkably less pronounced scorbutic and rachitic changes.* Upon a careful comparison between these teeth and the teeth from Scania it would appear that the latter are in many cases decidedly inferior. One of the Arvidsjaur teeth, however, shows the most severe rachitic destruction exhibited in the whole of the material, the dentin mass in the crown of the milk tooth having the appearance of a sieve; here the interglobular spaces are true porosities.

Otherwise, these teeth are often sound, possessing a normal dentin structure and normal structure in the pulp chamber. The pulp in the root canal shows strongly increased fibrillarity, and in the apical third there are the ordinary scorbutic symptoms. It is worth noting that all the teeth from Övertorneå, Kalix and Nedre Kalix are entirely without diverticular structures; they have normal pulp and no denticular structures in the cavity or the root canals; while only within the apical third is it possible to observe slight divergences from the normal type of blastema and pulp. Rachitic calcifications on a small scale are demonstrable in cases from Övertorneå only. In short, it may be said that this material shows the least hypo-vitaminotic changes in the dentinal and pulpal structures.

The 9 teeth from Långnäs, Piteå (extracted from adults) form a heterogeneous body of material without any pronounced character. 4 are practically normal, showing only slight scorbutic changes farthest down towards the apex; 2 exhibit somewhat more marked symptoms; in the remaining three numerous annual rings are observed in the crown, the degree of calcification varying.

Scania (Skåne).

The material collected in Scania afforded me the greatest surprise in the whole investigation. True, 6 of these teeth were found to be very normally constructed and calcified without giving occasion for any special comments. 1 of these, a six-year molar belonging to an 11-year-old girl, is the most normally ideal tooth I have so far studied under the microscope, the pulp being perfect and the odontoblastema absolute. Moreover, many signs are to be found of an individual type; the same peculiar uniformity in the pictures does not occur here as in large parts of the material from Norrland. On the whole, however, this material likewise shows remarkably wide divergences from normal structure and calcification. The predominant changes are the rachitic. Except for the Tärna material, *the Scania teeth exhibit the greatest and most serious frequency of deficient calcifications.* This is particularly striking in the large number of second milk molars in which the coronal area is characterized by singularly broad zones of Owen's contour-bands with extensive interglobular spaces. The 4 six-year molars (there are a total of 5 in the group; re the remaining one see above) show the same changes, though they are less severe; here we find broad zones of predentin, particularly in the apex.

Compared with these changes, the scorbutic changes are not so dominant, though they are by no means altogether absent. In no case are they in evidence along the walls or in the free tissue of the pulp-chamber. Broad secondary dentin zones occur along the walls of the root canals, with finely marked bands in process of healing; the dentin body exhibits numerous annual rings. Large formations of denticles, varying widely in their coating of dentin, in several cases fill up most of the pulp cavity of the second milk molars and in one case that of the six-year molar as well. Slight capillary bleedings beneath the odontoblastema are remarkably common.

The number of inflammatory changes is relatively large. In most of the milk fives are observed pit- or crater-like abrasions in the dentin cusps. Subjacent diverticula are filled with secondary dentin, which has undergone very little calcification.

The supplementary cases.

The Kiruna teeth.

These teeth are surprisingly normal both in their pulp and in their dentin structure. In none of them have serious scorbutic changes been observed, but all without exception possess changes in the interior dentin wall and the tissue of the root canal which are of a milder type, often showing signs of recidivation and healing at intervals. The rachitic changes are numerous, though in no case do they exhibit serious forms but consist only in the dentin's being clearly marked with annual rings, in which are relatively large interglobular spaces.

The Skellefteå teeth.

These teeth are very badly damaged by caries and inflammation. There are no pronounced scorbutic or rachitic changes, or else they could not be diagnosed owing to the ravages of pulpitis and caries.

The Umeå teeth.

These cases, which are intended to fill up the gap in the series investigated in 1929 and 1931, have been selected by Dr Saedén. We find wide variations here and uniform changes are not predominant. Nevertheless, the rachitic disturbances retarding the process of calcification, though not widely dispersed, are quite abundant. The scorbutic changes are on the whole confined to the apical third and are not very conspicuous. Inflammatory symptoms are common. In 4 cases masses of hard substance fill the diverticula, the calcification being fairly normal. In three cases it is observed that the pulp has been seriously destroyed by hydrops, damage being seen also in the pulp cavity and its blastema.

D. **Illustrated material.**

In order to afford a clearer idea of the above-mentioned changes I reproduce here a series of microphotographs taken

from the extraction material. On the whole, the pictures I have selected do not tell us anything very fresh beyond the phenomena with which we are already acquainted. I have deliberately avoided all peculiar or uncommon pictures. On the contrary, the pictures represent typical and quite common phenomena found in the material, which means that for each group has been selected the series of pictures that may be said to represent in greatest detail that particular kind of disorders with which it is concerned. For this reason the smallest number of pictures have been devoted to the inflammatory changes, for I have considered it unnecessary to reproduce pictures depicting caries or pulpitis as they are to be found illustrated in all the ordinary odontological textbooks. However, pictures are published here of inflammatory cellular infiltrations around the pulp vessels of the canal-opening when irritation arises from the cervical surface of the tooth, and also of the carious reaction in cases of rachitic and scorbutic changes. The »rachitic» changes are bound to be uniform and similar in type, seeing that variations relate only to the quantitative differences in the defective process of calcium fixation in the dentin. The »scorbutic» changes show of course the widest variations and are therefore the most abundantly represented. (I would however refer any interested reader to my monograph on dental scurvy in Man, which is more profusely illustrated.) The pictures reproduced here are selected with a view to giving the reader an approximate idea of the nature and extent of those divergences from the normal picture which are so frequently found in the material.



Fig. 1. *Normal dentin, normal odontoblastema.* Apical third, six-year molar. *Scania.*



Fig. 2. »*Rachitic*» *damage to the process of calcification.* Dentin cusp, second milk-molar. *Scania.* Series of broad contour-bands with wide interglobular spaces.

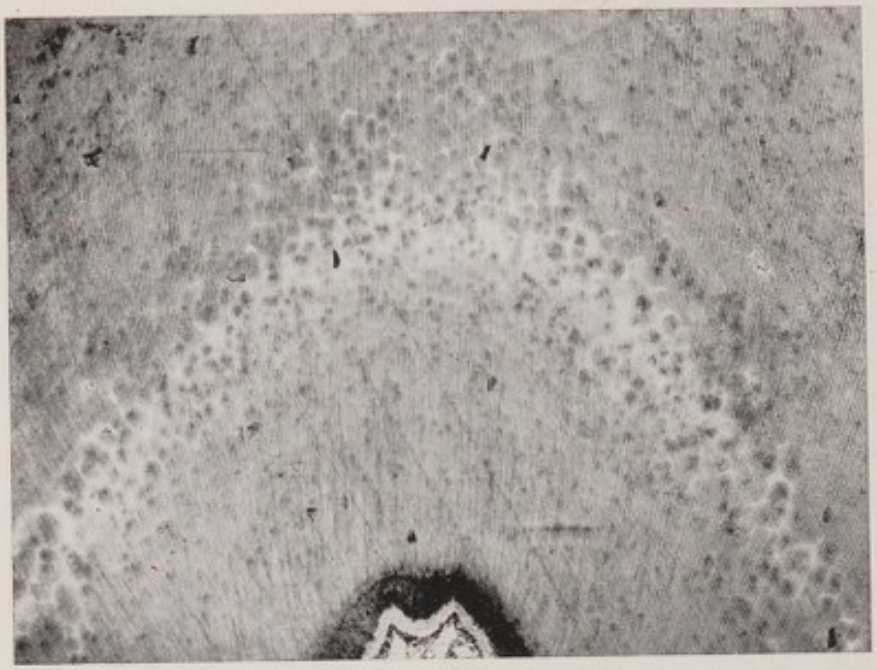


Fig. 3. *»Rachitic» damage to the process of calcification.* The roof of the diverticulum, 6-year molar. *Umeå.* Typical contour-band, poorly calcified.



Fig. 4. *»Rachitic» calcification.* The apical dentinal point, 6-year molar. *Tärna.* Typical example of defective calcification, with excessive breadth of the predentinal zone.



Fig. 5. *»Rachitic» damage to the process of calcification.* Dentin cusp and side of the crown, second milk-molar. *Tärna.* Interglobular spaces give the dentin a porous appearance.

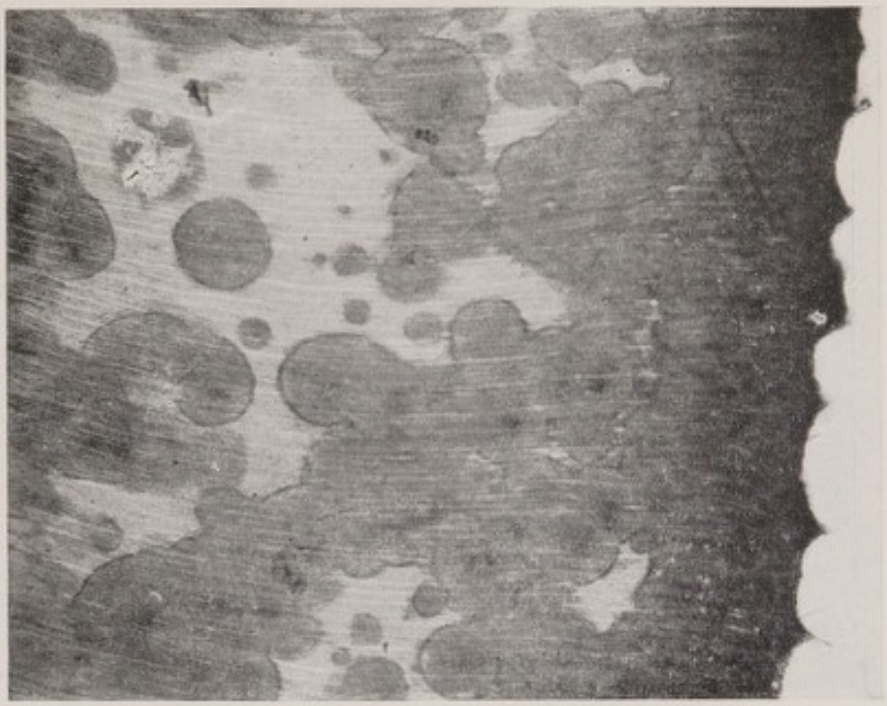


Fig. 6. »*Rachitic*» *damage to the process of calcification.* Proximal surface, dentin, incisor. *Tärna.* Extensive interglobular spaces immediately beneath the enamel.

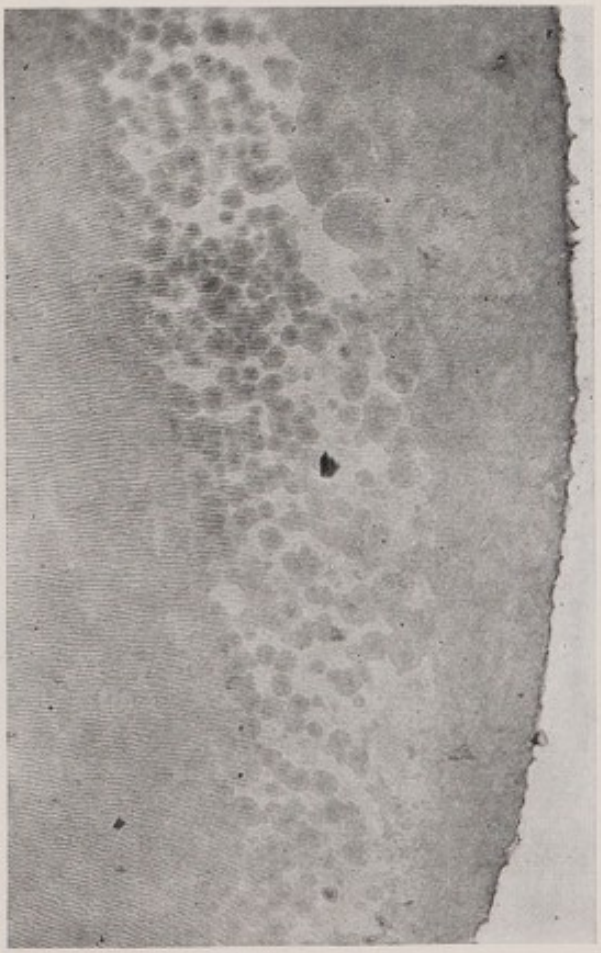


Fig. 7. »*Rachitic*» *damage to the process of calcification.* Labial surface, dentin, incisor. *Åsele.* Typical dentinal contour-band running into hypoplasia of the enamel.

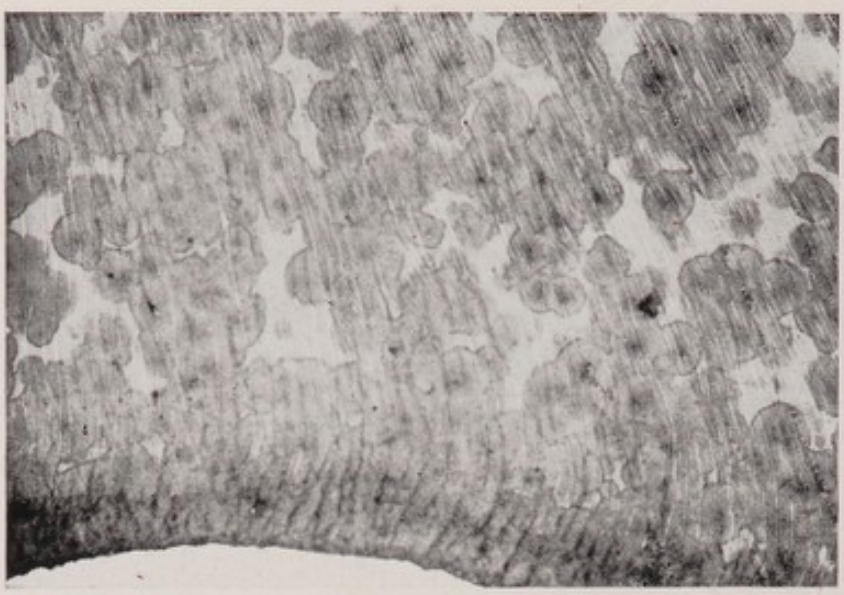


Fig. 8. »*Rachitic*» *calcification.* Porous dentin of the crown, second milk-molar. *Arvidsjaur.*



Fig. 9. »*Rachitic*» *calcification and caries.* Proximal part of dentin in the crown, second milk-molar. *Scania.* Lateral dispersion of caries within the contour zones with defective calcification.



Fig. 10. »*Rachitic*» *calcification and caries.* Proximal part of dentin in the crown, 6-year molar. *Norsjö.* Caries spreads into the interglobular spaces.



Fig. 11. »*Rachitic*» *calcification and scorbutic change.* New diverticular formation, poorly calcified, irregular dentin. Molar. *Sorsele.*



Fig. 12. *»Rachitic» calcification and scorbutic change.* New diverticular formation, poorly calcified, irregular dentin, second milk-molar. *Scania.*



Fig. 13. *»Scorbutic» injury to the pulp.* Odontoblastema on wall of bifurcation, second milk-molar. *Långsele.* Typical blastema-destroying capillary bleeding.

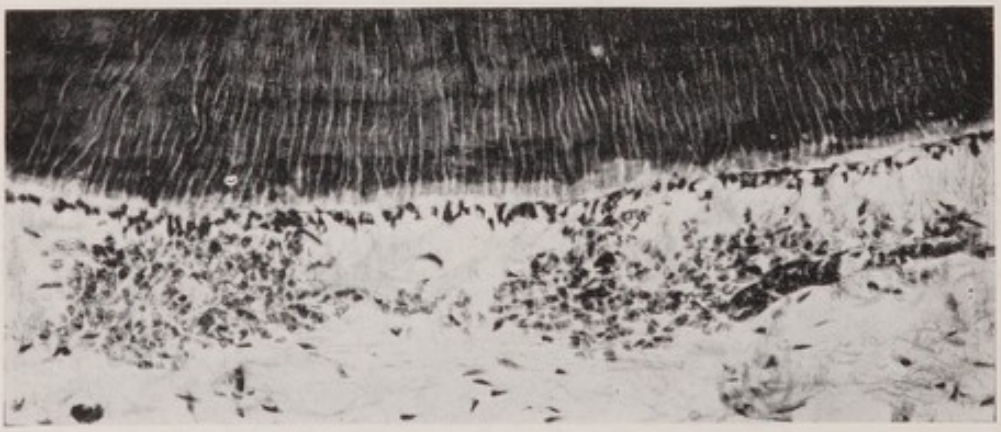


Fig. 14. *»Scorbutic» injury to pulp.* Odontoblastema, wall of pulp cavity, molar. *Stensele.* Series of bleedings beneath the blastema.

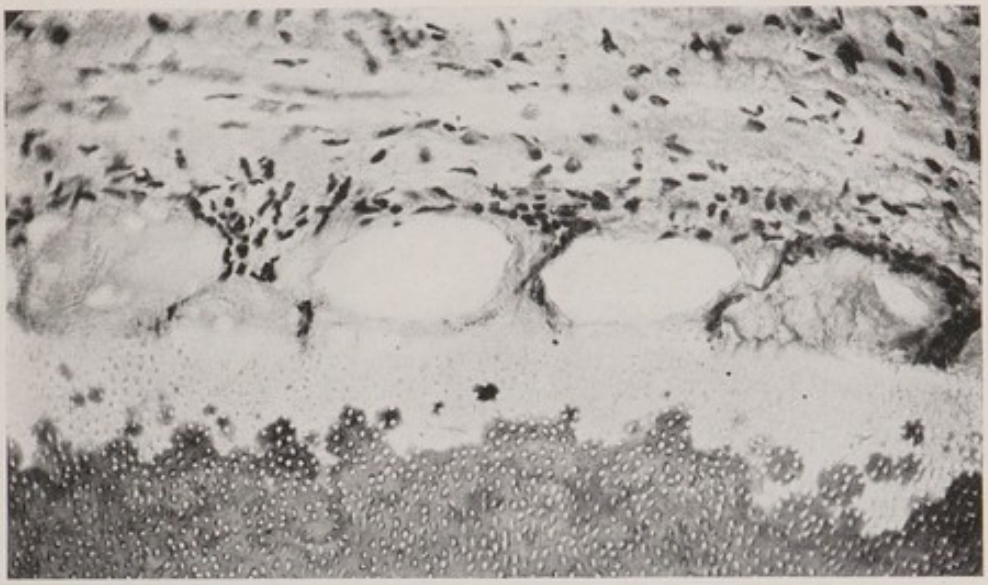


Fig. 15. »*Scorbutic*» *destruction of the blastema.* Odontoblastema, wall of the root canal, molar. *Dorotea.* Typical, hydropic destruction of the blastema.



Fig. 16. »*Scorbutic*» *destruction of the blastema.* Dentinal wall, odontoblastema, wall of root canal, incisor. *Dorotea.* The blastema completely destroyed, formation of irregular dentin and pulp bone.



Fig. 17. »*Scorbutic*» *destruction of pulp.* Dentinal wall and pulp, root canal, molar. *Dorotea.* Destruction of the pulp completed.



Fig. 18. »*Scorbutic*» *destruction of pulp.* Root canal, molar. *Dorotea.* The odontoblastema and pulp destroyed, amorphous calcification of the wall.

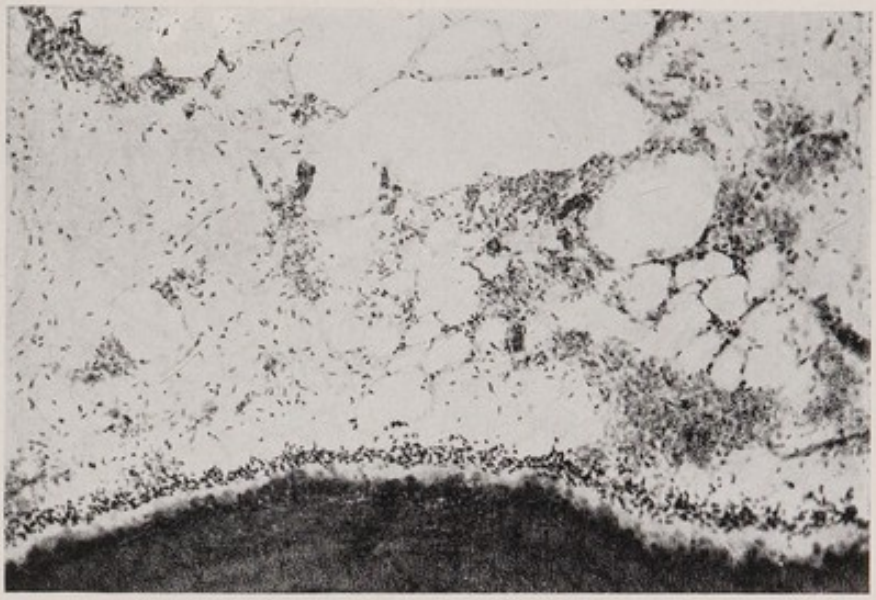


Fig. 19. »*Scorbutic*» *injury to the pulp.* Bottom of pulp cavity, second milk-molar. *Dorotea.* The pulp injured as result of numerous bleedings and hydrops.



Fig. 20. »*Scorbutic*» *structural change.* Root canal, cuspid. *Stensele.* The odontoblastema in last stages of disintegration, numerous bleedings, hydrops and calcareous degeneration of the pulp tissue.

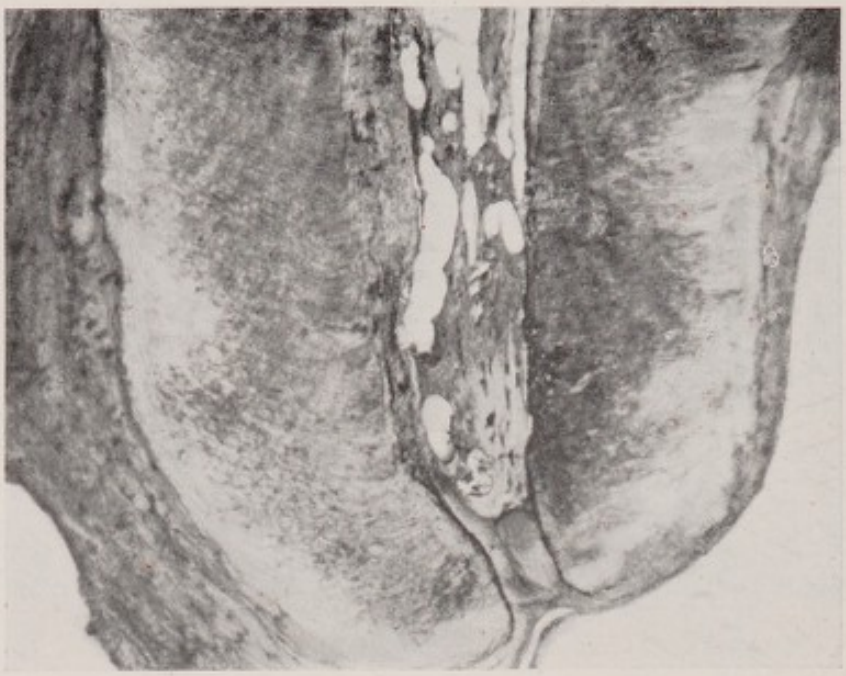


Fig. 21. »*Scorbutic*» *structural change.* The apical third, molar. *Dorotea.* The dentinal structure suspended, the odontoblastema eliminated, the pulp tissue destroyed, new formations of irregular dentin and pulp bone.



Fig. 22. »*Scorbutic*» *calcification.* Root canal, molar. *Umeå Hospital.* Typical calcareous degeneration and loss of blastema.

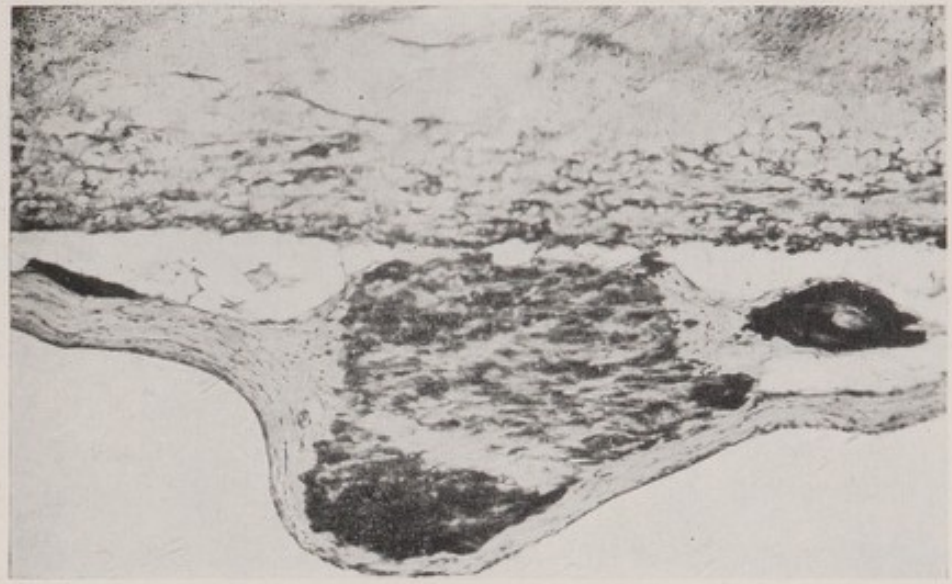


Fig. 23. »*Scorbutic*» *new formation and calcification.* The bottom of the pulp cavity, molar. *Dorotea.* Deposit of pulp bone along the wall and phlebolithic denticle, the blastema entirely destroyed.



Fig. 24. »*Scorbutic*» *new formation and calcification.* Canal wall at the bifurcation, second milk-molar. *Scania.* Typical calcification of vessel walls against the irregular dentin of the canal wall.

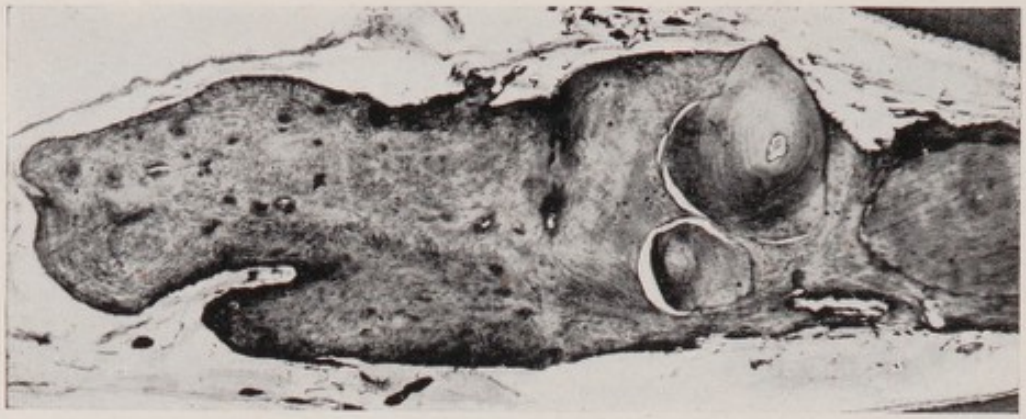


Fig. 25. »*Scorbutic*» *denticular formation.* Bottom of the pulp cavity, second milk-molar. *Bureå.* Complicated system of denticles. The structure shows seasonal variations in scorbutic formations and healing processes.



Fig. 26. »*Scorbutic*» *denticular formation.* Root canal, second milk-molar. *Scania.* System of denticles with numerous healed places and overgrowths of dentin.



Fig. 27. »*Scorbutic*» *resorption.* Apical third, molar. *Stensele.* Typical, numerous dentinal porosities, root denticle, recidivous wall deposits.



Fig. 28. »*Scorbutic*» *resorption.* Wall of the root canal, incisor. *Umeå Hospital.* Deposit of pulpal bone after resorption. The odontoblastema has been completely destroyed.

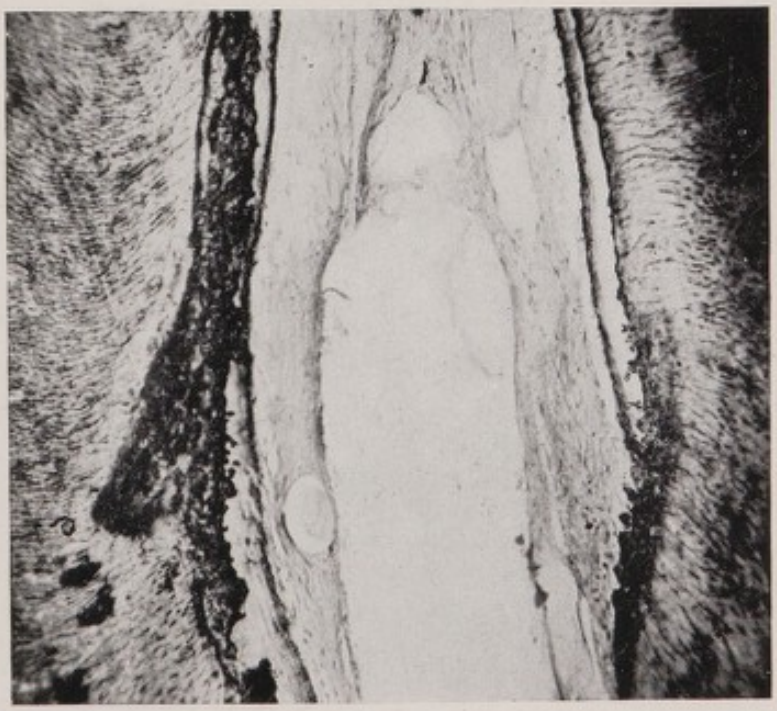


Fig. 29. *Healing process in the course of recidivous* »*scorbutic*» *changes.* Root canal, second milk-molar. *Bure Village.* Healing blastema, growing deep down from the pulp cavity, shows new scorbutic injury.



Fig. 30. *Healing after »scorbutic» injury.* Mouth of the canal, molar. *Umeå Hospital.* Typical deep growth of new osteo-odonto-blastema with irregular dentin over an earlier deposit of pulpal bone.

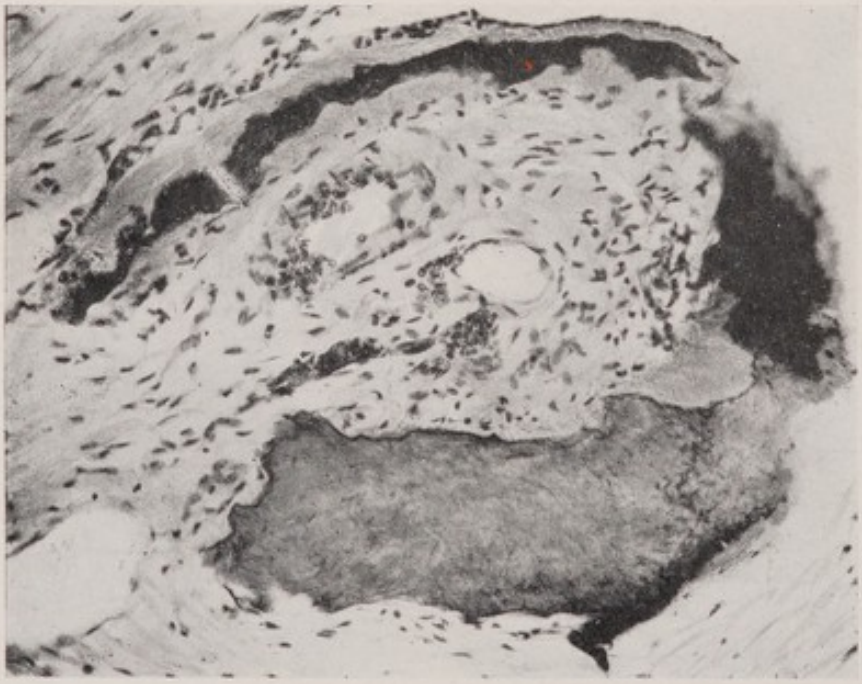


Fig. 31. *Healing after »scorbutic» injury.* Pulp cavity, molar. *Umeå Hospital.* Typical resorption of denticle.

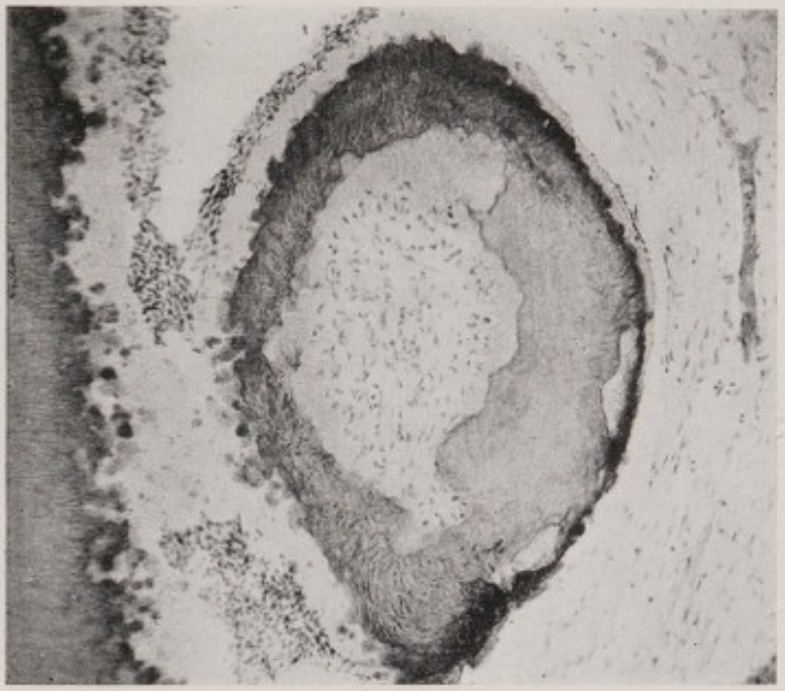


Fig. 32. *Healing process in the course of a recidivous »scorbutic» change.* Root canal, molar. *Bured.* Interrupted resorption and healing processes at the root denticle.

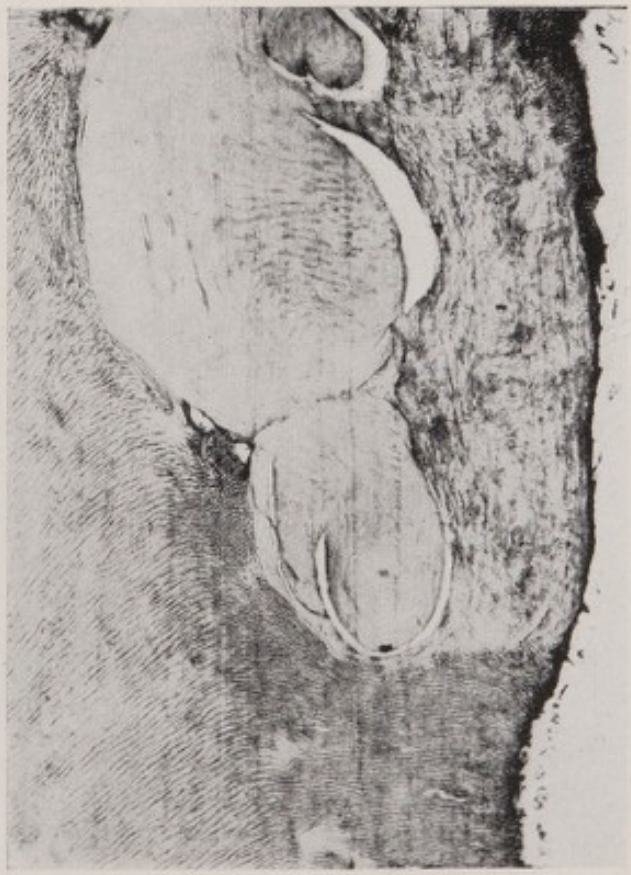


Fig. 33. *A denticle healing in the course of a recidivous »scorbutic» change.* Root canal, cuspid. *Byske.* Healing process of a root denticle, formerly repeated, now again interrupted.



Fig. 34. *»Scorbutic» seasonal variations in the dentinal structure.* Canal wall, incisor. *Vuollerim.*

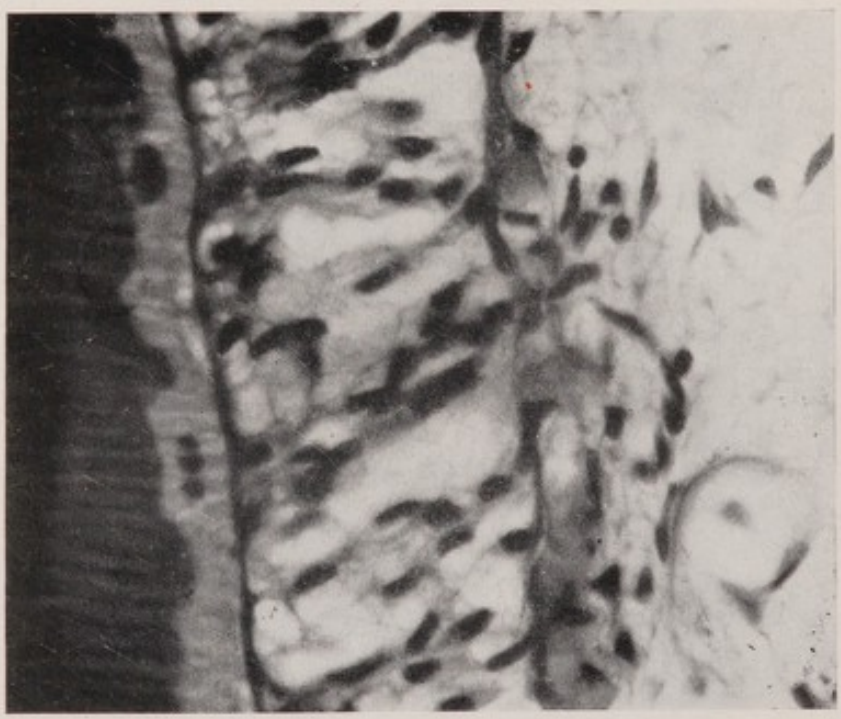


Fig. 35. *Regeneration of »scorbutically» destroyed blastema.* Wall of the pulp cavity, molar. *Umeå Hospital.*



Fig. 36. *Regeneration of »scorbutically» destroyed blastema.* Wall of the pulp cavity, molar. *Umeå Hospital.*



Fig. 37. *»Scorbutic» change structure showing »rachitic» calcification.* Wall of root canal, second milk-molar. *Byske.* Irregular dentin with defectively calcified predentinoid zone.



Fig. 38. *Caries and »scorbutic» change.* Wall of the pulp cavity, 6-year molar. *Asele.* Premature reaction in the form of secondary dentin in conjunction with de-differentiation of the blastema.

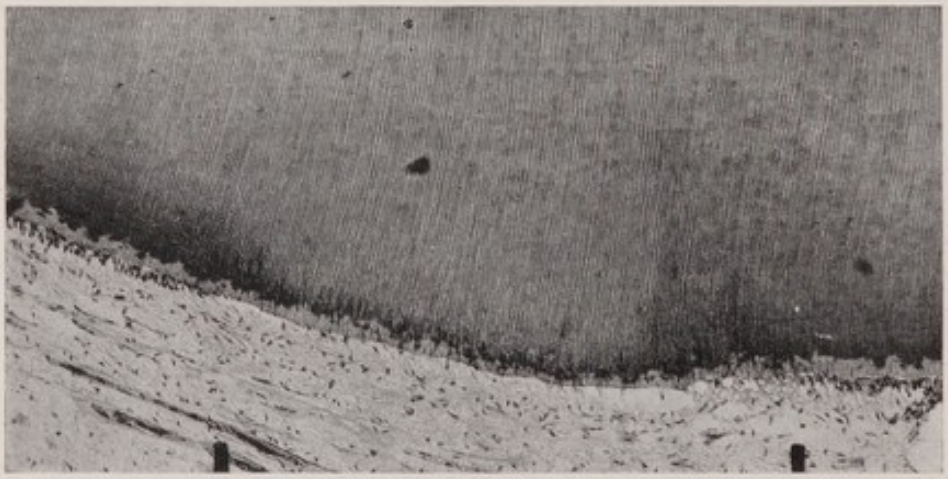


Fig. 39. *Caries and »scorbutic» change.* Mouth of canal, molar. *Sorsele.* Partial necrosis of the blastema along that part of the dentinal wall which corresponds to the superficial infection of the cement (between ■ — ■)



Fig. 40. *Caries and »scorbutic» change.* Wall of the pulp cavity, bicuspid. *Sorsele.* Partial necrosis of the blastema along that part of the dentinal wall which corresponds to the superficial caries of the enamel.

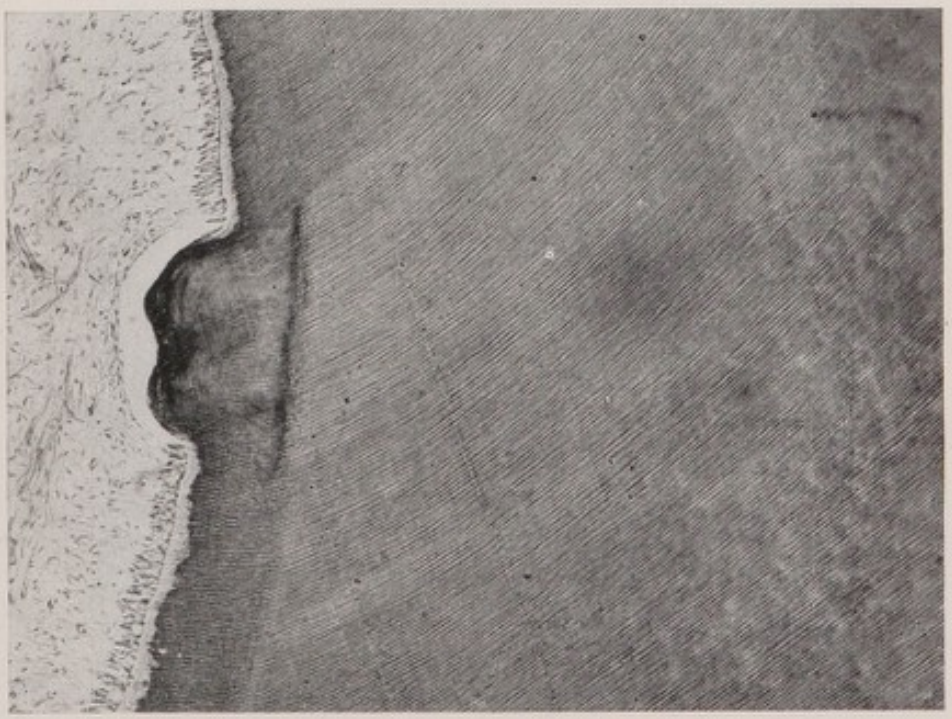


Fig. 41. *Pulpal reaction to caries.* Wall of the pulp cavity, 6-year molar. *Umeå.* Early stage of restricted reaction to superficial caries of the enamel.

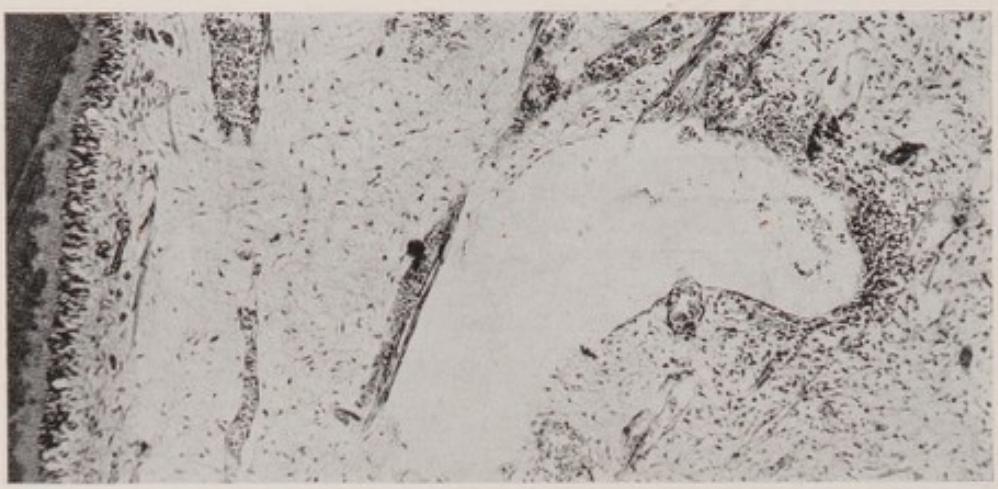


Fig. 42. *Pulpal inflammatory reaction to marginal infection.* Mouth of root canal, molar. *Långnäs.* Cellular infiltration into the tissue, oedema.

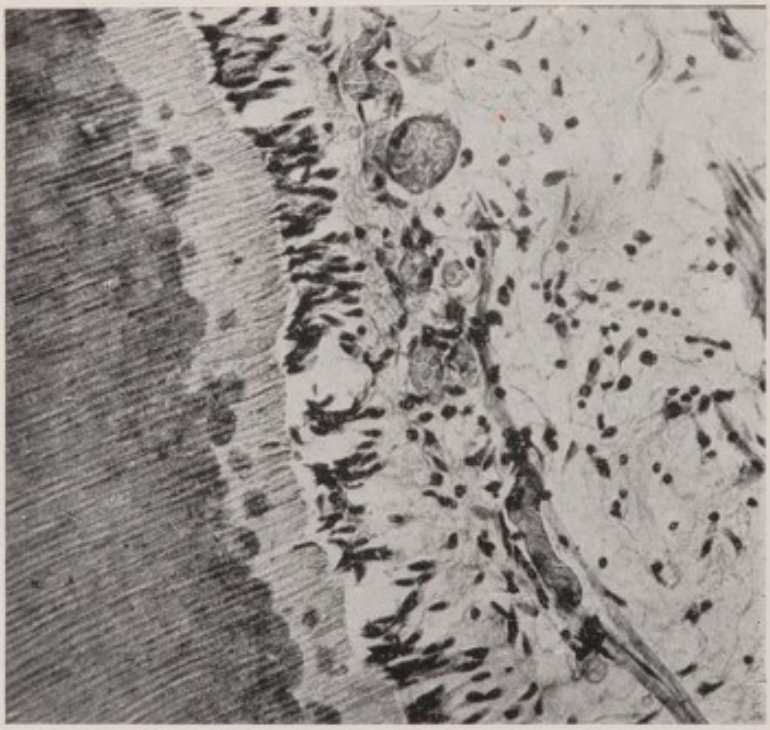


Fig. 43. *Pulpal inflammatory reaction to marginal infection.* Mouth of root canal, molar. *Umeå.* Cellular infiltration beneath the blastema, oedema.

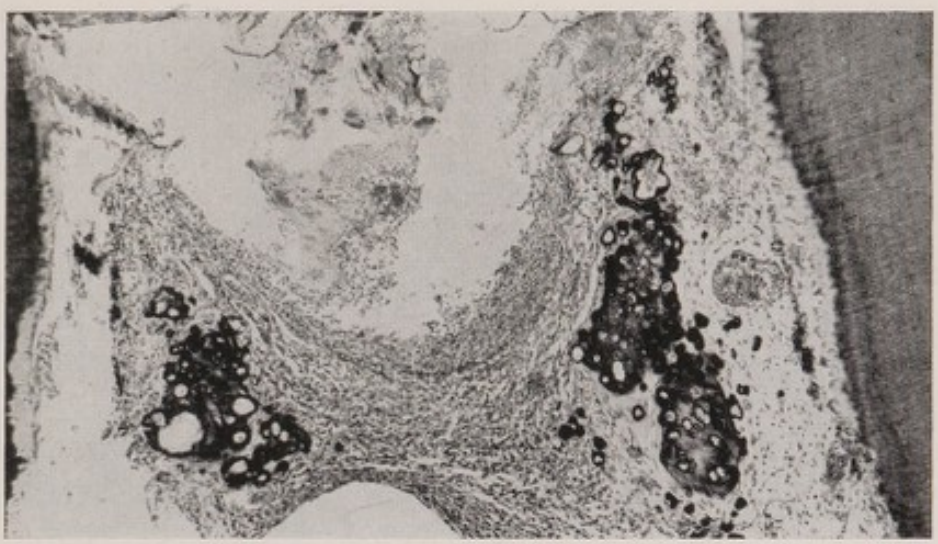


Fig. 44. *Chronic pulpitis.* Pulp cavity, incisor. *Umeå.* Proliferative and calcareous degeneration in the inflamed zone.



Fig. 45. *Chronic pulpitis.* Pulp diverticulum, molar. *Umeå.* Decapsulation in the inflamed zone, which has become calcified and subsequently acquired a dentinal structure.

E. Complex of causes governing the "scorbutic" dental changes.

1. General points of view.

In contrast to the view recently propounded by Fish-Harris that changes in the enamel are related to the pathology of scurvy I have already pointed out in my previously published monograph that, in cases of scurvy amongst those animal species which I have investigated, changes in the enamel have no relation to the typical and primary scorbutic changes in the hard substance. In Man it is conceivable that injuries to the enamel might arise secondarily in cases of serious Möller-Barlow. Throughout the many years I have spent studying cases of scurvy in the human subject I have so far never found any case of demonstrable scorbutic enamel changes. Enamel changes having a scorbutic pathogenesis will consequently not come under discussion in this study.

How far the changes in dentin and pulp that have been found to occur and which I have here called »scorbutic» are to be regarded as symptoms of a deficiency of vitamin C it is extremely difficult to decide. The question has given rise in odontological literature to two opposed views. The first of these is my own, as propounded in my monograph on scurvy published in 1931, to which reference has already been made; the other view has been developed by the German investigator Guido Fischer in a series of works on the biology of the pulp and the dental organ (published in 1932—33). In spite of the principle followed in these Norrland reports that they should not contain any account of literature or any criticism thereof, I feel it necessary, within the scope of the basic terms of reference laid down for this investigation, to discuss in some detail the two opposed views.

The author's view. Like certain species of animals, Man is extremely sensitive to a deficiency of vitamin C. It is primarily the tooth that reacts through the odontablastema and the embryonal connective tissue of the pulp. The supply of vitamin C plays a decisive part in the structure and calcification of the dentin and determines its form as well as governs the biology of the pulp through its effect on vascular structure, the condition of the tissue and cellular development. The fact that the pulp reacts as soon as there is the slightest reduction in the quantity of the protective dose of vitamin C is also due to the adverse

anatomical conditions, the confinement within the dentinal body and the absence of collateral circulation. The more closely confined the pulp cavity is and the more inefficiently the vascular apparatus functions, the more serious, owing to lack of vitamin C, will be the changes undergone by the cells and tissues. Within the foundations of the teeth in the jaws, with their wide-open access to the pulp, lack of vitamin C does not arise at an earlier stage than it does in the osseous system as a whole. Thus, in the case of a slight deficiency a milk tooth may show extensive changes, while the germ in the jaw shows no such distinct changes. *This however by no means implies that the disturbance in the vascular system is the cause or explanation of the starting of the change. If the lack of vitamin C goes on for any length of time, or if it assumes a more serious character, then even those areas that have the best supply of vessels and which function best will ultimately be affected by the same kind of changes.* Consequently, anatomical and physiological obstructions are merely aggravating factors in the pathogenesis, causing the injury to manifest itself at an earlier stage than it would otherwise have done. *If the supply of vitamin C is kept sufficiently high, then neither anatomical nor physiological obstacles to the normal functioning of the vessels are capable of giving rise to scorbutic dental changes.* It follows from this that *the greater these obstacles are the larger must be the quantity of vitamin C supplied in daily doses in order to avoid C-hypovitaminotic changes.*

There is agreement in principle between the dental changes due to lack of C in Man, the ape, the dog, the guineapig etc. Those parts of the pulp that have the smallest quantity of embryonal connective tissue, which are most exposed to injury as a result of change of pressure and which are poor in the supply of capillaries to the odontoblastema are those which, in different types of tooth, are the first to be affected by C-hypovitaminotic changes even upon the slightest reduction in the daily dose of vitamin C below the protective minimum. In the human tooth these areas are the apical third and, in teeth with several roots, the coronal entrance to the root canal at the bifurcation and the top of the pulpal diverticulum. The dentinal body that is enclosed in cement shows greater sensitiveness to blastema than that part which is enclosed in enamel.

Indeed, the odontoblastema is not of equal value in the tooth. We have two types of odontoblastema along the dentin walls, the one corresponding to the enamel, the other to the cement. The cell elements of the former are stronger and longer than those of the latter, which appears to be more akin to the osteoblastema. The blastema-dedifferentiation (Wilton) in C-hypovitaminosis first attacks, morphologically speaking, the cement odontoblastema, and then, when the deficient condition is more severe or more protracted, it affects the enamel odontoblastema.

The coronal third in the guineapig's tooth is invariably exposed to C-hypovitaminotic changes, even if the animal is kept in a stall with a good supply of food containing vitamin C. In order to prevent the coronal third from undergoing such changes it is necessary to give a daily controlled supply of vitamin C in very large doses or a minimum of 10 gr. orange juice or 2.5—3 mg. ascorbin acid daily to animals

weighing 250—400 gr. and living on a basic diet free from vitamin C during an experimental peroid of 30—40 days. If we assume an equal degree of sensitiveness in Man, then — on a comparative estimate per kilogramme of bodily weight — a supply of about 2,000 gr. of orange juice is required daily in order completely to protect an adult person living on an otherwise vitamin-C-free diet from C-hypovitaminotic changes within the apical third of the tooth. It should be observed that probably under no circumstances does Man live on a diet that is to him free from vitamin C. The avitaminotic conditions seen in the guineapig living on a basic diet are as a rule not found in Man. Even human scurvy observed under clinical conditions shows mitigated scorbutic changes in the dental picture. The closest comparison between these animal species should therefore be made from the latent scurvy existent in the teeth of animals kept in stalls to the latent forms of scurvy in the teeth of Man. In both cases the supply of vitamin C is on the short side and is uncontrolled. Consequently the great majority of people in a civilized community at the present day *carry latent C-hypovitaminotic changes in their dental organ.* These changes belong to the physiological borderland; their degree of severity and their extent depend upon the size and duration of the deficiency of vitamin C in the daily diet. *Only a daily controlled, very abundant supply of vitamin C in the form of general articles of food containing vitamin C (milk, potatoes etc.), with the strong addition of orange juice, lemon juice, fresh fruit and vegetables or ascorbin acid, injected or taken per os, can prevent C-hypovitaminosis in the dental organ from becoming, in the true sense, a symptom of a general state of ill-health caused by a lack of vitamin C.*

Since the scorbutic injuries are in principle to be regarded as de-differential changes, the elements of the odontoblastema become more sensitive to lack of vitamin C the older it is, that is to say, the longer the time that has elapsed since the complete process of differentiation has run its course. The consequence is that the permanent tooth's need for C in Man gradually increases. After he has passed the 30's or 40's, for instance, Man's demand for supplies of C in order to maintain a normal condition in the blastema within the tooth would appear to be extraordinarily heavy.

General physiological and pathological conditions that have the effect of producing disturbances in the tooth's vascular system and its function, in particular general diseases of the circulation, local affections of the circulation (inflammatory conditions such as so-called paradentitis), and, finally, the ageing process, likewise combine to induce an earlier appearance and a severer form of the latent C-hypovitaminotic dental changes. *But the changes are nevertheless in their nature and in their cause hypovitaminotic and should be called scorbutic dental changes.*

In order to form a proper estimate of the extent and degree of severity of C-hypovitaminosis we must avoid any confusion with cases of inflammatory changes or general diseases accompanied by known disturbances in the circulation; moreover, special attention should be paid to increasing age. So far, however, I have not found any evidence that *healthy* human beings show the *total* pathological picture of scorbutic dental changes *for any other latent cause than lack of vitamin C*; on the contrary, in all those cases in which I have controlled the supply of C by

means of a substantial daily dose of vitamin C, I have observed how even so-called senility changes of a de-differential character have started healing. As I have demonstrated in my monograph, even in the case of old men in the seventies, showing every recognized sign of senility, the heavy deposits in the vascular walls in the pulp have then given way to an active resorption, degenerative denticular structures have been resorbed, embryonal connective tissue has reappeared, etc. I have found the same experience in cases of severe marginal so-called paradentitis and atrophy: previously observed scorbutic changes have started healing after a controlled supply of vitamin C. For some years past I have been engaged in collecting C-controlled cases of disease in Man, the dental condition having been controlled both before and after the supply of C in substantial doses. These cases include the various haemorrhagic diathesis, and further tuberculosis, lues, arteriosclerosis, diabetes, icterus, anaemia, cancer, gastro-entero-colitis etc. So far I have not found any case of this kind in which a scorbutic dental picture in the true sense of the term has not started healing or else improved provided the supply of C has been increased to an adequate extent. In more severe general infections, in tuberculosis, chronic intestinal diseases, cases of poisoning, other forms of hypovitaminosis etc. *in guineapigs* and *monkeys* I have found that the scorbutic picture of the tooth has been governed exclusively by the lack of and supply of vitamin C. Moreover in the C-synthetizing rat I have found scorbutic changes in the tooth determined by the C-content in the diet or healed upon the administration of large doses of ascorbin acid. It does not however follow that I am prepared to deny that injuries to tissue of a character similar to the scorbutic dental changes may arise in other ways. If the age is high and the cell or protoplasm is no longer capable of regeneration, it is obvious that a supply of vitamin C cannot prevent continued degeneration. If the injury has been caused by some other means, by a direct mechanical injury, abrasion, fillings, amputation, or through the influence of bacteria or toxins, caries, pulpitis, chronic apical paradentitis, damage to or cessation of the afflux of blood, etc., trauma, fracture, strain, it is possible for changes in dentin and pulp to arise showing pictures *in detail* resembling those seen in the total picture of the dental scurvy. A trained osteopathist who is well acquainted with experiments with vitamin C and has a thorough knowledge of the latent total picture of dental scurvy and the various stages in the healing process, seldom has any difficulty in distinguishing the detailed pictures, since the inflammation is local and exhibits the microscopical cardinal symptoms of inflammation. The changes here consist of symptoms of bio-necrosis, namely, the degenerative tissue-calcifying processes, and must not be confused with pictures representing de-differentiation due to lack of C. The other haemorrhagic diatheses are dominated entirely by the bleedings and their resultant symptoms and also secondary de-differentiation. The bleedings are absent from the biological picture of advancing old age, which picture does not possess the same integral character and is dominated by the general, evenly distributed, cellular atrophy.

I assume, therefore, that in persons who are not senile and who are declared quite healthy after medical examination, microscopically

demonstrable scorbutic dental changes showing generally definite symptoms — provided no local inflammation is present or any other of the above-mentioned causes of injury to tissue — indicate a deficient supply of vitamin C falling short of the protective dose. This lack of C is greater and probably influences the general state of health when the change in the teeth commences to show symptoms even in the free pulp cavity. *As a diagnostic symptom it may be said that, when in the above-mentioned pathogenetically demarcated cases the general scorbutic change in a tooth has become so extensive and so severe that the free tissue of the pulp cavity and its odontoblastema exhibit definite changes, then there is a serious lack of vitamin C, i. e. the human body's supply of vitamin C then falls short of the daily dose thereof which should be able to eliminate all risk of scurvy.*

Fischer's views on the same question.

Fischer has investigated teeth and jaws in a very large number of cases of various common diseases, diseases of the internal organs, paradentosis etc., and drawn comparisons with a great many healthy persons of different ages. He finds the teeth and the pulps characterized throughout by the divergences from normal tooth-structure occurring in scurvy. Fischer admits that the changes occur in all cases of scurvy, in which he has ascertained their existence in exactly the same way as I have previously described in my treatise. Both my description and my explanation of the part played by the vascular functions in the pathogenesis are in accordance with Fischer's views. Only in one important respect does Fischer express any divergent opinion. He rejects the pictures of the healing processes and interprets my account of them in such a way as to make them represent merely irregular variations in the course of the disease. Fischer asserts that the changes that take place in scurvy are similar to those in paradentosis, in general diseased states accompanied by disturbances in the circulation, and in the normal course of the tooth's ageing process. They represent symptoms of *the »alkaloide Staung» that is the fate of all teeth as they grow old through the blocking of the apex and the repression in the dentinal chamber, these changes arising out of the effect of the circulatory disturbances on the vascular system and biochemistry of the pulp.* In other words, the alkaline state of stasis in the pulp is an inevitable physiological phenomenon, brought about by the anatomical and physiological qualities of the pulp. *These qualities*, determined by individual, constitutional and hereditary factors, *give rise to the individual variations in extent and degree of severity; the pictures of the healing process are only apparent and represent variations in the course of development.* Scurvy gives rise to these pictures of stasis in the dental pulp because it is a haemorrhagic diathesis. *It is of course impossible to draw any conclusions from the presence of such stasis pictures as to the standard of vitamin C, latent scurvy, etc.*

Fish-Harris has latterly adopted much the same view as Fischer, laying special emphasis on the fact that the scorbutic dental changes are the same as changes in the tooth due to age.

According to my own observations, Fischer's views are based

on a conclusion which, though explicable, is certainly not defensible on that ground. My criticism is summed up as follows:

FISCHER's method of investigation seems to be unsatisfactory. FISCHER has manifestly not realized the necessity of exercising extremely accurate control over the standard of vitamin C in the dietary anamnesis. He has accordingly disregarded the fact that experimental vitamin research inevitably requires an exact determination of the daily dose of vitamin C in the diet, calculated both in the basic diet and in the daily extra supply of fruit with a high content of vitamin C. The result is that the correlations that FISCHER establishes in different cases in Man between dental picture and general disease or period of age are not scientifically justified. If in cases of various diseases, ages, or suchlike, we find changes in teeth such as peripherally or intimately belong to the picture of dental scurvy, then all opinions and diagnoses or individual correlations are worthless provided no evidence is available from a singularly accurate dietary anamnesis that the supply of C in a daily dose has been quite sufficient to prevent latent scorbutic changes in the tooth.

FISCHER's rejection of the pictures of the healing process is quite incomprehensible. His interpretation of these pictures as variations is unclear. The study of scurvy in guineapigs permits us to estimate with complete confidence the effect of a supply of C on the healing of a tooth. Variations in the dentinal structure denote in the majority of cases variations in the standard of vitamin C.

The dental picture of scurvy is of an integral character; in it a series of changes takes place in a regular sequence. If one or more of these changes occur locally in the pulp of a tooth, this fact does not mean that a characteristic scorbutic change is present in the tooth. The diagnosis is thus purely negative if it is based on mere discoveries of detail. Generally the integral pictures presented by advancing age and scurvy are not in accord with one another.

If, then, FISCHER's views on the question are not in themselves tenable, until these points have been objectively cleared up by future research it will continue to be necessary, when judging the complex of causes of the scorbutic dental changes, to take into account those general pathological conditions or local injuries which FISCHER has referred to as correlative to so-called scorbutic dental changes. In this connection I would also draw special

attention to the comparison made by Fish-Harris with dental changes due to advancing age.

2. Discussion on different groups of causes.

General pathological conditions or diseases in internal organs as cause. As already pointed out, the material collected in the dental investigation is almost exclusively derived from healthy cases. Strictly speaking, it might of course be asserted that only as the result of a completely satisfactory examination of a substantial body of material conducted in the internal medical ward of a hospital would it be possible with any degree of certainty to exclude the cases of disease. From this point of view the occurrence of isolated cases of disease amongst our healthy material, in which the diagnosis was made from a relatively superficial medical examination in the country districts, cannot be disregarded. But the extremely common occurrence of scorbutic dental changes in large portions of our material can never be explained by assuming the existence of isolated and overlooked cases of disease.

The medical examination has very carefully thinned out the hospital material taken from such cases as might conceivably have a misleading influence upon the results. (On this point see Vol. 2, Part II.) The few cases that have been selected for the purpose of dental examination are, in the main, cases of relatively typical Norrland diseases. They do not include such general diseased conditions or diseases of the internal organs as, according to Fischer, would be decisive factors in a picture of stasis in the dental pulps.

The material derived from children shows, in regard to both milk teeth and 6-year molars, extremely close agreement with that collected from adults. This material may be said to contain no instances whatsoever of diseases of the kind mentioned.

The influence of diseases cannot have any bearing on the origin of the scorbutic dental changes found in the present material.

Paradentosis as cause. Fischer hints vaguely at the influence of so-called paradentosis in causing the pulpal changes as a result of endogenous factors that influence the vascular function. Reichborn-Kjennerud-Häupl find the cause in that school's theses on the mechanical injuries to the inflamed zone

due to the altered pressure. The material in our possession shows only infrequent so-called paradentosis. There are no cases of paradentosis whatsoever in the non-adult material (see also under the heading: »Inflammatory changes»).

Paradentosis may be rejected as cause.

Exogenous irritations as cause. By far the majority of the teeth in our material are without exogenous injuries. This circumstance is a predominant factor in the large group of teeth extracted from adults living in the interior of Västerbotten, where the scorbutic destruction of pulp and the change in dentin are most prevalent. In the number of cases in which caries and other injuries caused by infection occur — which is particularly the case in the material from the Kalix district and partly also from Umeå and Skåne — the reaction of the tooth is decidedly local, being confined within the dentin or pulp. Here the structure of the tooth and the pulp is not affected in its entirety except in those cases in which total pulpitis or pulpal gangrene have resulted (five cases in all out of the entire material). The same general rule applies to the infectious irritations from the cervices of the teeth, in which only the material exhibiting slight scorbutic changes show local inflammation, whereas the rest do not. (See, further, under the heading: »Inflammatory changes».)

It is possible of course to determine statistically the number of cases of abrasion found in the extraction material, but it would be profitless to do so, as such a procedure would never give any reliable or useful result; however, cases of abrasion are decidedly more numerous in the group of material representing severe scorbutic changes. All the same, the teeth of that group include many (a subsequent checking of the results showed 9 definite cases of adult teeth from Stensele, Dorotea and Sorsele, which were entirely free from abrasion) which do not show any abrasion at all, but nevertheless exhibit scorbutic changes of at least the same degree of severity. The same tendency is indicated by the numerous records of extensive scorbutic changes even in the pulp chamber in young 6-year molars, where there has been no abrasion whatsoever. From this it follows that abrasion as such is not a decisive factor in the origin of the scorbutic dental changes. On the other hand, it is probable that in adults abrasion is in many cases the cause of the frequently observed diverticular processes within the crown accompanied by irregular dentin. This is, however, not a causal connection in all cases.

An argument against it is the observation of extensive abrasions deep down in the dentin, particularly in the event of injuries unaccompanied by the formation of new hard substance in the diverticula (Långnäs, Dorotea). In extremely few cases of manifest scorbutic dental changes have there been found fillings (patients from the Umeå Hospital) or other kinds of operative interference with the teeth; such interference is on the whole of rare occurrence in the material and could thus fortunately be excluded altogether from exercising any influence.

Infections and other exogenous injuries are thus not a decisive cause of the scorbutic dental changes.

The ageing process as cause. Even at a very early stage in the literature of scurvy the resemblance was observed between the general pathological picture of scurvy and of the ageing process. This resemblance has been clearly emphasized in the literature dealing with the experimental period of investigation (Höjer, the author, Wilton and others). Wilton's inquiry into the question is of special interest. Fischer's and Fish-Harris's views have already been dicussed. It may be said of the literature concerning the human subject hitherto that there has been no proper control of the supply of vitamin C, Fischer's presentation of the subject affording a typical example of this omission. I have already given in my treatise one or two very good instances — they have been mentioned above — of »typical» senility changes, which have led to healing upon vitamin C being introduced into the diet. From the present investigation I am able to produce several instances of the same healing phenomena recorded at the Umeå Hospital. Both Winström and I have obtained from there teeth extracted from patients upon entering hospital and after recovery. While in hospital the patients lived on a diet containing a large amount of vitamin C. The diseases recorded in these cases have generally been the characteristic Norrland diseases or else minor ailments not of a serious nature. These cases too, therefore, may be regarded as satisfactory material for deciding the question of the influence, as such, of the change due to the ageing process. If, then, the increasing age of the tooth were a decisive factor, the following proved facts would — in my view — be inexplicable:

The nature of the material: *all ages being represented, from children below school age to old men and women.* The term increasing age should thus be given a particularly wide definition. Six-year molars that have

just erupted and possess wide-open apices but distinct series of scorbutic dental changes cannot possibly, according to my definition, be considered to afford a picture of changes due to the tooth's increasing age.

The numerous variations (healing processes and recidivations) in the course of the scorbutic disturbances. Of the utmost importance is the discovery of evidence of healing processes even within the annual variations. It cannot be disregarded that the existence of such healing processes is not reconcilable with the idea of a gradual ageing.

The widespread occurrence of bleedings. In many cases, notably from Stensele—Sorsele—Dorotea, the bleedings dominate the pictures. In forming an estimate of them I have for reasons of caution avoided taking into account fresh bleedings, which in a number of cases might possibly have been due to an unsuitable method of administering the anaesthetic, or to the actual extraction of the tooth. Accordingly only bleedings of an earlier date have been taken into consideration, the diagnosis being determined by the degeneration of the blood corpuscles and the manifest reactions of the tissue. The great extent of the bleedings in both young and old, and their obvious correlation with a simultaneous, general degree of severity of the changes, prove that they are pictures of detail in the haemorrhagic scorbutic diathesis.

The dissimilarity in the distribution and form of the scorbutic changes as noted from the coast area via the intermediate country to the mountain districts. If a general age phenomenon were the cause of the changes there would be an approximate resemblance between persons of the same age and sex or between cases showing a similar apical repression, etc. *All attempts at drawing such comparisons have failed. The variations in the pictures are equally frequent in all ages.* The only possible support I could find for the idea that an ageing process is in any way responsible for or exerts any decisive influence upon the frequency lay in supposing that *race had some bearing on it* — a hypothesis that will be discussed further below. But then it should be observed that in the Stensele—Dorotea—Sorsele area, where the changes are most severe and where the intermixture of a more rapidly ageing race might supposedly be of some significance, the scorbutic changes are extremely serious, it is true, but not of a nature comparable with those due to increasing age. The form of scurvy described in literature as resembling that of increasing age is the mitigated scorbutic picture that develops slowly, and which is best represented in the area comprising Bureå, Byske and the Umeå Hospital. The serious form of scurvy occurring in the Stensele area is of a more severe type, is dominated by the destruction of the blastema even in the pulp cavity and is chiefly characterized, on the whole, by hydrops in the tissue and by symptoms arising out of the haemorrhagic diathesis. Scorbutic dental changes comparable with changes due to increasing age must be accentuated by fibrillary conversion of the pulp, equivalent cellular atrophy, calcareous degeneration and the formation of secondary dentin, and assume the character of a chronic and persistent regression of the tissue.

It will be seen from the above discussion that *I cannot discover any reasons affording even the slightest likelihood that the tooth's*

increasing age plays any decisive part in the development and frequency of the scorbutic changes we have found here. It by no means follows from this that I deny the pathogenetical influence on the scorbutic picture exerted by the vascular changes, the repression in the dentinal chamber and the defective collateral circulation in the pulp. I would refer the reader to the chapter on »Pathogenesis» in my monograph on the dental changes occurring in scurvy.

Internal secretory disturbances as a cause. The nature of the mutual interplay between vitamins and hormones is still undiscovered. It is probable however that the internal secretion can act as a regulator to counteract a deficiency of vitamins; in other words this would imply that to each vitamin or group of vitamins corresponds one hormone or a number of hormones in combination. On the basis of our discussion on scurvy and rachitis as affecting the process of calcification (see below), the hypothesis that there is a mutual relation between increased scorbutic calcification and a hyperfunction of parathyroidea (as described in the literature of the subject) should be considered tenable. In such cases, however, an increase of calcium in the blood would have been observed at least in later stages, which was not the case here. These questions however lie outside the scope of our immediate problem and may, practically speaking, have only individual application, so that they will be left out of the discussion here. Whether an altered general internal secretory status, determined by racial and hereditary factors, that is, a racially determined constitution, has any decisive bearing on the frequency of scorbutic changes in our cases, is a question of far wider scope.

The significance of race. Whereas, when discussing above other possible causes, I was able to base my judgment on the examination and the results of the material available, here I have no material to work upon. The significance of race can be estimated only after special study, in which an attempt is made to trace the courses followed by heredity through families and generations and thereby discover clues as to where to place any observed changes in racial characteristics and the scheme of heredity. Here the question is of immense interest. One cannot avoid the impression that the more obvious scorbutic dental changes are extremely uniform in the desolate interior of Västerbotten. Moreover, they often appear to be combined with a series of fairly typical symptoms in the denture: abrasion, yellow teeth,

marginal atrophy, low frequency of caries. These facts might be interpreted as implying that the scorbutic dental changes found in the material were to be regarded as details in a complexity of symptoms indicating reactions to environment which are indigenous to the race and determined by heredity. In that case it would be the strong intermixture of Lapps in the Stensele-Dorotea area that determined the type of denture. The proved resemblance between the picture of scurvy and that shown by increasing age strongly supports an assumption of the significance of the intermixture of Lapps. The literature on the subject appears to show that premature ageing is characteristic of the Lapps, and consequently perhaps of the intermixture with Lapps as well. From these premisses it might be concluded that intermixture with Lapps is also a decisive factor in the severity of the scorbutic dental picture as revealed in the dentures examined in the Stensele-Dorotea area.

Any such assumption is however contradicted by several facts. It is obvious that scorbutic changes occur throughout the entire area investigated, *and that the difference between them is not an essential one but only a difference in degree*, which has reference to their scope within the dentinal body and the pulp. In principle, therefore, the changes are alike; within the Stensele-Dorotea area they cover the tooth in its entirety, and in the rest of the material only minor portions of the dental organ. It seems unlikely that any such difference is determined by racial factors.

The possibility of taking up a more definite attitude in the matter is afforded me by the numerous manifestations of a healing process and by the annual variations, which are exceedingly common in all the most serious cases. If the scorbutic changes were determined by racial factors and were due to premature ageing or greater susceptibility, then logically speaking they should show a uniform and, in the degree of severity, a gradual development. It is difficult to understand why a racially determined change of this sort should frequently be entirely interrupted and through a healing process show a growth of embryonal tissue in various stages, and after that start afresh. Moreover, as we have seen, these annual variations are in complete agreement firstly with similar pictures taken of experimental animals brought up on a diet ranging, as regards vitamin C, from entire lack of it to a protective dose, secondly with quite analogous pictures of human subjects previously suffering from clinical scurvy and healed after a supply

of vitamin C, and thirdly with pictures of healing found in the same material collected at the Umeå Hospital. It appears to me that the observations just enumerated cannot possibly be reconciled to the assumption that race is a decisive fundamental cause.

Although it is impossible from the results of the present inquiry to give a final decision on the question of the significance of race, *there appear to be no justifiable reasons for assuming that the racial and hereditary factors are a cause of the scorbutic dental changes that have been discovered.*

Lack of vitamin C a factor of decisive importance. By a process of elimination the discussion carried on above has on the whole excluded the factors of disease, paradentosis, local external irritation and senility from the complexity of causes accounting for the scorbutic changes discovered in this material. All this negative evidence is supported by one extremely important positive testimony, viz. *the data provided by the dietary anamnesis concerning the extent and distribution of the deficiency of vitamin C.* For more detailed information I refer the reader to the inquiry into the question of diet carried out in the medical examination and propose here merely to draw attention to the following observations.

On the whole, Swedish diet may be divided into two main groups. The first of these is the type of food consumed in urban, industrial, railway and other centres, in which the population lives together in considerable numbers with generally well organized internal and external communications, purchasing their food from the local shops. This diet is of course influenced more or less by the agricultural conditions etc. prevailing in the surrounding district, but generally speaking may be said to be fairly uniform and comprise a good proportion of albumen, fat, carbohydrates and minerals, at the same time often representing the vitamins in more or less suitable quantities (with the exception of vitamins D and C). The second of these types of diet is that of the provinces, that is to say, the food consumed on the farms, in the cottages and cotters' huts, as well as in the smaller villages. This diet is determined by the possibilities of cultivation and the means of supply — and that to an ever-increasing extent the further the locality is situated from the trade routes. The form of diet in the countryside thus shows far greater dissimilarity from place to place; in the agricultural

areas it is dominated by cereals, milk, butter, in the hunting areas by game (elk, hare, fowl etc.), in the coast fishing districts by »strömming» (the Baltic herring), herring, and so on. There is here a distinct risk of one-sided diet. A deficiency of essential foodstuffs and vitamins is ubiquitous, though it varies in different districts.

Scurvy was at one time an endemic disease in Scandinavia. Thanks to the gradual increase in the knowledge of its causes its ravages were reduced and became confined to the military and naval services, the mercantile marine, the prisons and other institutions in which a number of people were forced to live on a one-sided diet. By degrees scurvy has been expelled even from these last strongholds and was for a long time thought to have been practically eradicated from Swedish pathological history. Thanks however to present-day research into vitamins carried on by both medical and odontological investigators, it has been shown that the clinically observable picture of disease has been succeeded by the latent picture, indicating a very wide dispersion throughout the country. (HÖJER, WILTON, ÖHNELL, *the author.*) The Swedish nation has been saved from the ravages of scurvy in its overt form by the quantity of *milk* and *potatoes* consumed daily and in the extra supply of fruit and vegetables. Nevertheless the Swedish public's neglect of fruit and vegetables as food has not yet been entirely overcome, although enlightened propaganda and the craze for »slimming» have given tremendous impetus in the right direction in recent years. It is probable that the provincial population and the working classes are still mainly dependent upon milk and potatoes for their daily supply of vitamin C. But the C-content of milk depends upon the quantity of C in the cows' fodder, which diminishes gradually after mid-winter, while the C-content of potatoes declines during storage. The period between Christmas and summer each year is characterized by an ever-increasing lack of C in the case of the greater part of the population in the country, which thus becomes exposed to the latent symptoms of scurvy. The first symptoms appear microscopically in the roots of the teeth. *We are therefore justified in suspecting the presence of latent scurvy if the dietary anamnesis indicates a scanty supply of potatoes and milk and an inconsiderable extra supply of fruit and vegetables with a strong C-content.* These deficiencies are still further aggravated by the length of the winter, which diminishes the C-content of fodder,

and by the shortness of the summer, which prevents the effective cultivation of potatoes and of garden produce, and finally by bad communications and poverty, which make it difficult to distribute an adequate supply of southern fruit. *All these factors obtain in the highest degree amongst the country population of Upper Norrland.* Attention should be drawn to the noteworthy lack of potatoes in large parts of the mountainous districts of Västerbotten, where, for instance, the children are in many cases given potatoes at the most once or twice a week. The towns, industrial and railway centres in Upper Norrland, on the other hand, are apparently on an approximately similar footing to the rest of the country as regards the supply of vitamin C thanks to a more abundant market and consumption of imported southern fruit and garden produce, as well as a constant supply of milk and of potatoes brought from the south.

As far as the question of vitamin C is concerned, therefore, the classification of diet drawn up by the medical investigators is of but little significance, although it was a decisive factor in the compiling of the correlation tables, which afforded statistical evidence. Urban and industrial districts, the main centres of communication, and so on, do not in themselves form a particularly interesting group in this respect. As affecting the scattered population in the provinces, on the other hand, the supply of vitamin C is an extremely vital problem. *From the point of view of dietary anamnesis, the population in the desolate mountain districts and in the forest areas is bound to be the most seriously exposed to a lack of C. The agricultural and coast population is no doubt somewhat better supplied with C provided the diet includes an adequate daily quantity of potatoes and milk.* Here there are wide variations.

These data regarding dietary anamnesis are in remarkably close agreement with the patho-histological discoveries. The Stensele-Dorotea zone shows the most serious lack of C — and here too we find the worst dental changes. The urban and industrial centres show the ordinary latent and somewhat indifferent scorbutic picture that we find in people living in towns in Sweden generally. The dental pictures that come from the lacto-cereal coast zone exhibit a more mitigated form of scurvy, which here — presumably according to the quantity and the C-content of the milk provided in the daily diet — varies from case to case.

My general conclusion, then, is as follows:

A perfectly tenable and generally applicable explanation of the extent and degree of severity of the so-called scorbutic dental changes discovered is only to be found in the data provided by the dietary anamnesis regarding the content of vitamin C in the food. There is every reason for believing, therefore, that the microscopical dental changes that have been demonstrated afford evidence of the widespread occurrence of C-hypovitaminosis in the areas investigated.

F. Diagnosis and complex of causes of the "rachitic" dental changes.

The »rachitic» dental changes, the hypoplasia in the enamel and the broad OWEN's contour bands or augmented interglobular spaces in the dentin, are mere disturbances of the process of calcification, i. e., the fixation of the calcium has either deteriorated or ceased altogether. In the enamel, indeed, this means a defect, because the organic substance is too unsubstantial to carry the tissue. These changes are therefore not so complicated as the scorbutic changes; they exhibit but little qualitative variation, but differ from one another in the quantitative degree of calcification. In point of time they are confined to the periods of infancy, growth and development. As soon as the skeletal system and the dental organ are completely formed, the rachitic changes cease, being observed afresh only in serious cases of disease, such as osteomalacia, tetany in adults, fluorine poisoning, and so on. On the other hand, the weaker latent forms, which are only characterized by an extended predentin zone or by inferior calcification of secondary dentin and denticular processes, may continue throughout life and may occur simultaneously with »scorbutic» and inflammatory changes.

The causes of the »rachitic» dental changes are to be found in all the dietary deficiencies, internal secretory disturbances and diseases which during the growing period give rise to inferior calcification of bone or retarded differentiation of the cellulae of the blastema (Wilton). The complex of causes as a whole must therefore be discussed primarily with regard to its effects on children; it also applies, however, to a certain extent to mothers and pregnant women, while it affects men least of all. If

the causes are summerized under separate heads and discussed with reference to the instances discovered in this material, the result works out as follows.

Lack of calcium-phosphorus salts or negative calcium-phosphorus balance. The most obvious, though presumably the least important, cause is the organism's lack of those salts that are essential for the normal calcification of enamel and dentin. Many years' experience gained from experiments on animals have proved how extraordinarily sensitive the building-up process of dentin is to such direct deficiencies or faulty quota conditions. A large body of literature on the subject has commented on these questions, particularly in recent years. It is children during the period of dentition and calcification of the teeth and women during pregnancy and lactation who are most severely exposed to conditions due to lack of salts (Toverud s). The deficiency arises here mainly *owing to lack of milk* or possibly to water with a poor content of calcium salts (lack of lime in certain species of soil).

Hypofunction of the parathyroids (tetany). Hypofunction of the parathyroids or the organism's lack of parathormon induces in children tetany (spasmophilia), characterized by the hypocalcemia and the alkalosis (anacidosis) of the blood, and results, as experiments have shown, in hypoplasia of the enamel and interruption of the calcification process in the dentin. Etiologically speaking, this hypofunction is connected with alimental disturbances, is thereby intimately connected with D-hypovitaminosis and is cured by the same therapy as the latter. Rachitis and tetany thus combine to form a uniform disease-complex in which the lack of D is, pathogenetically speaking, a decisive factor in the development of rachitis during the winter, followed by the hormonal crisis in the spring.

Lack of vitamin D, D-hypovitaminosis (rachitis). In spite of intensive research in recent years, the complex of causes of clinically observable rachitis in human subjects has not yet been fully explained. It has been proved that already in its very early stages this disease causes disturbances of the process of calcification in the skeletal structure, during which the tooth in particular is early attacked. Similar disturbances of the calcification process arise at once upon the protective dose of vitamin D being slightly reduced, so that any such deficiencies in the calcification may with some justification be called latent symptoms of rachitis.

Even more obscure are the changes characterized by inferior calcification which in the tooth are visible inside the dentin body only under the microscope. These changes also may certainly be termed »rachitic», although they lie on the border-line of normal physiological variations in the calcification picture. All these changes appear to be similar in character upon a microscopical examination of the tooth, though they vary in their quantitative extent. The cause may be either of the following:

a. *direct lack of vitamin D*, which in this case means lack of D content or destruction of the quantity of D in foodstuffs;
b. *indirect lack of vitamin D*, which implies lack of sunlight or of ultra-violet rays directed on to the bare skin.

(See further under the heading: »Light thrown on the problem of the calcification of the tooth» etc.)

The pathogenetical significance of the lack of vitamin D is generally explained thus: its absence prevents the calcium-phosphorus salts from fixing in the protoplasm of the hard substances, or else the explanation is that the lack of D retards the complete differentiation of the cells that go to make up the hard substance (Wilton).

The »rachitic» changes discovered in the material cannot directly serve the purpose of determining the frequency of clinical rachitis. We are perhaps justified, however, in combining the condition of considerable width of the inadequately calcified zones as well as very large interglobular spaces with a protracted and severe state of deficiency. In these cases there must have been a risk of the disturbance being so protracted and so severe that it had got past the latent stage and clinically certifiable rachitis had set in. Similarly we might be prepared to assume that the disturbances in the process of calcification that are only revealed in the extended Owen's contour bands or in the elliptical stripes on the dentin body which have been characterized as annual rings are to be conceived of as latent phenomena on the border-line between normal physiological and pathological states. If this interpretation is justified, then the following conclusions may be regarded as probable.

1. *A large number of children in Upper Norrland during the early years of infancy and childhood go through states of deficiency that generally recur each year and are of such a*

nature that the dental substances are thereby exposed to latent disturbances of a rachitic character in the process of calcification.

2. *Amongst the agricultural population in the interior areas, especially Tärna, in the Stensele-Dorotea district, Jokkmokk and Arvidsjaur, in the order given, these states of deficiency are often of such long duration and degree of severity that clinical rachitis (spasmophilia) should be suspected.* This disease is therefore assumed to be numerously represented in the districts mentioned.

3. *In the Scanian area many children in earlier years apparently go through brief periods of deficiency, leading to latent disturbances in the process of calcification.* It is particularly noteworthy that a not inconsiderable number of cases must have gone through protracted and severe states of deficiency even in these districts. (Under-nourishment among farm-labourers' children.)

The difficulty of estimating the significance of the rachitic disturbances in the process of calcification in adult material collected in Norrland is complicated by the simultaneous scorbutic changes. (On this point see further: The problem of the calcification of the tooth.)

States of deficiency are caused by lack of vitamin D soluble in fat or lack of calcium-phosphorus salts (in milk and water) or lack of sunlight. From this it follows that the microscopical examination of teeth has lent support to the assumption that there still exists in the areas investigated an important problem concerned with the diet and hygiene of the population, namely, the supply of foodstuffs with sufficient vitamin D and mineral content, also light dwellings and school premises. The foodstuffs par excellence in this respect have been considered to be rich unskimmed milk and butter. Investigations carried out in recent years have given rise to justifiable doubt as to the possibility of butter-fat providing sufficient vitamin D all through the year. Under such circumstances it should be stated that on the whole Swedish diet lacks an adequate supply of vitamin D, in particular for mothers and children, especially during our long and dark winter months. The problem is further complicated by the fact that »natural» foodstuffs are scarcely able to provide the required amount of D, so that the supply of that vitamin probably has to be arranged for in some other way, e. g. through a daily dose of cod-liver oil. MELLANBY's evidence of the existence of toxamin in cereals and its anti-D effect should

perhaps be stressed in this connection. A high cereal content — notably of oats — in the diet, accompanied by a low D content, is likely to have a hampering effect on normal dental calcification. The question of popular hygiene becomes one of organizing school hygiene, maternity hygiene and the care of children. I refer to my inquiries into these questions, which are dealt with in the chapter on the calcification and the care of the teeth, and also to the summary of the results of the dental investigations.

G. Diagnosis and causes of the inflammatory changes.

The limited occurrence in the material of inflammatory changes should not in itself lead to any far-reaching conclusions. The chief cause of their limitation lies in *the selection of the material*, because, as has already been pointed out, the study of the effect of endogenous factors on the tooth — in this case the effect of hypovitaminosis — necessarily requires dental material that does not show reactions on the part of the dental pulp to exogenous irritations, injuries and infections. However, certain interpretations may be placed on the predominant occurrence of pictures of inflammatory changes in the teeth from Umeå, Piteå and the Kalix area. Obviously, in these districts the ravages of caries in the denture have been so widespread and so severe that when extraction became necessary for the purpose of oral hygiene there was no other material available than teeth that were a source of inflammation. These facts have been of importance in forming an estimate of the material and drawing a distinction between its various groups. It has been possible to indicate from the microscopical material those zones that have been most severely ravaged by caries. There is scarcely a single tooth from these districts that does not show some form of inflammatory disturbance, even in cases where dentinal caries has not been found — an observation that is in my opinion of the greatest interest.

In my previous writings on the subject I have propounded the view that caries in a tooth with a vital pulp may be defined, from the pathohistological aspect, as an inflammatory phenomenon, a case of osteitis or dentitis. What we strictly speaking call caries is the final stage of this inflammatory disease, a gangrenous decomposition under the influence of lactic acid formed on the spot and putrefaction-forming bacteria from the bacterial flora in the cavity of the mouth after the inflammation has

led to the local necrosis of the hard substance. Caries in the non-vital tooth (in the strict sense of the term) is generally only a local necrotic decomposition. According to this view, caries, pulpitis and apical osteitis are in the main one single uniform and homogeneous inflammation of the dental organ induced by the toxins from subsequently ingrowing acidifying and pathogenic bacterial matter from the oral cavity. This inflammation begins with the enamel reactions beneath the cuticle, which in their turn are a result of the primary irritation of the odontoblastema via the enamel cuticle, interprismatic protoplasm and lamellae through the Tomes canaliculi. It ends with the chronic reaction at the apex of the tooth of the periapical tissues. The absence of collateral circulation, and the anatomical confinement of the pulp have an adverse effect on the inflammatory reaction to the infection and lead to the necrosis and decomposition of the enamel block and of the dentin wall (this is caries in the true sense of the word). The pulpitis, whose latent forms are however the primary ones, similarly results in the final stage, which is pulpal gangrene (equivalent to caries in the enamel and dentin). Ultimately there arises the at first acute, and then chronic, periapical osteitis. Here the inflammatory process comes to an end, owing to the »defensive works» opportunely put up by the periapical bone tissue largely thanks to its collateral circulation. When osteitis of this kind has finished up in the root cyst with its fistular passage opening in the oral cavity, the vicious circle is complete.

This inquiry has provided us with an extremely rich body of material for studying the course of development of caries from the earliest stages. If one works with sufficiently thin longitudinal cuts and succeeds in finding one's way along the route of the caries through the enamel and along the relative Tomes's canaliculi, until one reaches that diminutive portion of the odontoblastema which is immediately responsible, and which lies far deeper down in the direction of the apex than the injury to the enamel, one will invariably find vital reactions in the form of degenerations, small dilatations of the odontoblastema's capillaries and an occasional leuko- or lymphocyte in the pulp tissue. These reaction pictures are also observable in the case of a quite undamaged dentinal body — a fact that proves their existence even in a relatively superficial injury to the enamel. Manifestly, reactions of this kind are not microscopically demonstrable in their very first stages; an obvious change in the morphological structure already represents a later phase.

When, now, these reactions are predominant in the cases collected from the towns, the industrial centres and the coast areas, whereas they are demonstrable only in exceptional cases in the interior of Västerbotten, we are at once driven to seek an explanation. The first point to observe here is that all attempts

at solving the problem of caries merely by way of the histopathology of the disease are doomed to failure. In spite of many attempts made in present-day odontological literature, this branch of caries research can never do anything but serve the purposes of experiment, clinical work and, above all, statistics. Nevertheless, pathohistology is capable, with all its limitations, of acting as a signpost to research. The reaction from the vital tooth is either an obvious consequence of the exogenous irritation or else a co-ordinated factor operating simultaneously with it. From this it follows that the fact of the ravages of caries differing so widely in degree can from the histopathological point of view be explained, on the whole, in two ways. The purport of the first is that the inland population of Västerbotten is not subject to that potent external exogenous factor (the formation of lactic acid, bacterial infection) from the oral cavity which induces the reaction, but that this external injury is very strongly represented amongst the coast and urban population. This then may be summed up in the statement that the pathogenic irritation from the oral cavity is the decisive factor in the proved geographical pathology of caries. The second way of explaining the difference points in the opposite direction. It might be accounted for by the fact that the dental organ's ability to react to an ever-present external infection is the decisive factor. The lower carious picture exhibited by the inland population would thus be due to an inability of the pulp to show any inflammatory reaction to the infection. A combination of these two theories, which presumably affords the most accurate explanation, might best be worded as follows: *the strength of the infection in its relation to the activity and force of the reaction determines the frequency of the caries.* The frequency of the caries thus depends upon the organism's susceptibility to infection, the toxins. An increased carious tendency might also then be interpreted as a symptom of oversensitiveness (an allergetic symptom). The suitability of prophylactic measures to that end should be examined by medical therapy.

There is a further inflammatory reaction on the part of the pulp, which differs from that directly connected with caries, and which is of interest from that point of view. In a number of cases collected from the carious areas there occur, within that part of the pulp which corresponds to the exposed cervix, numerous superficial inflammatory centres, resembling dense

accumulations of cellular infiltrations around peripheral capillaries or minor veins with slight oedematous effusion into the surrounding parts. At the same time neither the dentinal body nor the superficial layer of cement appear to be impaired. No such pictures occur in the material taken from the inland population. There seems to me to be no other means of explaining these pictures except by the fact that they represent a chronic form of inflammation as a reaction to a slight protracted irritation caused by septic matter from the gingival socket round the exposed cervix of the tooth via the channels penetrating the cement and the dentin. This observation supports the assumption of a stronger ability to react on the part of the pulp and greater susceptibility to external irritation from the oral cavity possessed by the said group of the population from which our material has been collected.

H. The inter-relation between the inflammatory changes and simultaneous »scorbutic» changes in the dentin and pulp.

The fact that the extraction material is a selected material naturally precludes the drawing of any direct conclusion in regard to the frequency relation between the three different groups of changes described here. Our knowledge hereof is obtained from the statistical summaries and the correlations. (See Holtz' and Lindström's reports and the summary given in the next chapter.) The histopathological picture revealed by simultaneously occurring inflammation and rachitic or scorbutic dental changes, as the case may be, deserves however closer study.

In the great majority of cases of scorbutic dental changes the dentin and pulp show no inflammatory reactions. In regard to the comparatively smaller number of cases of these changes in which caries and latent pulpitis are found to occur, two observations of importance may be made.

The first observation is made in those cases in which the scorbutic changes assume the most serious form, i. e. in which there is present the pulpal degeneration which has been described in connection with the cases from Dorotea or from the Stensele group in general. In these severe cases of a scorbutic effect on the pulp, the latter is impaired by hydrops of the tissue and by

the odontoblastema being so degeneratively injured that there is hardly any locally restricted reaction. If in the series of cuts we follow the dentinal caries in its longitudinal direction, we find in several cases, on the spot where the responsible part of the odontoblastema lies, a necrotic process going on in the blastema layer unlike the pathological picture of the surrounding parts. It is possible, also, that there is a greater tendency to bleeding at the point where the caries has attacked the pulp. In some cases of slight scorbutic damage to the pulp in the material from Bjurholm, Byske and Umeå, the reaction of the pulp is more clearly demonstrable, though it is not very strong. In a group of carious cases accompanied by less severe scorbutic changes, occurring mainly in the apical half of the root, distinct pulpitis can be diagnosed. In order to obtain a more definite idea of this difference in the degree of reaction to caries I separated all these cases of simultaneous caries and dental scurvy from the rest of the series with a view to making a uniform study of them. I think I am justified in drawing from this study the conclusion *that in cases of more or less severe pulpal injury caused by scorbutic changes the pulp tissue's inflammatory reaction to caries is far weaker than in normal cases*, and is characterized especially by the more rapid necrosis of the odontoblastema and the tissue in the vicinity. In cases of slighter scorbutic injury to the pulp, any difference there may be in the strength of the reaction is too little pronounced to permit of any definite conclusion being drawn. (On this point see the interesting study published by J. Hertz on the effect of scurvy on the development of traumatic osteitis.)

Cases of scorbutic dental changes in the pulp cavity and the entrance to the canal sometimes show severe gingivitis accompanied by deposits of tartar. In none of these cases however do we find inflammatory changes in the cervical parts of the pulp tissue. Gingivitis showing marked scorbutic changes does not therefore, it seems, give rise to reactions of this kind on the part of the pulp.

The second of the above-mentioned observations concerns the relation between the destruction caused by caries and the scorbutic structural changes within the dentinal body. A priori, it seems probable that changes within the old dentinal body of such a nature as to give rise, as in scurvy, to dentinolysis accompanied by the destruction of lime and collagen in the

protoplasm from the dentin canals, afford excellent soil for the subsequent development of carious putrefaction. Changes of this nature however occur only in very rare cases within the dentinal cone of the crown, viz. in particularly obstinate cases of severe, protracted scurvy; otherwise — as in this material — they are present in the apical half or third of the root, wherefore they are of no significance as far as dental caries is concerned. Within the mountain and forest districts blastema de-differentiation is predominant, accompanied by irregular dentin deposits and followed by pulp bone and ultimately by reticular atrophy of the pulp. As I have previously emphasized, some of these changes also form part of the picture of increasing age and moreover show agreement with the regressive dentin reactions that arise locally in connection with the development of carious pulpitis. The matter may be expressed in the following way: when scorbutic dental changes are present the coronal area has already undergone the series of regressive structural changes that elsewhere within the tooth are locally interpreted as the pulp's defence against caries.

It seems probable, therefore, that it is in these two phenomena, the weakened local reaction to the carious infection and the scorbutic-coronal structural changes which apparently give the impression of being defensive measures to prevent the infectious matter from penetrating deeper, that we have to seek the explanations — histopathologically capable of proof — of any contrast between a disposition to caries and scorbutic dental changes.

To judge from the pathohistological pictures, when caries and scorbutic dental changes occur together, then in those cases in which the latter predominate there must be a considerably lower frequency of caries.

I. The relation between the inflammatory changes and simultaneous »rachitic» injuries to the dentin.

Where the enamel shows hypoplasia, the result of a process of defective calcification in the enamel has been the formation of a passage into the dentinal cone, where a transition takes place into the terminus of the broad OWEN's contour-band, which has been built up at the same time as the hypoplasia of the enamel in the form of a zone of uncalcified predentin — imperfectly calcified internal dentin — on the then coronal periphery of the pulp.

From this it appears that there are sound reasons for assuming that the rachitic dental change must constitute a particularly favourable predisposition to caries. The literature on the subject has, it will be remembered (cf. MELLANBY and many others of her way of thinking), attempted to extend the purport of this so far as to imply that caries might simply be said to represent a rachitic or latent rachitic phenomenon. As has already been mentioned, the ability of a microscopical study to decide this question is limited to the observation of the relation between the pathohistological picture of the carious condition and the rachitic dental changes. The investigation has produced some observations that are of value in judging the question in its entirety.

If the hypoplasia of the enamel is in such a position that it brings about a retention on an inactive surface, or if it has assumed such a form that the hollow in itself, apart from its position, serves as the site of a retention, then the number of foramina and fissures in the oral cavity is increased by the number of hypoplastic hollows thus conditioned or localized. This produces a greater number of points liable to fermentation or the accumulation of bacteria, accompanied apparently by a greater tendency to caries. If the hypoplasiae of the enamel are smaller — on the way to being of a merely microscopical nature — they at any rate represent a gap in the cuticle, a depression in the enamel surface with subjacent protoplasm of poor lime content, and thus form, in a restricted sense, a kind of enamel-sore predisposed to infection and subsequent inflammation.

The earliest rachitic dental changes due to the mother's diet or insufficient food occur in the milk teeth and the cuspidal area of the 6-year molars, and as an isolated phenomenon are only of importance as affecting the caries picture of the milk molars. If in this connection we disregard the complexity of the problem of caries involving the question of how far caries in the milk molars aggravates the growth of the bacterial flora and adversely affects the taking of nourishment etc., and possibly also infection by contact in the erupting 6-year molar, and if we merely consider the permanent denture, we may be justified in regarding even an extensive and severe rachitic injury to the cusp of a 6-year molar as being entirely a phenomenon that is preventive of caries. The result is, in most cases, the early loss of the cusps, the masticating surface of the crown becomes smoothly polished and the emergence

of the normal deep fissural retentions, with their pregnant disposition to caries, is prevented. When so damaged, the 6-year molar remains up to a very late age with its masticating surface either polished smooth or else chronically discoloured by caries. This phenomenon is a striking example of how a severe metabolic injury may lead to a prophylaxis of disease.

The later rachitic injuries, which are caused by the child's defective dieting or by ill-health, may have a bearing on the frequency of caries on the proximal surfaces of incisors and cuspids. If they arise at the age of 6—10 mounths, they are of no significance as far as caries is concerned, seeing that they then only affect the edge of all the incisors in the lower jaw and the central incisors in the upper jaw and later on hasten their abrasion, and in doing so ultimately minimize the risk of caries by contact. If they continue beyond that period or arise later on

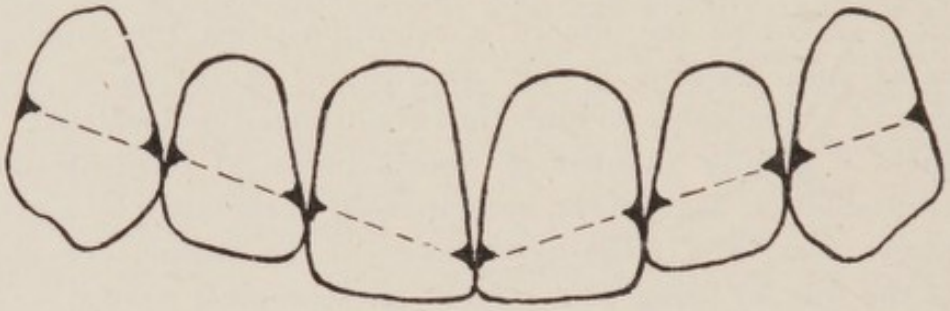


Fig. 47.

in life, their effect on caries becomes greater. Here however the same principle applies as in the case of the 6-year molars: the more severe the injury, that is to say, the larger and deeper the scope of a protracted hypoplasia, the greater will be the prophylactic effect on the injury as a defence against caries. An extensive hypoplasia of the crown entails a loss of inter-proximal contact and gives a conical shape to the crown, with its convergence towards the incisal rim. Compared with the normal cases, these cases are strongly preventive of caries. The less severe rachitic changes in the enamel between the ages of 1 and 2—2 $^1/_2$ involving isolated hypoplasiae situated in groups or bands, or else resulting merely in deeply marked lines of imbrications in the contiguous area, are those which, in the strict sense of the term, dispose the tooth to caries. If we carefully examine the way in which they are placed, however, we shall find that their position on the teeth is opposite to the place attacked by caries.

Proximal caries in the incisors and cuspids appears regularly within the proximal surface, bounded incisally by the point of contact, cervically by the edge of the gingiva, and labially-lingually and palatinally respectively by the boundary-lines of the axial angles. The primary point of attack is just below the point of contact. The tooth's points of contact do not lie in the same horizontal plane. As fig. 47 shows, the distal point is invariably placed closer to the cervix of the tooth than is the mesial point. The position of the rachitic changes likewise follows certain laws, being bound to follow the curved line round the tooth which is described by PREISSWERCK's perichymatiae. Nor do these latter move quite horizontally but form curved lines, whose centre lies towards the mesial, incisal cusp, because the calcification commences there (fig. 48). Hypoplasiae of the enamel situated just

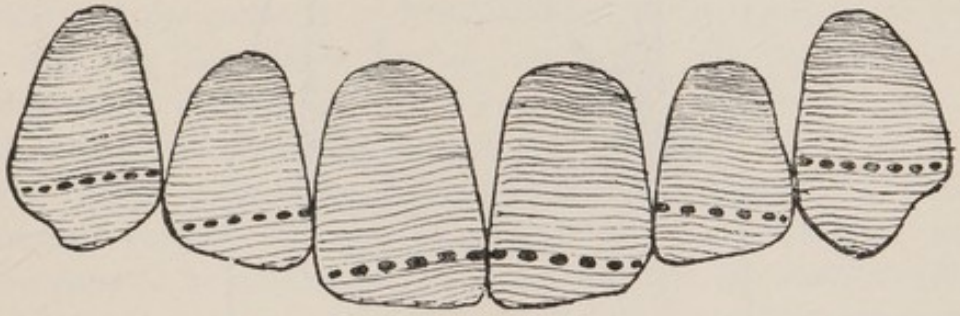


Fig. 48.[1]

below the point of contact mesially thus have their corresponding points within the development period placed in approximately the distal corner. A hypoplasia of the enamel situated just below the point of contact distally has its correlative about in the middle of the mesial contiguous surface, and so on. We find here, then, no agreement between the picture of hypoplasia and that of caries. On the whole it may be said that about 3—4—6 months (dependent upon the anatomy of the tooth and the degree of proximal contact) of the period of growth separate the areas covered by the contact points from one another. Accordingly, the theory that caries is a latent rachitic condition presupposes a rachitic injury to the tooth that is of long duration or else is repeated after intervals of healing. From the pathohistological point of view, therefore, the primary importance of the rachitic changes

[1] Hypoplasia of the enamel in this position presupposes therefore disturbances in the process of calcification at 3 distinct periods, or approximately: for the 1:s at 1 year of age; for the 3:s at 2 years of age; for the 2:s at 2 ½ years of age.

in the enamel as a condition disposing to caries consists in prevalent, diffusively limited, sub-normally calcified surfaces with loosened and torn cuticle caused by slight but protracted disturbances. For the same reason the part played by late rachitis possesses its significance in the predisposition to caries in the gingival third of the incisors and cuspids.

As has already been mentioned, histological examination discloses the fact that morphologically speaking dentin is presumably more susceptible to injuries to the calcification process than is the enamel. The numerous OWEN's contour-bands of fairly

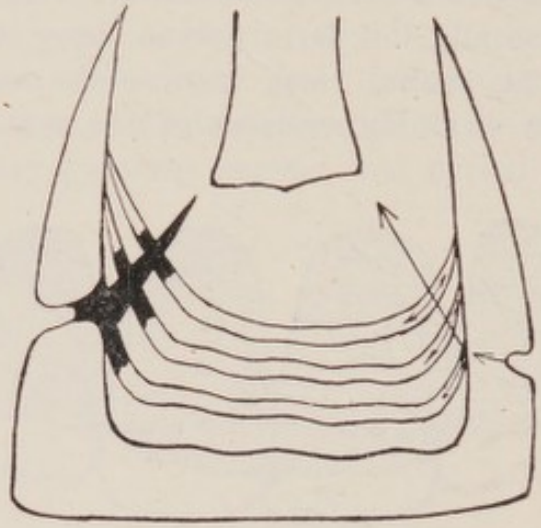


Fig. 49.

large interglobular spaces, which in such cases mark, under a normally calcified layer of enamel, the earlier pulp line, can scarcely be supposed to exert any influence on the disposition to caries, though they certainly do on the shape and the seriousness of the dentinal cavity that arises in cases of caries. Equal significance may, it appears, be attributed, in the main, to the defective calcification which begins to show itself beneath the hypoplasia of the enamel. In fact, here too it should be noted that the course taken by caries towards the pulp is quite different from that followed by the interglobular band. Caries makes its way along the dentinal passages and thus cuts right across the interglobular bands. In many cases it has been found, as shown in fig. 49, that on its way to the pulp the caries may traverse as many as 3—5 interglobular bands, as well as the intermediate, normally calcified zones. When caries reaches the contour bands it shows a strong tendency to extend laterally, following the

curved lines of the contour bands, owing, of course, to the possibility of considerably enhanced bacterial growth in these parts of the dentin, which are poorer in lime but richer in protoplasm. The interjacent, normally calcified zone is penetrated by the medium of infection through a small number of passages, after which a fresh lateral extension again takes place in the next interglobular band area. The outcome of this must be that the dentinal cavity caused by caries assumes a more crater-like form and the attack on the pulp can take place on a far wider front. In this fact lies, apparently, the importance of the part played in the carious process by the rachitic injuries to the calcifying process in the dentin. Assuming the correctness of the statement made above concerning the annual rings in the dentin, in which the OWEN contour bands correspond to the winter period and the zones of normal calcification to the summer period, we may say that their bearing on caries lies in the fact that caries easily spreads in the winter dentin, whereas it can only with difficulty penetrate the summer dentin.

To judge from the histopathological pictures, in cases of combined caries and rachitic injury to the calcification process there seem to be no reasons for assuming that the rachitic changes facilitate the onset of caries in any other way than through increased retention; it may be expected that in cases with deficient calcification of the dentin the size of the carious cavity that arises is perceptibly increased.

J. Light thrown on the problem of the calcification of the tooth by the relation between simultaneous D- and C-hypovitaminoses.

Our study of the cases exhibiting a combination of rachitic and scorbutic changes leads us to take a brief survey of the problem of the tooth's calcification. Normal calcification proceeds as follows: the calcium salts in the blood and the tissue juice, having been brought into solution, combine with the collagen-yielding dentin- and cement-protoplasm in the form of high-value albumin-calcium-phosphorus compounds, which from the morphological aspect are fixed microscopically in the form of rounded grains in the dentin mass lying in dense patches and piled up on one another. We are acquainted with the changes undergone in calcification and

have found that in this material they differ from the normal picture in two directions diametrically opposite to each other and leading on the one hand to the rachitic and on the other to the scorbutic changes in the calcification process. The rachitic lime-fixation entails a quantitative reduction of calcification, the scorbutic a quantitative increase in calcification, which has at the same time become poorer in quality. In rachitic calcification the lime-fixation is gradually reduced right up to a final stage, when no lime is fixed any longer; at the same time this represents the primary stage of the hard substance. Rachitic lime-fixation bears a resemblance to the embryonal stage, or to that of defective dif-

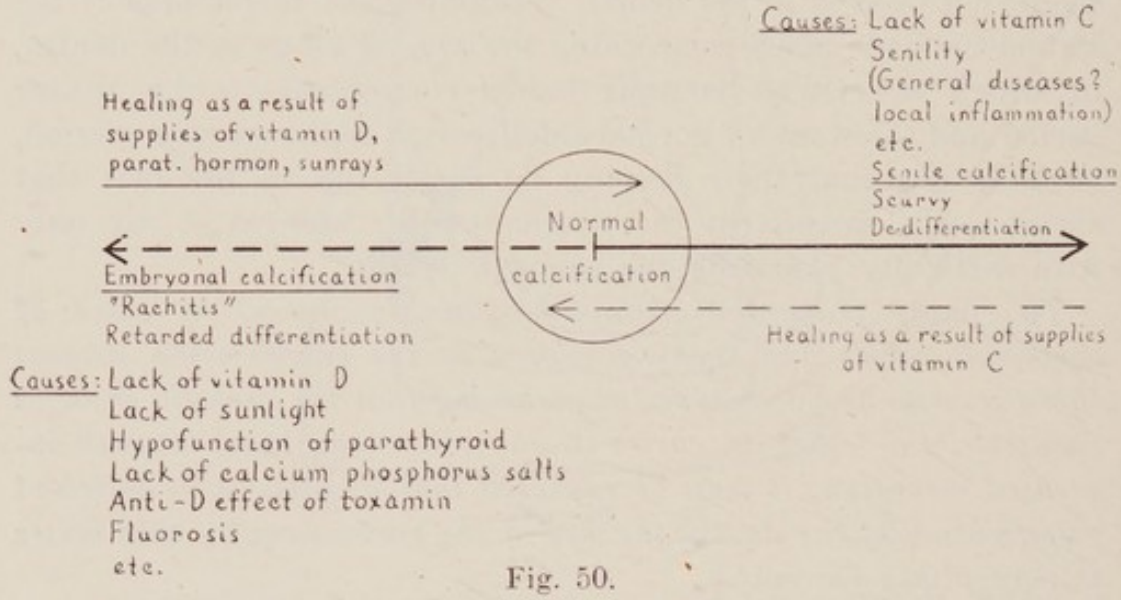


Fig. 50.

ferentiation, of the cells (Wilton). In milder forms of scorbutic calcification the latter process increases as a detailed picture within the de-differentiation, in the severer forms the lime is no longer fixed but is scattered about in the damaged non-collagenous protoplasm in the form of small heaps of amorphous gravel, as occurs in old age. Schematically this process assumes the appearance indicated in fig. 50. The »normal» process of calcification is however a particularly unstable phenomenon. I have shown in a previous work that a heavy over-dose of vitamin C beyond the proper supply carries the calcification process above normal so far as to induce rachitic changes. Wilton has stated that a heavy over-dose of parathormone gives rise to scorbutic calcification, and similar phenomena have been known to arise in cases of calcification of the vascular wall, through an over-dose of some vitamin-D preparation such as vigantol, etc. Normal calcification,

then, may be said to occur in the well-balanced interplay between C and D factors determining the calcification. Moreover, normal calcification involves the right differentiation of the bone-constructing cells, whose active rôle in the calcification process is however not yet fully understood.

This peculiar kind of interplay of mutually counteractive factors is distinctly observable in the combination of fluorine poisoning and scurvy, which I have described in another work. Under such circumstances the rachitis-inducing effect of fluorine tends to offset the scurvy that arises from the lack of vitamin C, it being found that more or less normal calcification was obtained in those cases in which these factors that individually produced disease neutralized one another, whereas the »rachitic» effect of flourine was most conspicuous when the largest supply of vitamin C was administered. This example justifies the conclusion that all the factors that may conceivably influence the still not fully understood calcification process are bound to act reciprocally and influence one another in order that the normal process of calcification may go on. If the series of processes is interrupted at any point, the calcification diverges from its normal picture. The normal calcification of the tooth would appear to be simultaneously determined by the proper balancing of the C and D content in the diet, the quantity of cereals in it and their toxamin content in proportion to D and C, the quantity, nature and utilization of calcium and phosphorus salts, the problem of the effect of sunrays, the iodic salts, the fluoric content in water and food, the interplay of the secretory apparatus with special reference to the function of parathyroidea, the gastric and intestinal functions, age and sex etc. The problem of calcification is evidently extremely complicated, and the utmost caution must be exercised when attempting to draw conclusions from the morphological picture as to the cause of any injury to the calcification. Light is thrown on this question by a series of curious observations made in connection with the present material.

Noteworthy disturbances in the calcification process are met with particularly in the Stensele group, in which the serious scorbutic dental changes generally show a divergence from the picture of scurvy with which we are already familiar, in that it is only in a few cases that the calcification shows signs of typical scorbutic injury. While, then, the scorbutic changes are

otherwise remarkably uniform, the calcifying conditions show a more individually pronounced variation. This would perhaps justify our seeking the cause in a factor that is present at the same time as a deficiency of C and which governs the increase in calcification. Such a factor may be looked for in a lack of vitamin D, lack of sunlight, or possibly in too large a toxamin content in the diet, etc.

Several cases from the Norrbotten coast zone show remarkably good calcification. It seems to me not impossible that the reason for this may also be found in some sort of collaboration between weak factors represented by C and D deficiencies counteracting one another. Seeing that in the non-adult material the rachitic pictures are very largely predominant, in spite of the simultaneous presence of scorbutic injuries to the dentin and the pulp, one cannot resist the impression that in these cases the lack of D or of sunlight, as the case may be, must be very pronounced, and that the factor represented by a lack of C thus acts as a check and a protection. It would undoubtedly be of interest to draw from these observations far-reaching conclusions particularly as to the relation between types of diet and frequency of caries in the districts that have been investigated, but as this field of inquiry is still unexplored and the known facts very few, I can only hope that subsequent research will devote careful study to the problems brought up in the present discussion.

K. **General conclusions.**

The questions put at the beginning of this article may be answered to the effect that the extraction material investigated shows a predominant series of pathological changes of a scorbutic, rachitic and inflammatory nature.

The scorbutic changes are curiously uniform within the *Stensele-Sorsele-Dorotea* group, being here of a serious—mitigated type; within the *Byske-Bureå-Norsjö* group they are represented in the overwhelming majority of cases, usually in a mitigated—latent form; the material from the *Umeå Hospital* is dominated by scorbutic changes exhibiting considerable variety; the *Skåne* cases show a large number of slight scorbutic injuries.

The *rachitic* changes are entirely predominant in the material from the boarding school in *Tärna*, being otherwise widely represented amongst the teeth from *Skåne*. In the rest of the

non-adult material these factors that disturb the normal calcification have a widespread distribution with much individual variation.

The frequency of the *inflammatory* changes cannot be stated on any conclusive grounds owing to the subjective selection of material; otherwise they take the first place in the material collected from the Jokkmokk and Kalix areas, and from Kiruna and Umeå (Skellefteå).

Out of the *complex of causes* the scorbutic changes have been attributed to *lack of vitamin C in the food*, the rachitic changes to *direct and indirect lack of vitamin D*, and the inflammatory changes to *caries and marginal infections*.

The dispersion and frequency of these hypovitaminoses cannot be determined by microscopical examination because the cases examined have been subjectively selected and they are far too few in number. The investigation however lends strong support to the *assumption that there is in Västerbotten a widespread C-hypovitaminosis* which varies geographically in its degree of *severity. The D-hypovitaminosis is more individually variable and more unevenly distributed throughout the areas.*

Both of these conditions of deficiency are apparently common phenomena — even in severe forms — in Västerbotten; in their slighter forms they are likewise widely dispersed amongst the children throughout the investigated parts of Skåne.

CHAPTER V.

General summary of the results of the dental investigation.

By

G. WESTIN.

The dental investigation yielded a great many results which from the medico-odontological point of view may be summarized in broad outline as follows:

1) *Microscopical examination of the dental pulp and hard substances.*

a. General distribution of structural changes in the dentin and pulp, revealing in the majority of cases all the characteristics of those injuries that are due to C-hypovitaminosis. The frequency of the changes and their degree of severity are consistent with the data contained in the dietary records relating to the lack of C in the daily food. The changes have been regarded as symptoms of a widespread, latent scorbutic condition within districts investigated, the latent pathological condition varying according to the daily supply of potatoes, milk and fruit with a C content. Distinct annual variations have been observed. The dental organ's need of vitamin C appears to be very considerable in Man and to increase with age. The actual standard of vitamin C cannot be exactly determined clinically. Even in a diet which under Swedish conditions contains a relatively large quantity of potatoes, milk, berries and fruit, the need for vitamin C as indicated by a microscopical study of the dental organ is not fully satisfied, there apparently being required in addition a substantial daily supply of fruit with a high vitamin-C content (e. g. oranges or lemons).

Changes in the enamel have not been found among the cases of other kinds of structural injury due to C-hypovitaminosis.

No support has been found for the assumption that there is a connection between an increased predisposition to dental caries and a lack of vitamin C.

The latent pathological condition of the teeth arising out of a lack of vitamin C, especially as affecting the changes in the process of calcification, is influenced by a simultaneous lack of D, and also, presumably, by the quantity of cereals supplied at the same time. In seeking to explain the interaction of these factors we may be justified in assuming that the parathyroidea has a regulating function.

In cases in which the dental changes prove to be due at the same time to C-hypovitaminosis and infection, it is possible to observe reduced inflammatory reaction in the tissue, while there is an increased tendency to necrosis, especially in cases of severe injury to the coronal pulp tissue due to lack of C.

b. General distribution of disturbances in the process of calcification within the enamel and the dentin, assuming the form of deficient calcification: *in the enamel*, hypoplasiae of the enamel and opaque patches; *in the dentin*, broad Owen's contour bands and numerous large interglobular spaces; *along the periphery of the pulp*, abnormally wide zones of non-calcified predentin, frequently terminating the dentin body at the apex. To judge from a comparison with the dietary records, it seems unlikely that these disturbances are attributable to a lack of calcium and phosphorus in the diet; in all probability they are due to a direct and indirect lack of vitamin D during the winter months, followed by a hormonal crisis in the spring. They occur most frequently in children, especially during the period of growth of the milk teeth and during an early stage in the calcification of the 6-year molars and the permanent incisors and cuspids, implying either that the mothers were under-nourished during pregnancy and lactation or that the children suffered from latent attacks of rachitis-tetany during infancy. Not very marked seasonal variations in the calcification of the dentin — what may be called summer dentin and winter dentin — are extremely common. Unlike the changes due to C-hypovitaminosis, the injuries to the calcification show individual variation from case to case within the same localities.

Our study of these injuries has also revealed the same curious interaction, affecting the process of calcification, between a simultaneous lack of vitamins C and D and the effect of disturbances in the function of the parathyroidea.

Severe and protracted disturbances in the calcification accompanied by extensive hypoplasiae of the enamel-cap evidently reduce the frequency of caries in the 6-year molars and the permanent incisors and cuspids. Less severe hypoplasiae of the enamel increase the frequency of caries by the number of places where fresh retentions appear, especially if they are situated proximally beneath the points of contact. Slight but widespread injuries to the enamel may increase the tendency to caries as in such cases it takes less time for bacteria and acid to penetrate the enamel wall, and the mucous plaque adheres more easily. On its way through the dentin, caries spreads over the poorly calcified contour-bands, so that the resultant dentinal cavity acquires a far greater breadth and the pulp can thus be attacked on a far wider front.

2) *A clinical statistical study of*

a. the eruption and shedding of the teeth in the first and second dentitions;

b. the frequency and distribution of dental caries;

c. » » » » » other diseases of the teeth and mouth;

d. the correlations between caries on the one hand and other dental diseases, the character of the occlusion etc. on the other, and the interaction between these diseases and conditions.

a. Holtz' inquiry has shown that the period at which the transition from the deciduous teeth to the permanent teeth sets in differs in a remarkable degree, the difference in this respect between boys and girls being demonstrable by statistics. Biologically, girls appear to develop earlier, since their permanent teeth erupt at an earlier age. This difference in point of time is very striking and may be as much as a year or more. The same phenomenon is observed in all the geographical groups and indicates a marked and universal difference between the sexes. Account should be taken of this fact when conclusions are to be drawn from the results of studies of caries. In girls the permanent teeth are exposed at an earlier age to such exogenetic factors as may be conducive to caries. There are differences also between groups in geographically different localities, though it is more difficult in this case to prove by statistics the existence of any marked divergences in the results. In certain groups distinct differences are observable, in others again there are merely hints

of their existence, noticeable only in a general tendency prevailing throughout the entire age series.

b. As regards the frequency and distribution of caries within the areas investigated, HOLTZ' inquiries have proved the existence of a marked difference between the sexes, which, already clearly discernible in infancy, becomes more and more pronounced throughout life. Women are incomparably more predisposed to attacks of the disease than men. The most significant result obtained from the investigation is the evidence that the pathology of caries differs geographically in a marked manner. Reviewing the inquiry into caries in all its aspects, we arrive at the definite conclusion that the caries found in Norrbotten is of a severer character and that in Västerbotten is of a milder character, also that the disease is severer in the coast zone and milder in the mountainous districts. The strong predisposition to caries prevailing in the coast zone of Norrbotten, as compared with the weaker tendency to contract the disease, bordering on immunity, in the mountain zone of Västerbotten, indicates how greatly the occurrence of caries depends upon the manifold circumstances of environment.

c and d. A summary of the results of LINDSTRÖM's statistical studies shows how surprisingly wide are the variations exhibited in the different districts of Norrland regarding the diseases of the mouth in their association with the general mode of living and the prevailing hygienic conditions. Much valuable information has been gained from a comparison between the Norrland material and the examination of school children in south Skåne (Scania). Generally speaking, the children in the country districts of Skåne are better off as regards the ordinary diseases of the mouth than the children in Norrland. In certain points of detail, however, the position is reversed.

A normal occlusion is somewhat less common in Norrland than in Skåne, owing primarily to the less frequency of prognathism (projecting upper jaw) in the latter province. In Norrland the types of occlusion vary considerably — from 84 % normal in the mountainous and desolate regions of Västerbotten to only 46 % in the coast zone of Norrbotten. The same conditions apply, on the whole, to the position of the teeth.

The presence of defects in the enamel varies widely in different localities, e. g. in typical desolate districts they occur in 12—13 %,

whereas in the more densely populated and more prosperous districts they are found in less then half of these values.

In all age classes the men have yellower teeth than the women. In the former the teeth undergo a steady yellowing process as age increases, whereas in the latter this tendency is interrupted between the ages of 19 and 30. These circumstances, as well as the local distribution of the colours of the teeth, are worthy of close observation considering the higher frequency of caries amongst women in general, especially during pregnancy and lactation. In children the colour of the teeth tends towards a lighter tone at the age of 11.

Abrasion is stronger in men than in women, both sexes being liable to a considerable increase in the affection after the age of fifty. Amongst the children a distinct local variation was demonstrable in regard to the stronger types of abrasion.

Both materia alba and tartar increase with advancing years. In the case of the former a more abundant deposit prevails in the case of the boys. As regards tartar, the distribution as between the sexes is uniform. Both kinds of deposit exhibit a striking reduction in frequency at the age of 11. The geographical grouping of the cases of tartar according to its frequency appears to harmonize with the geological localization of the limestone deposits.

A normal gum occurs comparatively seldom. The more malignant forms of gingivitis among elderly people have been observed in about 55 % of all the persons examined. The development of gingivitis in the men proceeds as a steady aggravation of the severer forms up to the age of 65. From the age of 13 healthy gums become increasingly rare, and after 30 the cases of severe inflammation of the gums become more and more numerous.

Somewhat severe forms of gingivitis have been noted in the boys in 17 % of the cases, while the corresponding percentage for girls is not more than 13 %. Amongst the school-children, too, the gingival changes increase with age, although the difference is not so conspicuous in earlier years as it is in elderly people. A certain retardation and reversal of the process is noticeable at the age of 11—12. As regards the severer forms, the boys are throughout slightly worse off than the girls. From the standpoint of the geographical pathology of the gums we have observed that a great many of the school children in some of the Lapland districts investigated show symptoms of severe gingivitis. At Tärna and

Arvidsjaur distinct signs of gingivitis are observed in about every fifth child. In the country districts of Skåne the children appear to be less subject to manifest gingival inflammation than those in the country districts of Norrland.

In the consistency and abundance of saliva secretion a sharp contrast has been found to exist between those localities which are poles apart in the matter of the frequency of caries, the conditions being normal where the frequency of caries is at its minimum and abnormal where it is at its maximum.

Irregularities in the position of the teeth are often found to occur combined with malformation of the palatal arch. A high palatal arch, especially one with a narrow, compressed premolar part, is accompanied by faulty position of the teeth. The anomalies in the position of the teeth increase proportionately to the appearance of hypoplasiae of the enamel, a fact that lends support to the view that the former are caused by metabolic disturbances.

As the teeth wear down the frequency of caries decreases. Persons with strong abrasion are found to have predominantly yellow teeth. The frequency of caries, which is directly associated with the colour of the teeth, declines as the types of colour shift from white to yellow.

Normal gums occur most frequently where the denture is free from caries. Spontaneously bleeding forms of gingivitis appear to be associated with the various types of proximal and gingival caries. Deposits on the teeth increase as gingivitis develops, tartar being a far more important factor in this respect than softer deposits and its colour also varying in a typical manner. Materia alba deposits increase as the frequency of the tartar becomes greater.

Regular oral hygiene is practised by twice as many girls as boys. In Tärna, where there is extremely little caries, not one of the children used a toothbrush. Brushing the teeth has been found to be of no importance as far as caries is concerned, but milder forms of gingivitis decline somewhat in frequency if the teeth are looked after regularly. On the other hand, the severer forms of gingivitis are not favourably affected by the daily practice of brushing the teeth.

The frequency of caries appears to be reduced to a certain extent in persons living on an abundant meat diet. Gingivitis increases appreciably on a lacto-cereal diet (a milk-flour diet) as compared with a mixed diet. Persons living on a more or less

abundant meat diet are least subject to gingival inflammation. The practice of chewing tobacco deteriorates the gums, though it may possibly reduce the chances of caries setting in. The investigation affords no evidence that the amount of coffee consumed affects the condition of the mouth.

There is a distinct connection between the standard of vitamin C and gingivitis. Caries, on the other hand, appears irrespective of the content of vitamin C in the food. Those hypoplasiae of the enamel of which a lack of vitamin D is one of the causes appear to have no influence on the development of caries. Of course, hypoplastic defects in the enamel do to a certain extent develop into carious injuries, from which it follows that among dentures showing such defects, dentures that are entirely free from caries are less in evidence. As a rule, however, individuals exhibiting signs of early disturbances in the calcification of their teeth are apparently not liable subsequently to suffer from severe caries.

The most serious cases of caries are more numerously represented when the general alimental condition is recorded as being poor. Other types of caries, on the other hand, group themselves irrespective of the alimental condition. The latter, however, shows a distinct tendency to co-variation with gingivitis, any worsening of the alimental condition being accompanied by a deterioration in the state of the gums.

The values obtained from determinations of the fragility of vessels are widely scattered without any relation to the various types of caries, whereas they indicate the existence of an association with gingivitis. The vascular fragility tests carried out on our material have not served to determine the standard of vitamin C within either large or small groups of the individuals investigated. In cases of severe caries the development of the disease may possibly be accompanied by a decrease in the haemoglobin numbers. It may be pointed out, on the other hand, that in those forms of gingivitis that occurred amongst the school-children under investigation it was not possible to observe a displacement of the haemoglobin values in any definite direction.

PART IV

DETERMINATION OF THE ANTISCORBUTIC POTENCY OF VEGETABLE PRODUCTS, CHIEFLY BERRIES, GROWN IN NORRLAND; CARRIED OUT IN 1929—1930

By

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(This investigation has been previously published in *Acta Medica Scandinavica*, Supplementum LIII, 1933)

CONTENTS.

		Page
Chapter I.	Introduction	5
» II.	General Remarks on the Berry Material in this Investigation	7
» III.	Technique of the Experiments Proper	11
	A. Basal diet	11
	B. Animals' environment in the place of experiment. Time of preparation for an experimental series	14
	C. Method and technique of administration of the antiscorbutic foodstuff	16
	D. Criteria of scurvy discernible in life	17
	E. Criteria of scurvy grossly visible at autopsy	18
	F. Criteria of scurvy discernible by radiography at autopsy	18
	G. Criteria of scurvy found in microscopic examination of the teeth	23
	H. Application of the criteria described above to the estimation of the minimum antiscorbutic protective ration	26
» IV.	Tabular Survey of the Organisation and Results of the Biological Experiments in Series B, C, D, E, F, G, H, K, L and N	31
» V.	Discussion of the Organisation, Course and Results of Each Series of Experiments	56
» VI.	Supplementary Investigations not Financed by the Royal Medical Board	72
» VII.	Numerical Results and Theoretic Conclusions	75
» VIII.	Practical Consequences of the Investigations Described in Chapters IV—VII. Author's Suggestions for the Raising of the Vitamin C Content of the Winter Diet in Upper Norrland	82
Bibliography		88
Appendix.	Radiograms.	I—LII

CHAPTER I.

Introduction.

In hospital records, the physicians of the Umeå County Hospital in the county of Västerbotten, Norrland, called attention in the course of 1926—1928 to the circumstance that certain types of disease, such as anaemia, stomach ulcers (strikingly often in conjunction with anacidity), achylia, enteritis, haematuria and sepsis, were much more common in this part of Norrland than in the more southerly districts of Sweden. Not only the physicians attached to the Umeå Hospital itself — chiefly Dr. M. Odin (1) — but also those in other parts of the country, among them in particular Dr. E. Perman (2), expressed the opinion that the essential cause of the greater local frequency of these diseases was to be sought in the monotonous, vitamin-deficient diet, in fact in unfavourable dietary conditions in general. Dentists as well as physicians expressed the belief that dietary errors were also the cause of the excessive dental destruction common among the children and young people of Norrland.

Having had my attention called to this problem by these statements as well as by an animated discussion in the press, and starting from the conviction that the most probable explanation of the serious dental destruction among young people lay in vitamin deficiency in the diet, I gave special consideration in a paper (3) to the vitamin aspect of the problem. Knowing as I did the manner of life of the population of Upper Norrland and the raw ingredients in their diet, I drew the conclusion that there was reason to suspect a deficiency of the *antiscorbutic* (and possibly also the antirachitic) vitamins in the diet of certain social classes and that subnutrition with regard to the antiscorbutic vitamin might be a contributing factor in producing the inferior state of health of the population of this part of the country.

Proceeding from this conviction, I attempted in the mentioned paper to survey the possibilities offered by the vegetable products growing wild, as well as by those of agriculture and horticulture, of raising the antiscorbutic content of the diet. Here I struck a serious obstacle in the fact that of the most natural vitamin sources, viz., the wild and cultured berries growing in Norrland, only one, the cloudberry, had been tested scientifically (HÖJER, 4) for its content of the antiscorbutic vitamin in a manner which was satisfactory from the point of view of the great hygienic importance of this question for this part of the country. This lack must be regarded in the light of the circumstance that there need be no deficiency of vitamin C in the diet of even the poorest Norrland family if it should be found in a fully satisfactory investigation that the red whortleberry and the blueberry so abundant there contained even approximately the same amount of vitamin C as the cloudberry, and if a method could be devised of preserving them for winter use without reducing their vitamin content.

On these considerations, I suggested the organisation of a searching scientific investigation into the vitamin C content of red whortleberries and blueberries as well as respberries, red currants and arctic raspberries, which also belong to the flora of Norrland. Desiring to include in this investigation some suitable winter vegetable, I suggested kale harvested during frost and boiled.

The author's proposal of such an investigation of the antiscorbutic potency of the mentioned vegetable products, with special attention to Norrland conditions, was received with understanding by the Director of the Royal Medical Board of Sweden, Dr. N. HELLSTRÖM, and so the present investigation was realised and included in the extensive socio-hygienic research into the origin, treatment and prophylaxis of the »Norrland diseases» which was instituted largely on the energetic initiative of Dr. HELLSTRÖM, after various government authorities, private organisations and private persons in Sweden had given generous support to its realisation.

In August, 1929, after the sum of 15,245 *kronor* estimated as necessary had been guaranteed, this vitamin investigation was begun under my superintendence, with headquarters at the Physiological Institute of the Upsala University.

CHAPTER II.

General Remarks on the Berry Material in this Investigation.

The current method of biological investigation of the vitamin C content of a vegetable product, with guinea-pigs as experimental animals, presupposes that these animals either voluntarily or by forced feeding consume the daily ration of this product required for the purposes of the investigation. In planning the examination of the Norrland berries, I thought it unlikely that the feeding of animals with large quantities of berries, which contain substances difficult to absorb and which easily cause fermentation in the intestines, would be possible without injury to their state of health. Good health in the subjects of investigation, however (with the exception of possibly occurring symptoms of scurvy), is a necessary prerequisite for the estimation of whether or not a certain daily ration of the vegetable substance provides adequate protection against scurvy. I therefore considered it much too venturesome in experiments on so large a scale to make use of a method which is in addition very time-consuming, viz., that of feeding the animals on whole or mashed berries. On the basis of previous investigations, e. g., those of A. Höjer (5), it seemed safer to use the expressed juice of the berries, since the animals can more easily be taught to swallow such juice when it is introduced into the mouth through a pipette.

This indirect procedure of using the expressed juice instead of the whole berry could only be employed, however, if a determination of the minimum antiscorbutic protective ration of the expressed juice of some special berry can with an adequate degree of accuracy be transformed into a corresponding protective ration of the berry itself. Such a re-calculation is no doubt possible, as I shall show by the following reasoning:

Vitamin C is easily soluble in water and filtrable through a Berkefeld filter without loss of its efficiency (HARDEN & ZILVA, 6). It is only to a very limited degree subject to adsorption. It is thus not adsorbed in a suspension of FULLERS' earth (HARDEN & ZILVA) or in one of collodial ferric hydroxide, but it is adsorbed from orange-juice by charcoal (ELLIS, STEENBOCK & HART, 8).

In view of these physical properties of vitamin C, it seems obvious that if berries containing the vitamin are mashed, and juice expressed from the mash by such strong pressure that some juice is obtained even from the skin, and if filtration is made only through the comparatively coarse meshes of the cloth in the fruit-press, there is no reason to suppose that the cloudy juice thus obtained has undergone any reduction in the concentration of its vitamin C. Not all the juice can, to be sure, be obtained from the berries by such pressure, but the minor quantity remaining in the crushed berries may in my opinion be regarded, without mentionable error, as having a vitamin C content corresponding to that of the expressed juice. If analyses of the water content of each kind of berry are available — and such analyses are to be found in J. KÖNIG's *Chemie der menschlichen Nahrungs- und Genussmittel* (24) —, then it becomes also possible to calculate the total juice content of the berries, and thus to compute from the minimum protective ration of expressed juice that of the berry itself.

The berries were first crushed in a small mill. The mash obtained was then packed into a cloth bag and subjected to strong pressure in a berry press with an iron screw. The diameter of this screw was 28 mm. and the thread 6 mm. The wings of the screw for the application of hand power extended 20 cm. beyond the axis. The expressed juice was then allowed to run through another cloth. *The juice thus obtained will not be clear.*

As far as circumstances permitted, the material used in the investigation consisted of berries grown in Upper Norrland. The red whortleberries, arctic raspberries and cloudberries were all grown in Norrland. Currants and blueberries were obtained from Norrland as long as possible, but after the frost came on, the same kind of berry, grown in the province of Upland, could still be bought for another fortnight in Upsala. In the year of the investigation (1929), there was total failure of the raspberry crop in Upper Norrland, and only about half the required amount could be got from Lower Norrland. The remainder was bought from orchards

in the Upland plains. In order to obtain kale of a satisfactory quality that winter, it was necessary to purchase it in middle Sweden.

The period during which it was at all possible to obtain ripe, but not over-ripe berries for the preparation of expressed juice was, as a matter of fact, less than the fifty days for which the animals had to be given the berry juice by the method used. It therefore became necessary to preserve raw expressed juice while there were still berries by the addition of some harmless preservative, for use during the latter part of the experimental period. Only one of the juices in question, that of the red whortleberry, remained, owing to its natural content of benzoic acid, unaltered without the use of preservatives. The content of benzoic acid in the berries themselves ranges according to various analyses (7, Nachtrag B zu Bd. 1, S. 363, 1923) from 0.11 to 0.22 gm. for each 100 gm. of the berry.

In order to keep the other berry juices free from fermentation in a harmless way during storage, I made use of Nature's own methods, and added to them benzoic acid to an amount not exceeding that contained in red whortleberries. To the best of my knowledge, it has never been claimed that fresh red whortleberries — large amounts of which are consumed in Sweden — are poisonous. *By the addition of 1 gm. sodium benzoate to each litre of juice in berry juices of other kinds, these could, under the favourable storing conditions available during this investigation, be completely protected from fermentation for the duration of the experiments.*

All the juice was filled into glass bottles with patent stoppers. The bottles had previously been sterilised in an autoclave.

All the juice, with the exception of red whortleberry juice, was stored in refrigerators of the Frigidaire type at a temperature of from + 1 to + 4° C.

On the basis of the observations made in the investigations of the Royal Medical Board, the author elaborated a new general method for the raw preservation of berries in the shape of mashes or juice. Benzoic acid had up to then not been used in Sweden for this purpose, but it had been used for the better conservation of *boiled* juices or jams. The raw juices of raspberries and cloudberries prepared for home consumption according to this new principle of preservation were also included as test material in

the main biological inquiry into the existence of an antiscorbutic protective potency.

All the preliminary preparation of the berries, from their cleansing to the storing of the completed, bottled and labelled juices in the refrigerator was excellently done by Miss Ellen Åderman, domestic science instructor.

Two cloudberry preserves prepared in traditional Norrland style, and known as *myltgröt* (cloudberry porridge) and *vattenhjortron* (water cloudberries) were tested in series L and N for their protective properties against scurvy by a method analogous to that used for fresh berries.

CHAPTER III.

Technique of the Experiments Proper.

A. Basal diet.

In the choice of a basal diet, I proceeded from that described by SHERMAN, LA MER & CAMPBELL (9), the composition of which was the following:

Oats, sound whole grain, ground in the laboratory as required ..	59 gm.
Skimmed-milk powder, heated on opon trays at 110° C. until all antiscorbutic vitamin is destroyed	30 »
Butter fat, freshly prepared	10 »
Sodium chloride	1 »

The skimmed-milk powder was heated in dry-air canisters in an autoclave at a temperature of 110° C. for two hours. The layer of powder was not allowed to exceed 1 cm. in thickness. The melted butter was filtered at as low a temperature as possible.

Compared with the natural diet of guinea pig, this basal diet is disproportionately rich in both fat and protein. The surplus fat is due to the circumstance that the basal diet content of fat soluble vitamins is chiefly supplied by the addition of butter. The surplus protein, which must as a general rule be considered as disadvantageous in a basal diet, I regarded as an advantage in the testing of the sweetened juices of raspberries and cloudberries, which actually contain one third their own weight in cane sugar. A surplus of protein in the basal diet may in such cases give a more favourable proportion between protein and carbohydrate than one that is poorer in protein. For this reason chiefly, the unmodified SHERMAN basal diet was selected for the two series in which sweetened berry juice was to be studied, in series F and K.

In the remaining series, in which the material to be tested was not specially rich in sugar, it seemed likely that a basal diet with a smaller protein content would be more favourable. In order to

ascertain whether this was the case, the author tested the following modification of the basal diet, in which the protein content was considerably reduced. At the same time, some of the crushed oats were replaced by wheat bran so as to secure a more plentiful supply of vitamin B. Through these two changes, a basal diet of the following composition was obtained:

Crushed oats, ground in the laboratory	50 gm.
Wheat bran	24 »
Skimmed-milk powder, heated in dry air in an autoclave to 110° C. for 2 hours in a layer not exceeding 1 cm. in thickness	15 »
Fat from the best dairy butter melted and filtered at as low a temperature as possible	10 »
Sodium chloride	1 »

All the basal diets used in this investigation were prepared by the technical assistant at the Physiological Institute, Miss HELGA FINN.

A first series of experiments — series A — was exclusively devoted to the testing of whether or not the different basal diets plus an adequate amount of a known antiscorbutic agent entailed normal growth and development in the animals. This series, consisting of 8 animals fed in two equal groups, lasted 75 days.

Animals called A_1 were fed on oats, swedes, hay and water, all of these foods *ad libitum*, just as they had been by the breeder who had sold them to us.

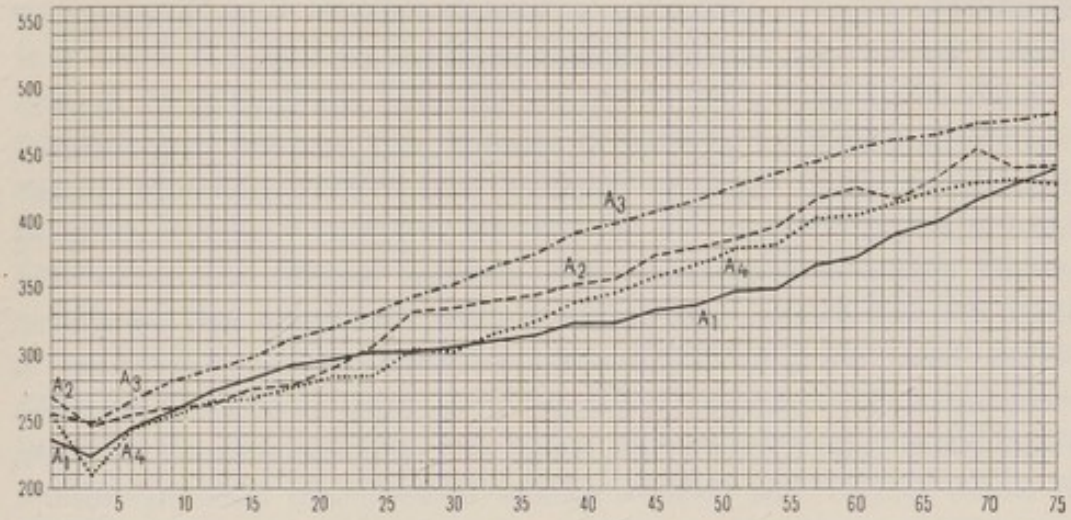
Animals designated A_2 were placed on the original SHERMAN basal diet plus water, and were daily given 4 c. c. fresh orange juice.

Animals designated A_3 were given the author's modification of the SHERMAN basal diet, plus water and 4 c. c. fresh orange juice daily.

Animals designated A_4 were kept on a basal diet which differed from the original SHERMAN only in that 1 per cent OSBORNE'S nutritive salt was administered instead of the 1 per cent sodium chloride.

One group became imperfect through the death of one of the animals in the course of the experiment. The growth curves for the four animals of the other group are given in the following diagram.

Weight in gm.



The weight increase of the individual animals during this 75-day period was the following:

A_1	increased	from	236	gm.	to	440,	i. e. 86.4 %
A_2	»	»	268	»	»	441,	i. e. 64.6 %
A_3	»	»	256	»	»	481,	i. e. 87.9 %
A_4	»	»	256	»	»	428,	i. e. 67.2 %

The animal on diet A_3, i. e. the author's modification of SHERMAN's basal diet, when 4 c. c. fresh orange juice were added daily, thus grew just as fast as that fed on the breeder's free diet of oats, swedes and hay (A_1). Animal A_2 on the original SHERMAN basal diet exhibited distinctly inferior growth. A_4, which had the sodium chloride replaced by an equal amount of Osborne's salt, grew about as fast as the animal on the original SHERMAN diet.

Microscopic examination of the dental pulp in the animals of series A showed that the most normal pictures were found in A_3, and were entirely commensurate with those of A_1. In A_2, however, the dental pulp exhibited very slight deviations from the normal, which was also the case in A_4, though here they were even less.

The tray with the basal diet for each animal was weighed both before being placed in the animal's cage and after its removal at the same hour next day. The difference in weight, considered as the amount consumed during the day, is noted for each animal and day in the record. In most of the series, the animals were weighed every day, but in the three series B, C and D only every

three days. The trays containing the basal diet and the animals themselves were weighed on a Toledo balance with a range of from 1 to 500 gm., with possible readings of 1 gm.

Each of the 10 series of experiments for the testing of the antiscorbutic poetency of some substance also included unprotected controls, so-called negative controls, which were fed only on the basal diet plus water. In all the 14 negative controls included in the entire investigation, the average length of life on the basal diet mentioned was 25 days. The maximum and minimum values were 30 and 17 days respectively. There were also in each series two positive controls, i. e. fully protected controls. These were either given the basal diet plus swedes *ad libitum*, in which case it was first necessary to ascertain that the animal was willing to eat large quantities of swedes, or they were in addition to the basal diet given through a pipette the full protective ration (3 c. c.) of fresh orange juice, to prevent microscopic changes in the teeth. In two cases, the control was purposely given only 2 c. c. orange juice, which involves protection against gross scurvy symptoms, but not against microscopic ones.

B. Animals' environment in the place of experiment. Time of preparation for an experimental series.

In the University Physiological Institute in Upsala, where, with the exception of one series, the animal experiments were made, a room with a capacity of 229 cubic meters was adapted as the guinea pig laboratory. It has five windows facing in two directions, one of them with southern exposure. The lighting of different parts of the room may be regulated by curtains. In winter, the room is heated by hot-water radiators. The air is changed by a suction ventilator near the ceiling.

The laboratory coops consist of a floor of zinc plate and detachable, rectangular walls of galvanised iron net. The dimensions of each coop are 50 cm. by 30, and the height is 42. The floor is covered with a layer of sawdust which is frequently changed. In one corner of the coop there is a wooden box turned upside down, about 20 cm. square, and furnished with an opening on one of the free sides, large enough for a guinea pig to pass through. This »kennel» is a necessary refuge whenever the animal becomes uneasy.

For the experiments we tried to get animals which had at the time of arrival a weight of between 280 and 340 gm. Owing to incidental difficulties in obtaining animals of this weight, however, a few had to be included although their weight was slightly beyond these limits. The animals consisted of different litters of approximately the same age, with two to four in the litter. The breeder, Mr. A. Wikström, Hammersta Farm, answers for the correctness of the date of birth given in the tables for each animal.

The normal number of guinea pigs in each series was 20. Each series has been designated by a letter. Within the individual series, each animal had its own number. Thus B_{17} means animal no. 17 in series B. In this way the series and number of the different animals appear on the radiograms, printed photographically on the film (cf. Appendix).

The transport over a sixty-mile railway journey from the farm to the laboratory, and the transfer from large pens holding several animals to smaller, single coops at the laboratory, was a radical change producing a considerable, though in healthy animals transient change in their willingness to take food.

The first few days after their arrival at the laboratory, the guinea pigs were fed exactly as at the farm with oats, hay, swedes and water, to whatever amounts they desired. Although the food is thus unchanged, the change in the conditions of life nevertheless as a rule caused a loss in weight for one or more days. Not until the weight had begun increasing again were the oats replaced by the basal diet, and gradually the hay was also discontinued. The animals were at the same time taught to drink orange juice through a pipette, and when it was found that on the basal diet plus swedes and orange juice, the gain in weight had for some days been satisfactory, the transition was made to the experiment proper by the discontinuation of swedes and the administration through a pipette of the juice to be tested instead of orange juice. The time required for the preliminaries from the moment of the animal's arrival at the laboratory to the actual commencement of the experiment was as a rule 10 days, and sometimes slightly more. Animals which did not in the course of such a period of adjustment attain a normal increase in weight were discarded.

C. Method and technique of administration of the antiscorbutic foodstuff.

According to the experience gained at the Lister Institute in London (10), it is not as a rule possible to ascertain differences in the scorbutic reaction when the rations differ by less than 25 per cent.

In the Royal Medical Board investigations, the difference in rations was in only one series — that of arctic raspberries — as low as 20 per cent. In currants it was kept at 25 per cent. In most series, the interval was 35 per cent. This interval was used in the investigations of blueberries, red whortleberries, cloudberry beverage and juice of stewed cloudberries. Raspberry beverage was examined at intervals of 50 per cent, and natural raspberry juice, of 100 per cent. With regard to »water cloudberry» juice in a series with an original interval of 35 per cent, only every second ration could be studied, owing to the scarceness of the material, and this procedure was chosen in order to get rations which exactly correspond to those in the stewed cloudberry series.

The berry juice was given to the animals by means of a pipette. Since all the juices were cloudy, owing to having been merely strained through a cloth after pressure, the bottles of juice were shaken each time before the amount required for distribution was poured off. According to the size of the daily ration, the juice was portioned out each day in suitable amounts (cf. tables). No one portion ever contained more than 9 c.c. juice, and in the great majority of cases, the separate portions were appreciably less.

In order to augment the possibilities of ascertaining the minimum protective ration of juice with a low vitamin C content, we procured even for the first series of experiments an apparatus for the concentration of juice *in vacuo*. We selected one designated as a »Schnelltrockenapparat», constructed by W. Gaede and W. Straub (11), and fully described in the *Biochemische Zeitschrift*, Bd. 165 (1925).

From a graded glass burette with an accurately adjustable stopcock, the juice is allowed to drip into a container in which a vacuum of 1 mm. Hg. is maintained by an oil air-pump, and from which any steam that is formed is rapidly carried away through a retort-like connection with a vessel containing about 1 litre concentrated sulphuric acid, and dropped into a bath of cir-

culating water (from the tap) at a temperature of about 10° C. The container itself stands in a bath of + 55 to + 60° C.

When a drop of juice falls into the vacuum, it is split up into fine particles of moisture which undergo a great loss of steam and settle on the walls of the container, gradually forming a layer of juice concentrate on its floor.

The concentration of juices was done by the mechanic of the Institute, S. Liliedahl. In most cases, the original volume was concentrated down to one fourth. The original and final volumes were accurately measured and the ratio between them made the basis of the portioning-off of the concentrate. In the animal experiments, the concentrate was administered by means of pipettes on which readings of 1/100 c.c., can be made. In order to concentrate 400 c.c. juice to 100 c.c., the apparatus had to be operated for 20 minutes. In a few cases, the concentration was even carried to one fifth the original volume. Such results could not be obtained in the sweetened juices. In series K, two animals, K_{18} and K_{19}, were given sweetened juice concentrated to half its own volume, and in series F it was possible to give animals F_{15}—F_{18} the sweetened juice concentrated to $^3/_8$ its original volume. The juice of red currants could not be concentrated at all, as it lost its fluid consistency under concentration (pectin).

In animals on a particularly high daily ration of juice, it was found necessary to increase the amount by degrees for several days before giving the full ration. A high ration from the very first day has occasionally been found to be lethal (cf. tables, animal C_{15}).

D. Criteria of scurvy discernible in life.

In pronounced scurvy, difficulties in locomotion are usually observed in life. The motions become slower and stiffer, especially those of the hindlegs. This diminished activity in scorbutic animals is frequently accompanied by a diminished fear of man, which is possibly deceptive. It is not uncommon that the scorbutic animal has regions of tenderness, sometimes so intense as to cause it to squeal even when carefully handled. In a few cases of pronounced scurvy, swellings of the costochondral junctions were palpated through the integmentum. In severe cases, the faeces gave Weber's reaction for blood (D. Palm; cf. series K).

E. Criteria of scurvy grossly visible at autopsy.

For scorbutic criteria visible to the naked eye, the reader is referred to the Medical Research Council Report on . . . Accessory Food Factors (Vitamins), 2nd ed., pp. 62—63. To this description may be added a few observations made on the internal organs in our investigation.

In the scorbutic animals, haemorrhages were often found (B. Hamne) in a group of mesenterial glands between the intestinum coecum and the ileum. The adrenals were not weighed, and it is therefore impossible to say whether they were atrophied, as Höjer (5, p. 103) declares, or whether, on the contrary, they represented a greater part of the body's weight than in normal animals, as E. Brouwer (12) states. It has been observed, however, that in scorbutic animals the adrenal cortex generally represents a proportionally larger part of the total cross-section of the organ than in healthy animals (B. Hamne).

F. Criteria of scurvy discernible by radiography at autopsy.

Special attention has been paid to the radiological criteria in order, by means of pictures, to give the reader, who is obviously not in a position to see the autopsy findings or the microscopic details of the teeth, some insight into the *degree* of scorbutic alteration in the individual animals. In the autumn of 1929, in co-operation with Dr. C. G. Sundberg, the author found that in scorbutic guinea pigs, the degree of severity of the scurvy was reflected largely in the degree of a characteristic alteration of the costochondral junctions in the radiogram. *This alteration is seen as a more intense absorption of the X-rays through a transverse, ribbon-like zone of the rib at its junction with the cartilage.* A *very narrow* transverse streak of *only slightly* increased ray absorption may occur normally at this spot but in healthy animals weighing less than 400 gm., it apparently does not exceed $^1/_3$ mm., and in those weighing between 400 and 550 gm., it does not exceed $^1/_2$ mm. in the longitudinal direction of the costal arch.

In the radiogram of the scorbutic costochondral junction, on the other hand, this black zone in the length of the costal arch

exceeds to varying degrees the limits given above. Moreover, it presents a border which in a large number of cases is concave towards the cartilage (cf. radiogram G_5). It is probable that the latter phenomenon bears some relation to what TOZER (13) found in the microscopic picture, viz., a concave zone of ossification towards the cartilage, and in the severest cases an infraction telescoping the cartilage into the ossified zone. Since the author has not yet concluded his investigation into the microscopic and histo-pathological foundation of this increased X-ray absorption in scurvy, a discussion of it now would be premature.

As early as HOLST and FRÖLICH's (14) fundamental investigations into guinea pig scurvy, it was observed, and subsequently often confirmed, that the costochondral junctions are swollen in advanced scurvy. In such cases, the absorption zone mentioned above is also enlarged at right angles to the costal arch (cf. radiogram G_{12}).

Such an absorption zone may in moderate cases be restricted to a small number of costochondral joints, and these are then regularly found to be situated in costal arches connected with the sternum. In the severest cases of scurvy, the changes may be found in all such costal arches (cf. radiogram H_5).

It is evident from the tabulated summaries (Chapter IV) that this radiological criterium is slightly more sensitive than that of a swelling of the costochondral junctions discernible at autopsy by the naked eye or by palpation. It is not by any means, however, as sensitive as the microscopic reaction in the teeth. In certain border cases, it gives doubtful results (cf. radiograms of animals N_7, N_8 and N_9). But that the radiological picture is nevertheless a satisfactory guide to the degree of scorbutic alteration when the latter is not too mild, is, the author hopes, evident from the illustrations accompanying this paper (Appendix).

More than half the radiograms reproduced here were taken by Dr. C. G. SUNDBERG, the remaining ones by the assistants at the Physiological Institute, Dr. SVEN ÅKESSON and Messrs. CURT BLOMDAHL and KARL-OVE GEDDA. The developing and copying was done by Miss HELGA FINN, the technical assistant of the Institute.

The use of this radiological method had already spread beyond the Physiological Institute to other investigators [C. NÆSLUND (15), O. RYGH (16), H. VON EULER (17), S. ZILVA (18)] before its present publication by its originators.

In order to exploit thoroughly the evidential value of the method, the costochondral joints of all costal arches connected with the sternum are radiographed. The necessity of this procedure is evident from the foregoing.

The method of preparing the »breast-plates» at autopsy is the following:

The skin is cut through in the median line along the full length of neck, chest and abdomen. On both sides of the body, it is also cut transversely from the median line to the shoulder and to the gluteal regions. The flaps of skin outlined in this way covering the chest and abdomen are then detached from the underlying tissue and folded over to the sides.

Next, all the muscles on the outer surface of the thorax are carefully removed, and the abdominal wall is cut through, both in the median line and along the lower edge of the thorax, and folded over to the side. The thorax is firmly fixed by means of a thumb forceps holding the apex of the breast-bone, the diaphragm is cut close to its line of origin, and the connections of the mediastinal organs to the anterior thoracic wall are detached. The lungs are now collapsed, and it is easy to see one's way to cutting the ribs, without injury to the thoracic organs, close to the spinal column, working up from below on the left, and then, after cutting the cervical muscles attached at the upper edge of the thorax, passing down on the right. When this has been done, the »breast-plate» is entirely free.

The fresh breast-plate preparation — not to be treated with formalin — is then spread out quite flat, with its anterior surface upwards on the opaque covering enclosing the Röntgen film. When necessary, it may be held down by a strip of gutta-percha plaster along the sternum. The exposure is made at a distance of about $^1/_2$ meter, a Röntgen tube with a sharp focus being used. The film is copied on hard paper.

As we know, the zone of ossification is also affected by vitamins other than vitamin C. Tozer (13) states that pathological changes in the costochondral junctions may develop when a growing guinea pig is deprived of vitamin A (no distinction was at that time made between the A and D vitamins). Lack of vitamin A, however, is signified by the more striking symptom of xerophthalmia, which is easily observed in life. Since none of the experimental animals in this investigation were afflicted with xerophthalmia, there is little reason to fear that the radiological changes observed can have been brought about by vitamin A deficiency.

It seemed of greater importance to exclude the possibility of vitamin D deficiency as a contributing factor. The author considered it safest to determine by means of a control examination whether or not vitamin D deficiency in guinea pig may give rise to a radiological picture which may be confused with the one described here as characteristic of scurvy. Such control experiments were made from December 1931 to February 1932 in the following manner:

In order to produce vitamin D deficiency and possibly rickets in the guinea pigs, the author started from A. SCHEUNERTS (19) statement, that vitamin D is lacking in swedes. By mashing swedes and mixing the mash with 5 per cent chemically pure casein, a diet was obtained which contained vitamins A and B, and a much larger amount of vitamin C than is required by the guinea pig. 10 gm. of fresh swedes daily are probably sufficient to protect a guinea pig from scurvy. But, providing SCHEUNERT's statement is correct, such a diet contains no vitamin D. Two guinea pigs on this diet reacted as follows:

Animal A. From December 1st, 1931, this animal was fed exclusively on fresh swede mash plus 5 per cent of its weight in casein. The experiment was terminated Feb. 2nd, 1932, when the animal was killed by ether. In the course of this period, it had eaten an average of 79 gm. of the méntioned mixture daily. Its initial weight was 295 gm., and its final weight 292 gm. Its highest weight was reached on the 22nd day, and amounted to 348 gm. No changes, either gross or radiological, were discoverred at the costochondral junctions.

Animal B. After living on a diet consisting exclusively of fresh swede mash plus 5 per cent casein from Dec. 2nd, 1931 to Feb. 12th, 1932, the animal died of bronchopneumonia after a day's illness. The average consumption of this foodstuff was 93 gm. daily. The animal's initial weight was 318 gm. and its final weight 317 gm., with the maximum at 391 gm. (on the 17th day).

At the autopsy of animal B, it was found that the costochondral junctions of the third and fourth ribs on the left, but only these, could be felt on palpation from the thorax side to be somewhat, though only very slightly, swollen. In the radiogram of the breast-plate, these junctions did not show any intensified X-ray absorption. Since the animal had subsisted on a vitamin D-free diet for 72 days, i. e., longer than the animals in the main series, this was regarded as a guarantee that the vitamin D deficiency could not have caused the radiological changes in the main series.

Prof. W. BOSÆUS had the kindness, at my request, to study microscopically the two swollen costochondral junctions in animal B, and for control, the corresponding junctions in one normal animal and one scorbutic animal (longitudinal section, stained with WEIGERT's haematoxylin and the VAN GIESON stain).

The essential resemblances and differences in the microscopic structure of the costochondral junctions in the animal lacking vitamin C and the one lacking vitamin D he found to be the following:

The costochondral junctions of the scorbutic animal exhibited an uneven zone of ossification towards the cartilage, in agreement with TOZER's previous report. No distinct »hypertrophied» zone could be seen in the cartilage. The »column» zone passed directly into a »temporary

zone of calcification». Close to the latter, there was a yellowish necrotic mass, containing a small number of fragments of enchondral osseous trabeculae. That part of the bone marrow that bordered on the necrotic mass was fibrously altered. In several places along the junction, the periosteal bone was fractured. In the region of the junction of cartilage and bone, there were minor haemorrhages in the periosteum and the perichondrium. The muscles inserting at the junction presented inflammatory changes with a fair degree of degeneration of the muscular fibres.

The costochondral junctions in the animal with vitamin D deficiency (animal B above). The area round the junction of cartilage and bone was, as in the scorbutic animal, swollen, and the line of ossification rather uneven. A »hypertrophied zone» could, to be sure, be distinguished, but like the »column» zone, it was quite narrow and presented comparatively few and irregularly scattered rows of cells. The enchondral osseous trabeculae were somewhat better developed than in the scorbutic animal, and to a lesser degree necrotic. The bone marrow, which containd some fairly copious haemorrhages, was necrotic both nearest the zone of ossification and in some parts further away, but most of these necrotic areas were less compact than in the scorbutic animals, and partially liquefied. Further, the bone marrow nearest the necrotic areas had not to any mentionable degree become fibrous. The soft tissues lying outside the junctions presented some, though rather insignificant, inflammatory cell infiltration appearing in spots.

Summarising, one may say that in one guinea pig, vitamin D deficiency alone for 72 days, did not induce grossly discernible rickets nor the previously described radiological reaction found in scurvy.

The microscopic picture of the costochondral junctions in the guinea pig deficient in vitamin D corresponded in its essentials (inhibited and irregular bone formation, necrosis, haemorrhages, inflammatory changes in the surrounding soft tissues) with that in the scorbutic animal examined, although the anomalies in the bone formation and the inflammatory changes were on the whole less pronounced than in the scorbutic animal, and the necrotic areas in the bone marrow were less compact and to a certain extent liquefied, with the marrow nearest them not mentionably fibrous.

It is probable that factors having no connection with the vitamins may also have some influence on the degree of radiological alteration in the costochondral junctions in scurvy. This assumptions is strengthened by a comparison between the breast-plate radiogram of animal G_9, which was fed 12.3 c. c. natural red whortleberry juice daily, and that of animal G_{10}, which received the same amount of whortleberry juice, though imperfectly neutralised by calcium carbonate. In the former case, in which the total acidity was higher (but the calcium intake less), the changes were considerably more pronounced than in the latter (cf. Appendix, plate XXIV).

G. Criteria of scurvy found in microscopic examination of the teeth.

All the microscopic examination of teeth in this investigation was made on those of the *lower jaw, and to a much larger extent on molars than on incisors.*

The guinea pig has 4 molar teeth in each half of the lower jaw. These two rows of molars converge towards the front of the mouth, and the grinding surfaces are not fully horizontal, but incline slightly towards the median line. Each molar tooth consists of a vertical, deeply folded, hard lamina (cement, enamel, dentine). On the labial surface of each molar is a deeply penetrating, vertical fold, and on its lingual surface, a similar, slightly shallower fold. These two folds form corresponding grooves in the tooth, and their floors are filled with cement (see Fig. 1). A transverse section through such a molar need not produce more than *one* cross-cut through the hard lamina, but in a sagittal section, the lamina is usually traversed in several places. Since, moreover, a sagittal section may be run through the entire row of molars and thus yield material for observation that is richer in every respect, we have in this investigation worked principally with sagittal molar sections like that illustrated in Fig. 2. The deepest part of the hard lamina encloses a pulp cavity (P.c. in Fig. 2). At approximately the border between the second and third fifths from the bottom of the tooth, the pulp cavity narrows fairly rapidly to a fine pulp channel (P.ch. in Fig. 2). Outside the odontoblast layer in the pulp, we have the dentine, the striated structure of which is caused by TOMES' fibres, the elongated, radial processes of the odontoblasts of the pulp, filling the dentinal tubules (see Fig. 3, D).

The grinding surface of a molar (Gr.s. in Fig. 2) is for the most made up of dentine, and is subject to constant wear and tear. But the tooth grows in length commensurately with this wearing-down process, and the grinding surface is thereby kept at a definite height above the gingiva. This growth of the tooth takes place from the pulp, which is wide open towards the alveolar floor. While the tooth is growing in length, the dentine also increases in thickness, and it is this increase that results in the extreme narrowing of the pulp cavity in the two-thirds of the tooth nearest the grinding surface. In animals receiving large quantities of orange juice, it was found that this narrowing could take place exclu-



Fig. 1. Row of right mandibular molars of guinea pig, seen from above. Dotted surfaces represent cement.

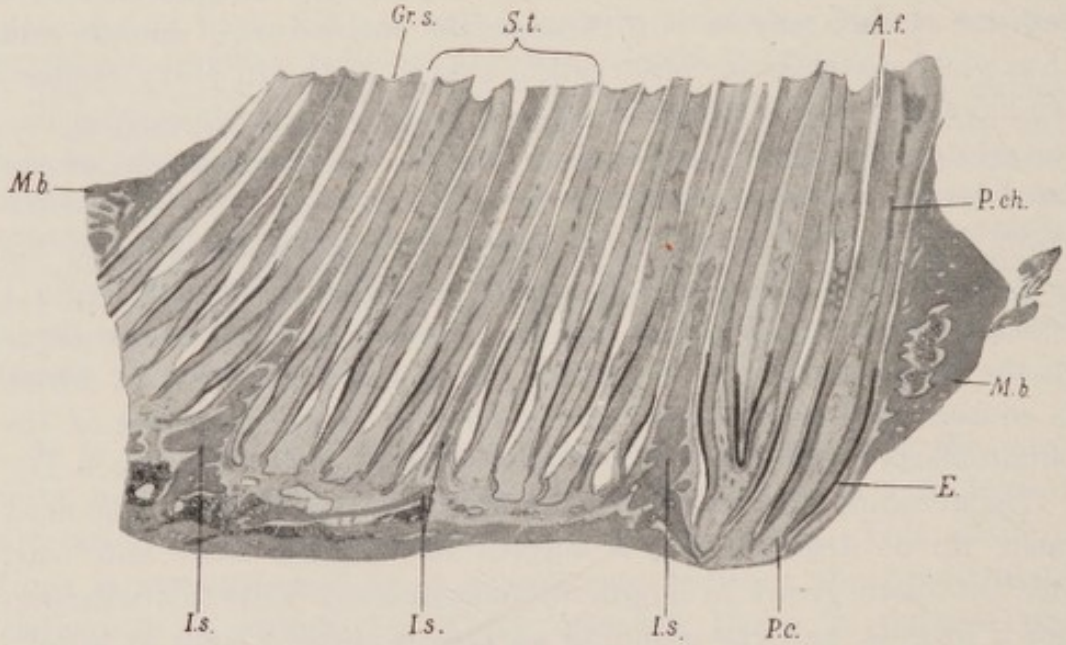


Fig. 2. Sagittal section through the 4 molars in one half of mandible of guinea pig. Between adjacent teeth, an interalveolar septum (I. s.). M. b.: mandibular bone; S. t.: single tooth; P. c.: pulp cavity; P. ch.: pulp channel; E.: enamel; Gr. s.: grinding surface; A. f.: artificial fissure, caused by detachment of enamel in decalcification.

sively by means of the formation of dentine. But this particular part of the molar teeth appears to be exceedingly sensitive to an

insufficiency of vitamin C in the system; when there is such an insufficiency, osteoid tissue will develop instead of dentine in this part of the tooth, and the more serious the scorbutic condition, the greater will be the layer of osteoid tissue.

When a diagnosis of scurvy was made on the basis of microscopic examination of this part of the molars, attention had to be given to the *degree* of the development of bone in the place of dentine. When the development of osteoid tissue was as slight as that shown in Fig. 3, and the dentinal tubules were intact in the nearest part of the hard lamina, the structure was not regarded as a criterium of scurvy. Not until the osteoid tissue had appeared in the pulp channel to the extent shown in Fig. 4, and the nearest layer of hard tissue, which should normally consist of dentine, had taken on a non-striated appearance without dentinal tubules, was a diagnosis of scurvy considered justifiable.

In animals in which the ration of the antiscorbutic factor was found to lie at or close to the minimum protective ration, we made, in addition to the sagittal section in one half of the lower jaw, a transverse section in the other half, passing through the first molar and the subjacent incisor tooth, in accordance with the technical instructions given by HÖJER and WESTIN (20), modified by the circumstance that only half the lower jaw was included. We judged the sections of the incisor teeth in accordance with the instructions given by the above authors in the same paper.

All the sections prepared in this investigation had a thickness of 10 μ. Although cut in a complete series, only every 20th of them was stained with haematoxylin and eosin and mounted in Canada balsam for microscopic inspection. For this entire investigation, a total of 11,800 sections of decalficied teeth were stained and prepared. In series A, C, E, F, G, H, K, L and N, they were prepared by the associate laboratory assistant of the Histological Institute in Upsala, Miss SONJA HALVARDSON, adviced by the regular assistant, Miss BERTHA SANDÉN; series B was prepared by the laboratory assistant at the Histological Department of the Caroline Institute in Stockholm, Miss S. FORSGREN, and series D by Miss EBBA WÄSTFELT, of the Pathological Institute in Upsala.

By inspecting microscopic sections of all these series and ascertaining by this means the limits of microscopic scorbutic dental changes, Prof. E. AGDUHR has carried out a most important task, of extreme value for the results of this investigation; each indi-

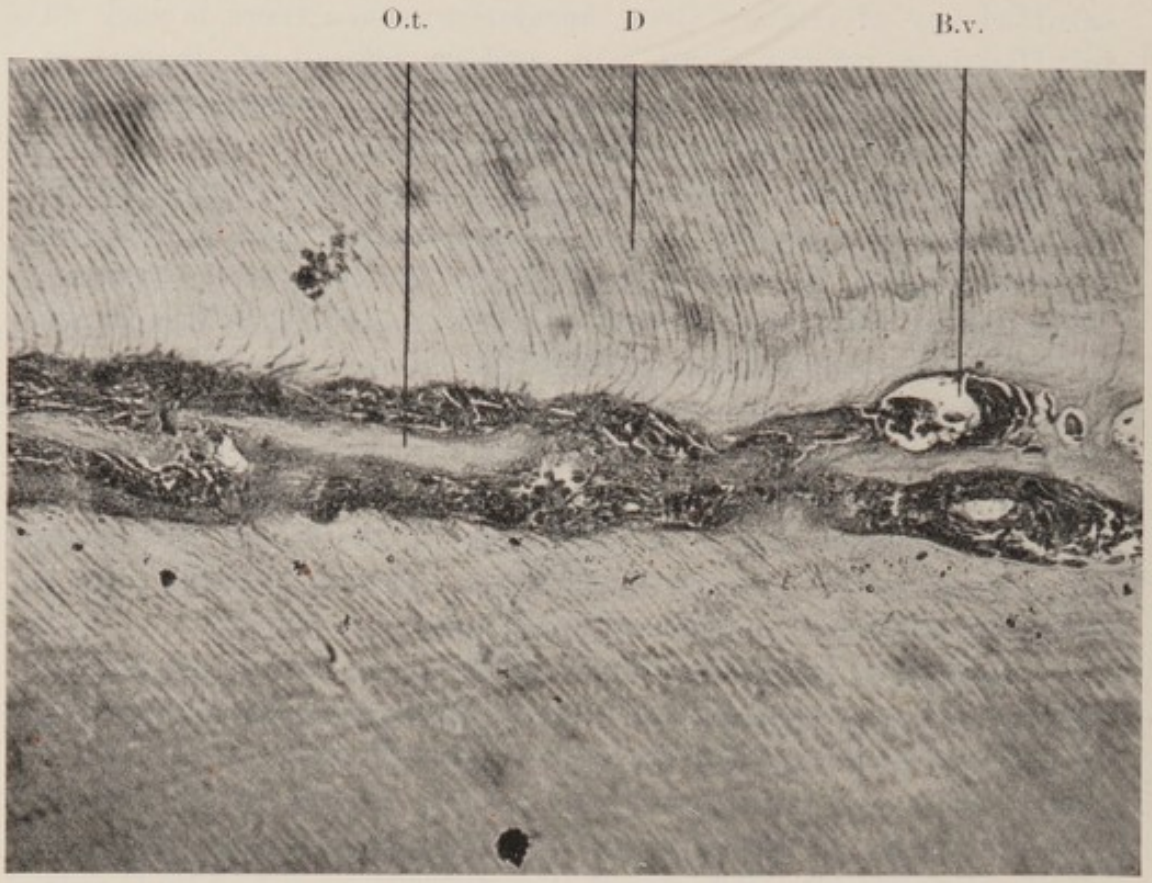


Fig. 3. Sagittal section through the hard lamina of a molar at the site of transition of the pulp cavity to the narrow pulp channel in a guinea pig protected against scurvy. Photomicrograph, enlarged 200 times. D: dentine; O. t.: Osteoid tissue; B. v.: blood vessels.

vidual investigator, as well as the organizers of the undertaking as a whole, are therefore deeply indebted to him.

H. Application of the criteria described above to the estimation of the minimum antiscorbutic protective ration.

Comparatively good growth in the experimental animals was not taken as a counter-indication of a digagnosis of scurvy, since it has been found that several animals had good or fair growth curves, even when the autopsy distinctly revealed all or some of the criteria of chronic scurvy yielded by the methods described in the foregoing. This was the case for instance in animals B_6, B_7, K_9, K_{10}, K_{12}, N_7, N_9 and N_{14}.

In other laboratories in which similar investigations are being

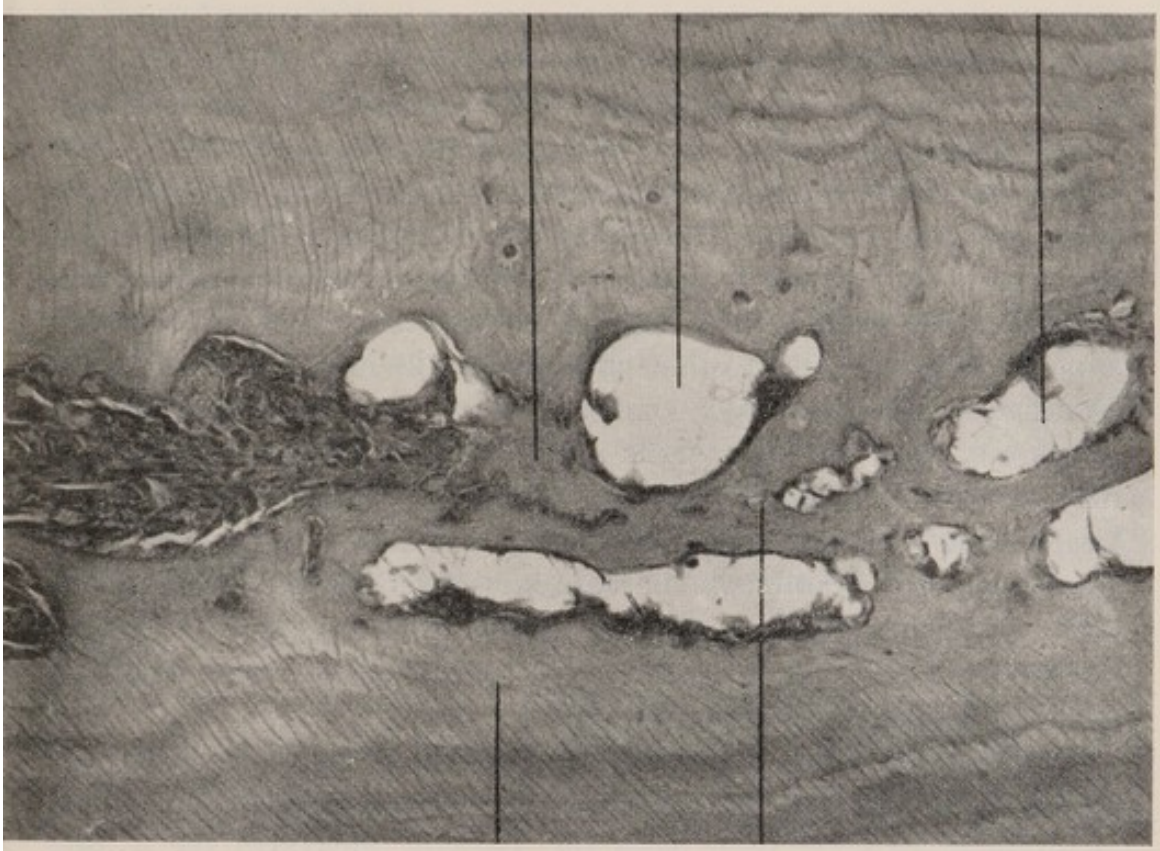


Fig. 4. Minimum scorbutic alteration in a cross-section of the hard lamina of a molar at site of transition of pulp cavity to the narrow pulp channel. Photomicrograph, enlarged 200 times. D: dentine; O. t.: osteoid tissue; B. v.: blood vessels.

made, it has not been common in the determination of the minimum antiscorbutic protective ration of some foodstuff, to make microscopic or radiological examinations. That the author did not follow the same line of action here probably requires special explanation.

Formerly, determinations of the minimum antiscorbutic protective ration for guinea pigs were made from predominantly theoretical points of view. Since the author, however, experimentally determined the minimum antiscorbutic protective ration of fresh orange juice *for man*, and stated a principle (21, pp. 258—261) for the calculation of the minimum ration for man from a microscopically ascertained minimum protective ration for guinea pig, the more sensitive determination by microscopy of a numerical value of the minimum protective ration for guinea pig has gained considerably in value for practical hygiene.

The procedure devised by the author for calculating from guinea pig to man presupposes the use in both cases of approximately equivalent criteria in the determination of the smallest quantity of a given foodstuff that will protect the systems of both from symptoms of vitamin C subnutrition. For man, the author tested the lower limit of an adequate vitamin C supply, with the strength of the skin capillaries as the criterium. To the best of my knowledge, no other criterium permitting such a determination has been suggested in any other quarter. It is considerably superior in sensitivity to that obtained in the macroscopic autopsy findings in guinea pig experiments. To what extent it agrees in sensitivity with the first signs and symptoms of a scorbutic condition manifest in the teeth of guinea pig is still an open question, but we may without exaggeration say this much: with regard to sensitivity, the results of the capillary strength test must be in *closer* correspondence with the dental reaction than with the macroscopic reaction of spontaneous haemorrhage, bone fragility, loosened teeth, etc., in the guinea pig.

In order to draw the greatest possible advantages from the investigation on berries reported here, an investigation which is intended to serve as a basis for hygienic measures for a long time to come in a part of the country where the winter diet is meagre in vitamin C and is in need of improvement in this respect by the use of the region's berry resources, it has been necessary to work to some extent along a *double front*.

We have had to ascertain the lowest possible protective ration for guinea pig by macroscopic autopsy findings in order to be able to make comparisons with the results obtained in other laboratories, regardless of whether the comparison was made on the same foodstuffs (berries) as those with which we worked, or on others. Further, the lowest protective ration for guinea pig had to be microscopically determined by ascertaining the normal structure of dental pulp and dentine in order to make possible a calculation of daily human requirements of the foodstuff in question to avoid vitamin C subnutrition by means of this foodstuff alone. This calculation, on the basis of the author's observations, is made as follows: *a human adult weighing 60 kg. is protected against vitamin C subnutrition if he consumes a daily ration of the protective foodstuff which is 14 to 20 times the minimum protective ration for guinea pig obtained by the microscopic dental criteria*, providing that this foodstuff is taken in a form in which

the human digestive system is able to utilise it to the same extent as the guinea pig's.

The radiological reaction was, to be sure, chiefly intended as evidence for the reader. Apparently, however, it may in future also be useful as a labour-saving device. In this investigation, in which about 160 animals were examined by both the radiological and the microscopic methods, *there was no case in which the microscopic method failed to reveal scurvy when the radiological method did reveal it.* In an investigation for the accurate determination of the minimum protective ration, the radiological method should therefore make it possible in a number of cases to do without the microscopic method, which, as we know, takes far more time and makes much greater demands on the investigator's skill. *The microscopic method might then, it appears, be reserved exclusively for cases with a negative radiological reaction.*

CHAPTER IV.

Tabular Survey of the Organisation and Results of the Biological Experiments in Series B, C, D, E, F, G, H, K, L and N

by

Bertil Hamne and *Gustaf Göthlin*

Series B. Blueberries (Vaccinium Myrtillus L.).

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
B_1 June 29	264/320 25 d. †	+ 21	0	Control. Basal diet + swedes *ad libitum*. Bronchitis the last days.
B_2 » 15	272/416 50 d.	+ 53	0	Control. Basal diet + swedes *ad libitum*.
B_3 » 15	260/399 »	+ 51	2.0 orange juice	Control. Basal diet + orange juice.
B_4 » 15	278/206 43 d. †	− 26	5.0 unc. blueberry juice	Juice in one portion.
B_5 —	280/228 50 d.	− 19	6.7 »	» » » »
B_6 June 12	284/394 »	+ 35	9.1 »	» » 2 portions.
B_7 » 20	287/382 »	+ 33	12.3 »	» » » »
B_8 » 15	290/429 »	+ 48	16.6 »	» » », then in 3 portions.
B_9 » 11	308/442 »	+ 43	16.6 »	As above. Nasal catarrh; bronchitis.
B_{10} —	298/424 »	+ 45	22.3 con.	Juice in 1 portion.
B_{11} June 10	328/426 »	+ 30	22.3 »	» » » » Nasal catarrh; bronchitis.
B_{12} » 11	304/449 »	+ 48	30.2 »	Juice in 2 portions.
B_{13} » 12	330/500 »	+ 51	30.2 »	» » » »
B_{14} » 10	328/420 22 d. †	+ 28	40.7 »	» » » » Bronchitis; pneumonia.
B_{15} —	314/426 50 d.	+ 36	40.7 »	Juice in 2 portions.
B_{16} June 11	334 354 25 d. †	+ 6	55.0 »	» » 3—2 » Nasal catarrh.
B_{17} » 12	368/449 44 d. †	+ 22	74.2 »	Juice in 3—2 portions. Peritonitis.
B_{18} » 20	286/227 31 d. †	− 21	2.0 unc.	Juice in 1 portion.
B_{19} » 10	420/224 24 d. †	− 47	0	Control. Basal diet + water.
B_{20} » 12	316/194 30 d. †	− 39	0	» » » » »

Abbreviations. U.: unexamined; con.: concentrated; unc.: unconcentrated; R.: right;

Experiments by Assar Normark.

Experiments on all the animals begun Aug. 9, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
Increased liquid content and diminished air content of lungs. Enlarged vessels of duodenum and upper jejunum. Mesenterium plethoric. No scorbutic alteration.	–	U	–	B_1
Mucous membrane of trachea covered with a small amount of mucus. Normal air content of lungs. No scorbutic alteration.	–	–	–	B_2
Cut surface of lung presents slight increase of liquid content, otherwise nothing pathological.	–	–	– (?)	B_3
In the liver pale brownish yellow spots and stripes. Artophied mandible with subperiosteal haemorrhages. Considerable scorbutic rosary. Fragile long bones.	+	U	+	B_4
Cutaneous and muscular haemorrhages. Swollen knee joints. Scorbutic rosary.	+	+	+	B_5
Subfascial haemorrhages around the knee-joints. About 10 small, white nodes on the surface of the liver. C.-ch. j. thickened L. c. II—V, VII, R. c. III—VI.	+	+	+	B_6
Cutaneous and muscular haemorrhages. Lungs present increased liquid and diminished air content. Liver as above. Thickening in most of the c.-ch. j.	+	+	+	B_7
Nothing pathological.	–	–	+	B_8
No skin haemorrhages. Joints normal. C.-ch. j. on L. c. IV—V, slightly thickened.	+ (?)	+ (?)	+	B_9
No scorbutic alterations. In the liver, a single yellow-white island.	–	–	+	B_{10}
Mucous membrane of trachea and bronchi covered with a small amount of mucus. Increased liquid, diminished air content of lungs. Liver as in no 6. Breast-plate and joints normal.	–	–	+	B_{11}
Some tough mucus in trachea and bronchi. No scorbutic alteration.	–	–	–	B_{12}
Increased liquid content of lungs. Spleen enlarged (1.25 gm). No scorbutic alteration.	–	–	–	B_{13}
Tracheal and bronchial mucous membranes reddened; surface layer of mucus increased. In each lung an abscess of the size of a hemp-seed. Mucous lining of stomach and intestines congested. Small intestine and coecum dilated.	–	U	–	B_{14}
In the liver 4 small yellow-white islets (gregarinosis?).	–	–	–	B_{15}
Increased liquid content of lungs. Intestinal mucous membrane very congested.	–	U	–	B_{16}
Abdomen swollen. In the abdominal cavity 1 tablespoonful bloody, serous liquid. Enlarged vessels of peritoneum. Small intestine dilated.	–	–	–	B_{17}
Skin haemorrhages. Mucous membrane of trachea slightly reddened. Considerable scorbutic rosary; one rib fractured. Fragile long bones.	+	U	+	B_{18}
Haemorrhages on mucous lining of stomach. Enlarged vessels in ileum and colon; meteorism. Atrophied mandible with subperiosteal haemorrhages. Scorbutic rosary.	+	U	+	B_{19}
Skin and muscular haemorrhages. Fragile long bones. Scorbutic rosary.	+	U	+	B_{20}

L.: left; c.-ch. j.: costo-chondral junction; c.: costa; †: died or killed because of illness.

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
C_1 May 27	289/278 47 d.	− 3.8	74.2 c.c. con.	Juice only one day but in full ration. Afterwards ailing for several weeks. Basal diet + swedes.
C_2 » 23	280/531 47 d.	+ 89.6	—	Control animal. Basal diet + swedes *ad libitum*.
C_3 » 21	298/473 47 d.	+ 58.7	—	Control animal. Basal diet + 2 c. c. orange juice. Ration raised to 3 c. c. on 42nd day.
C_4 » 27	357/218 43 d. † (died)	− 39	5.0 unc.	Juice in 1 portion.
C_5 » 17	366/425 47 d.	+ 16.4	6.7 »	» » » »
C_6 » 25	337/360 37 d. † (killed)	+ 6.8	9.1 »	» » 2 portions (accident on 33rd day).
C_7 » 29	349/444 47 d.	+ 27.2	» »	Juice in 2 portions.
C_8 » 23	359/525 47 d.	+ 46.2	12.3 »	» » » »
C_9 » 30	321/452 47 d.	+ 40.8	16.5 »	» » 3 »
C_{10} » 27	313/468 47 d.	+ 49.5	22.3 con.	» » 1 portion.
C_{11} » 17	369/495 47 d.	+ 34.2	30.2 »	» » 2 portions.
C_{12} » 21	284/348 40 d. † (killed)	+ 22.5	40.7 »	» » » » Feeble animal.
C_{13} » 23	294/248 5 d. † (died)	− 15.6	55.0 »	Juice in 3 portions. Refused to eat when juice was given.
C_{14} » 17	342/252 8 d. † (killed *in agone*)	− 26.3	» »	Juice in 3 portions.
C_{15} » 27	293/293 1 d. †	± 0	74.2 »	» » » » Died at night after having got full ration of juice *one* day.
C_{16} » 27	362/456 48 d.	+ 26.0	» »	Juice in 3 to 2 portions.
C_{17} » 25	314/207 35 d. † (died)	− 34.1	1.5 unc.	» » 1 portion. Conjunctivitis on 30th day.
C_{18} » 25	363/270 20 d. † (killed *in agone*)	− 25.6	2.7 »	Juice in 1 portion.
C_{19} » 27	361/196 21 d. †	− 45.8	—	Negative control. Basal diet + water.
C_{20} » 27	288/176 17 d. †	− 38.9	—	As above.

Explanation of abbreviations and signs. con.: concentrated; unc.: unconcentrated; c. ch. j.: costo-chondral junction; †: died or killed because of illness; **: of

Experiments on all the animals begun Aug. 3, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
Nothing pathological observed.	–		–	C_1
» » »	–		–	C_2
» » »	–		+	C_3
Died after 43 days. Ascending mandibular branches highly atrophied. Long bones fragile. Considerable scorbutic rosary.	+	X-ray examination of the living animals gave no serviceable results.	+	C_4
Haemorrhages of skin and muscles. Highly atrophied mandible. Long bones fragile. Considerable scorbutic rosary.	+		+	C_5
Haemorrhages of skin and muscles. Somewhat atrophied mandible. Slight thickening in most of the c.-ch. j.	+		+	C_6
Haemorrhages of skin and muscles. Atrophied mandible, long bones fragile. Great thickening of c.-ch. j. in ribs I—V.	+		+	C_7
Nothing pathological.	–		+	C_8
» »	–		+	C_9
» »	–		– (?)	C_{10}
» »	–		–	C_{11}
» »	–		–	C_{12}
The animal was thin. No signs of scurvy.	**		**	C_{13}
The animal was very thin. No signs of scurvy.	**		**	C_{14}
Stomach and small intestine dilated, filled with juice.	**		**	C_{15}
Fissures at corners of the mouth. Otherwise nothing pathological.	–		–	C_{16}
Skin and muscular haemorrhages. Atrophied mandible with subperiosteal haemorrhage. Long bones fragile. Considerable scorbutic rosary.	+		+	C_{17}
Rectal prolapse. Much blood, in part coagulated, in lower part of abdominal cavity. Mesocolon congested and discoloured. Atrophied mandible. Fragile long bones. Scorbutic rosary.	+		+	C_{18}
Muscular haemorrhages. Subperiosteal haemorrhages around the mandible. Fragile long bones. Scorbutic rosary.	+		+	C_{19}
Muscular heamorrhages. Highly atrophied mandible. Fragile long bones. Scorbutic rosary.	+		+	C_{20}

no importance, since the animals died after a short period of intolerance of the large rations of juice.

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
D_1 —	296/460 50 d.	+ 55.4	—	Control. Basal diet + swedes. Nasal catarrh 22nd—25th days.
D_2 July 14	286/508 50 d.	+ 77.6	—	Control. Basal diet + swedes. Nasal catarrh 19th—22nd days.
D_3 » 12	286/388 50 d.	+ 35.7	2—3 orange juice	Control. Basal diet + 2 c. c. orange juice. From 16th day on, 3 c. c.
D_4 » 15	301/176 33 d. † (killed *in agone*)	— 41.5	1.5 unc. juice of arctic raspberries	
D_5 —	318/394 62 d.	+ 23.9	1.8 unc. From 26th day on, 19.3 con.	Juice in 2 portions.
D_6 July 15	304/236 34 d. † (killed)	— 22.4	2.2 unc. From 26th day on, 23.1 con.	» » » » Albino.
D_7 » 15	329/208 31 d. †	— 36.8	2.6 unc.	Nasal catarrh 14th—20th days.
D_8 » 12	338/230 36 d. † (killed *in agone*)	— 31.9	3.1 »	
D_9 » 5	349/357 61 d.	+ 2.3	3.7 unc. From 26th day on, 27.7 con.	Nasal catarrh 15th—20th days.
D_{10} » 8	360/242 33 d. †	— 32.8	4.5 unc.	
D_{11} —	320/246 43 d. † (killed)	— 23.1	5.4 »	Nasal catarrh 18th—22nd days.
D_{12} July 14	294/244 41 d. † (killed *in agone*)	— 17.0	6.5 »	Juice in 2 portions.
D_{13} » 12	333/193 41 d. †	— 42.0	7.7 »	» » » » Nasal catarrh 15th—20th days.
D_{14} » 5	386/230 41 d. †	— 40.4	9.3 »	Juice in 2 portions. Abortion 10th day.
D_{15} » 8	372/314 61 d.	— 15.6	11.1 con. From 35th day on, 23.1 con.	Juice in 2 portions. Nasal catarrh 18th—22nd days.
D_{16} —	315/246 44 d. † (killed)	— 21.9	13.4 con.	Juice in 2 portions.
D_{17} —	346/340 51 d.	— 1.7	16.0 »	» » » » Nasal catarrh 17th—22nd days.
D_{18} July 8	365/362 51 d.	— 0.8	19.3 »	Juice in 2 portions.
D_{19} » 5	341/199 28 d. †	— 41.6	—	Negative control. Basal diet + water.
D_{20} —	292/177 29 d. †	— 39.4	—	Negative control. Basal diet + water.

Abbreviations. con.: concentrated; unc.: unconcentrated; U.: unexamined;

Experiments on all the animals begun Sept. 2, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
No signs of scurvy.	—	U	—	D_1
» » » »	—	U	—	D_2
» » » »	—	U	+	D_3
Cutaneous and intestinal haemorrhages. Fragile long bones. Scorbutic rosary.	+	+	+	D_4
No cutaneous haemorrhages. Moderate fragility of the mandible. Slight thickening of c.-ch. j. of some ribs (R. c. II—VI).	+ (?)	+	+	D_5
No cutaneous haemorrhages. Fragility of the long bones. Slight thickening of most of the c.-ch. j.	+	+	+	D_6
Cutaneous haemorrhages. Intestinal haemorrhages. Fragile long bones. Scorbutic rosary.	+	+	+	D_7
Cutaneous haemorrhages. Small subpericardial haemorrhages, haemorrhages in intestinal submucosa. Skin abscess of the size of a grain of rice. Fragile long bones. Scorbutic rosary.	+	+	U	D_8
No cutaneous haemorrhages. C.-ch. j. thickened on R. c. III—V and L. c. III—VI. Microscopic haemorrhages in renal cortex.	+	+	+	D_9
Cutaneous haemorrhages. Intestinal haemorrhages. Superficial haemorrhages in the liver. Fragile long bones. Scorbutic rosary.	+	+	U	D_{10}
Cutaneous haemorrhages. Haemorrhages in gums and intestinal mucous membrane. Microscopically degenerative changes of liver cells. Fragile long bones. Scorbutic rosary.	+	U	U	D_{11}
Cutaneous haemorrhages. Subpericardial haemorrhages. Fragile long bones. Scorbutic rosary. Submandibular glands swollen (microscopic diagnosis: tb.).	+	U	U	D_{12}
Cutaneous haemorrhages. Intestinal haemorrhages. Fragile long bones. Scorbutic rosary.	+	U	U	D_{13}
Same findings as in D 13.	+	U	U	D_{14}
Cutaneous haemorrhages. Fragile long bones. C.-ch. j., R. and L. c. II—VIII, thickened.	+	+	+	D_{15}
Cutaneous haemorrhages. Pulmonary abscess the size of a grain of rice. Fragile long bones. Scorbutic rosary.	+	U	U	D_{16}
No haemorrhages. Fragile long bones. C.-ch. j., R. and L. c. II—VI, slightly thickened.	+	U	+	D_{17}
No haemorrhages in skin, muscles or mucous membranes. Long bones of normal strength. C.-ch. j., R. c. II—V, L. c. III—V, slightly thickened, otherwise no discernible scorbutic alteration.	+ (?)	U	+	D_{18}
Subcutaneous and muscular haemorrhages. Pronounced scorbutic rosary. Highly atrophied mandible. Fragile long bones.	+	U	U	D_{19}
Scorbutic rosary. Highly atrophied mandible. Fragile long bones.	+	+	U	D_{20}

c.-ch. j.: costo-chondral junction; c.: costa; R.: right; L.: left; †: died or killed in a state of extreme debility.

Series E. Red Currants (Ribes rubrum L.).

Animal's no. and date of birth, 1929	Dates of experiments and duration in days	Initial and final weight in gm	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
E_{22} —	17. IX—6. XI 50 d.	345/434	+ 22	—	Control animal. Basal diet + Swed. turnips *ad libitum*.
E_2 May 27	4. IX—24. X 50 d.	327/492	+ 50	—	» » » »
E_3 July 10	4. IX—24. X 50 d.	297/492	+ 65	—	Control animal. Basal diet + orange juice 2 c. c. (21 d.), 2.5 c. c. (17 d.), 3 c. c. (11 d.).
E_4 June 28	5. IX—25 X 50 d.	351/261	— 25	1.5 unc.	Juice in one ration.
E_{23} —	17. IX—6. XI 50 d.	353/260	— 26	1.9 »	» » » »
E_6 July 10	4. IX—24. X 50 d.	298/297	± 0	2.3 »	» » » »
E_7 June 13	4. IX—24. X 50 d.	289/420	+ 69	2.9 »	» » » »
E_{24} —	17. IX—6. XI 50 d.	344/319	— 7	3.7 »	» » » »
E_{29} July 14	27. IX—18. XI 52 d.	382/360	— 6	4.6 »	» » » »
E_{27} » 11	27. IX—18. XI 52 d.	344/370	+ 7	5.7 »	3.7 + 2 c. c.
E_{11} » 1	4. IX—24. X 50 d.	282/427	+ 51	7.5 »	4 + 3.5 c. c.
E_{12} —	4. IX—24. X 50 d.	316/451	+ 42	8.9 »	4.9 + 4 c. c.
E_{13} —	4. IX—24. X 50 d.	379/530	+ 66	11.2 »	6 + 5.2 c. c.
E_{26} —	17. IX—6. XI 50 d.	335/469	+ 40	14.0 »	5 + 5 + 4 c. c.
E_{25} —	17. IX—6. XI 50 d.	340/459	+ 35	17.5 »	6 + 6 + 5.5 c. c. Miscarriage after 1 month.
E_{16} June 8	4. IX—24. X 50 d.	344/512	+ 49	21.8 »	Juice in 4 portions.
E_{28} July 11	27. IX—18. XI 52 d.	362/495	+ 37	27.3 »	» » 4 or 5 portions.
E_{18} —	4. IX—24. X 50 d.	371/491	+ 32	34.1 »	» » 5 portions.
E_{19} May 27	4. IX—27. IX 23 d.	375/201	— 46	—	Control. Basal diet + water.
E_{20} June 8	5. IX—3. X 28 d.	321/202	— 37		» » » » »

Abbreviations. unc.: unconcentrated; U.: unexamined; c.-ch. j.: costo-chondral

Experiments by Rolf Rhodin.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
No signs of scurvy.	—	—	—	E_{22}
» » » »	—	—	—	E_2
» » » »	—	—	—	E_3
Haemorrhages in skin and oral cavity. Atrophied mandible. Long bones fragile. Considerable scorbutic rosary.	+	+	+	E_4
Cutaneous hemorrhages. Considerable scorbutic rosary.	+	+	+	E_{23}
» » Femur and tibia fragile. C.-ch. j. of R. c. VI—VII, L. c. II—III and L. c. V—VI thickened.	+	+	+	E_6
No signs of scurvy. Inferior lobe of left lung hyperaemic.	—	—	+ very slight alteration	E_7
Cutaneous haemorrhages. Long bones of the forelegs fragile. C.-ch. j. of R. c. IV—VII and L. c. III—VII thickened.	+	+	+	E_{24}
Cutaneous haemorrhages. Long bones fragile. Scorbutic rosary. Small intestine highly congested.	+	+	+	E_{29}
Cutaneous haemorrhages. Distinct scorbutic rosary. Small intestine highly congested.	+	+	+	E_{27}
No signs of scurvy. Small intestine congested.	—	—	+	E_{11}
As above, but also firmer consistency of liver, grey spots in its surface.	—	—	—	E_{12}
No signs of scurvy.	—	—	+	E_{13}
» » » »	—	—	—	E_{26}
» » » »	—	—	+ slight alteration	E_{25}
» » » »	—	—	—	E_{16}
» » » »	—	—	+ (!)	E_{28}
» » » »	—	—	—	E_{18}
Extensive cutaneous haemorrhages. Vessels of duodenum highly congested. Long bones fragile. Distinct scorbutic rosary.	+	U	+	E_{19}
Extensive cutaneous haemorrhages. Long bones fragile. Distinct scorbutic rosary.	+	+	+	E_{20}

junction; c.: costa; R.: right; L.: left.

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
F_1 Aug. 10	358/510 54 d.	+ 42.4	—	Control. Basal diet + swedes.
F_2 » 4	344/368 53 d.	+ 6.9	7.6 raspberry beverage	Clinically normal at the end of the experimental period.
F_3 » 10	312/444 55 d.	+ 42.3	2—3 orange juice	Control. Basal diet + orange juice.
F_4 » 15	327/436 54 d.	+ 33.3	As above	As above.
F_5 » 4	312/300 54 d.	— 3.8	1.5 raspberry juice	32nd day, difficulty in walking.
F_6 » 8	366/410 53 d.	+ 13.4	3.0 » »	Clinically normal at the end of the experimental period.
F_7 » 10	304/391 53 d.	+ 25.3	6.0 » »	3 c. c. two times daily. Clinically normal.
F_8 » 10	368/468 55 d.	+ 27.1	12.0 » »	4 c. c. three times daily. Clinically normal at the end of the experimental period.
F_9 » 12	324/410 54 d.	+ 26.5	11.4 raspberry beverage con. 3: 8	4 c. c. twice, 3.4 once daily. Albino.
F_{10} » 4	280/254 46 d. † (killed)	— 9.3	2.3 as above, though unc.	Clinical scurvy.
F_{11} » 12	360/320 54 d.	— 11.1	3.4 » »	Clinically normal at the end of the experimental period.
F_{12} » 8	314/370 53 d.	+ 17.8	5.1 » »	3 + 2.1 c. c. daily. Clinically no scurvy.
F_{13} » 15	330/380 53 d.	+ 15.1	7.6 » »	4 + 3.6 c. c. daily. Clinically no scurvy.
F_{14} » 8	376/436 54 d.	+ 15.9	11.4 » »	4 c. c. twice, 3.4 once, daily.
F_{15} ?	298/380 51 d.	+ 27.5	17.1 » » con. 3: 8	4 c. c. three times, 5.1 once, daily. Clinically no scurvy.
F_{16} Aug. 10	362/453 52 d.	+ 25.1	17.1 » » con. 3: 8	As above. Albino.
F_{17} » 12	319/390 52 d.	+ 22.2	25.6 » » con. 3: 8	6 c. c. three times, 7.6 once, daily. Clinically normal at the end of the experimental period.
F_{18} » 4	330/364 51 d.	+ 10.3	25.6 » » con. 3: 8	As above.
F_{19} » 10	330/306 11 d.	— 7.2	—	Negative control. Only basal diet + water. Pneumonia.
F_{20} » 15	324/188 25 d.	— 41.9	—	Negative control. Only basal diet + water.

Abbreviations. con.: concentrated; unc.: unconcentrated; U.: unexamined; c.-ch. j.:

Experiments on all the animals begun Sept. 29, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
No signs of scurvy.	–	–	–	F_1
Muscular haemorrhages. Slight thickening of the c.-ch. j. in R. c. III and IV. Long bones and mandible not fragile.	+	+	+	F_2
No signs of scurvy.	–	–	+	F_3
» » » »	–	–	–	F_4
Muscular and subpleural haemorrhages. Haemorrhage in lower $^2/_3$ of the mucous membrane of the small intestine and in the lower part of the colon. Considerable scorbutic rosary. Deformation of the tibiae. R. knee-joint swollen.	+	+	+	F_5
Cutaneous, muscular and periostal haemorrhages. C.-ch. j. L. c. V—VII, R. c. II—VII, moderately thickened. Molar teeth not loose.	+	+	+	F_6
No scorbutic alteration.	–	–	–	F_7
» » »	–	–	–	F_8
» » » Anal prolapse.	–	–	+	F_9
Muscular haemorrhages and haemorrhages around knee-joints. Thickening of the c.-ch. j. on most of the ribs. Fragility of the long bones. Suprarenals hyperaemic, with enlarged cortex.	+	+	+	F_{10}
Cutaneous, muscular and periostal haemorrhages. Scorbutic rosary. Slight deformation of tibiae. Molar teeth not loose. Haemorrhages in the mucous membrane of trachea.	+	+	+	F_{11}
Intercostal haemorrhages. C.-ch. j. moderately thickened on L. c. III—VIII, R. c. III—V. Long bones not fragile. Teeth not loose.	+	+	+	F_{12}
Haemorrhages in hind legs. Knee-joints slightly swollen. C.-ch. j. moderately thickened on R. and L. c. II—IV.	+	+	+	F_{13}
No haemorrhages, especially not in the hind legs. Slight thickening of the c.-ch. j. on R. c. II—VI. Long bones not fragile.	– (?)	+	+	F_{14}
No signs of scurvy.	–	–	–	F_{15}
» » » »	–	–	–	F_{16}
» » » » Submaxillary glands enlarged.	–	–	–	F_{17}
» » » »	–	–	–	F_{18}
» » » » Bronchopneumonia.	+	U	+	F_{19}
Muscular haemorrhages. Scorbutic rosary.	+	+	+	F_{20}

costo-chondral junction; c.: costa; R.: right; L.: left.

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
G_1 Aug. 14	334/424 42 d.	+ 26.9	—	Control. Basal diet + swedes.
G_2 » 9	304/361 41 d.	+ 18.7	—	As above. Last days nasal catarrh.
G_3 » 2	342/483 44 d.	+ 41.2	—	Control. Basal diet + 2 c. c. (27 days)— 3 c. c.(17 days) orange juice.
G_4 » 8	307/183 30 d. † (died)	− 40.4	3.7 unc.	In one portion.
G_5 » 14	333/181 29 d. † (died)	− 45.6	5.0 »	As above.
G_7 » 9	312/172 33 d. † (died)	− 48.1	6.7 »	3.7 + 3 c. c.
G_8 ?	327/201 26 d. † (died)	− 38.5	9.1 »	5 + 4.1 c. c.
G_9 Aug. 14	376/233 31 d. † (killed)	− 38.0	12.3 »	4 c. c. twice and 4.3 once daily.
G_{10} » 9	307/166 35 d. † (died)	− 45.9	12.3 unc.[1]	Rations of 6.3 and 6.0 c. c.
G_{11} » 14	334/209 34 d. † (died)	− 37.4	16.6 » [1]	3 rations (5 + 6 + 5.6 c. c.).
G_{12} ?	335/226 37 d. † (killed)	− 32.5	22.3 con.[1]	2 rations (3.6 + 2 c. c.).
G_{13} Aug. 8	344/223 32 d. † (died)	− 35.2	As above	As above. Parturition 24th day.
G_{14} » 8	336/231 39 d. † (killed)	− 31.2	30.3 con.[1]	2 rations (4.0 + 3.6 c.c.).

Abbreviations. con.: concentrated; unc.: unconcentrated; c.-ch. j.: costo-chondral U.: unexamined.

[1] Juice partly neutralized by addition of 1.5 % $CaCO_3$ and filtration before admini-

Experiments on all the animals begun Oct. 13, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
No scorbutic alteration.	—	—	—	G_1
» » » (microscopically, the lungs exhibit bronchopneumonia).	—	—	—	G_2
» » »	—	—	—	G_3
Cutaneous haemorrhages. Haemorrhages in the fat around the scapulae. Blood appears to pressure on the gums. Atrophied jawbones, loose teeth. Considerable scorbutic rosary. Pea-sized haemorrhage in left lung. Fragile long bones.	+	+	+	G_4
As above, but no lung haemorrhage.	+	+	+	G_5
Cutaneous and muscular haemorrhages. A slight haemorrhage in the gums. Atrophied jawbones, loose teeth. Considerable scorbutic rosary. Pea-sized lung haemorrhage. Fragile long bones.	+	+	+	G_7
No cutaneous haemorrhages. Muscular haemorrhages. A slight intestinal haemorrhage. Atrophied jawbones, loose teeth. Fragile long bones. C.-ch. j. moderately thickened in L. c. IV—V and R. c. II.	+	U	+	G_8
Cutaneous and muscular haemorrhages. Suprarenal haemorrhage. Gums bleeding to pressure. Atrophied jawbone, loose teeth. Considerable scorbutic rosary. Fragile long bones. Weight of spleen 860 mgm.	+	+	+	G_9
Small cutaneous haemorrhages. Central haemorrhages in mesenterial lymph glands. Gums bleed only on strong pressure. Atrophied jawbone, loose teeth. C.-ch. j. moderately thickened on L. c. III—V, VIII, R. c. III—IV. Fragile long bones.	+	+	+	G_{10}
Cutaneous and muscular haemorrhages. Pulmonary haemorrhages. Central haemorrhages in mesenterial lymph glands. Gums bleeding to pressure. Atrophied jawbone, loose teeth. C.-ch. j. distinctly thickened in most ribs.	+	+	+	G_{11}
Same findings as in no. 11. Weight of spleen 375 mgm.	+	+	+	G_{12}
Cutaneous and muscular haemorrhages. Gums, jawbone, teeth, c.-ch. j. as in G 11.	+	+	+	G_{13}
Cutaneous haemorrhages. Haemorrhage in wall of bladder, and large haemorrhages in mesenterial lymph glands. Jawbone moderately atrophied, only one tooth loose. Distinct scorbutic rosary. Fragile long bones.	+	+	+	G_{14}

junction; c.: costa; R.: right; L.: left; †: died or killed in a state of extreme debility;

stration.

Series G (cont.).

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
G_{15} Aug. 21	364/254 34 d. † (killed)	− 30.2	40.7 −55 con.[1])	13/X—2/XI 2 rations. 3/XI—14/XI 3 rations.
G_{16} » 14	332/260 31 d. † (died)	− 21.7	40.7 con.[1])	2 rations (5.2 + 5 c. c.).
G_{17} » 8	410/440 27 d. † (died)	+ 7.3 (− 14.6) *	55.0 con.[1])	3 rations (5.5 + 5 + 3.3 c. c.). Pregnant. Died before delivery.
G_{18} » 1	422/236 26 d. † (died)	− 44.0	(55)—16.6 con.[1])	1 ration (4.2 c. c.). Paralysis of the hind legs.
G_{19} » 14	370/220 40 d. † (killed)	− 40.5	19/X−25/X 74.2 con.; 26/X−21/XI 55 con.[1])	First period 4 rations; second period 3 rations (5.5 + 5 + 3.3 c. c.).
G_{20} » 14	314/188 30 d. †	− 40.1	0	Negative control. Only basal diet + water.

* If the weight of the dead foetuses in the uterus is detracted, the loss in weight

[1]) For note, see preceding page.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
Cutaneous haemorrhages. Jawbone attenuated, but no teeth loose. Considerable scorbutic rosary. Fragile long bones. Weight of spleen 295 mgm.	+	+	+	G_{15}
Cutaneous and muscular haemorrhages. Suprarenal haemorrhage, ventricular haemorrhage (+ great ventricular dilatation, capacity of 43 c. c.); haemorrhages in mucous lining of large intestine. Jawbones moderately atrophied. Distinct thickening of c.-ch. j. in most of the ribs.	+	+	+	G_{16}
Extensive haemorrhages in skin of abdomen (pregnant). Haemorrhages in lungs and pericardium. Oral cavity, grossly normal. C.-ch. j. slightly thickened on R. c. II—V, L. c. II—III, VI—VIII.	+	+(?)	+	G_{17}
No haemorrhages (even after recovery from the paralysis of the hind legs, the animal was active until its death). Fairly loose teeth. C.-ch. j. distinctly thickened on R. c. III—VII, L. c. II—VIII. Long bones moderately fragile.	+	+	+	G_{18}
Cutaneous and muscular haemorrhages, and a haemorrhage in the lung. Central haemorrhages in mesenterial lymphatic glands. Gums bleeding to pressure. Atrophied jawbones, comparatively loose teeth. Scorbutic rosary. Long bones moderately fragile. Weight of spleen 220 mgm.	+	+	+	G_{19}
Cutaneous and muscular haemorrhages, haemorrhage in the lung; haemorrhages in mucous membrane of mouth. Atrophied jawbones, loose teeth. Considerable scorbutic rosary. Long bones exceedingly fragile. Weight of spleen 370 mgm.	+	+	+	G_{20}

amounts to 14.6 %.

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
H_1 Aug. 15	380/436 46 d.	+ 32.1	0	Control. Basal diet + swedes *ad libitum*.
H_2 » 7	300/430 46 d.	+ 43.3	0	Control. Basal diet + swedes *ad libitum*.
H_3 » 14	338/430 47 d.	+ 21.4	→	Control. Basal diet + 2 c. c. orange juice.
H_4 » 21	310/165 24 d. †	— 46.8	3.7 unc.	Juice in 1 portion.
H_5 » 15	318/190 27 d. †	— 40.3	5.0 »	» » » »
H_6 » 13	338/196 26 d. †	— 42.6	6.7 »	» » 2 portions.
H_7 » 7	322/196 24 d. †	— 39.1	9.1 »	» » » »
H_8 » 21	350/195 29 d. †	— 44.3	12.3 »	» » 3 »
H_9 » 11	326/203 36 d. †	— 37.7	16.6 »	» » » »
H_{10} » 11	368/204 26 d. †	— 44.6	16.6 con.[1]	» » 2 »
H_{11} » 14	352/178 28 d. †	— 49.4	19.4 » [1]	As above. Rhinitis from 27th day.
H_{12} » 6	356/283 28 d. †	— 20.5	22.3 »	Juice in 2 portions, from 18th day approximately neutralized by addition of $NaHCO_3$.
H_{13} » 15	370/261 30 d. †	— 29.5	26.6 » [1]	Juice in 2 portions. Sneezing the last days.

Abbreviations. con.: concentrated; unc.: unconcentrated; U: unexamined; e.-ch. j.: extreme debility.

[1] The concentrated juice nearly neutralized by addition of $CaCO_3$ in the ratio 6 gm.

Experiments on H_4 begun Oct. 30, on all the other animals Oct. 26, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
After sudden loss of weight (74 gm.) the last two days, the animal was killed by etherisation. Autopsy: trachea slightly reddened, lungs plethoric, subpleural haemorrhages. Highly congested vessels in the mucous membrane of colon and coecum. Peritoneum highly reddened, but smooth and moist. Weight of spleen 525 mgm.	—	—	U	H_1
Nothing pathological found.	—	—	—	H_2
The skeleton slightly more fragile than in the first 2 controls. No definite signs of scurvy. Weight of spleen 1005 mgm.	—	—	— (?)	H_3
Muscular haemorrhages. Large subpleural haemorrhages. Scorbutic rosary. The skeleton abnormally fragile.	+	+	U	H_4
Atrophied mandible, loosened teeth. Long bones fragile. Distinct scorbutic rosary. Weight of spleen 365 mgm.	+	+	U	H_5
Congested vessels of the colon. Atrophied mandible. Long bones fragile. Here and there thickening of the c.-ch. j.	+	+	U	H_6
Muscular haemorrhages. Mandible highly atrophied. Scorbutic rosary. Weight of spleen 215 mgm.	+	+	+	H_7
Atrophied mandible. Long bones fragile. Distinct scorbutic rosary. Weight of spleen 780 mgm.	+	+	+	H_8
Muscular haemorrhages. Extensive subpleural haemorrhages. Vessels of the mucous lining of the bladder congested. Atrophied mandible, loosened teeth. Long bones fragile. Considerable scorbutic rosary.	+	+	+	H_9
Small haemorrhages in the mucous lining of the stomach. Congested vessels in the mucous lining of the coecum. Atrophied mandible. Scorbutic rosary.	+ ?	+	+	H_{10}
Muscular haemorrhages. Large subpleural haemorrhages. Vessels of the mucous lining of the small intestine congested here and there. Atrophied mandible, fragile long bones. Scorbutic rosary.	+	+	+	H_{11}
Muscular haemorrhages. Around shoulders and knee-joints, large haemorrhages. Large subpleural haemorrhages. Mucous membrane of bladder with congested vessels. Scorbutic rosary. Atrophied mandible.	+	+	+	H_{12}
Coecum and colon enormously dilated by faeces and gases; colon also contains bloody mucus. In the mesenterium a few swollen haemorrhagic glands. Atrophied mandible. C.-ch. j. with slight thickening in R. c. IV—V, L. c. V.	+	+	+	H_{13}

costo-chondral junction; c.: costa; R.: right; L.: left; †: died or killed in a state of

to 100 c. c. and filtration before administration.

Series H (cont.).

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
H_{14} Aug. 6	364/187 30 d. †	− 48.6	30.2 con. [1]	Juice in 2 portions; miscarriage, 1 foetus, 20th day.
H_{15} » 9	353/274 25 d. †	− 22.4	30.2 »	Juice in 2 portions, from 12th day approximately neutralized by addition of $NaHCO_3$.
H_{16} » 15	406/326 28 d. †	− 19.7	40.7 » [1]	Juice in 2 portions. Pneumonia.
H_{17} » 31	418/340 32 d. †	− 18.7	55.0 »	Juice in 3 portions, from 18th day approximately neutralized by addition of $NaHCO_3$.
H_{18} » 13	450/294 39 d. †	− 34.7	55.0 » [1]	Juice in 3 portions.
H_{19} » 11	448/330 24 d. †	− 26.3	74.2 » [1]	Juice in 3 or 4 portions.
H_{20} » 2	333/176 25 d. †	− 47.1	0	Negative control. Basal diet + water.

[1] For note, see preceding page.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
Atrophied mandible. Distinct scorbutic rosary.	+	+	+	H_{14}
Muscular haemorrhages. Gums bleeding on pressure. Atrophied mandible; long bones fragile. Scorbutic rosary.	+	+	+	H_{15}
Muscular haemorrhages. Large haemorrhages around the knee-joints. L. lung does not contract normally; cut surface dryer than normal; small amount of granular, bloody fluid escapes from it on pressure. Stomach dilated (20 c. c.), mucous lining partly congested. Considerable scorbutic rosary.	+	+	+	H_{16}
Muscular haemorrhage (only slight). Large subpleural haemorrhages. Mucous lining of the small intestine congested. Atrophied mandible. Considerable scorbutic rosary.	+	+	+	H_{17}
Muscular haemorrhage. Atrophied mandible, loosened teeth. Long bones fragile. In the knee-joints reddened synovia. Considerable scorbutic rosary.	+	+	+	H_{18}
Stomach, small intestine and coecum extremely dilated, with congested mucous membranes; slight haemorrhages in the stomach. In the coecum, mucous polypi (microscopic diagnosis). In some ribs thickening of the c.-ch. j.	+ (?)	+ (?)	+	H_{19}
Muscular haemorrhages. Atrophied mandible; long bones fragile. Here and there slight thickening of the c.-ch. j.	+	U	+	H_{20}

Animal's no. and date of birth, 1929	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
K_1 Sept. 1	301/440 50 d.	+ 46.2	1 c. c. freshly expressed orange juice	Weber test in faeces neg. 25th and 50th days; no clinical symptoms of scurvy.
K_2 Aug. 6	324/458 52 d.	+ 41.4	2 as above	Weber test in faeces neg. 25th day; no clinical symptoms of scurvy.
K_3 » 28	308/465 53 d.	+ 51.0	3 » »	As above.
K_4 » 31	308/429 53 d.	+ 39.3	4 » »	» »
K_9 » 31	344/456 50 d.	+ 32.6	1.5 unc. cloudberry beverage	Weber test in faeces neg. 25th, 35th & 50th days; no clinical symptoms of scurvy.
K_{10} » 9	300/396 50 d,	+ 32.0	2.0 as above	Weber test in faeces neg. 25th & 50th days; no clinical symptoms of scurvy.
K_{11} » 21	360/505 51 d.	+ 40.3	2.7 » »	Weber test in faeces neg. 25th & 51st days; no clinical symptoms of scurvy.
K_{12} July 15	344/468 51 d.	+ 36.0	2.7 » »	Weber test in faeces neg. 51st day; no clinical symptoms of scurvy.
K_{13} Aug. 27	294/490 51 d.	+ 66.7	3.7 » »	Weber test in faeces neg. 25th & 51st days; no clinical symptoms of scurvy.
K_{14} » 18	300/392 51 d.	+ 30.7	5.0 » »	Juice in 2 portions. Weber test in faeces neg. 25th and 51st days.
K_{15} » 28	264/394 52 d.	+ 49.2	6.7 » »	Juice in 2 portions. Weber test in faeces neg. 25th and 51st days.
K_{16} » 9	298/386 52 d.	+ 29.5	9.1 » »	Juice in 2 portions. Weber test in faeces neg. 25th and 51st days.
K_{17} » 27	346/492 52 d.	+ 42.2	12.3 » »	Juice in 3 portions. Weber test in faeces neg. 25th and 51st days.
K_{18} » 31	372/430 52 d.	+ 15.6	16.6 » » con. by $^1/_2$ from 30th day on	Juice in 3 portions. Weber test in faeces neg. 25th and 51st days.
K_{19} » 27	384/464 52 d.	+ 20.8	22.3 as above con. by $^1/_2$ from 30th day on	Juice in 4 portions. Weber test in faeces neg. 52nd day.
K_{20} » 8	356/205 27 d.	− 42.4	—	Negative kontrol. Basal diet + water.

Abbreviations. con.: concentrated; unc.: unconcentrated; neg.: negative; pos.:

Experiments on all the animals begun Oct. 31, 1929.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
No signs of scurvy. Weber test in faeces negative. Weight of spleen, 697 mgm.	—	—	+	K_1
No signs of scurvy. Weight of spleen 658 mgm.	—	+ (?)	+	K_2
» » » » » » » 757 mgm.	—	—	—	K_3
» » » » » » » 777 mgm.	—	—	—	K_4
No signs of scurvy. Weber test in faeces negative. Weight of spleen 948 mgm.	—	—	+	K_9
No signs of scurvy. Weber test in faeces negative. Weight of spleen 918 mgm.	—	— (?)	+	K_{10}
No signs of scurvy. Weber test in faeces negative. Weight of spleen 917 mgm.	—	—	+	K_{11}
No signs of scurvy. Weber test in faeces negative. Weight of spleen 1 109 mgm.	—	+ (?)	+	K_{12}
No signs of scurvy. Weber test in faeces negative. Weight of spleen 839 mgm.	—	—	—	K_{13}
No signs of scurvy. Weber test in faeces negative. Weight of spleen 679 mgm.	—	—	—	K_{14}
No signs of scurvy. Weight of spleen 731 mgm.	—	—	—	K_{15}
» » » » » » » 750 »	—	—	—	K_{16}
» » » » » » » 699 »	—	—	—	K_{17}
» » » » » » » 579 »	—	—	—	K_{18}
» » » » Weber test in faeces negative. Weight of spleen 759 mgm.	—	—	—	K_{19}
Haemorrhages in prescapular muscles, in muscles of right posterior crural region and in mesenterial glands. Considerable scorbutic rosary, loose teeth. Long bones strikingly fragile. Weber test in faeces pos. Weight of spleen 226 mgm.	+	+	+	K_{20}

positive.

Series L. Kale (Brassica oleracea L., var. acephala D. C.); juice of swedes (Brassica Napus L., var. Napobrassica (L.) Peterm.); juice of stewed cloudberries (Rubus chamaemorus L.).

Animal's no. and date of birth, 1930	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily rations	Daily distribution of rations. Remarks.
L_1 Jan. 14	340/555 50 d.	+ 63.2	—	Control. Basal diet + swedes *ad libitum*.
L_2 » 6	359/568 50 d.	+ 58.1	5 c.c.	Control. Basal diet + 5 c. c. orange juice.
L_3 » 19	309/447 50 d.	+ 44.7	1 gm. raw kale	——
L_4 » 19	319/439 50 d.	+ 37.6	2 » » »	——
L_5 Dec. 31, 1929	326/500 50 d.	+ 53.4	4 » » »	The first 3 days, 8 mg. raw kale.
L_6 » 28, »	361/494 50 d.	+ 36.8	8 » » »	——
L_7 Jan. 6	330/211 72 d.	− 36.1	3 gm. boiled kale to 23rd day. Weber test in faeces at that time pos.	After 23 days no kale but 10 c. c. stored swede juice for 44 days; ultimately 15 c. c. of the same juice for 5 days.
L_8 » 14	363/218 73 d.	− 39.9	5 gm. boiled kale to 23rd day. Weber test in faeces at that time pos.	2.5 twice. 24th—67th day 10 c. c. and 68th—73rd day 15 c. c. stored swede juice (no kale).
L_9 » 5	420/260 31 d.	− 38.1	7 gm. boiled kale to 23rd day. Weber test in faeces at that time pos.	Kale in 3 portions. After 23rd day no kale but 19 c. c. stored swede juice in 2 portions.
L_{10} » 5	383/248 34 d.	− 35.2	10 » »	Kale in 4 portions. On 21st day, clinical signs of scurvy. Weber test in faeces pos. from 27th day.
L_{11} » 8	376/252 40 d.	− 32.9	15 » »	Kale in 6 portions.
L_{12} » 8	349/375 54 d.	+ 7.4	2 c.c. juice of stewed cloudberries ('myltgröt'), unc.	Juice in 1 portion.
L_{13} » 8	388/476 69 d.	+ 22.7	3.7 as above	» » » »
L_{14} » 18	329/510 54 d.	+ 55.0	6.7 » »	» » » »
L_{15} » 7	354/494 55 d.	+ 39.5	12.3 » »	» » 2 portions.
L_{16} Dec. 31, 1929	368/525 55 d.	+ 42.7	22.3 » »	» » 3 »
L_{17} Jan. 8	325/445 54 d.	+ 36.9	2.7 stored, sweetened raw juice of cloudberries ('cloudberry beverage')	» » 1 portion.
L_{18} » 8	391/510 54 d.	+ 30.4	5 as above	» » » »
L_{19} » 7	425/545 54 d.	+ 28.1	9.1 » »	» » 2 portions.
L_{20} » 15	353/250 23 d.	− 29.2	—	Control. Basal diet + water.

Abbreviations. con.: concentrated; unc.: unconcentrated; c.-ch. j.: costo-chondral

Experiments on animals 1—2 begun March 19, on the rest March 21, 1930.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
Normal findings.	—	—	—	L_1
No signs of scurvy. Lungs slightly oedematous.	—	—	— (?)	L_2
No gross signs of scurvy.	—	—	+	L_3
Normal findings.	—	—	+	L_4
» »	—	—	—	L_5
» »	—	—	—	L_6
Haemorrhages around knee-joints. Muscular haemorrhages. Mesenterial lymph glands saturated with blood. Weber test pos. in faeces. Atrophied lower jaw, loose teeth. Scorbutic rosary. Fragile long bones.	+	+	+	L_7
Same findings as in no. 7.	+	+	+	L_8
Same findings as in no. 7, except that the teeth are not loose, and in addition there is pulmonary haemorrhage.	+	+	U	L_9
Subcutaneous and muscular haemorrhages. Subpleural and intestinal haemorrhages, as well as in mesenterial lymph glands. Loose teeth. Scorbutic rosary. Fragile long bones.	+	+	+	L_{10}
Same findings as in no. 10.	+	+	+	L_{11}
No visible intestinal haemorrhage. Weber reaction in faeces green. Teeth fairly fast. Otherwise same findings as no. 10.	+	+	+	L_{12}
Large areas of haemorrhage around the knee-joints, smaller ones in mesenterial lymph glands. C.-ch. j. thickened in several ribs. Fragile long bones. No teeth loose.	+	+	+	L_{13}
No signs of scurvy.	—	—	+	L_{14}
» » » »	—	—	+	L_{15}
» » » »	—	—	—	L_{16}
» » » »	—	—	+	L_{17}
» » » » Lungs slightly oedematous.	—	—	+	L_{18}
Great thickening of c.-ch. j., R. c. II (fractured by an accident?); otherwise normal findings.	—	— (?)	—	L_{19}
Cutaneous, muscular and subpleural haemorrhages. Large areas of haemorrhage in mesenterial lymph glands. Intestinal haemorrhages. Scorbutic rosary. Fragile long bones. Loose teeth.	+	+	+	L_{20}

junction; c.: costa; R.: right; U.: unexamined; pos.: positive.

Series N. Juice of stewed cloudberries (Rubus chamæmorus L.). Juice of water cloudberries. [1])

Animal's no. and date of birth, 1930	Initial and final weight in gm; length of experiment in days	Gain or loss of weight in per cent	Daily ration of juice in c. c.	Daily distribution of rations. Remarks.
N_1 Jan. 13	356/548 50 d.	+ 54.0	—	Control. Basal diet + swedes *ad libitum*.
N_2 ?	290/332 50 d.	+ 14.5	5 orange juice	Control. Basal diet + orange juice.
N_3 Jan. 5	376/532 50 d.	+ 41.5	5 sweetened, raw cloudberry juice	Control.
N_4 » 4	285/306 50 d.	+ 7.3	1.5 juice of stewed cloudberries	Less active the last 14 days.
N_5 » 8	318/288 12 d. †	— 9.4	2.0 as above	Bronchopneumonia.
N_6 Dec. 31, 1929	388/317 50 d.	— 18.0	2.7 » »	Cries out on being touched the 36th day. Less active.
N_7 Jan. 3	304/416 50 d.	+ 36.8	3.7 » »	——
N_8 » 12	348/432 65 d.	+ 24.1	5.0 » »	——
N_9 » 2	375/553 65 d.	+ 47.4	6.7 » »	Nasal catarrh 22nd—32nd days.
N_{10} » 2	331/423 65 d.	+ 27.7	9.1 » »	——
N_{11} » 16	318/472 65 d.	+ 48.4	12.3 » »	Juice in 2 portions.
N_{12} » 13	337/464 65 d.	+ 37.6	16.6 » »	» » » »
N_{13} » 15	343/588 65 d.	+ 71.4	22.3 » »	» » 3 »
N_{14} » 15	332/458 50 d.	+ 37.9	1.5 water cloudberry juice	——
N_{15} » 3	288/406 50 d.	+ 40.9	2.7 as above	——
N_{16} » 12	343/477 50 d.	+ 39.0	5.0 » »	——
N_{17} » 16	313/454 51 d.	+ 45.0	9.1 » »	——
N_{18} » 13	309/433 50 d.	+ 40.1	16.6 » »	Juice in 2 portions.
N_{19} » 4	321/409 34 d.	+ 27.4	22.3 » »	Water cloudberry [1]) juice 34 days, then the store of juice emptied.
N_{20} » 4	320/198 25 d.	— 38.0	—	Negative control. Basal diet + water.

Abbreviations. U: unexamined; c.-ch. j.: costo-chondral junction; c.: costa;

[1]) Water cloudberries is a literal translation of the Swedish *vattenhjortron*, i. e.

Experiments on all the animals begun March 22, 1930.

Chief autopsy findings	Gross scorbutic alteration (autopsy findings)	Scorbutic x-ray alteration	Microscopic scorbutic alteration	Animal's no.
No pathological alterations.	–	–	–	N_1
No signs of scurvy, but reduced nutrition; lungs to a great extent atelectatic, with the exception of the anterior part of the left lung; liver permeated with connective tissue. Weber test in faeces: green colour.	–	–	–	N_2
Normal findings.	–	–	–	N_3
Subcutaneous and muscular haemorrhages. Subpleural pulmonary haemorrhages. C.-ch. j. greatly thickened on most ribs. Bone fragility.	+	+	+	N_4
Reddening of the trachea, subpleural pulmonary haemorrhages; bronchopneumonia in the right lung.	–	U	U	N_5
Subcutaneous and muscular haemorrhages. C.-ch. j. greatly thickened, R. c. III—IV, L. c. III—V. Fragile long bones. No loose teeth. Weber test in faeces neg.	+	+	+	N_6
Distinct fragility of the long bones, though only at the border-line between epiphysis and diaphysis. In other organs no unmistakable signs of scurvy.	+ (?)	+ (?)	+	N_7
Subcutaneous haemorrhages. Minor haemorrhages in mesenterial lymph glands. Slight thickening of c.-ch. j. in L. c. III—IV, VI, R. c. III. Fragile long bones.	+	+ (?)	+	N_8
Only slight bone fragility; otherwise no signs of scurvy.	–	+ (?)	+	N_9
No signs of scurvy. Left lung partly adherent to wall of thorax and pericardium.	–	–	+	N_{10}
No signs of scurvy.	–	–	+	N_{11}
» » » »	–	–	+	N_{12}
» » » »	–	–	–	N_{13}
Subfascial haemorrhages around knee-joints. Fragile long bones. No discernible thickening of c.-ch. j.	+	+	+	N_{14}
Congestion of vessels in shoulder muscles but not haemorrhages. No unmistakable signs of scurvy.	–	–	+	N_{15}
Normal findings.	–	–	+	N_{16}
» »	–	–	+ (?)	N_{17}
» »	–	–	–	N_{18}
» »	–	–	–	N_{19}
Muscular haemorrhages. Haemorrhages around knee-joints. Subpleural haemorrhages. Mesenterial lymph glands saturated with blood. Scorbutic rosary. Long bones exeedingly fragile; teeth somewhat loosened. Weber test in faeces highly positive. Weight of spleen 150 mgm.	+	+	+	N_{20}

R.: right; L.: left; †: died.

cloundberries preserved in water at a low temperature.

CHAPTER V.

Discussion of the Organisation, Course and Results of Each Series of Experiments.

Series B. Blueberries. Aug. 9th—Sept. 27th, 1929.

Investigator: ASSAR NORMARK.

Material: fresh, expressed blueberry juice. Berries delivered July 29th, Aug. 10th, 17th and 23rd from Mjödvattnet in the parish of Burträsk, province of Västerbotten, and Sept. 9th from Härnösand. To some of the juice of the last delivery, a preservative was added, viz., 1 gm. sodium benzoate to each liter of juice. This preserved juice was not required until a few days before the end of the experiment.

Beginning with a smallest initial ration of 5 c. c., a series of rations was organised, rising by degrees of 35 per cent. In this way, the following daily rations were distributed:

B_4	5.0 c. c.	B_8 & B_9	16.6 c. c.	B_{16}	55 c. c. (con.)
B_5	6.7 »	B_{10} & B_{11}	22.3 » (con.)	B_{17}	74.2 » »
B_6	9.1 »	B_{12} & B_{13}	30.2 » »		
B_7	12.3 »	B_{14} & B_{15}	40.7 » »		

Rations followed by the abbreviation *con.* (concentrated) are stated in terms of the volume of natural juice, but were not administered to the animal until after concentration *in vacuo* to about $^1/_4$ the original volume.

Animal B_4, which received the smallest ration, died of scurvy after 43 days. Animals B_{14} and B_{16} died of pneumonia after 22 and 25 days respectively. B_{17}, which received the highest ration, died of acute peritonitis only 6 days before the end of the period of experiment.

Of the remaining animals, only B_5 lost weight (19 per cent).

All the other animals fed on expressed blueberry juice not only lived the whole time, but also gained in weight during this period.

The lowest ration accompanied by gross freedom from scurvy was 16.6 c. c., but such freedom was found in only one test animal (B_8), while the other on the same ration (B_9) exhibited a minimum of gross alteration.

The smallest ration preventing all signs of scurvy, even under the microscope, was 30.2 c. c.

Series C. Blueberries. Aug. 3rd—Sept. 19th, 1929.

Investigator: KARL-ERIK GROTH.

Material: fresh, expressed blueberry juice. Berries delivered as in series B. The juice was expressed and preserved in the same way as described in series B.

Here, too, a series beginning with 5 c.c. was increased by 35 per cent degrees; in addition, there were 2 animals on a smaller ration than 5 c. c., viz., 2.7 and 1.5 respectively.

The different animals were given the following rations:

C_{17} 1.5 c. c.	C_5 6.7 c. c.	C_9 16.5 c. c.	C_{13} } 55.0 c. c. (con.)
C_{18} 2.7 »	C_6 } 9.1 »	C_{10} 22.3 » (con.)	C_{14} }
C_4 5.0 »	C_7 }	C_{11} 30.2 » »	C_{15} } 74.2 » »
	C_8 12.3 »	C_{12} 40.7 » »	C_{16} }

In this series, which was the first to be made, we were incautious enough to give those animals which were intended for a high ration the full amount from the very start. This was found, however, to be too great a strain on their digestive apparatus. Animal C_{15} died after 24 hours on a juice concentrate corresponding to 74.2 c. c. natural juice. C_{13} died 5 days, and C_{14} 8 days after having every day from the beginning of the experiment been fed juice concentrate to an amount corresponding to 55 c. c. natural juice. C_6 was injured in an accident, and was therefore killed, on the 37th day. In C_{12}, owing to some disease which could not be ascertained at autopsy, there was a sudden loss of weight on the 39th and 40th days; it was therefore killed.

The remaining animals in which there were no complications reacted as follows: the animals on the three lowest juice rations, viz., 1.5, 2.7 and 5.0 c.c. respectively, died of scurvy after 35, 20 and 43 days respectively. All the remaining animals fed on juice lived throughout the duration of the experiment, and gained weight. Unfortunately, the experiment had to be shortened by 3

days, since the investigator was then to enter upon clinical duties.

Although this series is imperfect in several respects in the larger rations, for the reasons explained above, it is complete with regard to the smallest protective rations. *Tested grossly only, the minimum protective ration is 12.3 c. c. Microscopically, it is in the neighbourhood of 22.3 c. c., and rather more than less,* since the dental sections of the animal on this ration were not quite surely free of alteration.

Series D. Arctic raspberries. Sept. 2nd—Oct. 22nd, 1929.
Investigator: BROR SÖDERBERG.

Material: expressed juice of arctic raspberries (Rubus arcticus L.). The berries were delivered from Luleå, and reached Upsala July 29th, Aug. 5th, 10th and 16th, 1929. A total of 43 kg. berries yielded 20 liters juice. Since the investigator failed to present himself at the time agreed on for the commencement of the investigation, the juice had to be preserved, which was done by the addition of 1 gm. sodium benzoate to each liter of juice.

Since arctic raspberries (R. arcticus) are species of the same family as cloudberries (R. chamaemorus) and since it was known from A. HÖJER's investigations that the minimum antiscorbutic protective ration for guinea pig of juice of the latter berry is as small as 3.5 c. c., it was assumed that the protective ration would be low for the former as well. The schedule was therefore drawn up on this assumption and contains no very high rations, a circumstance which the author later had occasion to regret.

The smallest daily ration was cautiously placed as low as 1.5 c. c., and from this the series was planned so as to progress upwards by grades of 20 per cent. The different animals thus received the following rations:

D_4	1.5 c. c.	D_9	3.7 c. c.	D_{14}	9.3 c. c.
D_5	1.8 »	D_{10}	4.5 »	D_{15}	11.1 » (con.)
D_6	2.2 »	D_{11}	5.4 »	D_{16}	13.4 » »
D_7	2.6 »	D_{12}	6.5 »	D_{17}	16.0 » »
D_8	3.1 »	D_{13}	7.7 »	D_{18}	19.3 » »

After this series had gone on for about 20 days, it was found that all the animals on small rations had got scurvy, and it was not certain that even the animals on the highest rations would escape. The rations of juice were therefore altered as follows:

D_5	ration	altered	the	26th	day	to	19.3	c. c.	(con.)
D_6	»	»	»	»	»	»	23.1	»	»
D_9	»	»	»	»	»	»	27.7	»	»
D_{15}	»	»	»	35th	»	»	23.1	»	»

All the animals from D_4 to D_{18} lost weight on the original rations, but D_{17} and D_{18} only very slightly, viz., in 51 days by only 1.7 and 0.8 per cent respectively. D_5, on the other hand, began to gain weight after the juice ration had been increased to 19.3 c. c., and by the 62nd day, it had gained 23.9 per cent of its original weight.

Some of the animals which had lost so much weight that they would according to our experience have had only a few days of life left, were from motives of humaneness killed by chloroforming when their weight had decreased from the maximum by 30 per cent or more. This was done in the cases of D_4, D_6, D_8, D_{11}, D_{12} and D_{16}. Animals D_7, D_{10}, D_{13} and D_{14} died spontaneously.

The autopsy showed that every single animal in the series presented symptoms of scurvy even to the naked eye. That *the antiscorbutic vitamin is not, however, entirely lacking in arctic raspberries,* is unmistakable both from the increase in weight of D_5 for a period of 62 days, and from the fact that D_{17} and D_{18} lived for 51 days with as little loss of weight as they did, while the negative controls in this series died after 28 and 29 days respectively.

This series proves further that a *daily ration of more than 19.3 c. c. of the expressed juice of arctic raspberries is necessary even for the macroscopic protection of guinea pig against scurvy.*

Series E. Red currants. Sept. 4th—Nov. 18th, 1929.

Investigator: Rolf Rhodin.

Material: raw, expressed juice of red currants. The berries were supplied by the Kallkällan orchards near Luleå and arrived in Upsala on Aug. 22nd, 29th, Sept. 5th, 12th and 14th, mounting in all to 24.2 kg., which yielded 9.5 liters juice. The juice of the last delivery amounted to 2,250 c. c., and was, unlike the rest of the juice, preserved by the addition of 1 per mille sodium benzoate. This quantity was intended to be used when the unpreserved juice had been consumed. After the 14th September, it was no longer possible to obtain from Luleå berries that were not frost-nipped. The juice from the Norrland berries was sufficient to

feed the animals until Oct. 13th. The further requirements in berries were filled by a purchase on Oct. 13th from the KRUSENBERG orchards in Upland. Part of the juice of these berries was also preserved by the addition of 1 gm. sodium benzoate to each liter juice.

Since the juice of red currants is so highly acid that large rations of it might have an unfavourable effect on the animal's digestions and perhaps even metabolism, it was thought suitable to undertake a partial neutralisation. After it had been ascertained that 100 c. c. of the juice could completely dissolve at most 2 gm. dehydrated calcium carbonate, it was so arranged that, shortly before giving the juice to the animals, each 100 c. c. of it was thoroughly mixed with 1.8 gm. calcium carbonate, after which the mixture was stirred until the calcium carbonate was completely dissolved.

This red currant juice could not be concentrated like other juices. When we tried to concentrate it, it became so thick that it could not pass through the pipettes. In order to administer the larger rations, it was therefore necessary for the investigator to feed the animals with juice five times daily.

This series of experiments was made at the Hygienic Institute of the University, which was at that time not equipped with an automatic refrigerator, but merely with an ordinary ice-box. Without the author's knowledge, the unpreserved juice had at the beginning of the experiment been stored in this ice-box instead of in a refrigerator before being fed to the animals. During this period, pronounced symptoms of enteritis developed in several of the experimental animals, probably because the temperature of the ice-box was not low enough to prevent fermentation. As a result of this occurrence, no less than 7 animals were affected, and had to be withdrawn and replaced by new ones. Owing to the difficulty of obtaining a sufficient number at one time, the investigator was compelled to put in substitutes on two separate occasions, 4 animals the 17th September and 3 the 27th. These new animals were also fed for a period of 50 days. In the table following, the withdrawn animals are not included. The numbers given the animals, owing to these arrangements, do not reflect the progressive increase of the rations.

The juice was given in rations increasing by grades of 25 per cent, as follows:

E_4 1.5 c. c.	E_{20} 4.6 c. c.	E_{26} 14.0 c. c.
E_{23} 1.9 »	E_{27} 5.7 »	E_{25} 17.5 »
E_6 2.3 »	E_{11} 7.5 »	E_{16} 21.8 »
E_7 2.9 »	E_{12} 8.9 »	E_{28} 27.3 »
E_{24} 3.7 »	E_{13} 11.2 »	E_{18} 34.1 »

None of the animals died of scurvy in the course of the experiment (50 days), but those on the lowest rations of 1.5, 1.9, 3.7 and 4.6 c. c. lost weight by respectively 25, 26, 7 and 6 per cent. The animal on a ration of 2.3 c. c. had the same weight at the end as at the beginning.

In the animal on a ration of 7.5 c. c., there were at autopsy no longer any signs of scurvy visible to the naked eye, nor were there any such changes in the radiogram of the costochondral junctions. There were, however, microscopic dental changes.

The lowest ration leading to absence of scorbutic symptoms in all three methods, even the microscopic one, *was 8.9 c. c.* But there were three animals out of five on larger rations which on microscopic examination were not free from signs of scurvy. In one of these, E_{25}, the explanation is obvious. This animal passed through pregnancy and had a miscarriage, thus requiring extra vitamin C for its foetuses. E_{13}, however, which was getting 11.3 c. c. and exhibited the best gain in weight of all the animals, also presented microscopic signs of dental scurvy. The same was true of E_{28}, which had the second highest ration (no less than 27.8 c. c.). The most probable explanation is in the author's opinion that these animals with a microscopic scorbutic reaction in spite of a high juice ration must before their delivery for the experiment have been on a diet with an inadequate content of the antiscorbutic vitamin. If this is the case, it follows that the microscopic criteria are completely reliable only when the investigator has from the start himself fed his animals on a diet guaranteeing an adequate intake of vitamin C.

Proceeding from the assumption that the lowest ration of red currant juice leading to entire absence of microscopic as well as gross signs of scurvy is the smallest protective ration, then this will amount to 8.9, i. e. practically 9 c. c.

Series F. Common raspberries. Sept. 29th—Nov. 22nd, 1929.
Investigator: Oswald Björkquist.

Material: fresh, raw, expressed raspberry juice, and preserved, raw raspberry juice (for manner of preservation, see below).

According to the Chief District Gardener of Luleå, the raspberry crop in the district of Norrbotten had miscarried in 1929. From the Norrland Nurseries in Härnösand, however, in the county of Västernorrland, we received a total of 13 kg. of berries, delivered Aug. 24th and 29th, from which preserved raw juice was prepared. The further requirements in berries were filled by purchases in Upsala. The fresh expressed juice, which was prepared for only a few days at a time and stored in a refrigerator without any preservative, was obtained exclusively from Upland berries. In all cases, cultivated red raspberries were used.

Preparation of presserved raw raspberry juice (»raspberry beverage»).

Six kilograms of well-cleansed and picked-over berries are thoroughly crushed in a berry mill with rifled wooden cylinders (in private households, the berries may be crushed with a wooden masher in an enamelware vessel). The berry mash is stirred with 2 liters water in which 10 gm. tartaric acid has been dissolved. This mass is then poured into stoneware jars, and allowed to stand in a *cold cellar* for two days, in the course of which it is occasionally stirred. At the end of the two days, the juice is strained through a cloth and measured; 350 gm. castor sugar and 1 gm. sodium benzoate dissolved in as little water as possible are added to each litre of juice. The mixture is then stirred without pause for one hour, after which it is poured into sterilised bottles and stored in a refrigerator. This juice has a very fine berry aroma.

For the raesons given above (p. 11), the original SHERMAN basal diet was used in this series, since it includes a highly sweetened product.

With regard to the number of animals fed with the two different materials used in series F, it is to be regretted that the number on fresh expressed juice wos too smal. This number should have been larger, and the rations should have risen, as in the case of blueberry and red whortleberry juice, by grades of 35 per cent each.

Fresh, raw natural juice was given as follows:

F_5 1.5 c. c.; F_6 3 c. c.; F_7 6 c. c.; F_8 12 c. c.

Raspberry beverage was given as follows:

F_{10} 2.3 c. c.	F_2 & F_{13} 7.6 c. c.	F_{15} & F_{16} 17.1 c. c. (con.)
F_{11} 3.4 »	F_9 & F_{14} 11.4 »	F_{17} & F_{18} 25.6 » »
F_{12} 5.1 »		

The juice given to animals F_{15}—F_{18} was concentrated *in vacuo* but corresponded to the volume in unconcentrated juice given above.

Animal F_5, on the lowest ration (1.5 c. c.) of natural juice, and animals F_9 and F_{10} on the lowest preserved juice rations (2.3 and 3 c. c. respectively) lost weight in the course of the experiment. All the others on juice gained weight.

The lowest ration of fresh raw natural raspberry juice at which there were no signs of scurvy in any of the three methods of testing was 6 c. c. The lowest ration of the raspberry beverage which had the same effect was 17.1 c. c. The difference between this and the nearest lower ration giving *no* protection, viz., 11.4 c. c., is great, and it is possible that the real minimum protective ration is closer to 11.4 than to 17.1 c. c. But even if this should be so, there is nevertheless no satisfactory agreement between the effects of the preserved juic and the fresh. In consideration of the value obtained for the fresh juice, it might have been expected that the corresponding value for the preserved juice would not go above 10 c. c. Since, however, the berries from which the two kinds of juice were prepared were of different kinds and origin, the most likely explanation seems to be that those from which the fresh juice was prepared (of a kind called Krusenberg Hornet), which were much larger and slightly more acid in taste than the Norrland berries used in the preparation of the preserved juice (from older bushes of the Marlborough species), were also to no small degree richer in vitamin C than the latter.

Series G. Red whortleberries (Vaccinium vitis idaea L.).
Oct. 13th—Nov. 21st, 1929.

Investigator: Bertil Hamne.

Material: expressed juice of red whortleberries. The berries were delivered from Luleå Sept. 13th, 17th, 20th and 23rd, and amounted to 109 kg. yielding 49 litres of juice. This juice was stored in a cellar at 12° C. in sterilised, 10-litre demijohns, and remained free from fermentation without any preservative for the whole time of storage. The daily rations began with a minimum of 3.7 c. c., rising by progressive steps of 35 per cent.

The animals in this series were given the following rations:

G_4	3.7 c. c.	G_9 and G_{10}	12.3 c. c.	G_{12} and G_{13}	22.3 c. c. (con.)
G_7	6.7 »	G_{11}	16.6 »	G_{14}	30.3 » »
G_8	9.1 »				

G_{15} received a ration beginning with 16.6 c. c. the first day and increasing successively until it reached 40.7 c. c. on the fourth; this amount was then kept unchanged until the 22nd day, when it was further increased to 55 c. c. and kept at this level for the remainder of the experiment.

G_{16} got 16.6 c. c. the first day, and then rising daily rations until 40.7 c. c. was reached on the fourth day and kept at this level for the rest of the experiment.

G_{17} got a juice quantity of 16.6 c. c. the first day, rising by steps to 55 c. c. on the fifth day and remaining at this level for the rest of the experiment.

The ration for G_{18} rose in the first four days from 16.6 c. c. to 40.7 c. c., but because the animal lost much weight during these days, its ration had to be reduced for the rest of the experiment to 16.6 c. c.

G_{19} started in on a ration of 16.6 c. c., to rise in the course of 7 days to 74.2 c. c. This ration was then unchanged for another 7 days, but the remaining 27 days, it had to be reduced to 55 c. c.

All the animals from G_{12} to G_{19} inclusive were given juice concentrated *in vacuo*.

In order to diminish any possible injurious effects on the digestion and metabolism of the animals of the large quantities of acid in the red whortleberry juice, part of the acid was neutralised for all the animals getting the concentrate. This was done as follows: before the concentrated juice was administered, $1\,^1/_2$ per cent of its own weight of calcium carbonate was added and it was then filtered through a cellulose filter in a porcelain funnel. The unconcentrated juice given to animals G_{10} and G_{11} was partly neutralised in the same way.

Animals G_4, G_5, G_7, G_8 and G_9 were given the unaltered juice.

All the animals on red whortleberry juice in this series died before the end of the experiment (50 days).

Series H. Red whortleberries (Vaccinium vitis idaea L.)

Oct. 26th—Dec. 8th, 1929.

Investigator: GEORGE WIDMARK.

Material: expressed red whortleberry juice. The berries were delivered, prepared and stored as in series G.

As in the previous series, some of the higher rations could only be given in vacuum-concentrated form.

All the larger rations of juice were, in order to protect the animals' digestions, *partially neutralised* before administration. Two different methods of neutralisation were employed.

1. *Calcium carbonate.* A quantity of concentrated juice, to be consumed the same day, was placed in a graded cylinder, and 6 gm. calcium carbonate added for each 100 c. c. concentrated juice. The cylinder was shaken repeatedly in the course of an hour until all gas formation ceased. The contents were then filtered by air suction through no. 3 filter paper, leaving behind in the filter a thin layer of a sticky mass ranging in colour from blue to reddish purple. Immediately after this filtration, the filtered juice was red. On being stored for 24 hours in a refrigerator, it gradually turned blue. Repeated quantitative analyses of the filtered juice showed that it contained in solution practically all the calcium that had been added, or, expressed in terms of calcium carbonate, 6 gm. to each 100 c. c. concentrated juice.

2. *Sodium bicarbonate.* A quantity of concentrated juice intended for consumption the same day was in the same way as described in 1., mixed with 8 gm. sodium bicarbonate to each 100 c. c. concentrate. Gas formation ceased earlier in this case than in 1. No filtration was done. The change in colour to blue described in 1. frequently appeared here immediately after the addition of the bicarbonate.

Incomplete neutralisation with sodium bicarbonate was carried out on the juice given to H_{12}, H_{15} and H_{17}. With this exception, all the animals from H_{10} to H_{19} inclusive were given juice partially neutralised with calcium carbonate.

By means of a quinhydrone electrode, the hydrogen ion concentration of the solutions was electrometrically determined both before and after the partial neutralisation. The following results were obtained:

1) Natural expressed juice	pH 2.52[1]
2) Concentrated juice	» 2.56[1]
3) Filtrate of the concentrated juice partially neutralised with $CaCO_3$	» 4.05
4) At point of transition from red to blue	» 4.96

In this series of experiments, the rations increase, beginning with a minimum of 3.7 c.c., by grades of 35 per cent. The following

[1] The small difference in pH value between concentrated and natural juice seems to show that some volatile acid has evaporated in concentration.

rations were given, all of them, including those of concentrated juice, expressed in terms of the unconcentrated:

H_4 3.7 c. c.	H_8 12.3 c. c.	H_{12} 22.3 c. c. (con.)
H_5 5.0 »	H_9 16.6 »	H_{13} 26.6 » »
H_6 6.7 »	H_{10} 16.6 » (con.)	H_{14} 30.2 » »
H_7 9.1 »	H_{11} 19.4 » »	H_{15} 30.2 » »

For H_{16}, the ration of 16.6 c. c. the first day was increased by successive steps to 40.7 on the fourth, and this ration was then retained without alteration.

The rations of H_{17} and H_{18} were raised from 16.6 c. c. the first day to 55.0 c. c. the fifth, and this ration was retained without change.

The ration of H_{19} was raised by successive grades from 16.6 c. c. the first day to 74.2 the sixth, remaining at this level from then on.

H_4—H_9 inclusive were given fresh unconcentrated juice. H_{10}—H_{19} inclusive all got their juice in concentrated form.

All the animals on red whortleberry juice in this series died of scurvy before the end of the experiment (50 days).

When the results of series G and H are compared, the most striking feature, beyond what has already been summarised above, is the fact that G_{12} and G_{14} lived 37 days each, and H_9, 36, since this exceeds by 7 and 6 days respectively the longest lifetime occurring in any of the negative controls with an initial weight of $^1/_3$ kg. in the entire investigation. The longest life on a diet entirely lacking vitamin C was 30 days, and was found in only *one* negative control, viz., G_{20}. The fact that G_{12}, G_{14} and H_9 thus lived about a week longer seems entirely to justify the conclusion that *there must be some traces of vitamin C in red whortleberries.* (The fact that H_{18} lived for 39 days is of no significance since this animal had an initial weight of 450 gm., a weight which was indeed in contradiction to our rules, but was in this case taken on purpose.)

Series K. Cloudberry Beverage (Rubus chamaemorus L.).
Oct. 31st—Dec. 21st, 1929.

Investigator: DAVID PALM.

Material: raw, sweetened cloudberry juice (»cloudberry beverage»). It was not considered necessary to investigate the minimum protective ration of the natural unswetened expressed juice, owing to A. HÖJER's previous determination of it (4).

The original Sherman basal diet was used in this series.

Recipe for sweetened, raw cloudberry juice (»cloudberry beverage»).[1]

Six kilograms cloudberries are crushed with a wooden masher in an enamel-ware vessel. To this mash 2 liters water are added, containing 10 gm. tartaric acid dissolved in advance, and the whole is stirred well. The mass is then poured into a stone jar which is allowed to stand in a cold cellar 2 to 3 days, in the course of which it is repeatedly stirred. At the end of this period, the mash is strained through a cloth. The juice obtained thus (which is not clear) is measured, and to each liter of juice, 300 gm. castor sugar is added, and the whole stirred uninterruptedly for one hour. This sweetened juice is then poured into sterilised bottles and stored in a refrigerator.

The bottle is to be shaken each time before using.

The following rations of this sweetened juice were given:

K_9 1.5 c. c.	K_{13} 3.7 c. c.	K_{17} 12.3 c. c.
K_{10} 2.0 »	K_{14} 5.0 »	K_{18} 16.6 »
K_{11} 2.7 »	K_{15} 6.7 »	K_{19} 22.3 »
K_{12} 2.7 »	K_{16} 9.1 »	

With the exception of K_{18} and K_{19}, the juice was administered in unconcentrated form, but even these animals were only from the 30th day on given the juice concentrated *in vacuo* to half its original volume.

Four animals in this series were given the following rations of expressed orange juice in order to verify where the minimum protective ration of this antiscorbutic, in our investigation regarded as the normal one, lay in microscopic examination. The following rations were given:

K_1 1 c. c. K_2 2 c. c. K_3 3 c. c. K_4 4 c. c.

All the animals on cloudberry juice gained weight continuously throughout the period of experiment. At the autopsies after the termination of the experiment, there was *no scorbutic alteration visible to the naked eye even in those animals which had been on the lowest rations, viz., 1.5 and 2 c. c. respectively.* But there were undoubted microscopic scorbutic changes in the teeth of

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[1] In preparation for household use, the following alterations should be made: tartaric acid, 60 gm. instead of 10, as here. When then juice is stored in an ordinary cellar instead of in a refrigerator, add 1 1/2 gm. sodium benzoate, dissolved in as little water as possible, for each liter sweetened juice. The quantity of juice may conveniently be increased (though with a corresponding decrease in the vitamin C concentration) by the addition of 3 liters water instead of 2. Served as a beverage, with at least as much water as juice, this mixture has a fine aroma of berries.

those on the lowest rations, in spite of the fact that they gained more than 30 per cent in weight in 50 days.

The lowest ration of cloudberry beverage at which no microscopic alteration in the teeth could be discovered was 3.7 c. c. According to our calculations, this corresponds to about 3 c. c. of natural expressed cloudberry juice, i. e. a little less than the protective ration given by HÖJER (4), which amounts to 3.5 c. c. If the smallest microscopically determined protective ration of expressed cloudberry juice may be as low as 3 c. c. (which is apparently possible some years), then the conclusion may be drawn that such natural cloudberry juice is an equivalent antiscorbutic to natural orange juice [the value of which, given as 3 c. c. by HÖJER and WESTIN (20), has been confirmed by this series], and that cloudberries are fully as valuable as oranges in protecting against scurvy.

Series L. Kale (Brassica oleracea L., var. acephala D. C.) **and cloudberry porridge** (»**myltgröt**») (Rubus chamaemorus L.)

Investigator: GÖSTA ATTHOFF.

Material: fresh, green kale, boiled for 20 minutes; *myltgröt*, the cloudberry preserve boiled in open vessels, common in Norrland, especially Jämtland.

It was our object to examine kale from Norrland which had been exposed to, as well as harvested in, frost. This plan could not be carried out, as the order contracted for in Norrland could not be filled. Instead, the kale had to be purchased in middle Sweden, and was delivered by the Nordiska Kompaniet, Stockholm. It had been harvested in winter, and no doubt more or less exposed to frost, but no definite information as to this was to be obtained. In order to guarantee the effects of a certain period of frost, the kale was stored for ten days after its delivery at the Physiological Institute in a refrigerator at a temperature of between —2 and —4° C.

Four animals were given raw kale stored in this way. The leaves were cut in strips and weighed, after which they were placed in the food trays. The entire ration was always promptly eaten.

The boiled kale was prepared as follows: a small quantity of leaves, about as much as would be required for 5 or 6 days, were freed of coarser fibres and ground 5 or 6 times in an electric chopper (household model). This ground mass was weighed in small portions, placed in a fire-proof porcelain dish and steamed in a sterilising apparatus for 20 minutes. When it had cooled, the kale was weighed again, showing that water had been absorbed. It was then passed through a fine steel sieve. Of this

strained mass, the required daily quantity was weighed off, wherein allowance had to be made for the water absorbed in boiling. This quantity was then mixed with three parts water and ½ per cent salt added for the taste, and fed the animals through a pipette. All the boiled kale was stored in a refrigerator.

The cloudberry porridge (*myltgröt*) is prepared from cloudberries by boiling them for 40 to 60 minutes with a small amount of water in an open vessel. In households, it is usually stored in wooden kegs in the cellar. For the same reason that the biological tests of the berries in this investigation were made on their expressed juice, and in order to have comparable material, we prepared expressed juice from the cloudberry porridge. As it was too thick, however, to give a sufficient quantity of juice, we diluted it first with water. We mixed 85 parts (24.4 liters) cloudberry porridge with 15 parts water (4.3 liters), stirring it to make a homogeneous mixture, and strained it through a cloth in a berry press. This expressed juice was then stored in a refrigerator at a temperature of from + 1 to + 4° C., and is in the following always referred to as cloudberry porridge juice.

The following rations of the foodstuffs in question were given:
Raw kale: L_3 1 gm.; L_4 2 gm.; L_5 4 gm.; L_6 8 gm.
Kale boiled 20 minutes (the weight given is that of the raw kale):
L_7 3 gm.; L_8 5 gm.; L_9 7 gm.; L_{10} 10 gm.; L_{11} 15 gm.
Cloudberry porridge juices L_{12} 2.0 c. c.: L_{13} 3.7 c. c.; L_{14} 6.7 c. c.; L_{15} 12.3 c. c.; L_{16} 22.3 c. c.
Cloudberry beverage (prepared according to the recipe given p. 67, though with the addition of 1:1000 sodium benzoate and stored in a refrigerator for 7 months): L_{17} 2.7 c. c.; L_{18} 5 c. c.; L_{19} 9.1 c. c.

The experimental results of this series show that the minimum ration of raw green kale harvested in winter and giving protection against microscopic scorbutic alteration is 4 gm. *All of the animals receiving the boiled kale died of scurvy before the end of the experiment.* Since even the animal on the highest ration, 15 gm., presented scorbutic symptoms visible to the naked eye at autopsy, this ration is by no means a sufficient protection for guinea pig.

The cloudberry porridge juice had the following effects: The smallest ration preventing macroscopic scurvy was 6.7 c. c. The microscopic symptoms did not disappear until a ration of 22.3 c. c. was reached. The next lower ration, 12.3 c. c., gave no such protection. The protective ration of cloudberry porridge juice probably can not, therefore, be placed at less than the mean, i. e., 17 c. c. Allowing for the dilution of 85:100 in the cloudberry porridge (see above), 17 c. c. of this juice corresponds to about 14.5 c. c. of the juice of the undiluted porridge. Since the mini-

mum protective ration of the juice of fresh cloudberries according to HÖJER's determination is 3.5 c. c., the conclusion may be drawn that *the vitamin C content of undiluted cloudberry porridge is about 4 times less than that of the same volume of mashed, ripe, fresh cloudberries.*

The cloudberry beverage stord for 7 months did not give full microscopic antiscorbutic protection to animal L_{18} in a daily ration of 5 c. c., but in the next series, it did protect N_3 on the same ration. The true microscopic protective ration may therefore be regarded as slightly more than 5 c. c., probably closer to 6. Since the corresponding ration of this juice after only one month's storing in series K was 3.7 c. c., the vitamin C content when storage lasted half a year longer was thus diminished to about 60 per cent of what it had been after one month.

Series N. Preserved cloudberries (Rubus chamaemorus L.)

Investigator: BIRGER SANDGREN.

Material: cloudberry porridge (*myltgröt*) and water cloudberries (*vattenhjortron*).

For the preparation of cloudberry porridge and its juice, see series L. »Water cloudberries» are prepared as follows: ripe berries are filled into large glass bottles, after which water is poured in up to the neck; then the bottle is corked. This preserve is said to be in use in the Lappland districts, but it could not be procured there. However, we obtained 9.5 liters water cloudberries from Älvdalen in Dalecarlia.

When the water cloudberries were shaken out of the bottles, this preserve was found to have consistency of a masch which was thinner than cloudberry porridge, and yielded juice without any dilution with water. In straining through a cloth in a berry press, we obtained 2.9 liters juice which in the following we call water cloudberry juice. It was stored for the period of the experiment in a refrigator at a temperature of from + 1 to + 4° C.

In this series, the following rations were given:

»Cloudberry porridge» juice:

N_4 1.5 c. c.	N_8 5.0 c. c.	N_{11} 12.3 c. c.
N_5 2.0 »	N_9 6.7 »	N_{12} 16.6 »
N_6 2.7 »	N_{10} 9.1 »	N_{13} 22.3 »
N_7 3.7 »		

Water cloudberry juice:

N_{14}	1.5 c. c.	N_{17}	9.1 c. c.
N_{15}	2.7 »	N_{18}	16.6 »
N_{16}	5.0 »	N_{19}	22.3 »

N_5 died of pneumonia. All the other animals on juice lived until the end of the experiment, and all but N_6 gained weight.

In these preserved cloudberries, the minimum protective ration of the juice based on microscopic inspection of the dental structure is very much higher than that based on the macroscopic post mortem findings. *No less than 16.6 c. c. water cloudberry juice and 22.2 c. c. cloudberry porridge juice was required to insure freedom from scorbutic symptoms to all three methods of investigation.* Gross protection, on the other hand, was reached by 2.7 c. c. water cloudberry juice and 6.7 c. c. cloudberry porridge juice.

On the basis of the latter values and of determinations of the solids in the preserves in question, an approximate calculation may be made of the relative antiscorbutic value of cloudberries preserved as »cloudberry porridge» and as »water cloudberries».

Prof. C. T. Mörner has had the kindness to determine, at my request, the percentage of solids (dry ingredients) in two general tests, one of cloudberry porridge, diluted 85 : 100, as in series L, and one of water cloudberries. The results were the following: diluted cloudberry porridge, 12.71 per cent solids; water cloudberries, 13.03 per cent; if the dilution of the cloudberry porridge is allowed for, the value obtained for solids is 14.99 per cent. The ratio between the antiscorbutic value of the two presserves, *when reduced to the same amount of berries (solids)* may be expressed, according to these results, as

$$\frac{\text{cloudberry porridge}}{\text{water cloudberries}} = \frac{2.7 \times 85.01 \times 13.03}{6.7 \times 86.97 \times 14.99} = 0.34.$$

In other words, *when cloudberries are preserved as »myltgröt» their antiscorbutic potency is definitely lower than when they are preserved as water cloudberries.*

CHAPTER VI.

Supplementary Investigations not Financed by the Royal Medical Board.

In the great forests of Upper Norrland, it still happens that timbermen must work at such great distances from inhabited communities that they are compelled to take supplies for as long as a week at a time. Since milk is one of the principal sources of vitamin C in the diet of the population of this part of the country, and since milk cannot be stored for a week without turning sour, it seemed to the author important to ascertain the vitamin C content of sour milk. This question is, moreover, of importance for other parts of the country as well as for Norrland, since sour milk is an important item in the summer diet of practically all of Sweden.

From May 1st to June 30th, 1930, the author organized an investigation into the minimum antiscorbutic protective rations of fresh and sour milk respectively with precisely the same technique as that employed in the study of berries. The animals were given the milk through pipettes. Nine guinea pigs of about the same age and weight were selected, and five of them were given fresh milk obtained from a well-managed farm in rations of 20, 30, 40, 50 and 60 c. c. respectively, while four animals received respectively 30, 40, 50 and 60 c. c. of the same milk after it had been turned sour by the addition of a pure culture of lactic acid bacteria (Flora Danica) and stored for 24 hours in a thermostat at a temperature of 20° C. In both cases the milk had previously been separated at the Physiological Institute.

This investigation of sour milk, which has already been described in an earlier paper by the author (21, pp. 262—263), led to the conclusion, briefly stated, *that when fresh milk is soured by inoculation with lactic acid bacteria, the sour milk*

thereby obtained is not inferior to the fresh in its vitamin C content.

From January to April, 1931, Prof. C. Næslund (22), then of the Hygienic Institute, Upsala, studied the vitamin C content of raw mash of red whortleberries. (The Physiological Institute lent coops and undertook the autoclaving of milk powder and the taking of breast-plate radiograms.) Since B. Hamne and G. Widmark as early as 1929 demonstrated in series G and H that from 55 to 74 c. c. of red whortleberry juice was insufficient to protect from scurvy guinea pigs with an initial weight of $^1/_3$ kg., Næslund found that *protection against scurvy could not be obtained by a daily ration of 50 gm. crushed berries, which was fed to the animals directly.*

C. Næslund's investigation has further interest through the results obtained in two animals serving as »Schädigungskontrollen». Of these, one was given a daily ration of 50 gm. red whortleberry mash plus 4 c. c. orange juice, and the other 50 c.c. red whortleberry juice plus 4 c. c. orange juice. The acid of the red whortleberry mash and juice was not neutralized. The animals died after 40 and 38 days respectively, having exhibited chiefly intestinal symptoms and signs of progressive feebleness. Yet they were protected from scurvy by the orange juice.

Since the main investigation did not include tests of black currants because of their very limited cultivation in Upper Norrland, the author attempted to fill this gap by subjecting the black currant to vitamin C tests lasting from August 29th to Nov. 1st, 1932. Twelve animals were placed on the following rations:

T_{21} 0.5 gm.	T_{25} 1.5 gm.	T_{29} 4.0 gm.
T_{22} 0.5 »	T_{26} 1.5 »	T_{30} 4.0 »
T_{23} 1.0 »	T_{27} 2.5 »	T_{31} 6.0 »
T_{24} 1.0 »	T_{28} 2.5 »	T_{32} 6.0 »

The berries were crushed to a fine mash together with the skins and pips, and mixed with two parts water, producing a very thick liquid which it was possible to give the animals through pipettes. The same diagnostic methods were employed, and were carried out just as thoroughly as in the principal investigation. Detailed post-mortem examination was made, radiograms of the breast-plates were taken, and histological sections of the teeth

prepared and searched for microscopic criteria of scurvy. The hitherto unpublished results were the following:

In animals on a ration of 0.5 gm. of the berry mash, there were no haemorrhages, and of macroscopic signs of scurvy, there were only very slight enlargements of some of the costochondral junctions.

Microscopically, there were mild symptoms of scurvy in rations of up to 1.5 gm., but there were none at 2.5 gm. *The minimum protective ration of black currants according to microscopic criteria was therefore estimated to be 2 gm.*

CHAPTER VII.

Numerical Results and Theoretic Conclusions.

This investigation of the berries of Norrland is probably the first in which accurate parallel determinations were made for a large number of vegetable substances of the minimum antiscorbutic protective ration for guinea pig, on the basis of both gross and microscopic criteria. It therefore appears justifiable to develop here a few methodological points of view which resulted from the practical experience gained in the now completed investigation. The extraordinary susceptibility — first observed by Zilva & Wells (23), later strongly emphasized and made use of for methodological purposes by Höjer & Westin (20) — which is shown by the finer structure of guinea pig teeth to an inadequate supply of vitamin C was in our investigation found to be particularly pronounced in the narrower part of the pulp of the molar teeth. This great susceptibility in the test object does not exclusively and under all conditions constitute an advantage. It also causes the investigator certain difficulties, especially since already existing changes are hardly reversible in the 50 days constituting the duration of the experiment. If a technique based on the microscopic criteria of the dental structure is to be reliable, it is therefore necessary that before the beginning of the experiment, the animals should have been kept on a diet containing enough vitamin C to prevent the development of such structural changes as are caused by vitamin C deficency. It is no doubt hardly possible to guarantee such a condition unless the feeding of the animals is personally supervised by the investigator from their birth to the time of the experiments. This has not, to be sure, been done in our investigation. In view of the expense, we have had to restrict ourselves to buying animals

from a breeder of known reliability, who included swedes in the animals' diets to the extent desired by the animals themselves.

The microscopic dental method is to be given preference chiefly in the determination of the antiscorbutic value of such substances as are rich in vitamin C. A substance with as small a content of vitamin C as blueberry juice is not far within the limits of usefulness of the microscopic dental structure method. Applied to substances with a still smaller vitamin C content, the method hardly supplies any information beyond what can be obtained by the macroscopic technique of investigation.

The author has not undertaken special research into this particular point, but he has gained the impression that the microscopic method hardly gives results which are very much more accurate, when expressed in per cent of the weight or volume of the ascertained protective ration, than the gross method. *The advantage of the microscopic determination in this series of experiments lies in another field, namely, in that the results may be employed in the calculation of the minimum antiscorbutic protective ration for man.* To the best of my knowledge, there is no other method for such a calculation *based on experimental results* than that devised by the author (21, pp. 258—261), according to which a human adult weighing 60 kg. requires a daily antiscorbutic ration which is 14 to 20 times that of a guinea pig. We have in this method regarded the normal strength of the skin capillaries as a criterion that the human being is protected. If any of the criteria of scurvy in guinea pig can be compared in sensitiveness with incipient reduction of the capillary strength in man, it should in that case be incipient microscopic changes in the structure of the teeth. An exactly equal degree of sensitiveness in these two reactions in man and in guinea pig may obviously not be expected, but only an approximate correspondence, which is sufficient, however, in view of the approximate character of the method of estimation.

The 10 series of this investigation have as their chief result given us a knowledge of the numerical values of the minimum antiscorbutic protective ration for guinea pig, both as it is found exclusively on the basis of the macroscopic criteria discernible at autopsy (protective ration M), and as it is found in the observation of microscopic structural changes in the animals' teeth (protective ration μ). To facilitate a survey, these results are tabulated.

Minimum antiscorbutic protective rations for guinea pig.

Series	Tested foodstuff		M ration		μ ration	
B	Blueberry juice (natural)		16.6 c.c.		30.2 c.c.	
C	Same as B		12.3 »		22.3 »	
B, C	» » »	mean	14.5 »	mean	26 »	
D	Arctic raspberry juice (natural)	slightly >	19 »			
E	Red currant juice (natural)		7.5 »		8.9 »	(— 14.6)
F	Raspberry juice (natural)	<	6 »		6 »	
		but >	3 »			
F	»Raspberry beverage»		11.4 »		17.1 »	
G	Red whortleberry juice (natural)	>	55 »			
H	Same as G	>	74 »			
K	»Cloudberry beverage» (stored one month)	<	1.5 »		3.7 »	
L	Raw kale, harvested in winter and exposed to frost	<	1 gm.		4 gm.	
L	Kale boiled for 20 minutes	>	15 »		> 15 »	
L	»Cloudberry porridge» juice		6.7 c.c.		22.3 c.c.	
L, N	»Cloudberry beverage» (stored 7 months)	<	2.7 »		6 »	(cf. p. 70)
N	»Cloudberry porridge» juice		6.7 »		22.3 »	
N	»Water cloudberry» juice		2.7 »		9.1—16.6 »	
					mean 12.8 »	

To get practical results, the minimum protective ration for guinea pig ascertained microscopically is multiplied by from 14 to 20, according to the method given above, in order to find the minimum protective ration for a human adult weighing 60 kg. From the values of the natural berry juices, the minimum antiscorbutic protective rations of the fresh, whole berries, as well as of the raw berry mash, are calculated by proceeding from the content of water in the berries, and the assumption that the watersoluble vitamin C is equally distributed in the total water content of the berries. For the hypothesis that vitamin C is not to be found in the juice but in the remaining parts of some berries (cf. A. SCHEUNERT, 19, p. 20), I find no plausible evidence. The water content of the berries is chiefly calculated according

to the figures given in J. KÖNIG's *compilation* (24). By these procedures, the following results are obtained:

Minimum antiscorbutic protective ration for human adults weighing 60 kg.

Foodstuff	Ascertained μ ration	Calculated μ ration	Minimum protective ration for human adult of 60 kg.
Blueberry juice (natural)	26 c. c.		364 to 520 c. c.
Bluberries (82 % water): fresh whole berries or raw mash		$\frac{100.26}{82} = 31.7$ gm.	444 » 634 gm.
Arctic raspberry juice (natural)	> 19 »		> 266 c. c.
Arctic raspberries (85 % water assumed): fresh whole berries or raw mash		$> \frac{100.19}{85} = > 22.4$ gm.	> 314 gm.
Red currant juice (natural)	9 »		126 to 180 c. c.
Red currants (84 % water): fresh whole berries or raw mash		$\frac{100.9}{84} = 10.7$ gm.	150 » 214 gm.
Black currants: fresh whole berries or raw mash	2 gm.		28 » 40 »
Cultivated raspberry juice (natural)	6 c. c.		84 » 120 c. c.
Cultivated raspberries (85.5 % water): fresh berries or raw mash		$\frac{100.6}{85.5} = 7.0$ gm.	98 » 140 gm.
Raspberry beverage (recipe p. 62)	17.1 »		239 » 342 c. c.
Red whortleberry juice (natural)	> 55 »		> 770 »
Red whortleberries (84.2 % water): fresh berries and raw mash		$> \frac{100.55}{84.2} = > 65$ gm.	> 910 gm

Foodstuff	Ascertained μ ration	Calculated μ ration	Minimum protective ration for human adult of 60 kg.
Cloudberry juice (natural)	3.5 c. c. (Höjer)		49 to 70 c. c.
Cloudberries (83 % water): fresh berries and raw mash		$\frac{100 . 3.5}{83} = 4.2$ gm.	59 » 84 gm.
Cloudberry beverage (stored one month)	3.7 c. c.		52 » 74 c. c.
Cloudberry beverage (stored 7 months)	6 »		84 » 120 »
Undiluted cloudberry »porridge» (stored 7 months)	(juice 22.3 c.c.)	$\frac{22.3 . 85}{100} = 19$ gm.	266 » 380 gm.
»Water cloudberries» (stored 7 months)	12.8 gm.		179 » 256 »

It now remains to place the results gained by the investigations of the Swedish Royal Medical Bord in their historical setting. The following numerical values (none but numerical values are considered here) of the macroscopic (M) or microscopic (μ) protective rations of the berries and berry juices dealt with herein comprise what was known or suggested before the present series of investigations:

Berry product	*M ration*	*μ ration*
Blueberry juice, natural (HÖJER, 5)	> 5 c. c.	
Raspberry juice (HOLST and FRÖLICH, 25)	< 25 »	
Red whortleberry juice (FÜRST, 26)	> 25 »	
Cloudberry juice, natural (HÖJER, 4)		3.5 c. c.
Cloudberries (HOLST and FRÖLICH, 25)	30 gm.	
»Cloudberry porridge» (FÜRST, 26)	20 »	

In 1929, that is, the same year in which most of the Medical Board investigations were being made, there were published, though unknown to us, the results of vitamin C determinations of various kinds of berries also belonging to the Norrland flora, made by A. SCHEUNERT in his book, *Der Vitamingehalt der deutschen Nahrungsmittel, Teil 1,* Berlin 1929.

The technique of SCHEUNERT's experiments is in essential points different from that used in the Swedish investigations.

His basal diet consists of oats and ordinary milk autoclaved for one hour at a pressure of one atmosphere. The animals were forcibly fed on whole berries. Each experiment covered a period of 60 to 90 days. The growth curve was used as the chief criterion of scorbutic protection. The ration of the protective foodstuff was altered for one and the same animal until a normal growth curve was obtained. The protective ration obtained by this method is lower than that apparent from careful post-mortem examination, since, as has already been emphasized by the author and confirmed by actual facts, a guinea pig with a good (»normal») growth curve may at autopsy present distinct macroscopic signs of scurvy.

Since, however, the values obtained by SCHEUNERT are of very great interest in this connection because he included all parts of the berry in his diets, those of them are here reproduced that may serve as a comparison with the results obtained in the Upsala investigation. The figures are taken from a later edition (1930) of SCHEUNERT's book (19, pp. 19—20).

Blueberries: 15 to 20 gm. required daily to protect growing guinea pigs.
Red currants: 4 » 7 » » » » » » » »
Raspberries: 5 » » » » » » » »

Simultaneously with the Upsala investigation, another was made in Hamburg by F. V. VON HAHN (27) and published in 1931, which also used edible berries as material. This inquiry also differed considerably in technique from the Upsala investigation but agreed in two important points: VON HAHN gave each animal unaltered rations for the entire period of experiment and based his conception of the presence or absence of scurvy primarily on the findings at autopsy.

The basal diet of VON HAHN consists of oats and hay. The latter is not usually lacking in vitamin C, but can be made so by thorough autoclaving. I have found no mention of such treatment in the monograph. If it has been neglected, then the basal diet must be regarded as having contained vitamin C, though only to a very small extent. In the testing of foodstuffs rich in vitamin C, this is not of much significance, but in those poor in vitamin C, e. g. red whortleberries, experiments made with such a basal diet yield no reliable results. Certain differences between the results of the investigations in Upsala and Hamburg may to some extent be explained by this circumstance.

Von Hahn gives the following macroscopic protective rations of whole or thoroughly crushed berries:

Blueberries	> 2 gm.	Red currants	> 2 gm.	Black currants	0.2 gm.
Raspberries	2 »	Red whortleberries	> 10 »		

The most important statement dealing with our subject that is to be found in von Hahn's paper is the following: »Die schwarze Johannisbeere weist den höchsten C-Vitamingehalt auf, den wir bisher überhaupt beobachten konnten.» As chapter VI shows, my results *indicate a somewhat higher antiscorbutic potency of black currants than of oranges. This fact not only is of the greatest importance for this investigation, but it has also radical hygienic and economic consequences for all the countries of northern Europe.*

CHAPTER VIII.

Practical Consequences of the Investigations Described in Chapters IV—VII. Author's Suggestions for the Raising of the Vitamin C Content of the Winter Diet in Upper Norrland.

This investigation was made because there were strong reasons for believing that the diet in certain parts of Upper Norrland is deficient in vitamin C. The research of the last few years has given results confirming this belief.

In 1930, G. F. GÖTHLIN (28, 21) elaborated a method of indirect estimation of the vitamin C standard of healthy persons on the basis of the strength of their skin capillaries. The same year, it was ascertained by him that according to this method there was in certain parts of the province of Uppland in Central Sweden an subnutrition of vitamin C in about 18 per cent of the school-children examined in April and May. The following year — April 1931 — a similar examination was made by FALK, GEDDA and GÖTHLIN (29) on school-children of Upper Norrland in several places north of the Arctic Circle; this investigation was carried on in conjunction with a questionnaire on the children's food. It transpired from this investigation that a subnormal standard of the antiscorbutic vitamin, in so far as this could be ascertained by the capillary strength tests, was present to a highly varying degree in different parts of the district under investigation. Where conditions were worst, the greatest percentage of vitamin C subnutrition was 21, and where they were best, it was 6. In these statistics, only such children were included as had no symptoms of disease either at the time of examination or for the two months preceding.

That the main antiscorbutic protection at present achieved by the diet in these districts lies principally in potatoes and milk

was known previously through knowledge of the mode of life of the population. In the above-mentioned investigation, an approximate calculation according to G. F. GÖTHLIN's method (21, pp. 259—261) was made — based on the daily rations of milk and potatoes stated in the questionnaire — of the total number of antiscorbutic guinea pig units [1] contained in the daily rations of these foodstuffs. When the average guinea pig units in the daily diet of the different communities examined were compared with the results of the capillary strength tests made at the same places, it was found that where the vitamin C intake with the food was high (e. g., in Svappavaara), the capillary strength was also high, and where the vitamin C intake according to the questionnaire was low, (e. g. in Lansjärv), the capillary strength was also low. Even without recourse to fruits, vitamin C subnutrition can, according to this investigation, be prevented, providing the child has a sufficient appetite to consume 5 potatoes and one full litre of milk daily. In the long run, however, such a diet must become monotonous, and for children with less appetite, it is no doubt necessary to supply the daily requirement of vitamin C in a less bulky and more appetising form.

The results of FALK, GEDDA and GÖTHLIN do not in the author's opinion allow of more than one interpretation. *There are in Upper Norrland, at least in the early spring, even among apparently healthy children, cases of vitamin C subnutrition, and in the communities with the greatest frequency of such cases, as many as one in every five such children may be suffering from vitamin C subnutrition.* Plainly, the situation is serious enough to call for action.

The tabular surveys, given in the previous chapter, of the minimum antiscorbutic protective ration for man of the berries examined show that a human adult may be fully protected even by a comparatively small amount of the foodstuff in question, provided he uses only those preparations of berries which contain vitamin C in its most concentrated form, i. e., raw mash (or raw juice) of black currants, raw cloudberry mash, cloudberry beverage, raw raspberry mash and »water cloudberries».

If curative treatment is the aim, it will, of course, be the

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[1] A guinea pig unit (cf. 21) here signifies the smallest protective ration, microscopically determined, of the substance in question for a guinea pig of an initial weight of $^1/_3$ kg.

physician's task to choose from the foodstuffs given in the tables on pp. 78—79 an available one and prescribe the proper quantity, in doing which he should find hardly any difficulty if he takes into consideration the degree of severity of the case and is guided by the figures given in the survey.

It must, however, be borne in mind that the protective ration for a child cannot be computed from the figures in the table exclusively on the basis of its body weight, since a child requires a larger intake of vitamin C per kilogram of the body's weight than an adult (cf. 29, p. 20). On account of this it seems reasonable to give children from the age of six years about the same rations as adults.

If the layman is to compose his own diet in such a way that it will without too great monotony enable him to maintain a normal vitamin C standard, then it appears that with the mode of life customary in Upper Norrland, this should be practicable by the daily addition to the ordinary mixed diet of one of the given berry products *to an amount corresponding to half the lowest value given in the table for the minimum protective ration for a human adult weighing 60 kg.* The layman wishing to do this may thus be advised to add to his diet a daily ration of 14 gm. (one tablespoon) raw black currant mash, or 30 c. c. cloudberry beverage, or raw cloudberry mash corresponding to 30 gm. whole berries, or 90 gm. »water cloudberries», or, finally, raspberry mash corresponding to 50 gm. whole berries. The amount consumed in a week may naturally be taken in a smaller number of days than seven, though preferably not less than three. For the sake of variety, different kinds of berries may be used at different times.

If the raw juices are preferred, not as a drink, but in some form which is suitable for use as food, the best way is to prepare juice jellies. The juice should be stirred into a little gelatine solution at as low a temperature as 35 to 40° C., after which thickening is brought about by rapid cooling. In this way, the vitamins are to the greatest possible extent protected against destruction by heating.

In the mountainous parts of Norrland, cloudberries grow wild on great moors, some years very abundantly. In these parts of the province, this delicious berry with its unsually high content of vitamin C is the foodstuff given by Nature itself, and should be

the first to be used to increase the vitamin C component of the diet. It is not sufficient, however, to gather the berries; they must also be preserved for the winter in a rational manner, keeping the vitamin C content intact to the greatest possible extent. In some of the special cloudberry districts, viz., those in Jämtland, cloudberries are at present preserved chiefly by boiling (*myltgröt*). But in other parts of Norrland and in a somewhat more southerly province, that of Dalecarlia, there is a raw preserve in use, »water cloudberries», which has by our investigation been shown to hold a vitamin C content approximately 50 per cent higher than that of the boiled preserve (cf. p. 79). The tables giving the results of the investigation show, however, that in raw cloudberry mash and cloudberry beverage, we have raw preserves in which the vitamin C is kept intact even better than in water cloudberries, probably owing to an acid content better adapted to its maintenance. Under such conditions, and presupposing an equivalent flavour, all the arguments are in favour of the preparation of cloudberries as well as other berries by the method giving the highest vitamin C yield, in other words the method of raw preservation, and the avoidance of wasteful methods. The latter include boiling in open pans, which we therefore advise against. Boiling in closed jars or hermetically sealed tins may, on the other hand, be used in addition to raw preserving.

In the northern parts of the cloudberry district of Norrland, much educational and organisational work is still required for the rational exploitation of cloudberries. The population, which is as yet rather indifferent to these questions, must be informed of the exceedingly valuable resources it has in its cloudberries, »the oranges of the North». It cannot be denied that there are considerable difficulties in the picking of these berries. Many of the richest patches grow in wilds where there are not even any roads. The exploitation of the berries, therefore, presupposes among other things *that the authorities undertake the mapping of all the more extensive cloudberry areas and the marking out of paths to them from the nearest inhabited localities.* In consideration of the fact that the communities in question are poor both in financial equipment and in initiative, such gathering and preserving work could probably not be instituted without *organization and financial aid from the county councils,* an expenditure which would probably pay in the long run. The author cannot resist the temptation of pointing out both the

opportunities for labour that would be created, and the fact, important from the economic point of view, that *the country may do without the importation of just so many tons of oranges as there are tons of cloudberries preserved and rationally used within the country.*

As to those parts of Upper Norrland in which agriculture and horticulture may be carried on, we should remember that the latitude here is too high to permit of the culture, with any reasonable hope of success, of satisfactory crops of tomatoes, apples, pears, cherries or gooseberries. The only berries that can be raised on a large scale in these districts are those given in the tables, possibly with the addition of a limited supply of wild strawberries and the small and uncertain crops obtained from cultivated strawberries.

If we proceed on the pronciple that aid is to be given by selfsupport, and compare the possibilities of crops of the various cultivated berries with their vitamin C content as given in the tables, making due allowance for the taste of the ingredients, it becomes apparent that *in addition to boiled potatoes and fresh milk, jams (and juices) of raw black and red currants and raspberries are preferable to other vegetable substances here cultivable as a means of counteracting the vitamin C scarceness.* The simple operation of preparing raw jams and juices from these berries (as well as cloudberries) may be found in G. F. GÖTHLIN's book *Råsyltning och råsaftning av vitaminrika bär.* In Norrland, however, especially in the northern parts, the number of these kinds of bushes should be greatly increased. *The authorities should make possible the cheap purchase of good qualities of such plants, and encourage diligence in their cultivation.*

It would be of great consequence for the counteraction of vitamin C subnutrition in Norrland if the raw preservation of berries was taught everywhere in the elementary schools. The author believes this an indispensable measure in Upper Norrland in consideration of the present situation. This is the author's opinion regarding the persuasion both of the mountain villages to a rational exploitation of the cloudberries and the agricultural communities to a rational use of currants and raspberries. Only thus may we hope that a rational exploitation of the berries will reach the general public, and the hygienic advantages connected with it become the property of the mass of the people.

Some further rules may be given which are not based on the Royal Medical Board vitamin investigation. What there is of wild and cultivated strawberries, which are also rich in vitamin C, may be preserved raw by being crushed to a mash and thoroughly mixed with 30 to 50 per cent castor sugar plus 0.1 per cent sodium benzoate. Rhubarb grows in all parts of Norrland. As a vitamin C bearer, it cannot compare with the berries recommended herein, but it deserves nevertheless to be cultivated for this purpose, and may be preserved cut in cubes, packed into bottles and covered with water.

During the transitional period, before it is possible to get under way the raw preservation of berries, a cheap food in the combating of vitamin C subnutrition is the freshly expressed juice of raw swedes. It probably gives the human adult *full protection* from scurvy when given to the amount of from 70 to 100 c.c. daily. The determinations in the guinea pig experiments made by the author in one of his own investigations show, however, that the storability of the vitamin C in this juice is entirely unsatisfactory, even when a suitable amount of acid is added. The swede juice must therefore be expressed only for the immediate occasion on which it is to be consumed. A further disadvantage is the fact that some people find it unpalatable.

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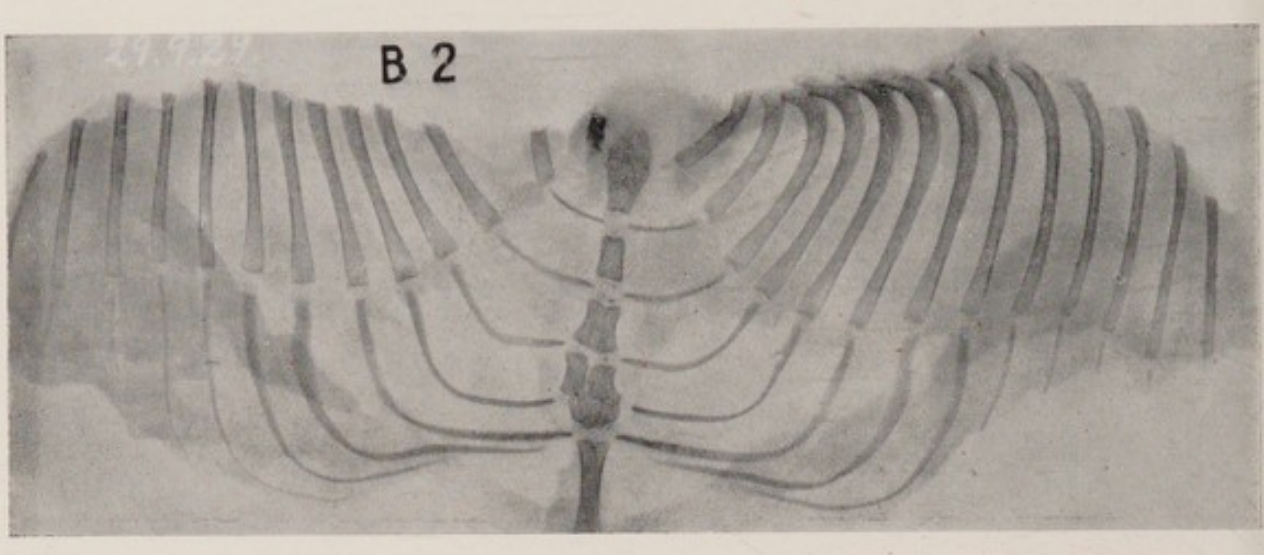
Bibliography.

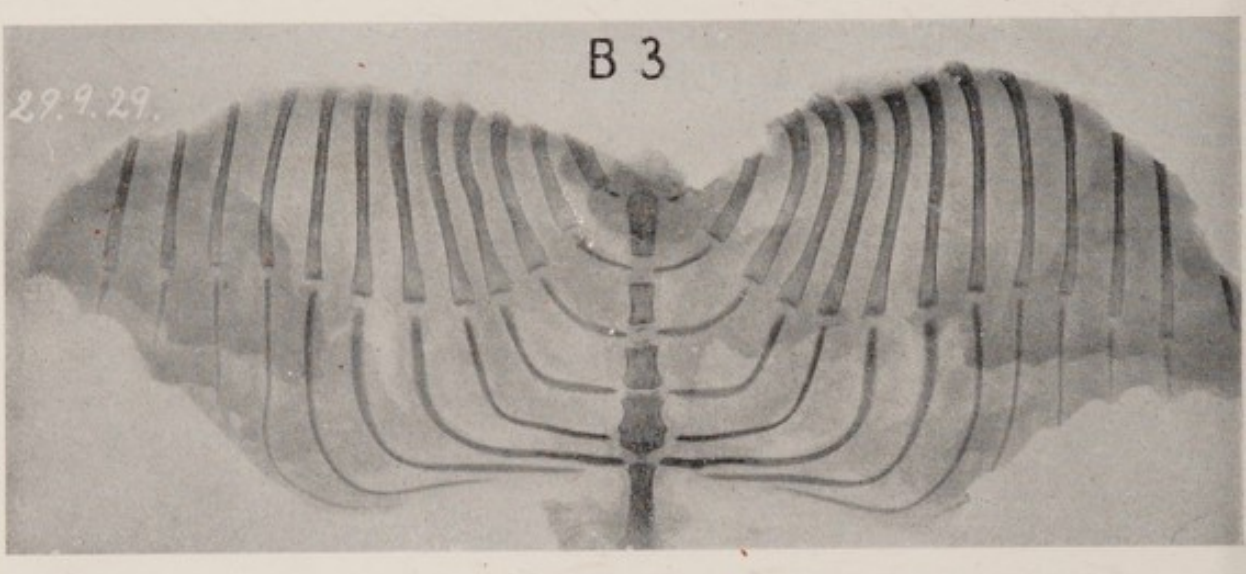
1. M. Odin, Årsberättelse från Västerbottens läns södra lasarett i Umeå för år 1927 och 1928. Umeå, 1928 and 1929.
2. E. Perman, Ett förslag till förbättring av de hygienisk-dietiska förhållandena i Norrland. Social-Medicinsk Tidskrift 1928, No. 10, pp. 180—184.
3. G. F. Göthlin, Norrlands vitaminfråga belyst rörande C-vitaminet. Ibidem 1928, No. 12, pp. 224—234.
4. A. Höjer, Method for determining the antiscorbutic value of a foodstuff by means of histological examination of the teeth of young guinea-pigs. Brit. Journ. of Experim. Pathol., Vol. 7, pp. 356—360, 1926.
5. —, Studies in scurvy. Acta Paediatrica, Vol. 3, Supplement, 1924.
6. A. Harden and S. S. Zilva, Biochem. Journ., Vol. 12, p. 93, 1918.
7. J. König, Chemie der menschlichen Nahrungs- und Genussmittel. Nachtrag B zu Bd. 1, 1923.
8. N. R. Ellis, H. Steenbock and E. B. Hart, Journ. of Biol. Chem., Vol. 46, p. 367, 1921.
9. Sherman, La Mer and Campbell, The quantitative determination of the antiscorbutic vitamin (vitamin C), Journ. of Americ. Chem. Soc., Vol. 48, pp. 165—172, 1922.
10. Medical Research Council, London, Report on the present state of knowledge of accessory food factors (vitamins), reprinted 1927.
11. W. Gaede und W. Straub, Ein Laboratoriumsapparat zur schonenden Schnelltrocknung leicht zersetzlicher Lösungen. Biochem. Zeitschr., Bd. 165, S. 247, 1925.
12. E. Brouwer, Über . . . das Gewicht verschiedener Organe beim Skorbut. Ibidem, Bd. 187, S. 183—193, 1927.
13. F. M. Tozer, Biochem. Journ., Vol. 12, pp. 445—447, 1918.
    —, The effect on the guinea-pig of the deprivation of vitamin A and of the antiscorbutic factor, with special reference to the condition of the costochondral junctions of the ribs. Journ. of Pathol. and Bacteriol., Vol. 24, pp. 306—325, 1921.
14. A. Holst und Th. Frölich, Über experimentellen Skorbut. Zeitschr. f. Hygiene u. Infektionskrankh., Bd. 72, S. 20—21 und Tafel III, 1912.
15. C. Næslund, Über den C-Vitamingehalt der Banane und die Frage der Bestimmung der kleinsten antiskorbutischen Schutzdosis. Upsala Läkaref. Förh., N. F., Bd. 36, S. 407—409, 1931.
16. O. Rygh, Kjemiske undersoekelser over det antiskorbutiske vitamin. Avhandl. utg. av det Norske Videnskaps-Akademi i Oslo, Mat.-Naturv. Klasse, 1931, No. 8.

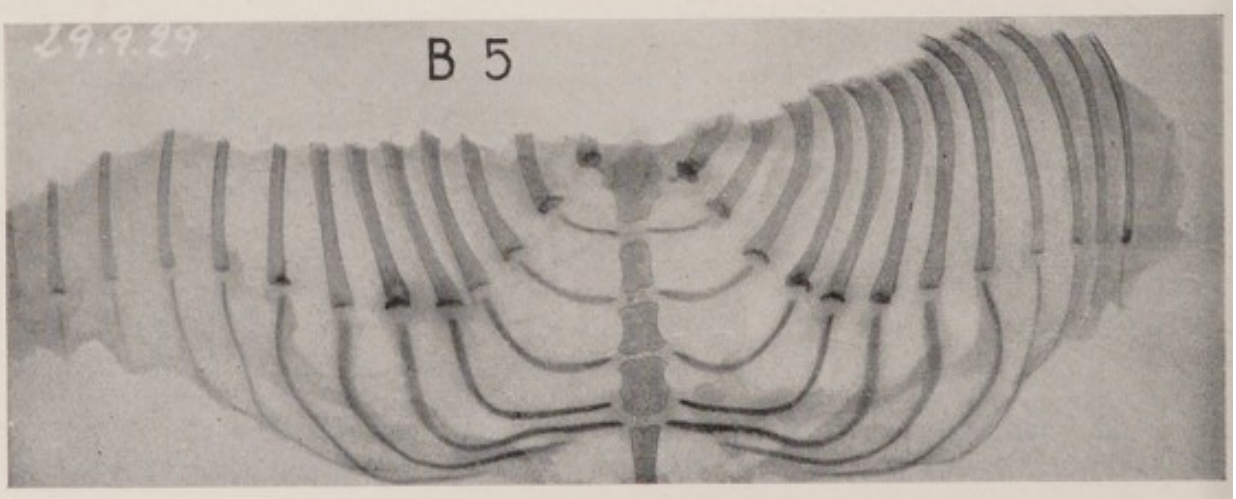
17. H. v. Euler und M. Rydbom, Einfluss Vitamin-C- und Vitamin-D-armer Kost auf den Quotienten Ca/PO_4 im Serum von Ratten und Meerschweinchen. Biochem. Zeitschr., Bd. 249, S. 149, 1932.
18. R. L. Grant, S. Smith and S. S. Zilva, Narcotine as the alleged precursor of vitamin C. Biochem. Journ., Vol. 26, Plate VI, 1932.
19. A. Scheunert, Der Vitamingehalt der deutschen Nahrungsmittel. 2. Auflage, 1. Teil, Obst und Gemüse, S. 33, 1930.
20. A. Höjer and G. Westin, Jaws and teeth in scorbutic guinea-pigs. Dental Cosmos, January 1925.
21. G. F. Göthlin, A method of establishing the vitamin C standard and requirements of physically healthy individuals by testing the strength of their cutaneous capillaries. Skand. Arch. f. Physiol., Vol. 61, pp. 258—261, 1931.
22. C. Næslund, Beitrag zur Frage nach dem Gehalt der wilden Waldbeeren an C-Vitamin. Acta Med. Scand., Vol 76, pp. 425—436, 1931.
23. S. S. Zilva and F. M. Wells, Changes in the teeth of the guinea-pig produced by a scorbutic diet. Proceedings of the Royal Society, London. Ser. B, Vol. 90, pp. 505—512, 1919.
24. J. König, Chemie der menschlichen Nahrungs- und Genussmittel. 4. Aufl., Bd. I, S. 834—837, 1903.
25. A. Holst und Th. Frölich, Über experimentellen Skorbut. Zeitschrift f. Hygiene u. Infektionskrankh., Bd. 72, S. 1—120, 1912.
26. V. Fürst, Weitere Beiträge zur Ätiologie des experimentellen Skorbuts des Meerschweinchens. Ibidem. S. 121—154, 1912.
27. F.-V. v. Hahn, Vitaminstudien. I. Reihe. Die experimentelle Untersuchung des Vitamingehaltes von Nahrungs- und Genussmitteln. Zeitschrift f. Untersuch. d. Lebensmittel, Bd. 59, S. 4—18, 1930. III. Reihe. Der Vitamingehalt des Obstes. Ibidem, Bd. 61, S. 369—411, 1931.
28. G. F. Göthlin, Användning av ett prov på hudkapillärernas hållfasthet för att utröna kroppsligen friska människors C-vitaminstandard och behov av C-vitamin. Upsala Läkaref. Förhandl., N. F., Vol. 36, p. 109, 1931.
29. G. Falk, K. O. Gedda and G. F. Göthlin, An investigation into the strength of the skin capillaries and indirectly into the vitamin C standard of school-children in the district of Norbotten, north of the Arctic Circle. Ibidem. Vol. 38, No. 2 (24 pp.) 1932. Condensed in Skand. Arch. f. Physiol., Bd. 65, S. 24—44, 1932.
30. G. F. Göthlin, Råsyltning och råsaftning av vitaminrika bär. 4th ed., Stockholm, 1933.
31. —, Methode zur Bestimmung der Festigkeit der Hautkapillaren und zu indirekter Beurteilung des individuellen C-Vitaminstandards. Klinische Wochenschrift, Jahrg. 14, No. 35, S. 1469—1471, 1932.
32. —, Outline of a method for determination of the strength of the skin capillaries and the indirect estimation of the individual vitamin C standard. Journ. of Laboratory and Clin. Medicine, Vol. 18, pp. 484—490, 1933.

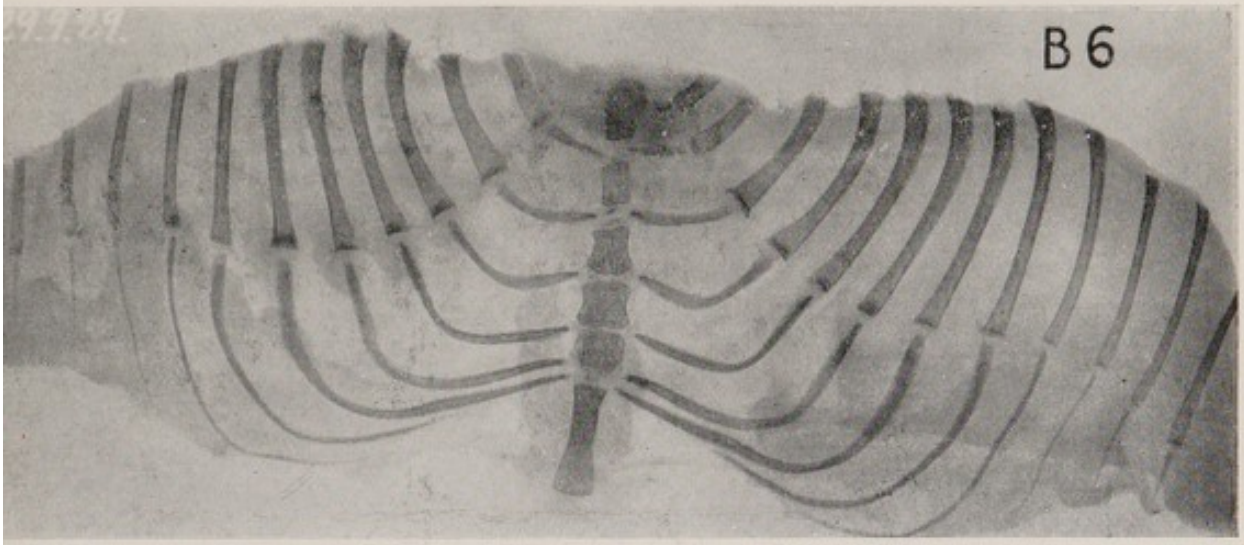
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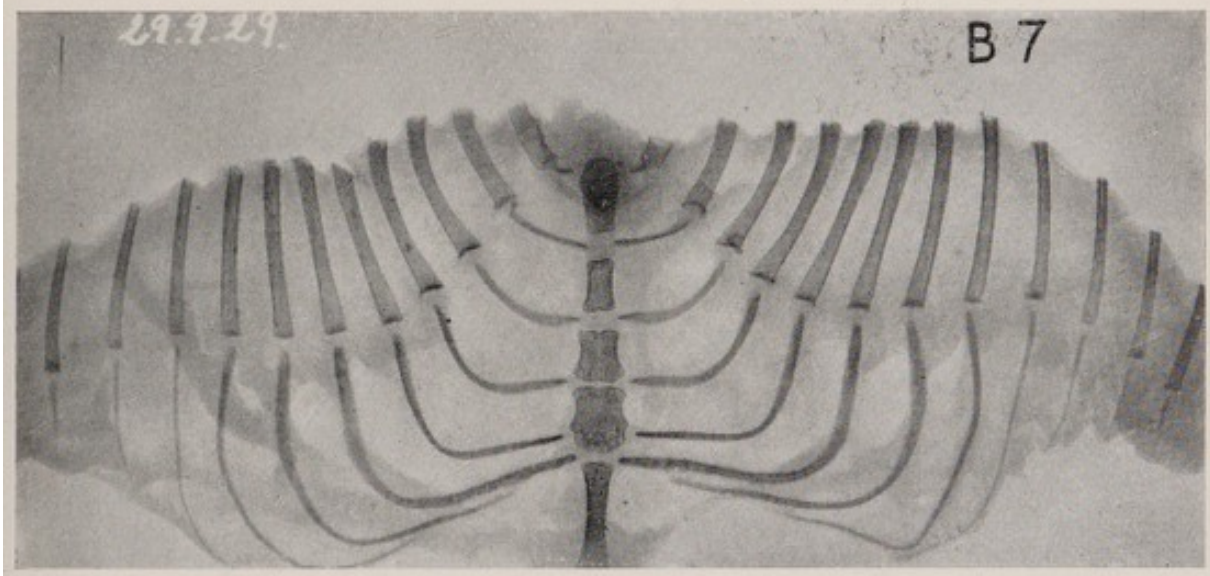
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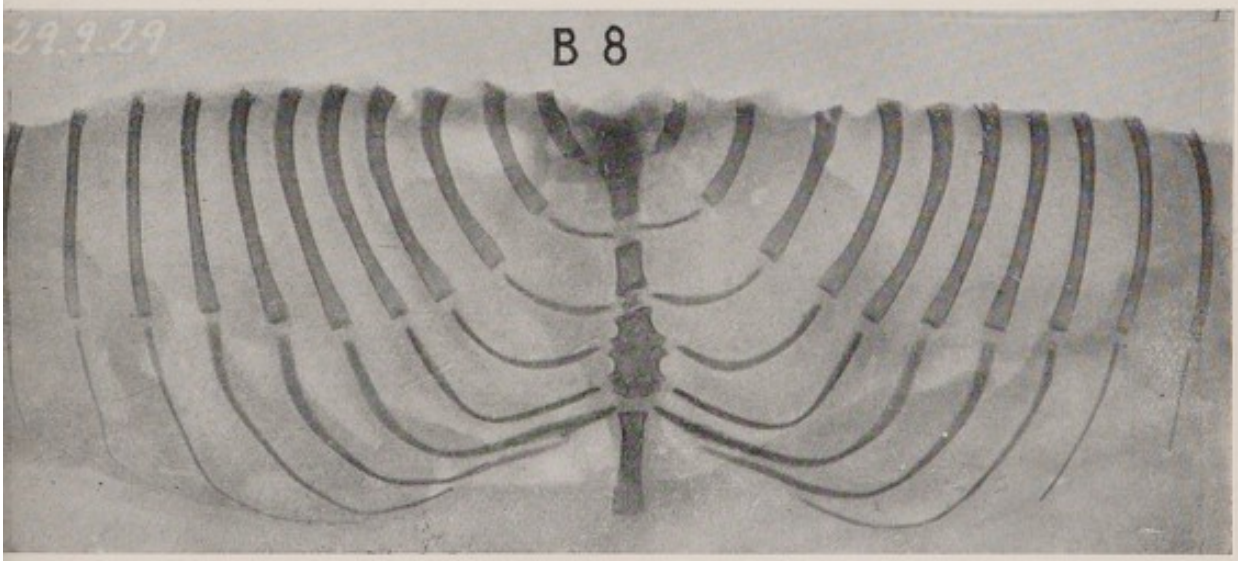

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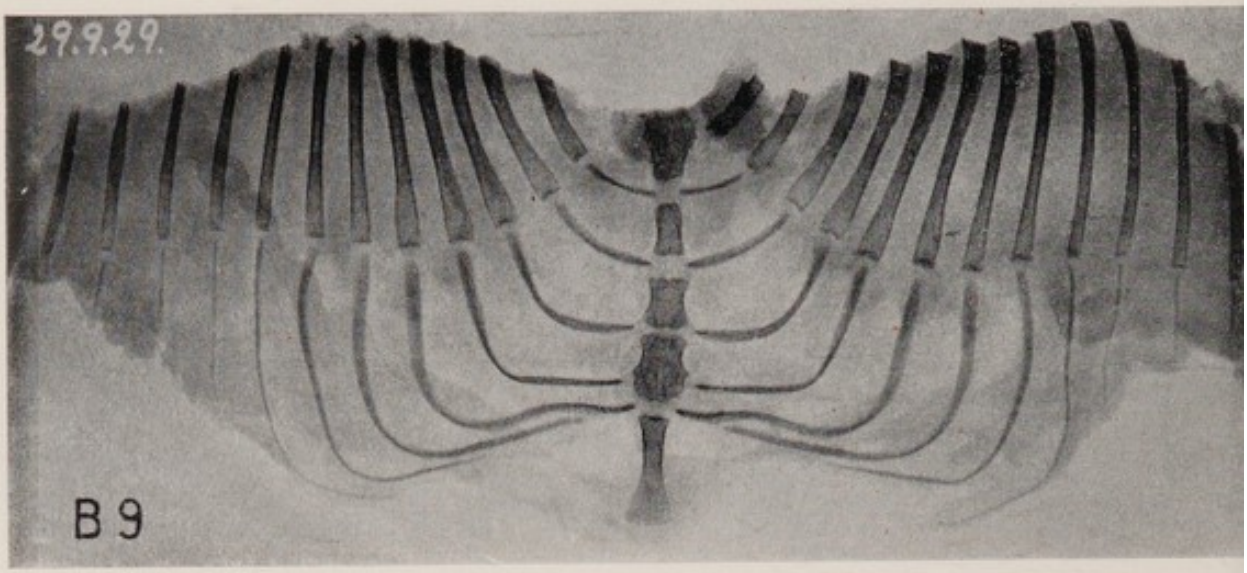

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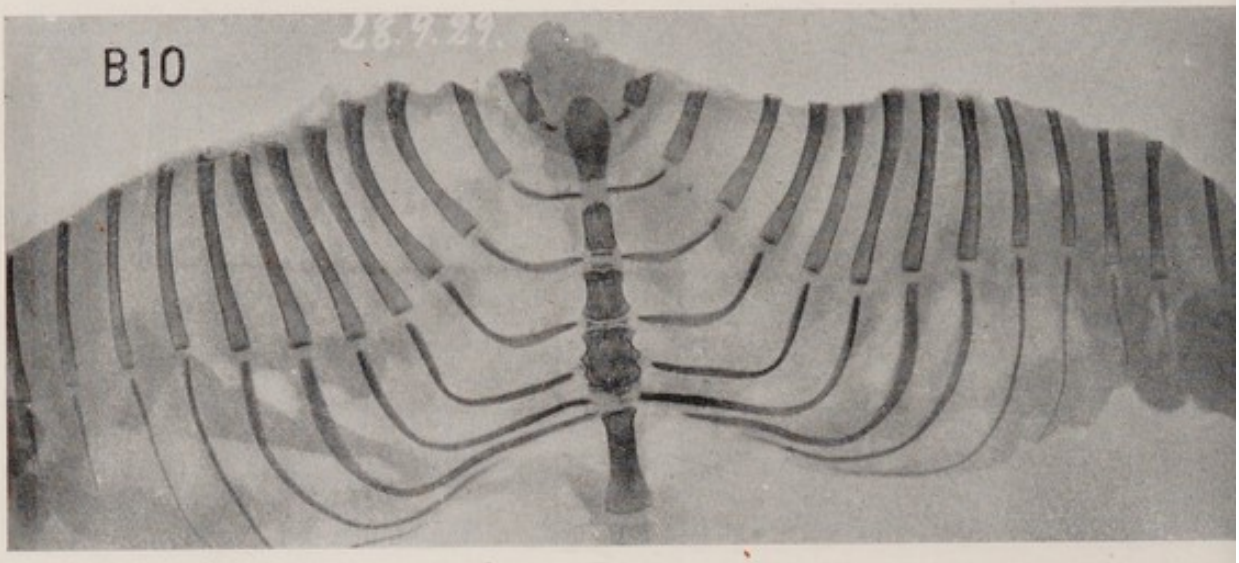

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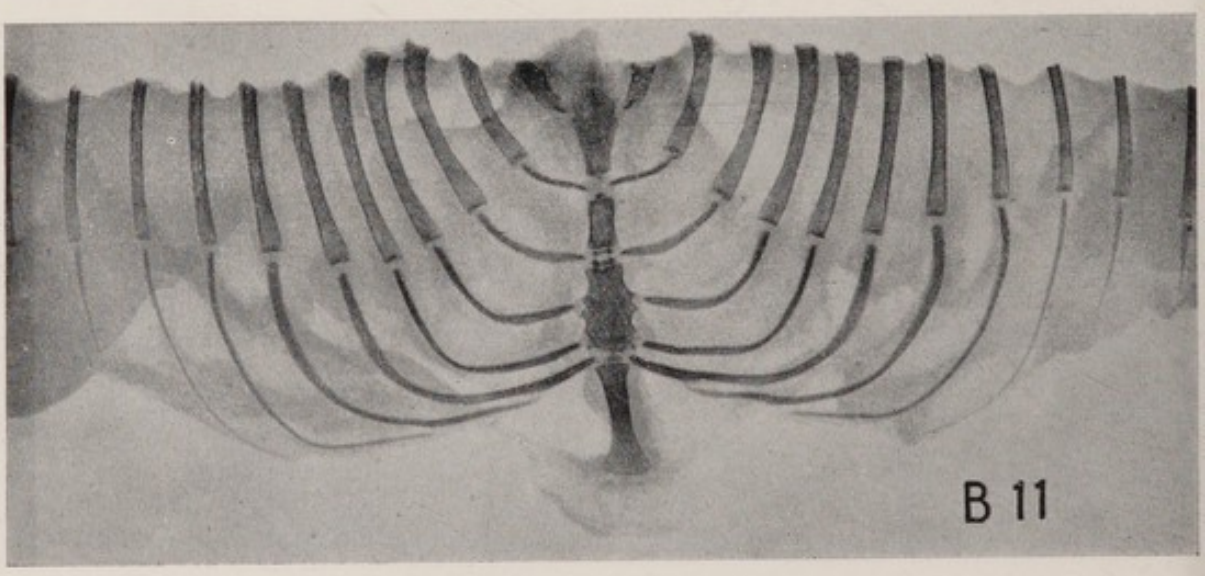

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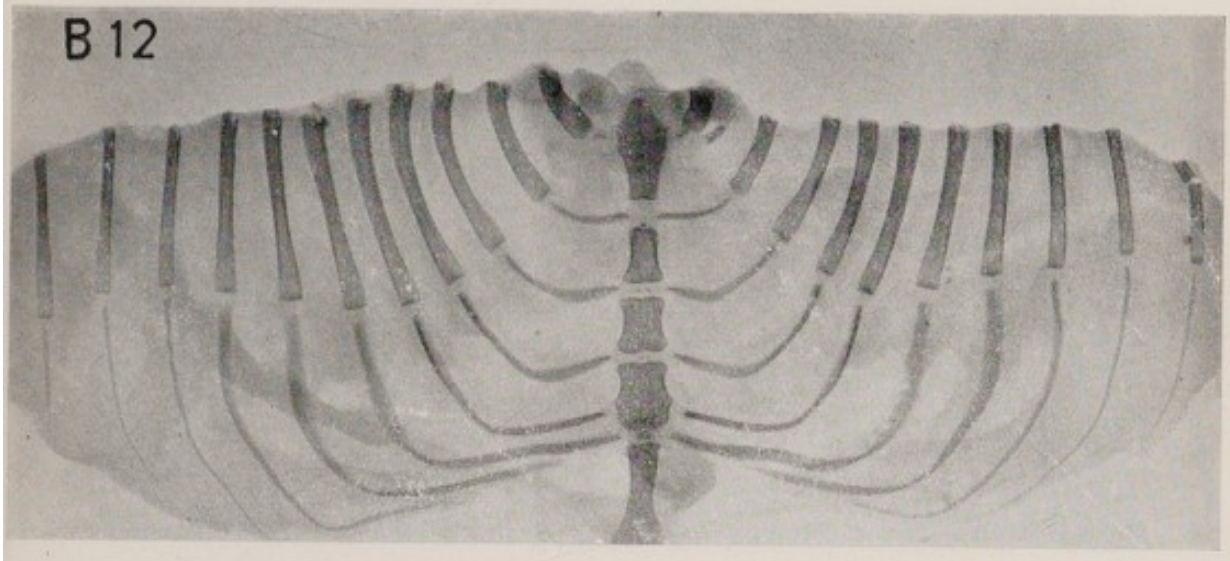

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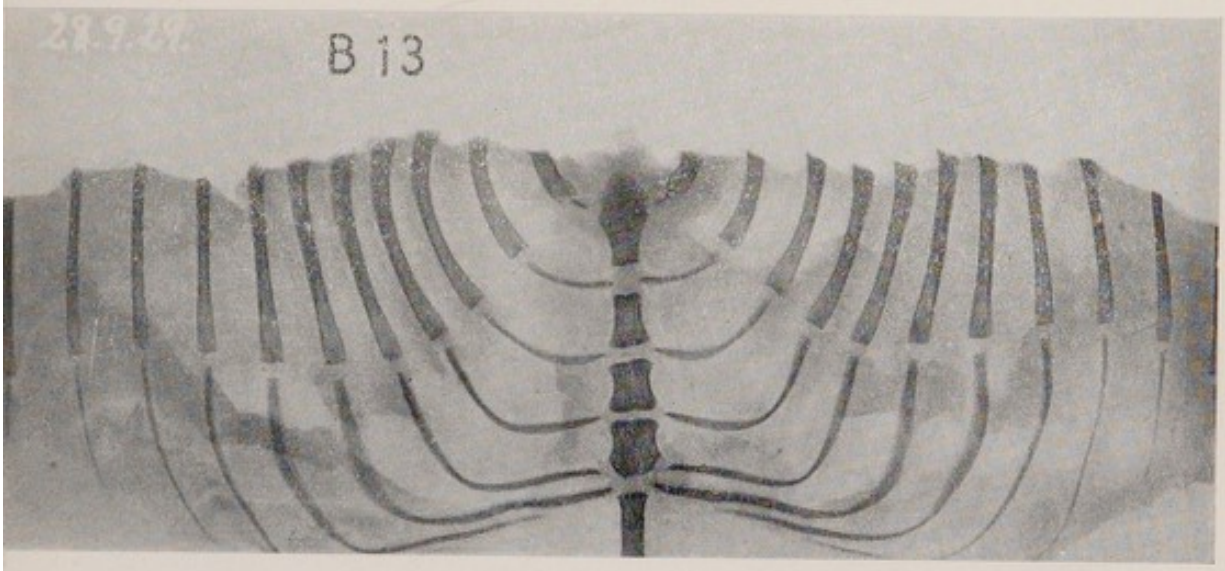

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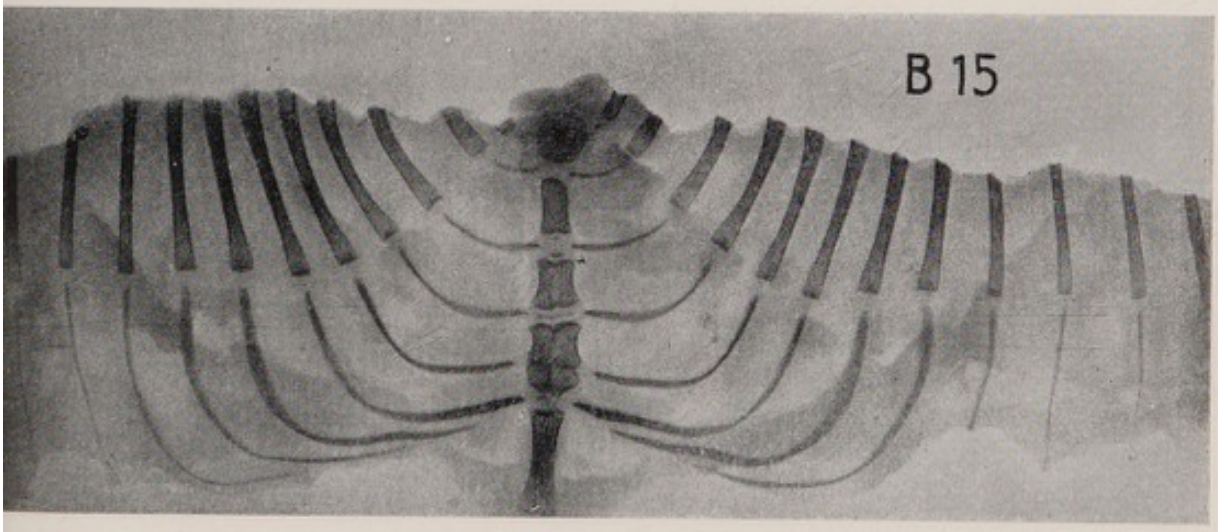

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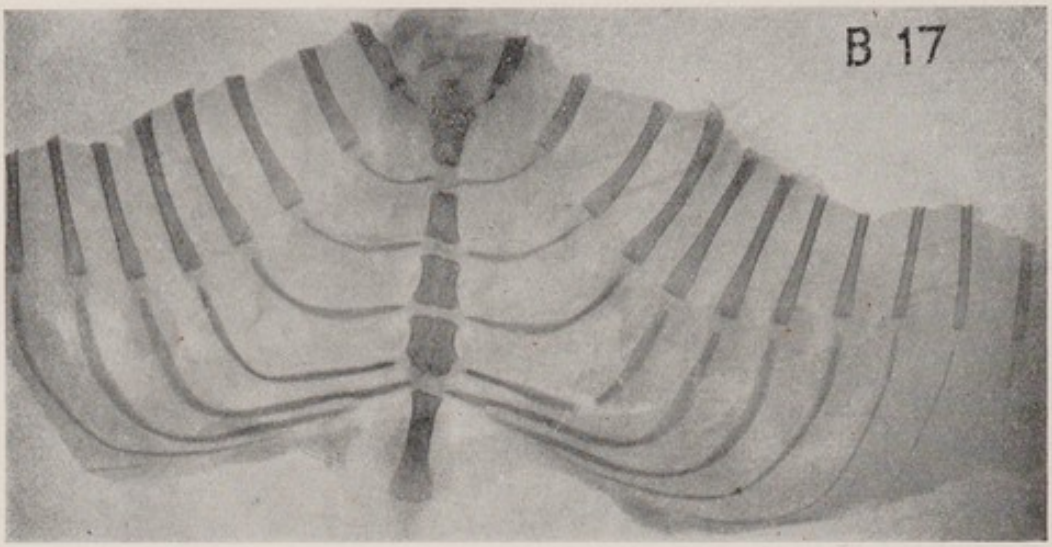

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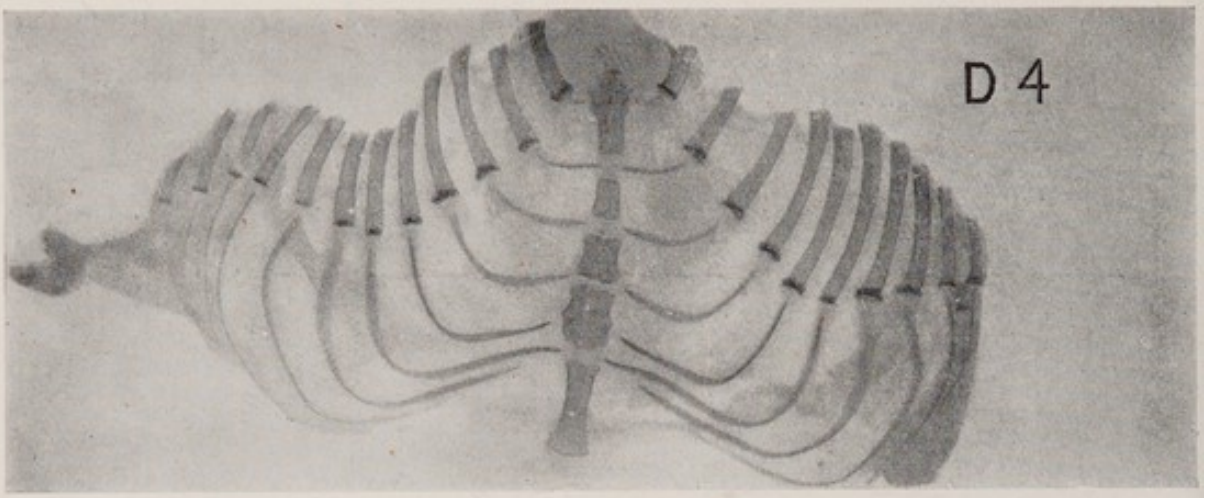

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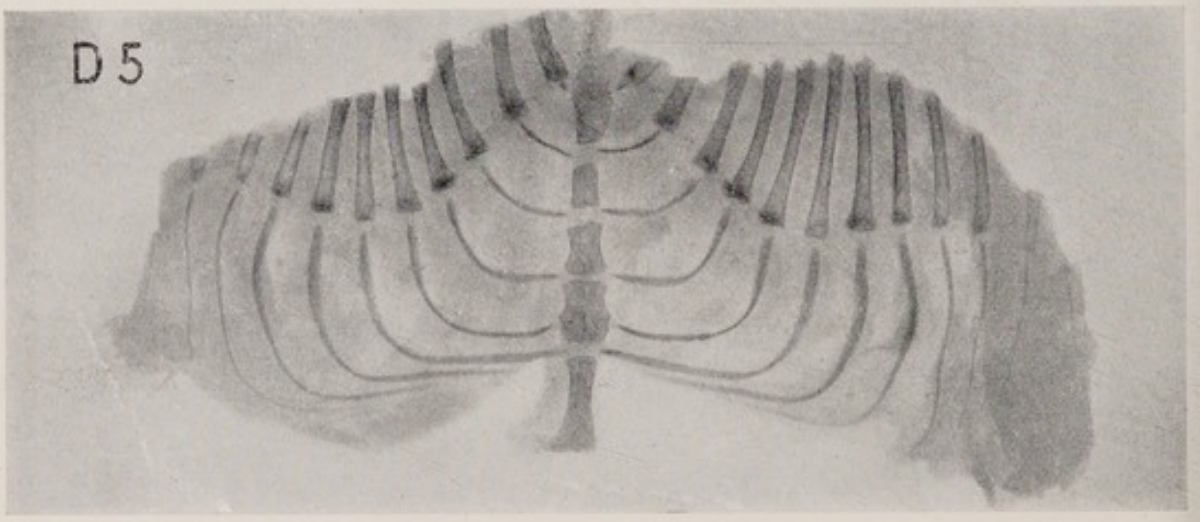

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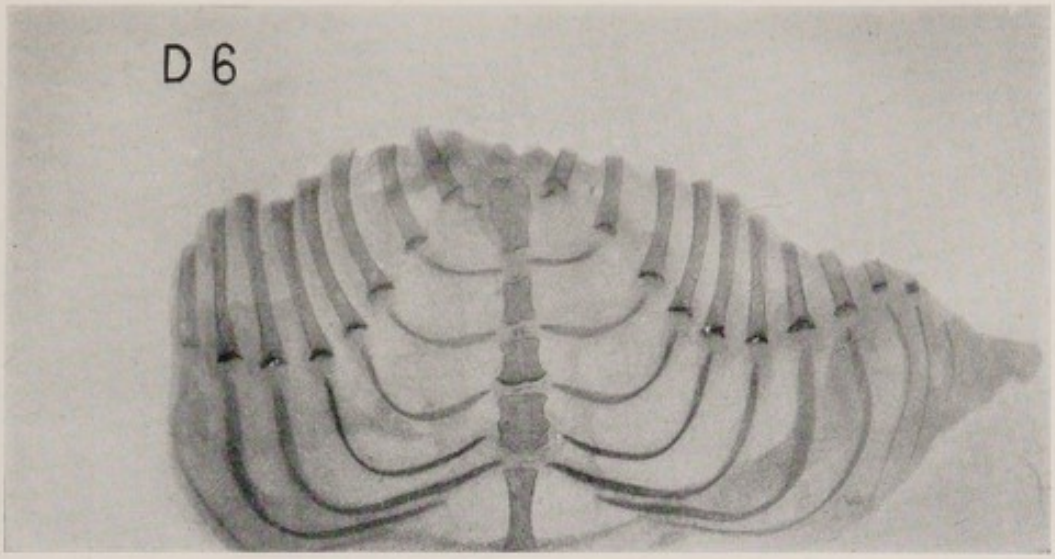

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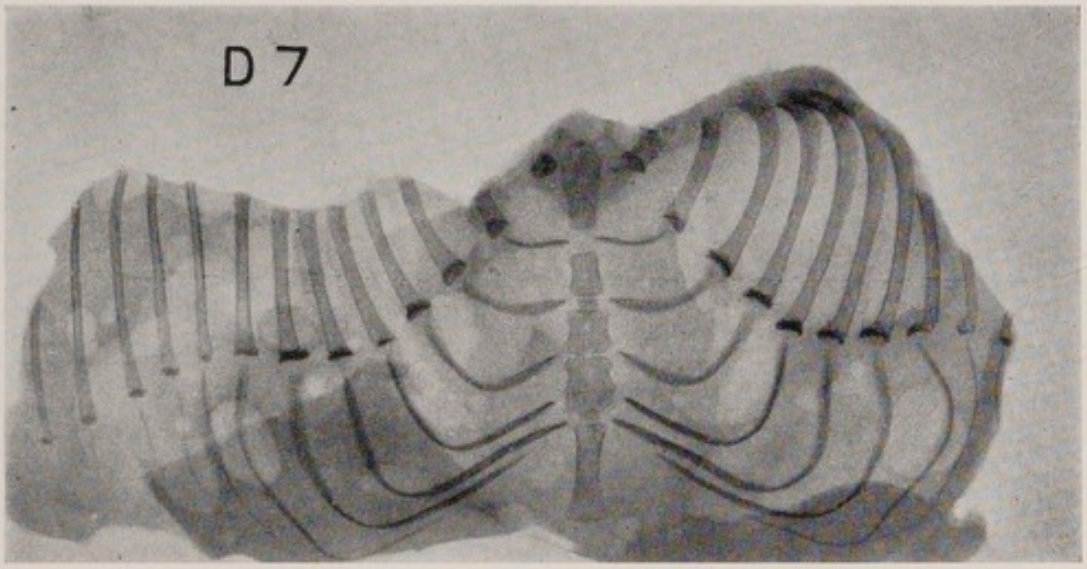

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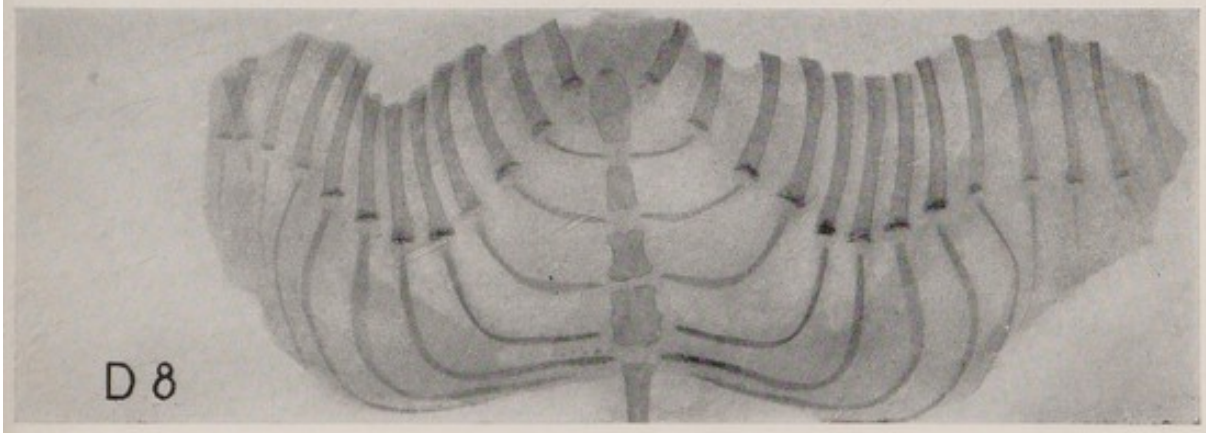

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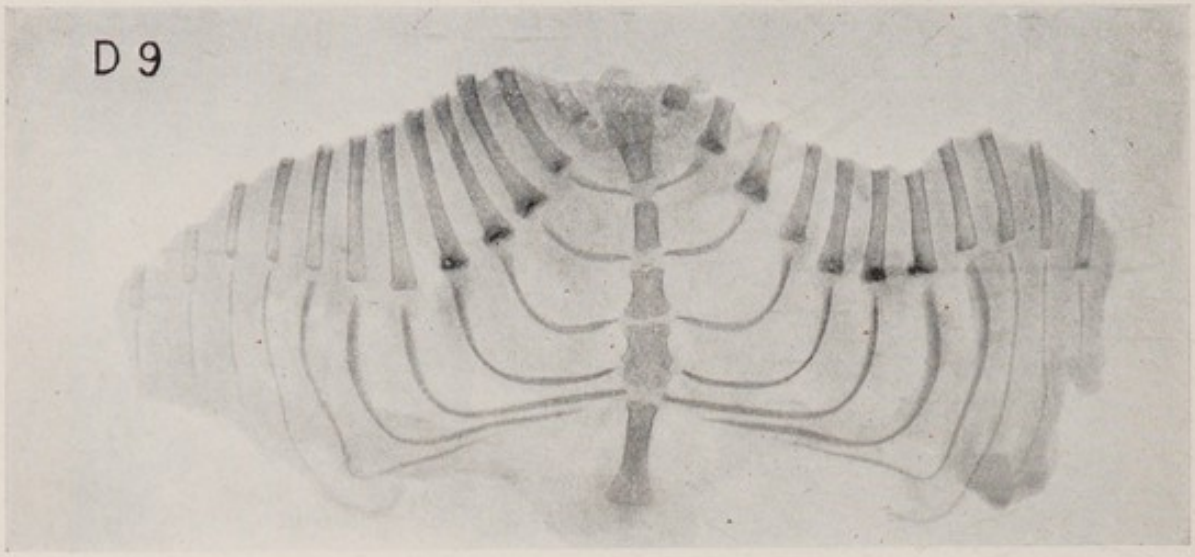

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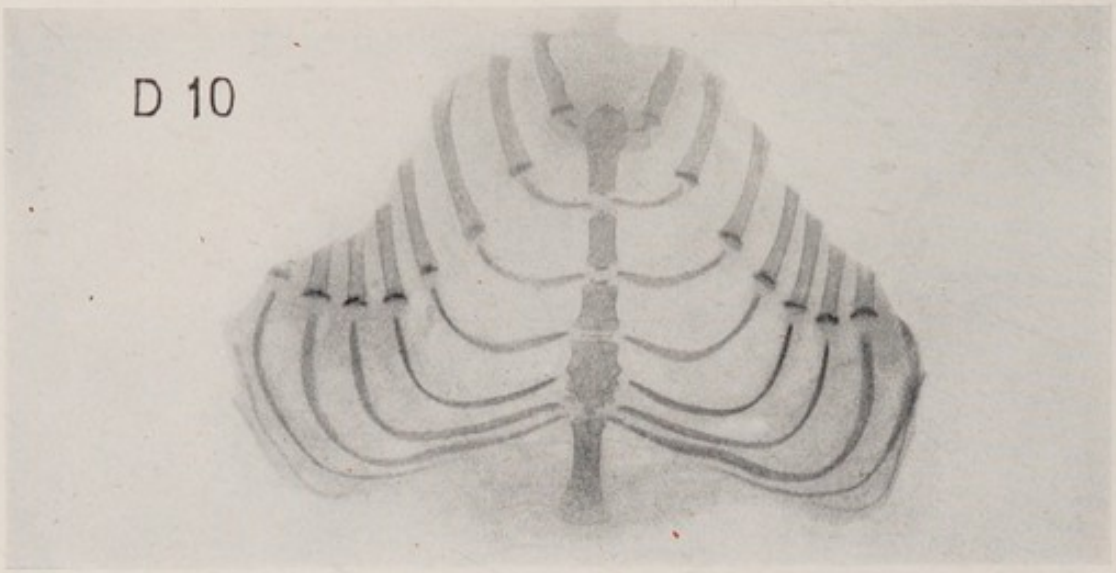

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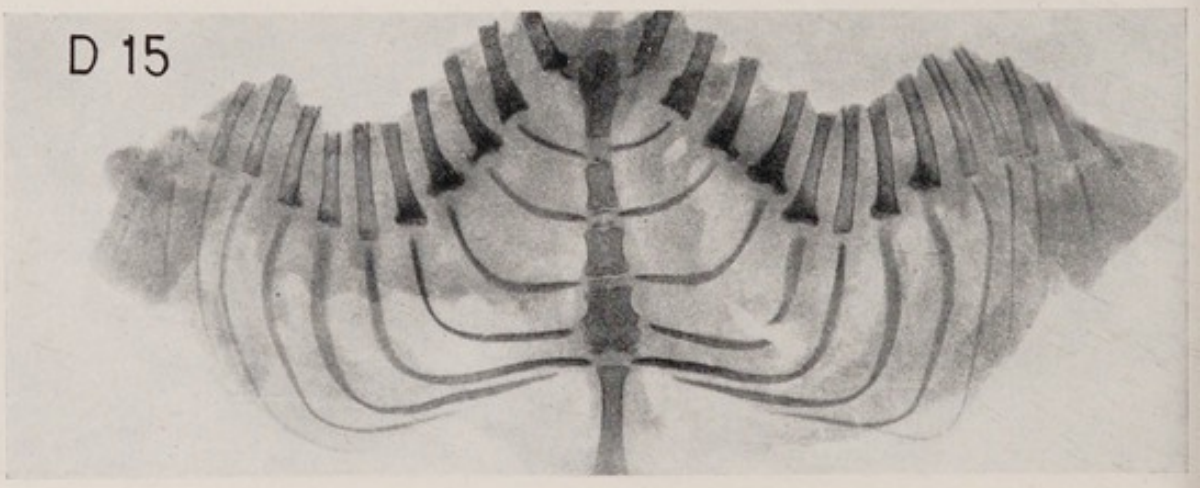

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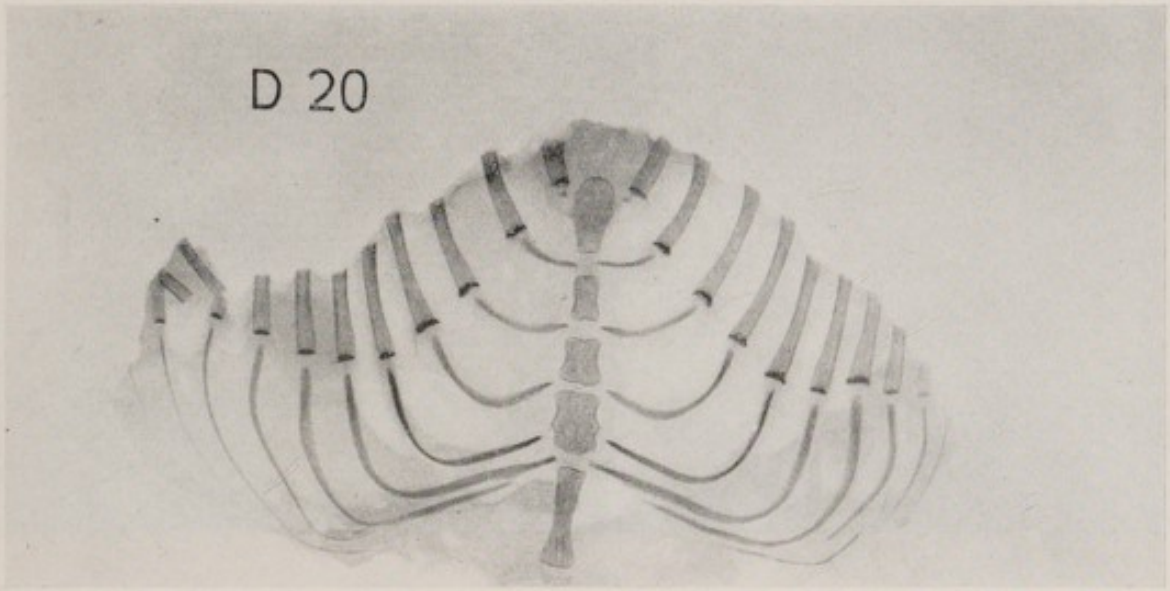

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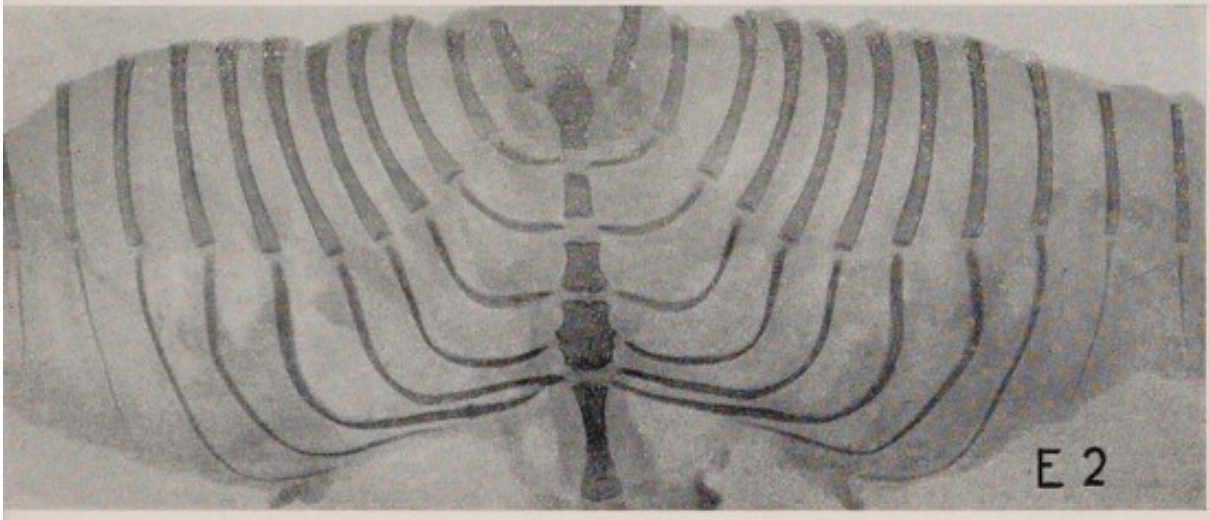

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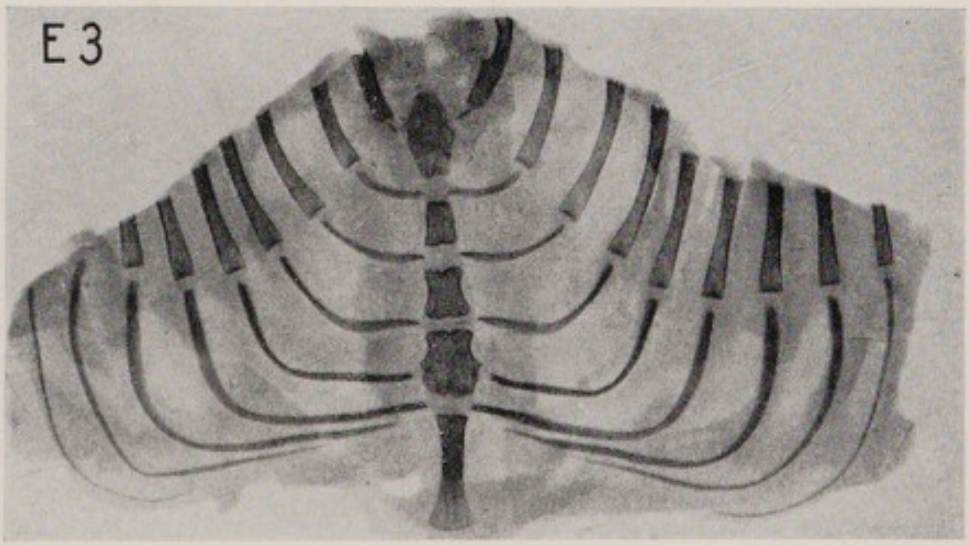

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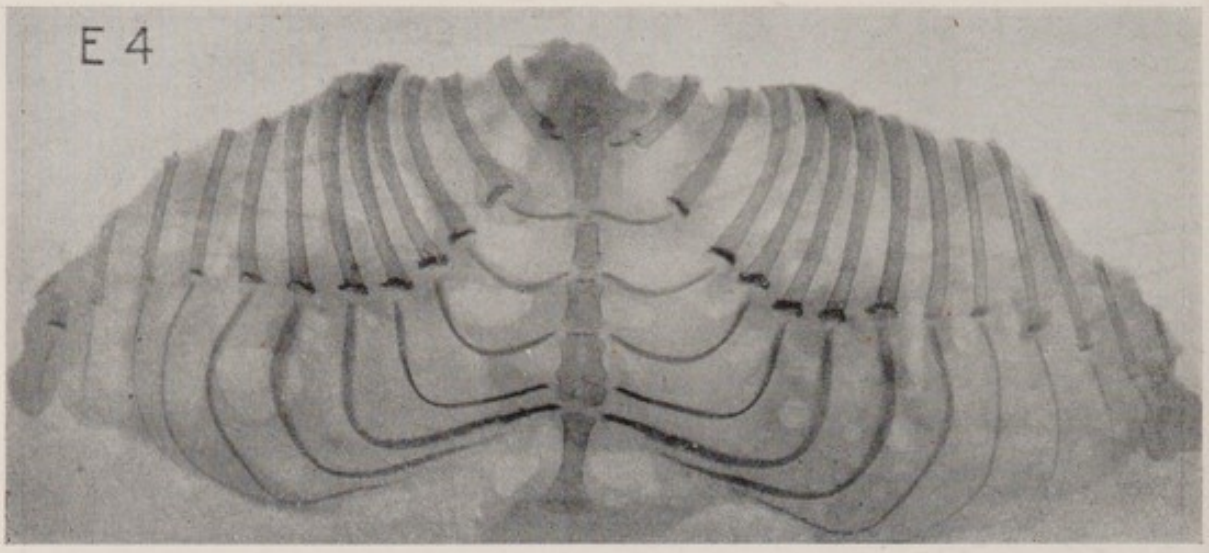

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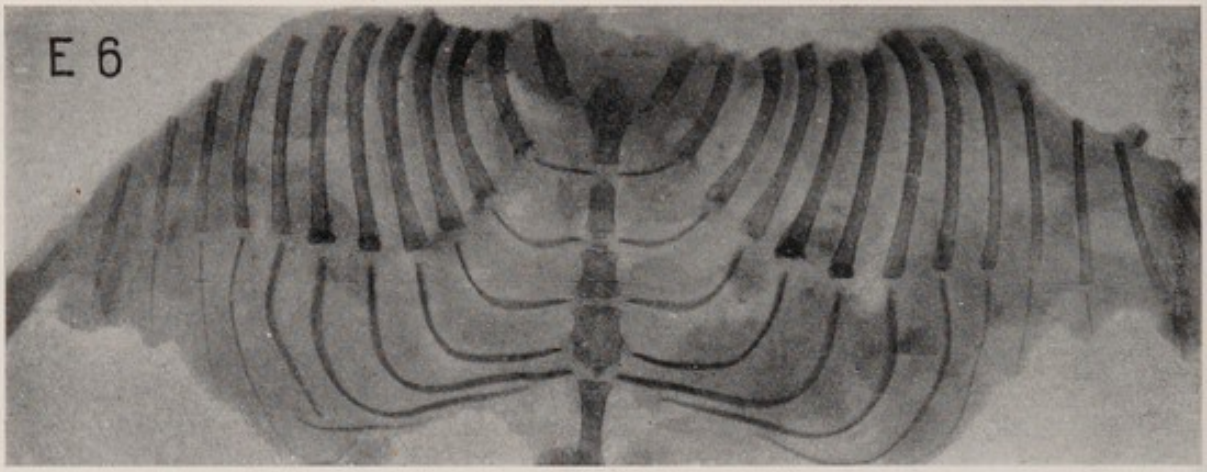

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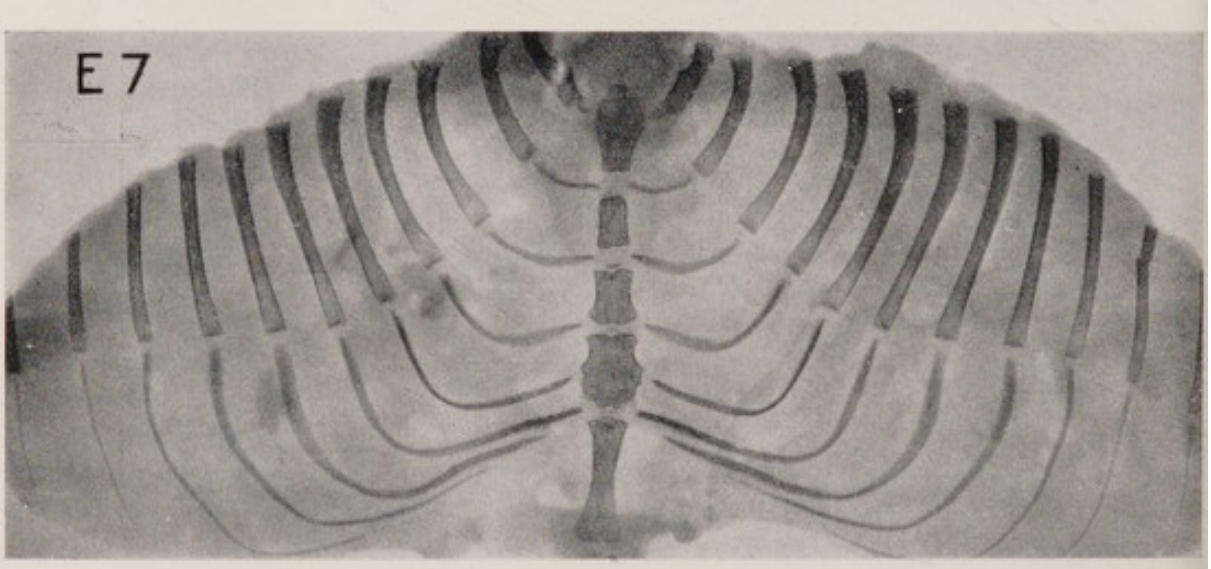

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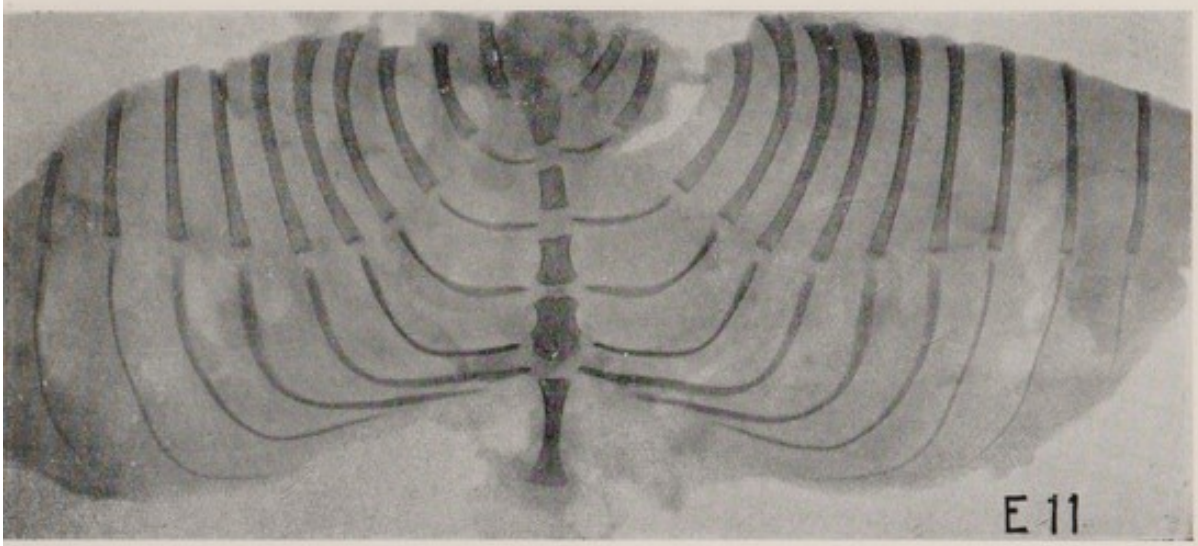

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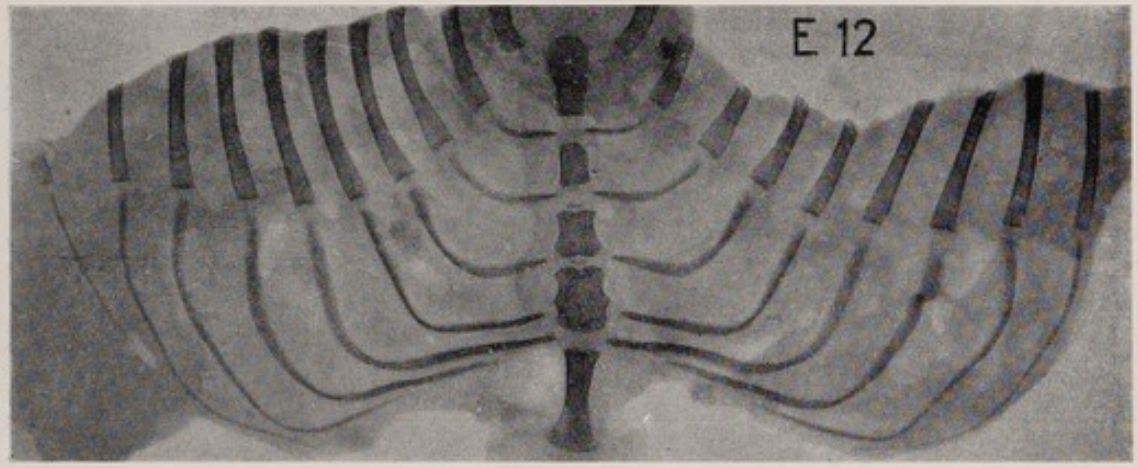

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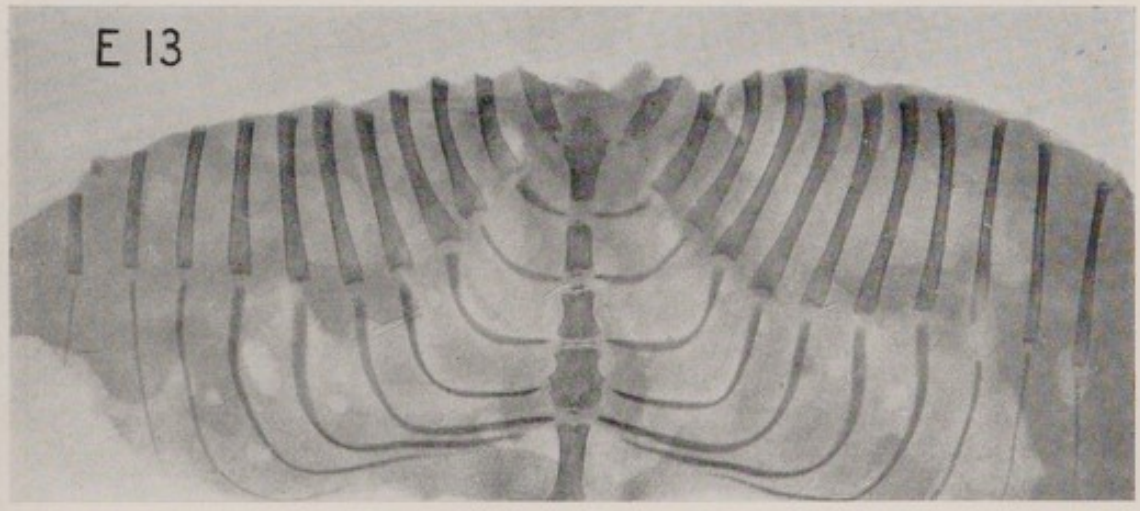

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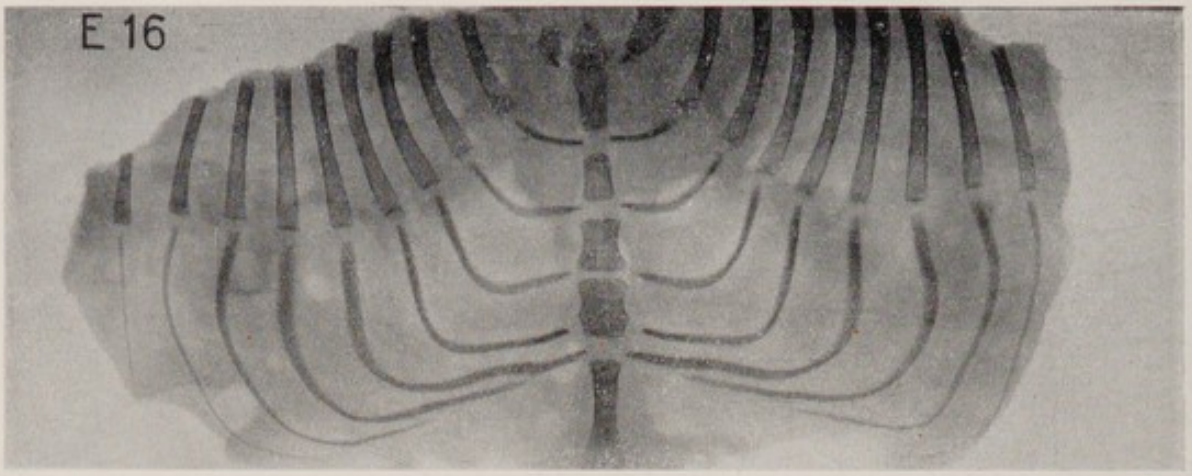

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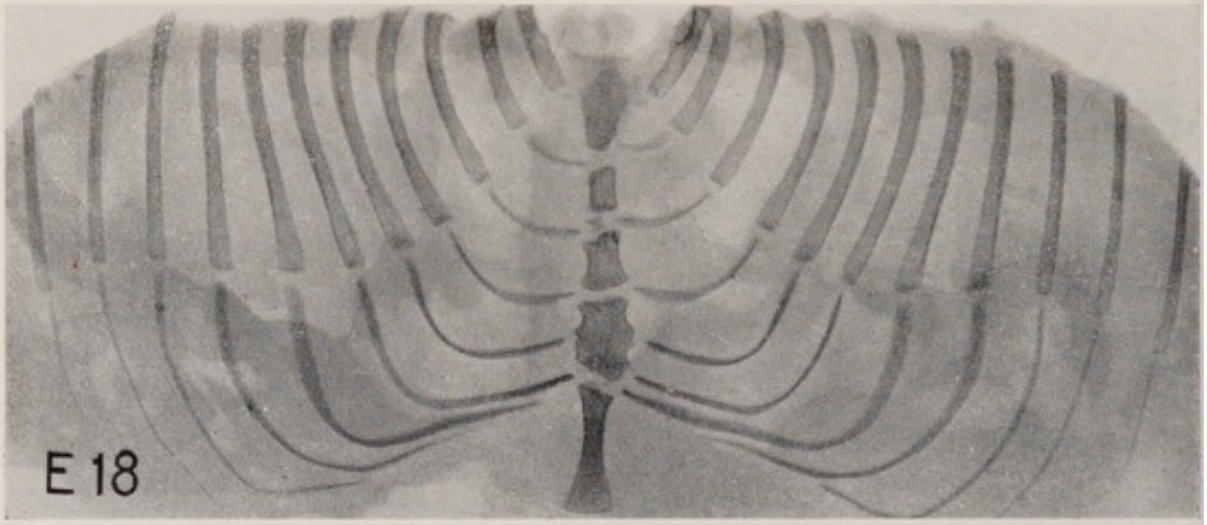

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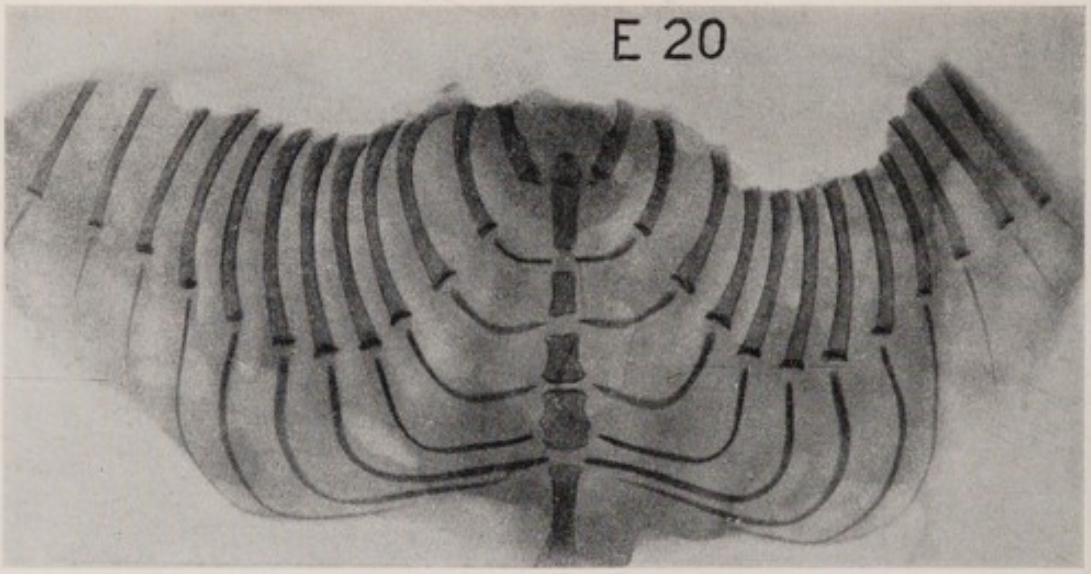

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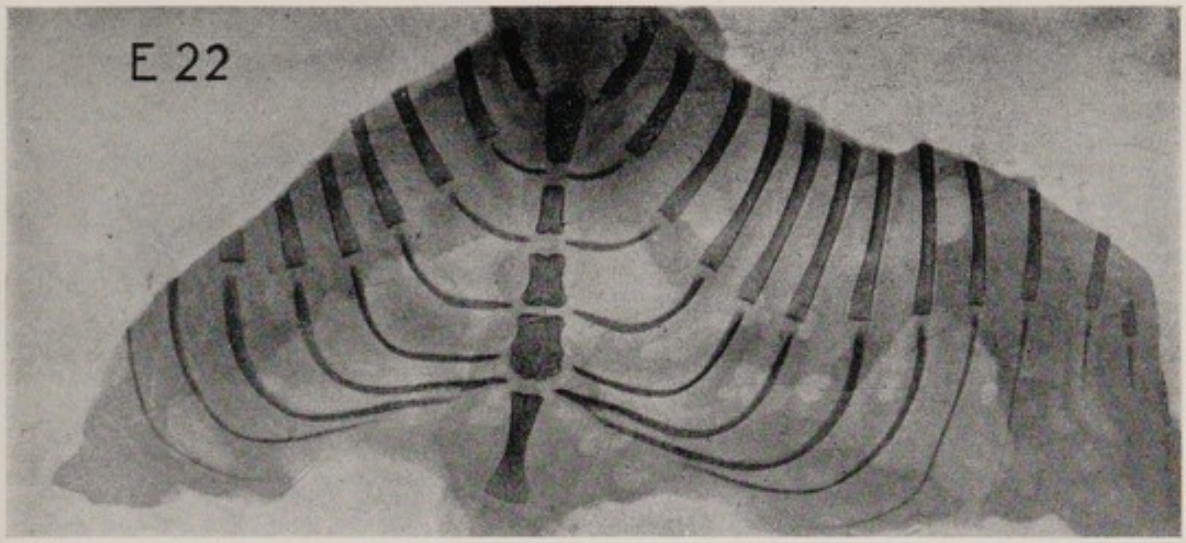

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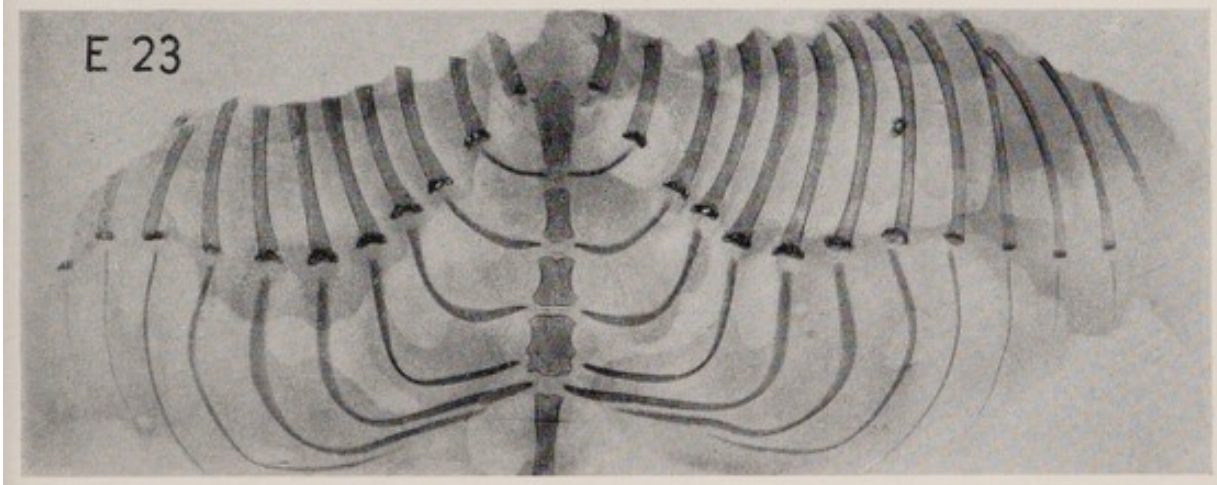

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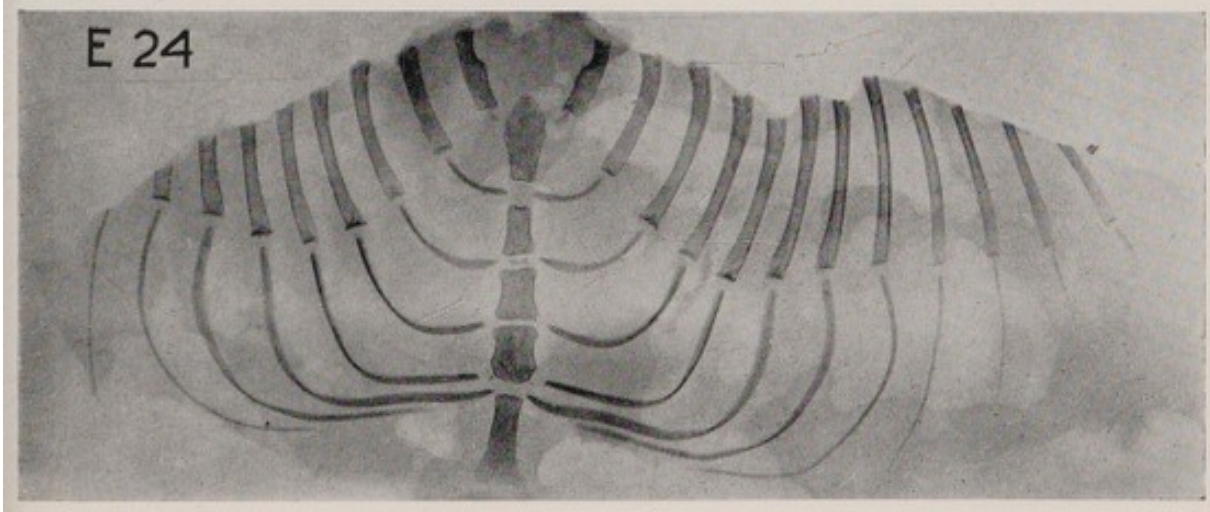

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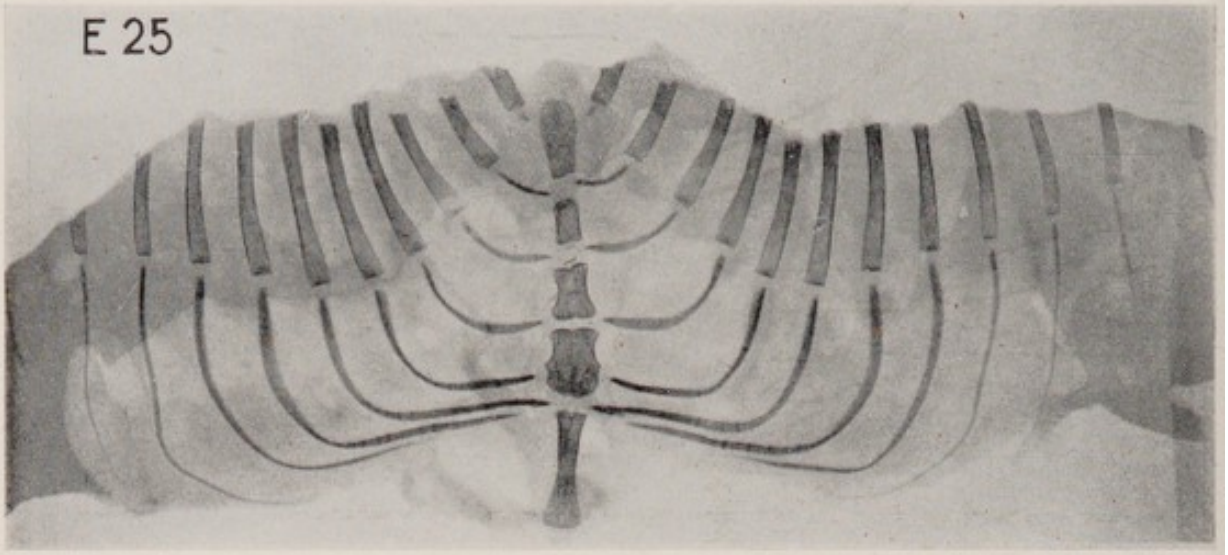

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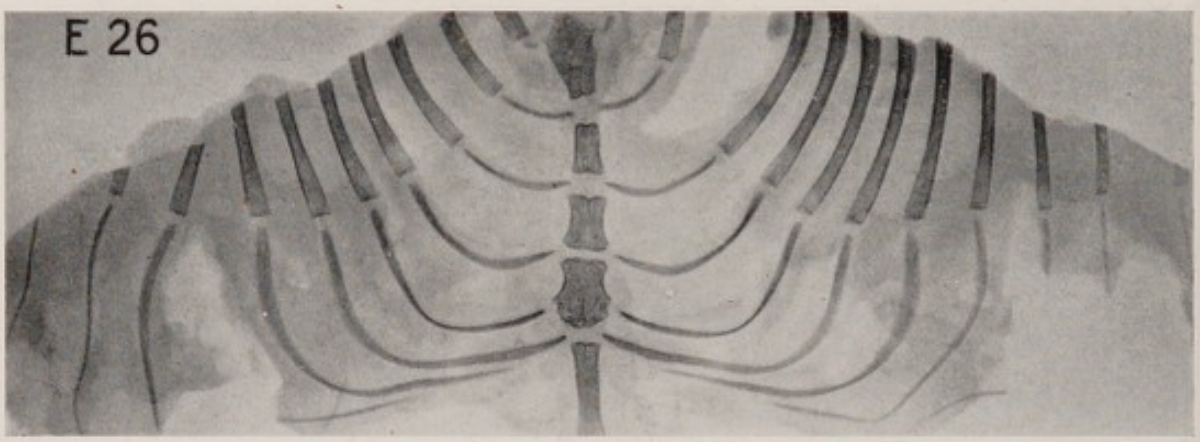

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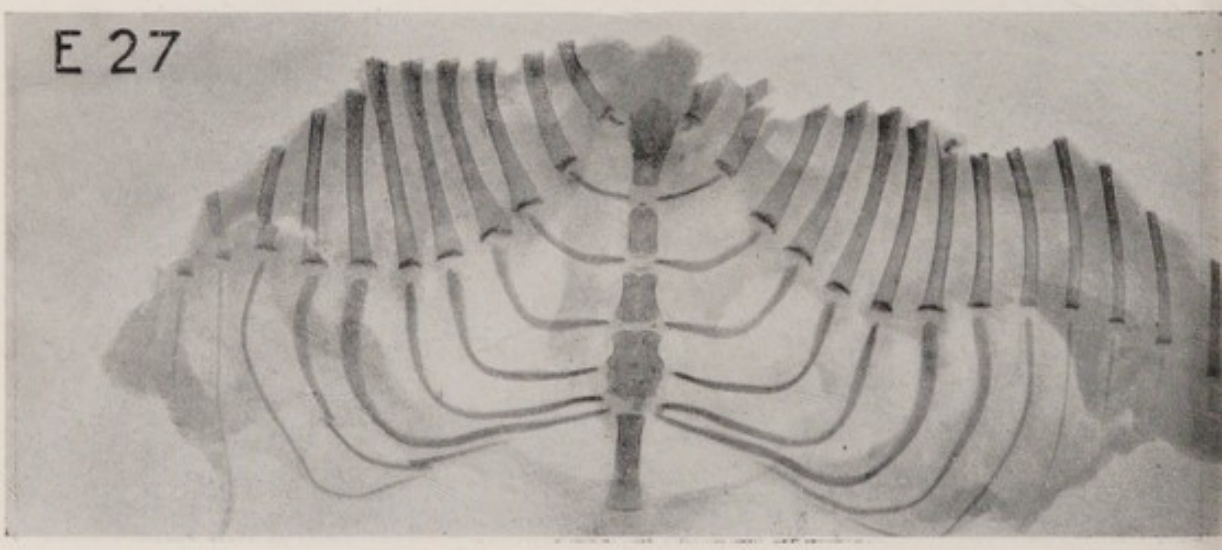

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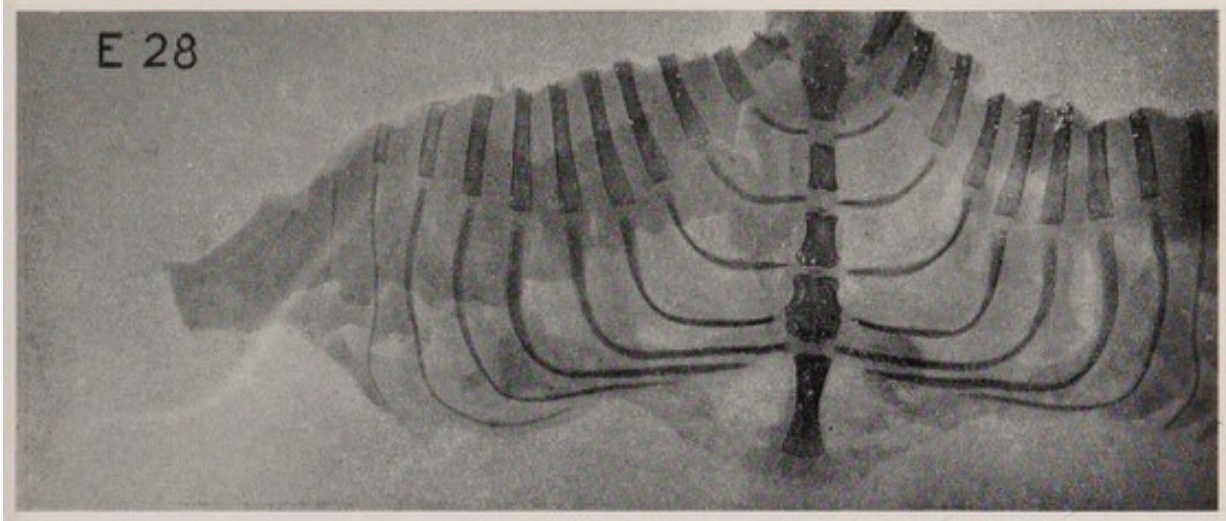

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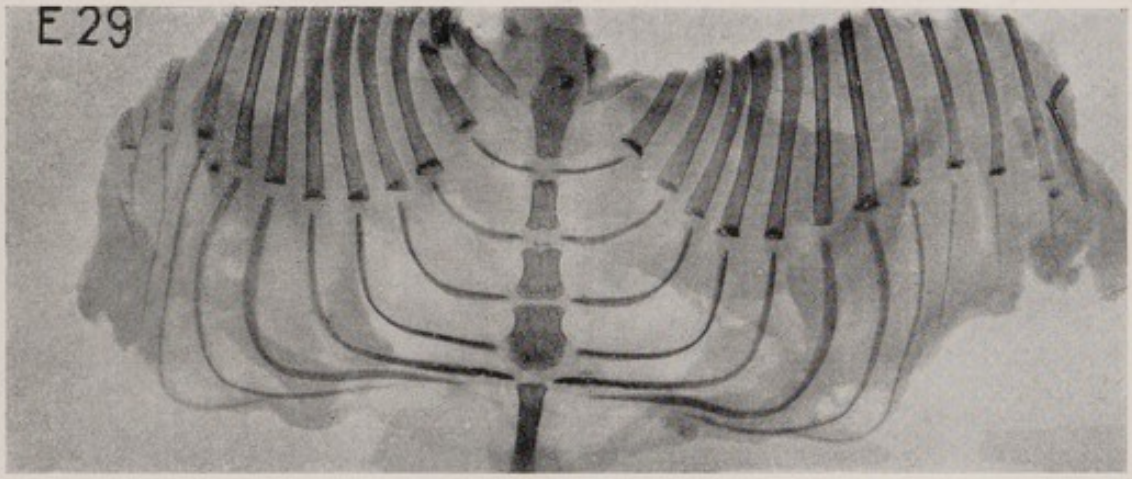

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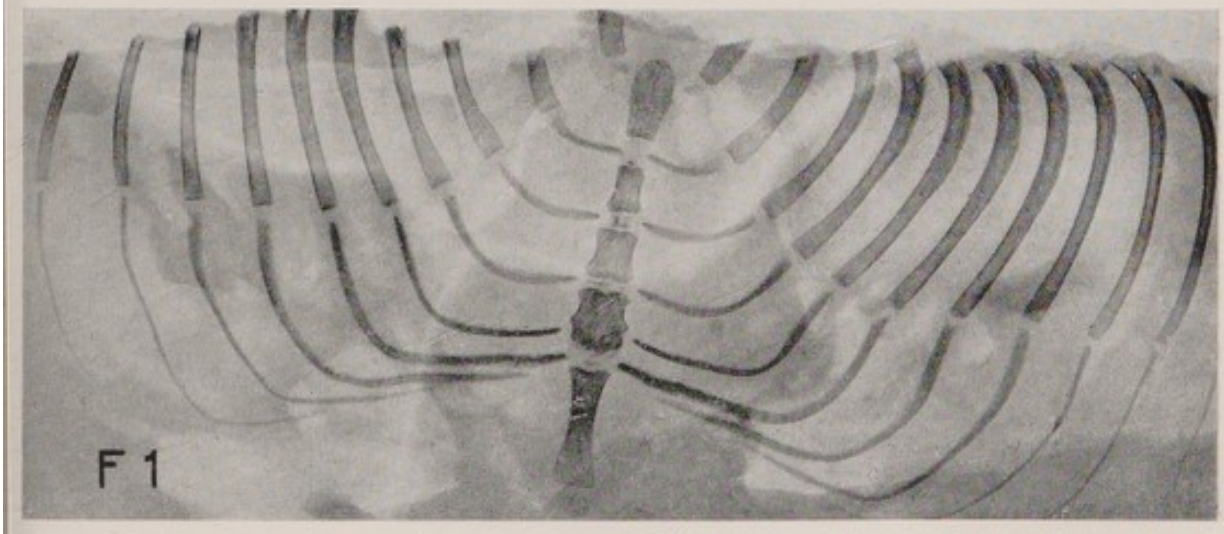

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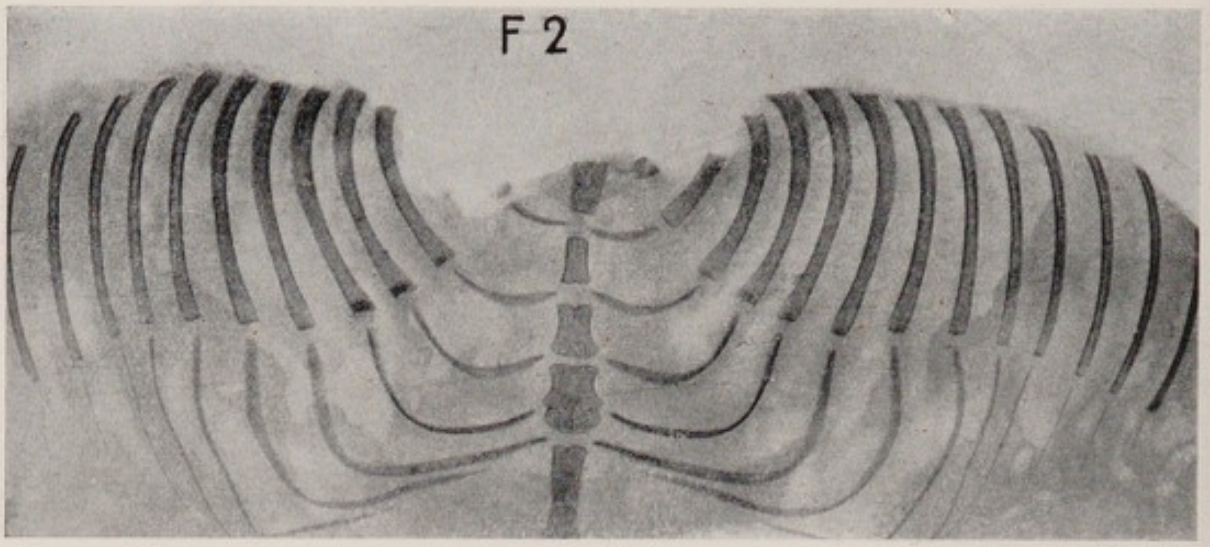

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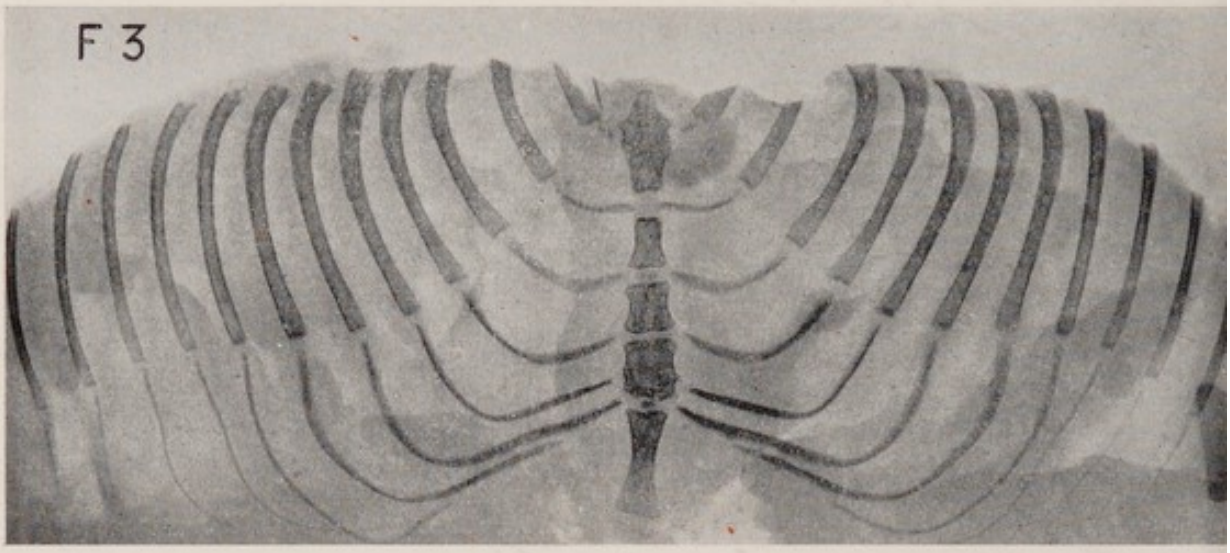

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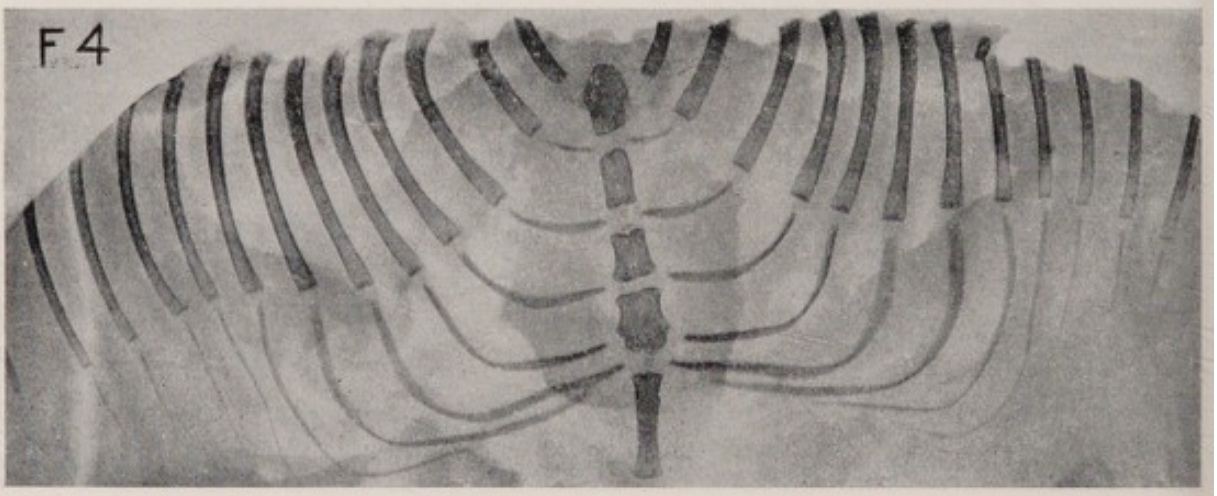

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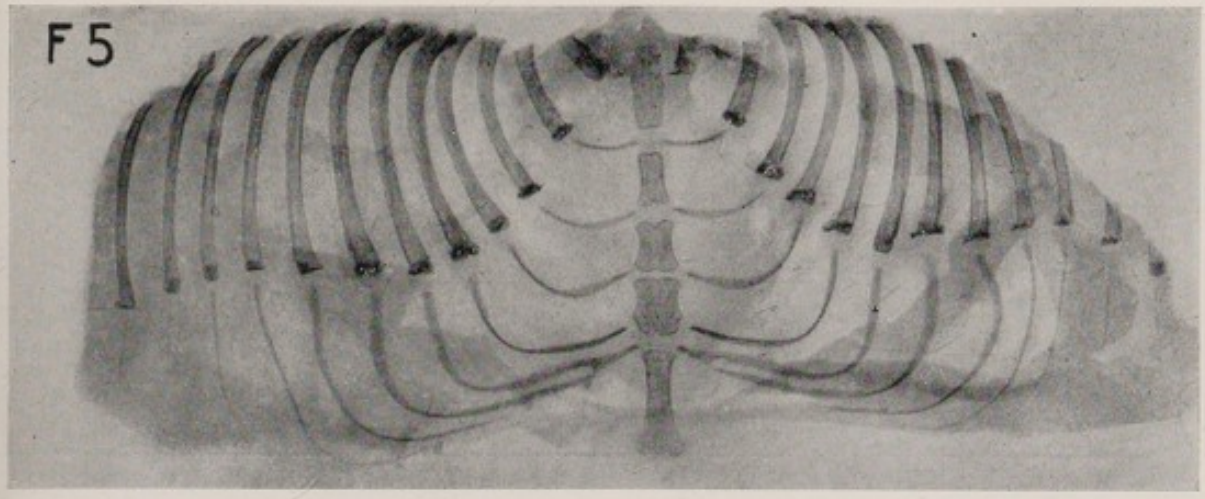

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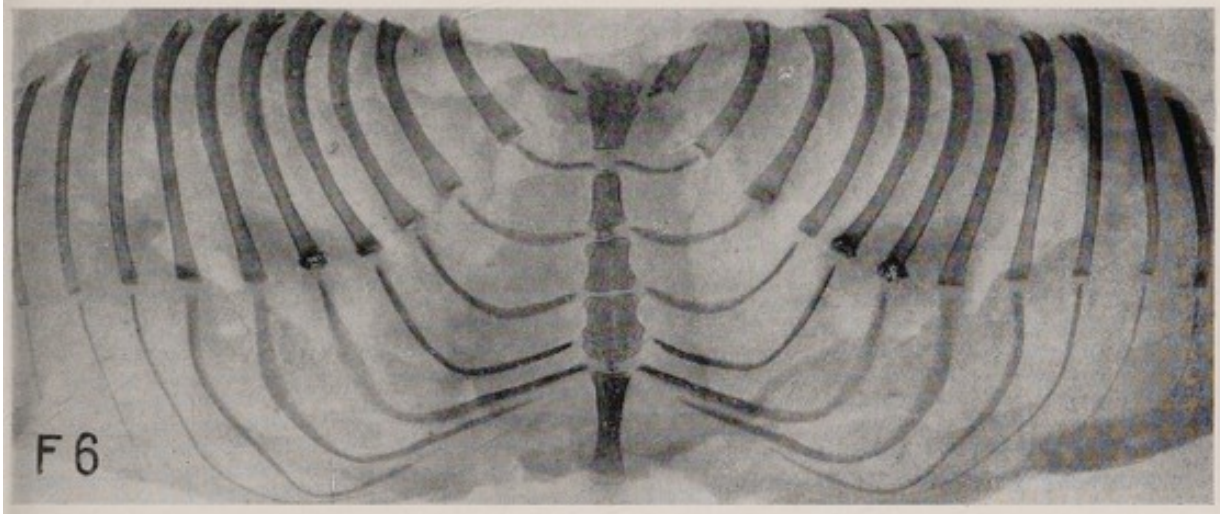

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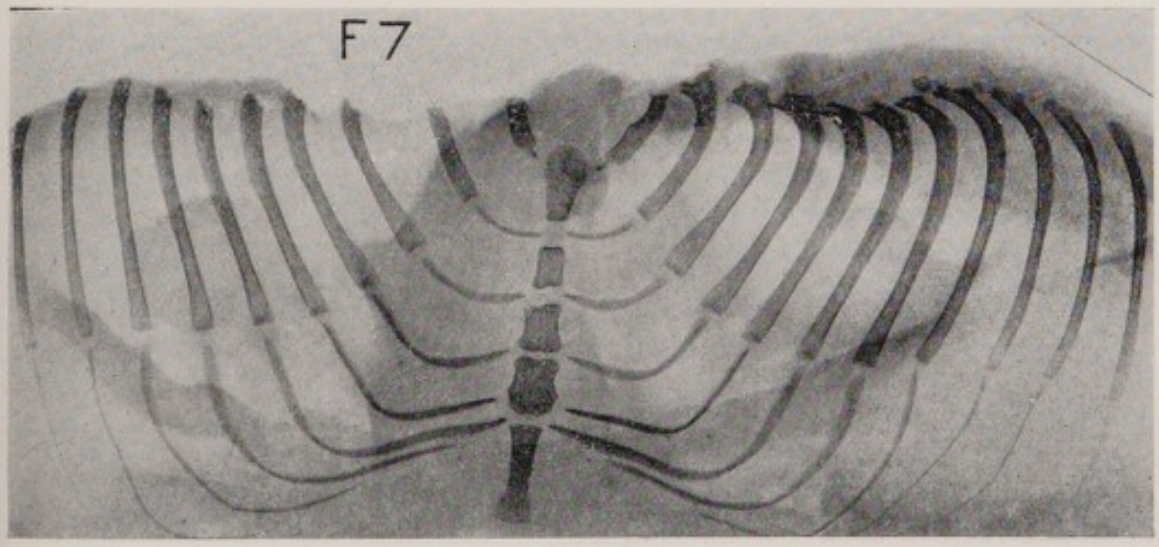

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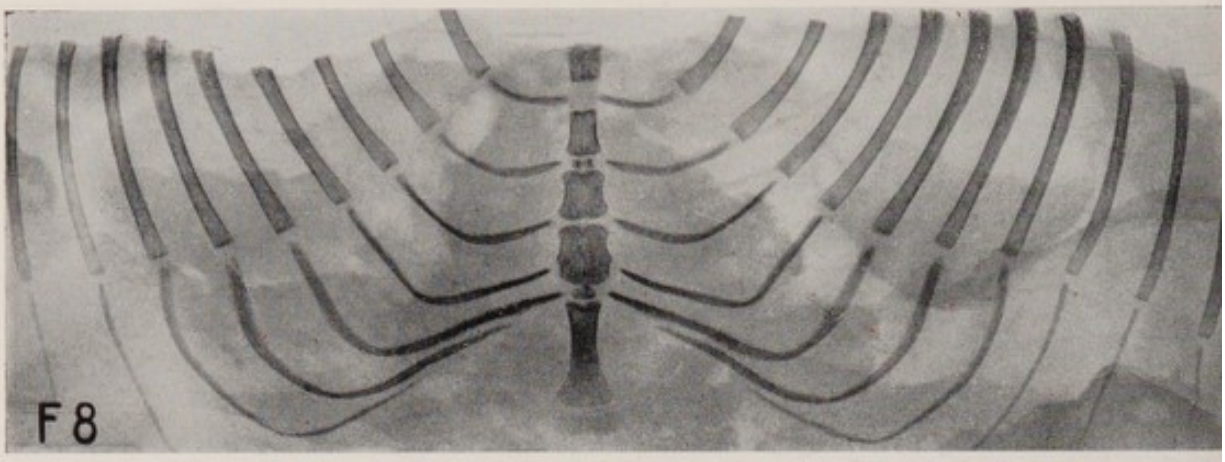

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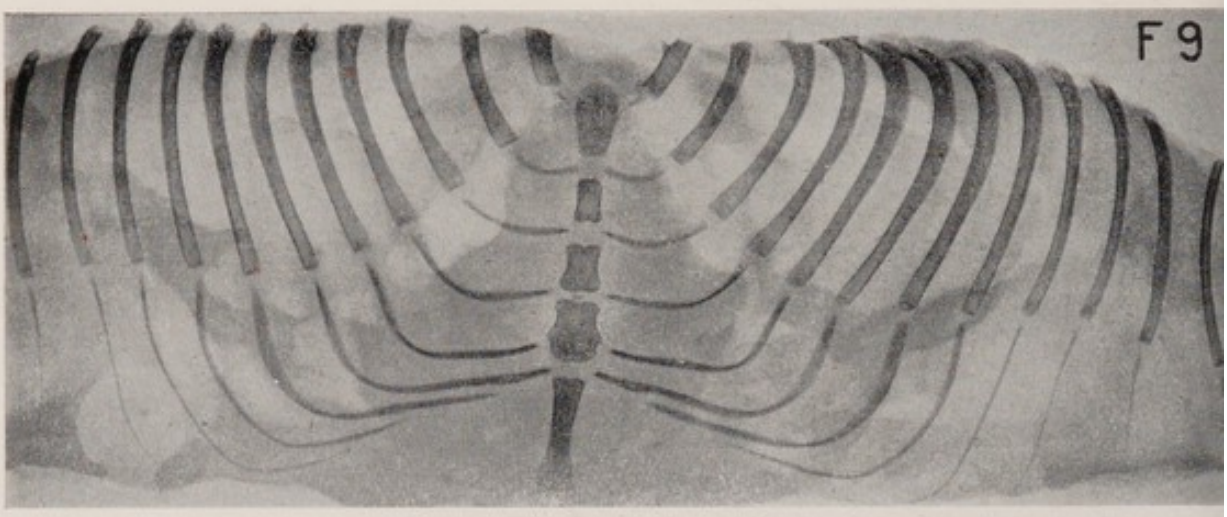

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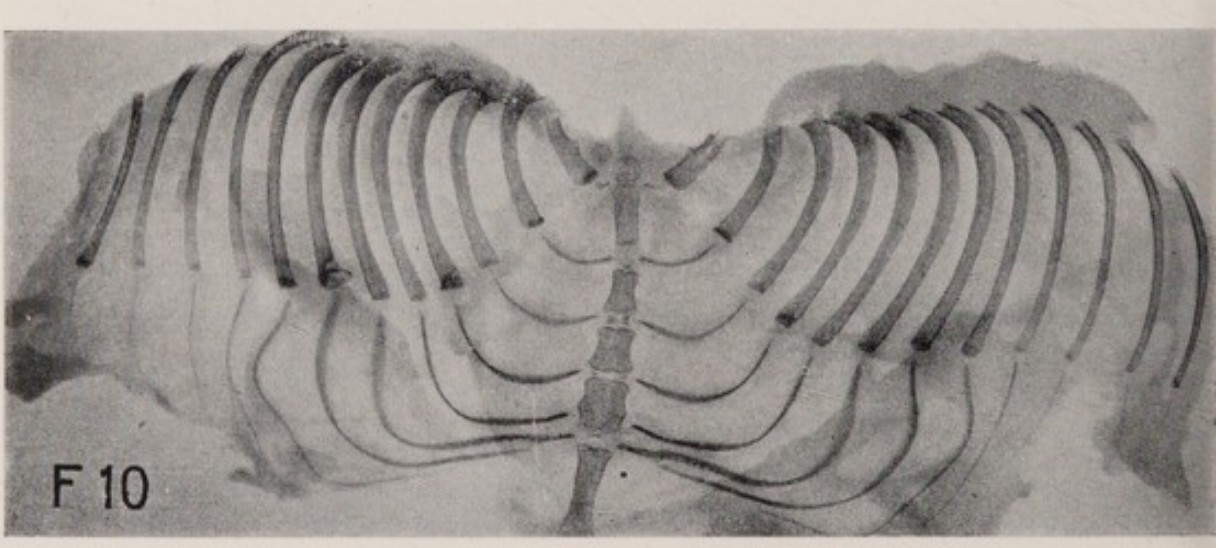

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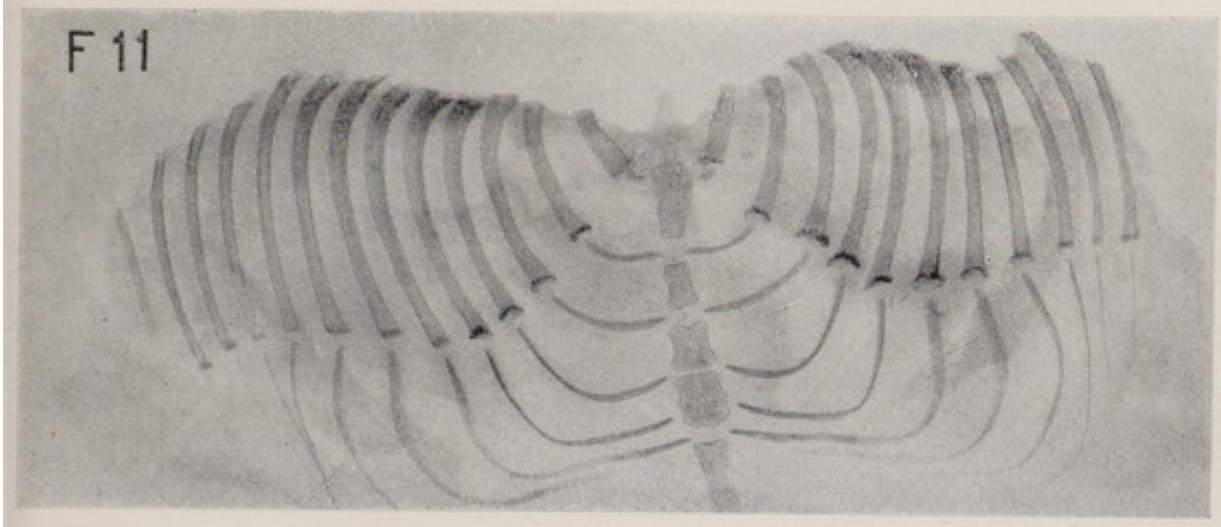

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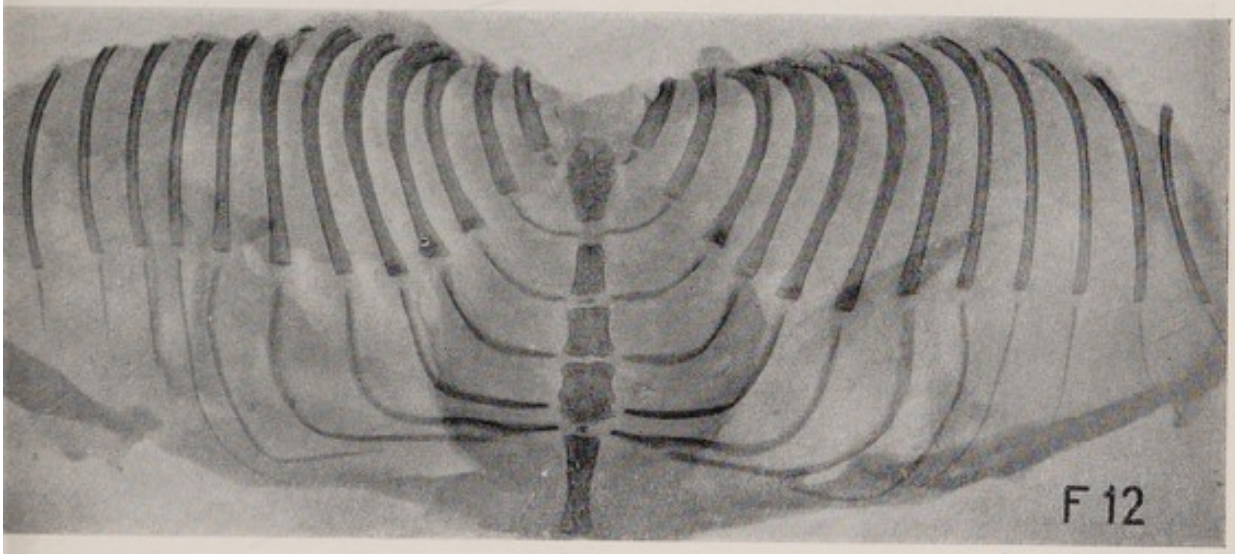

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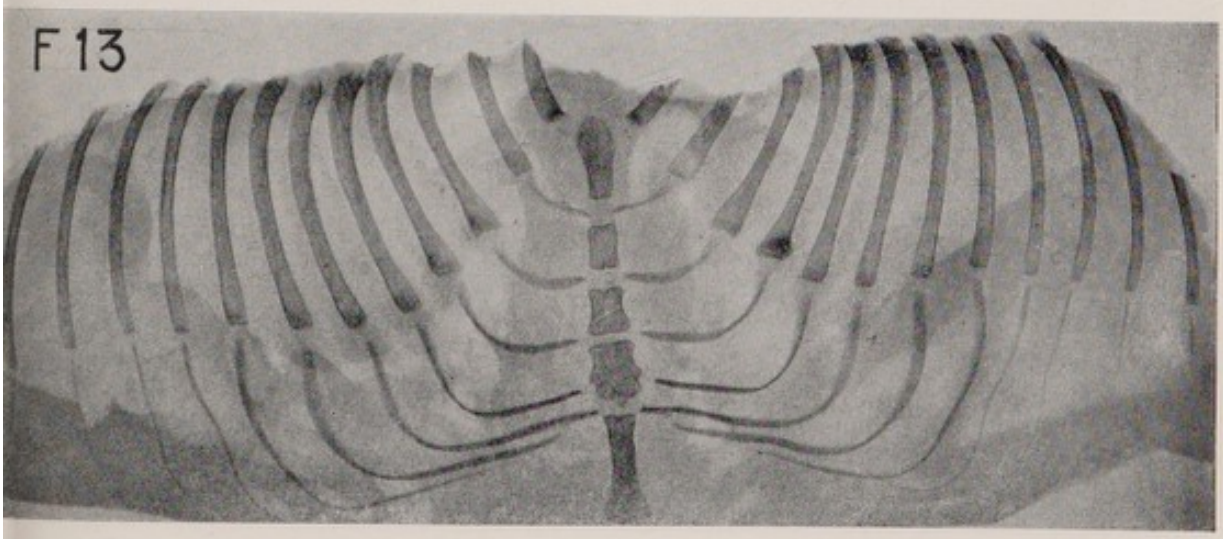

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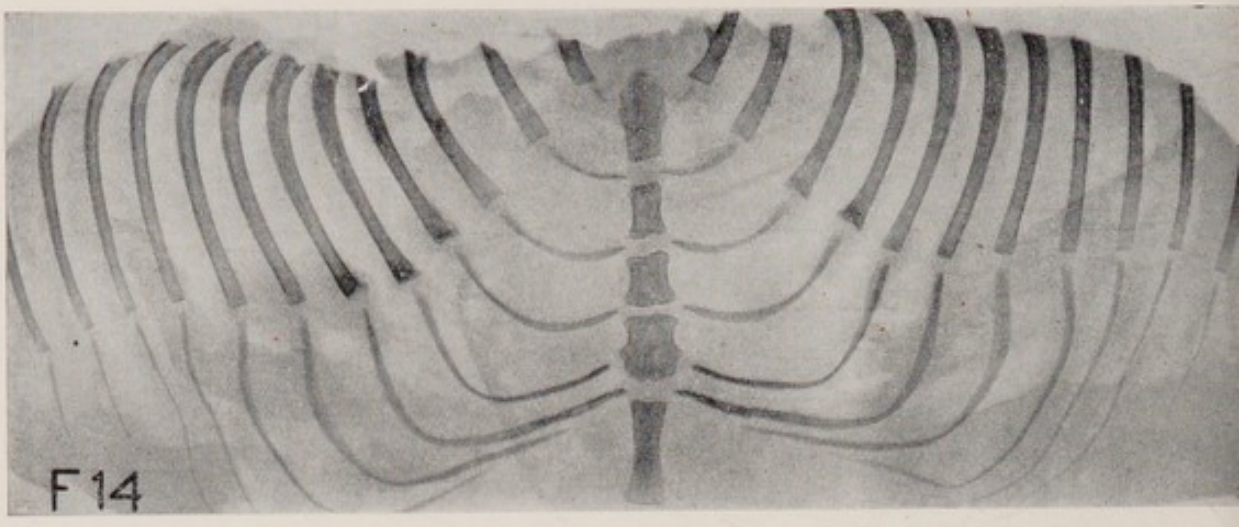

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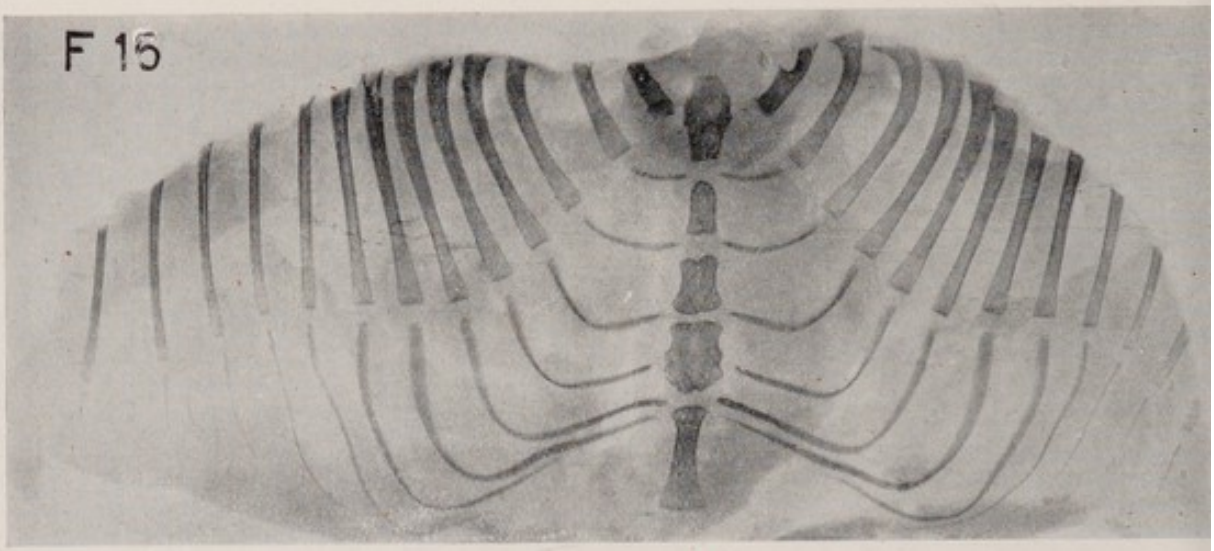

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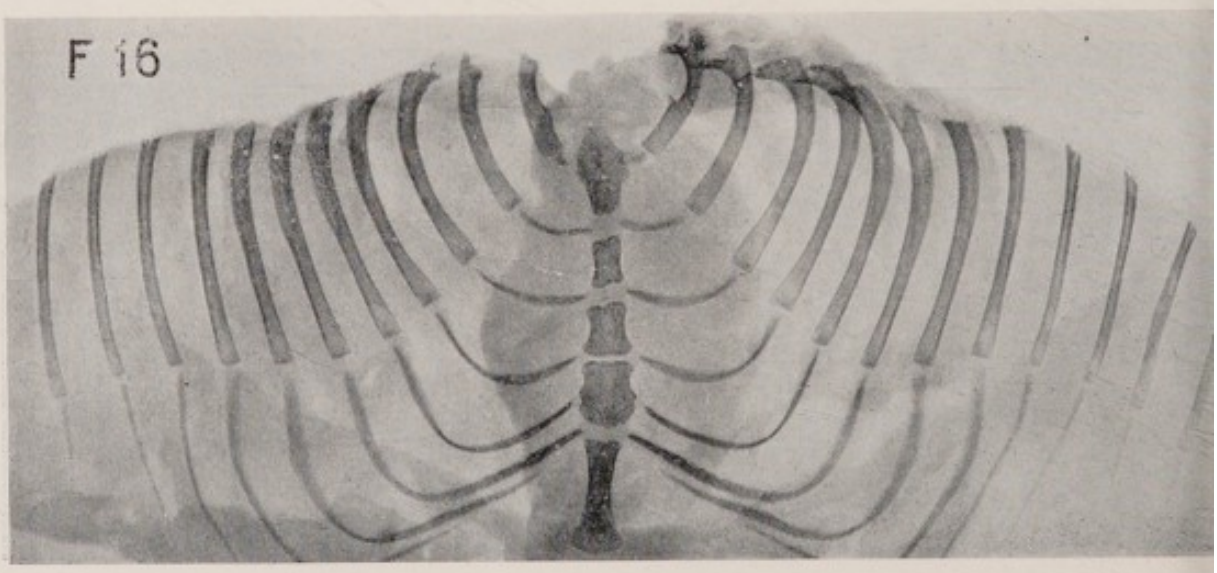

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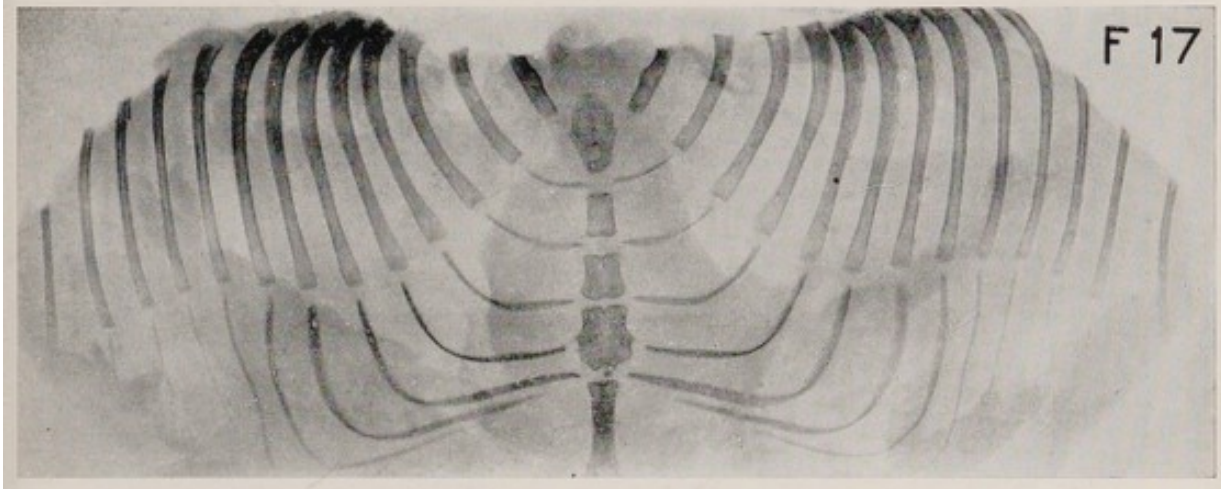

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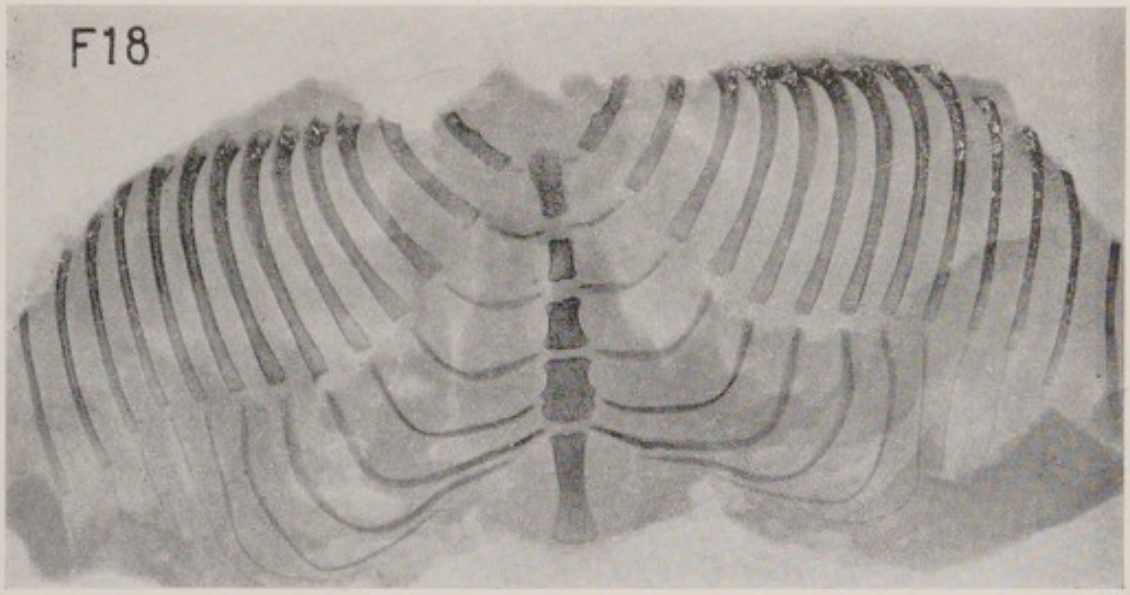

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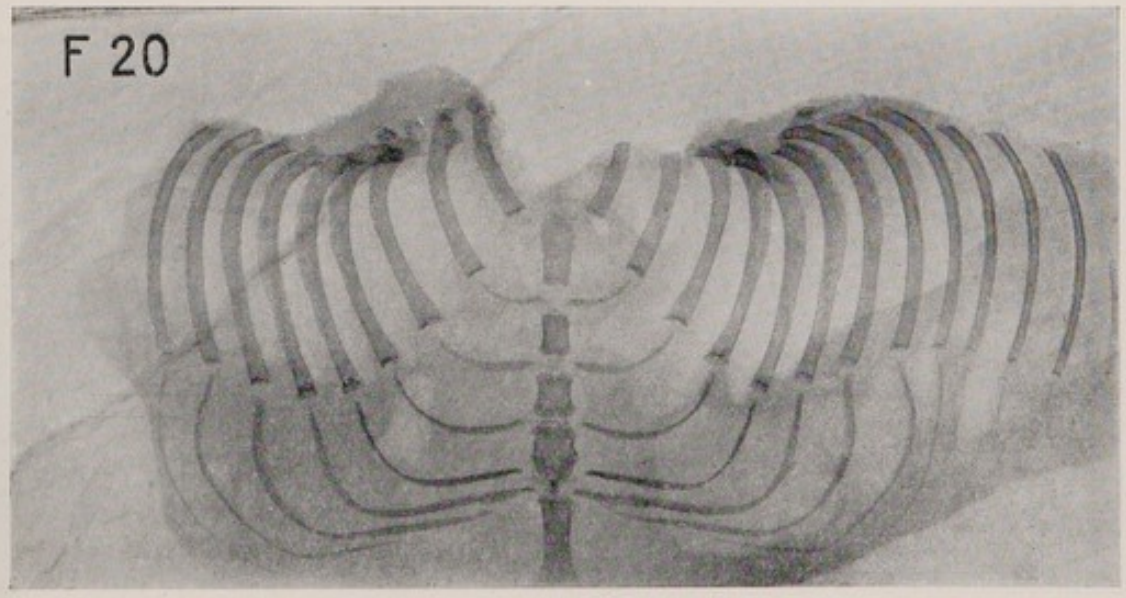

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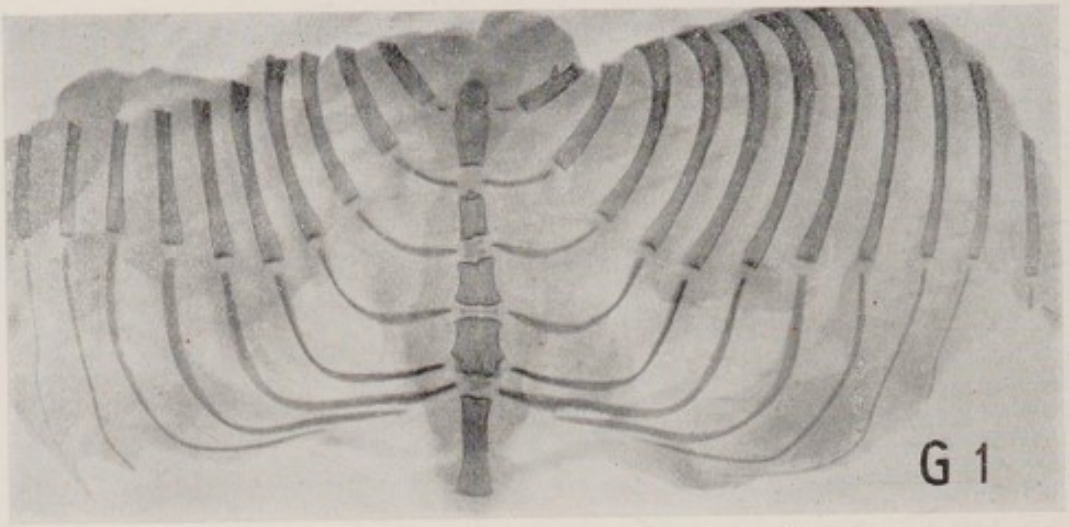

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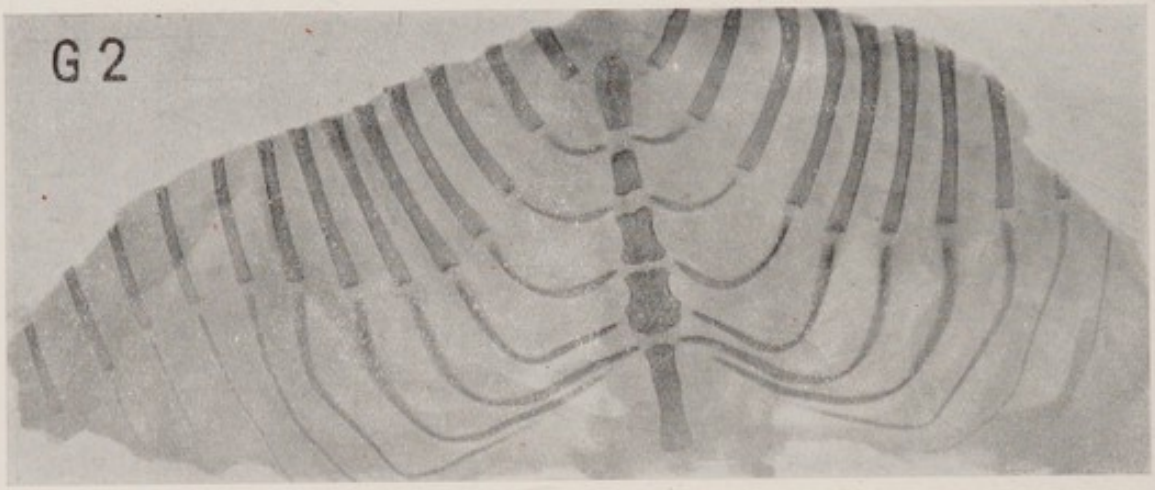

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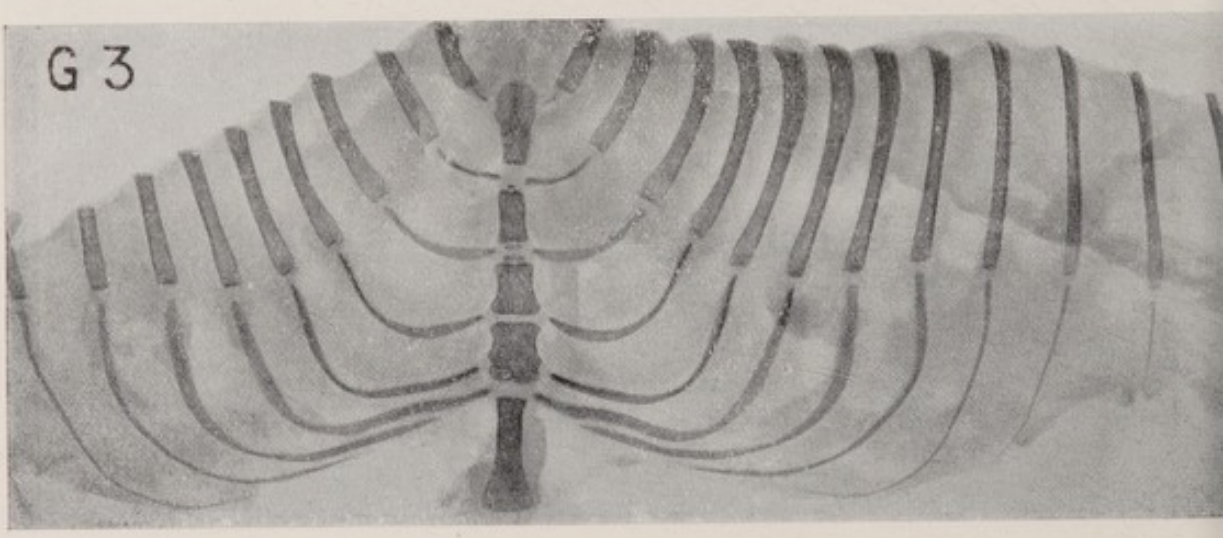

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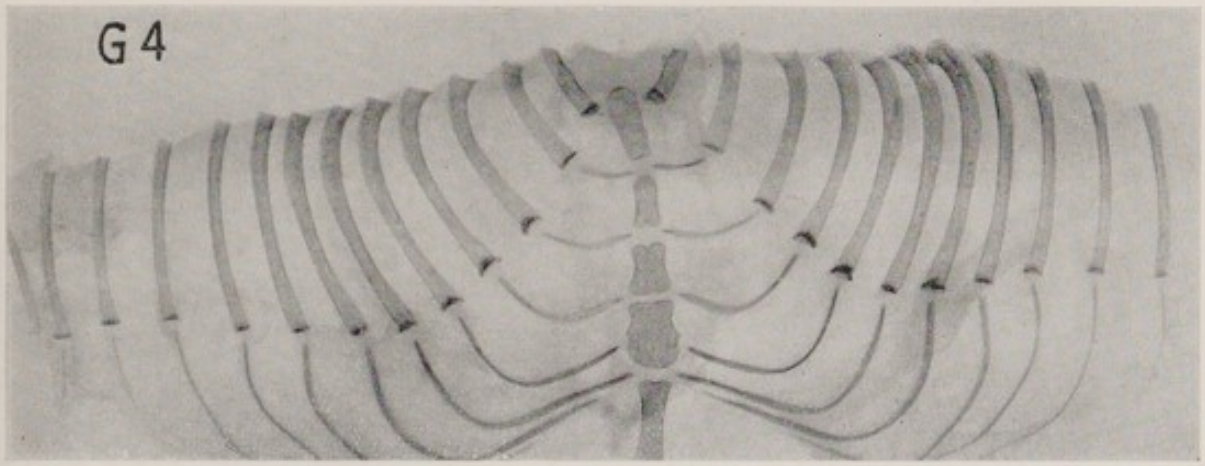

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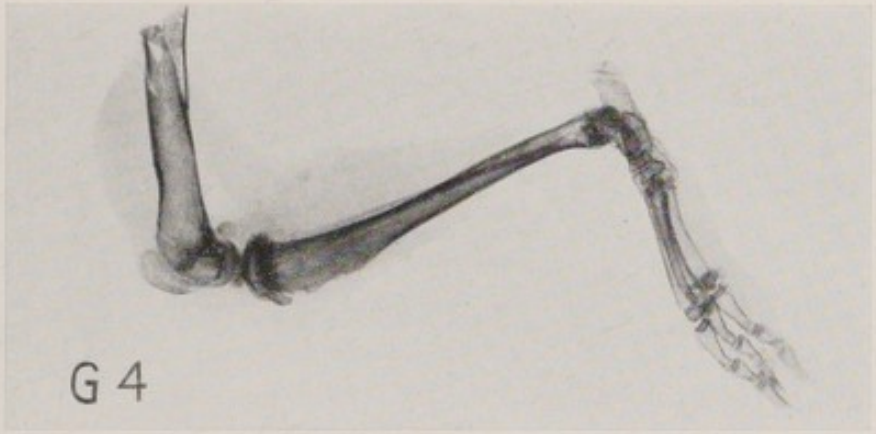

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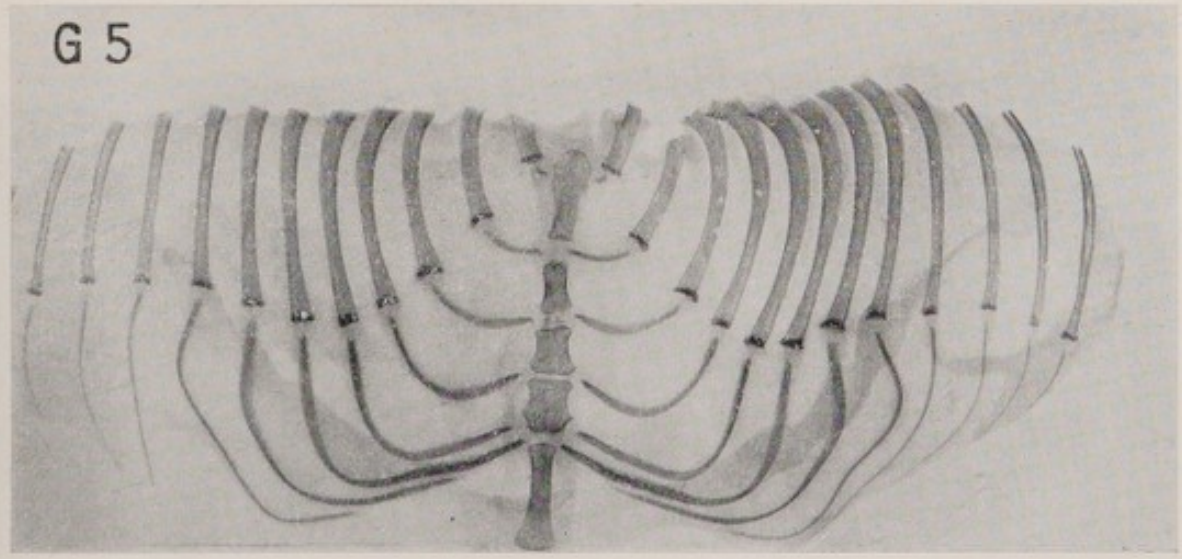

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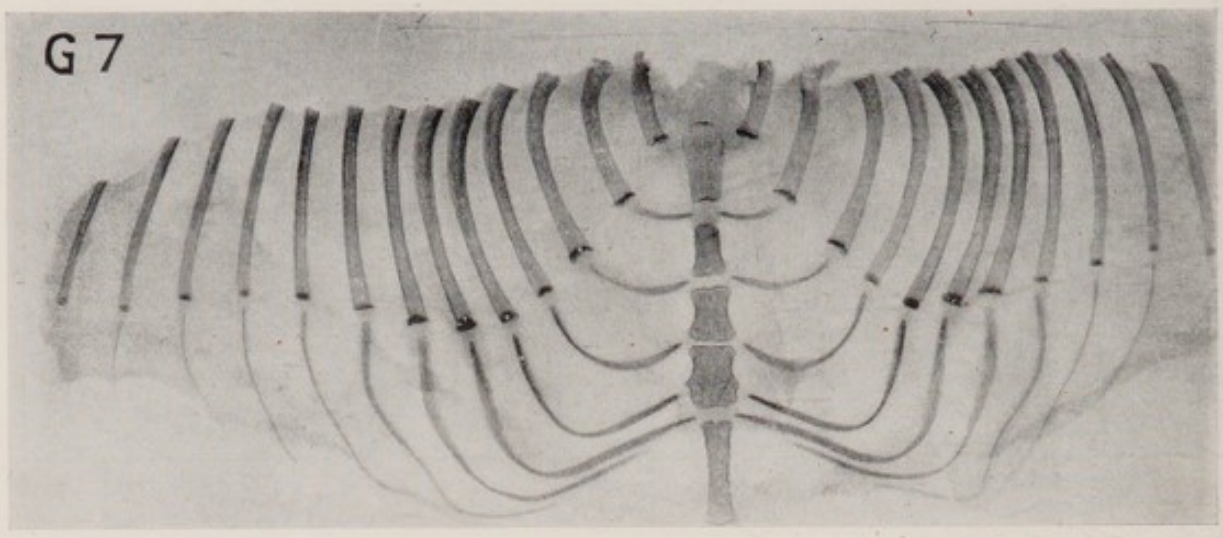

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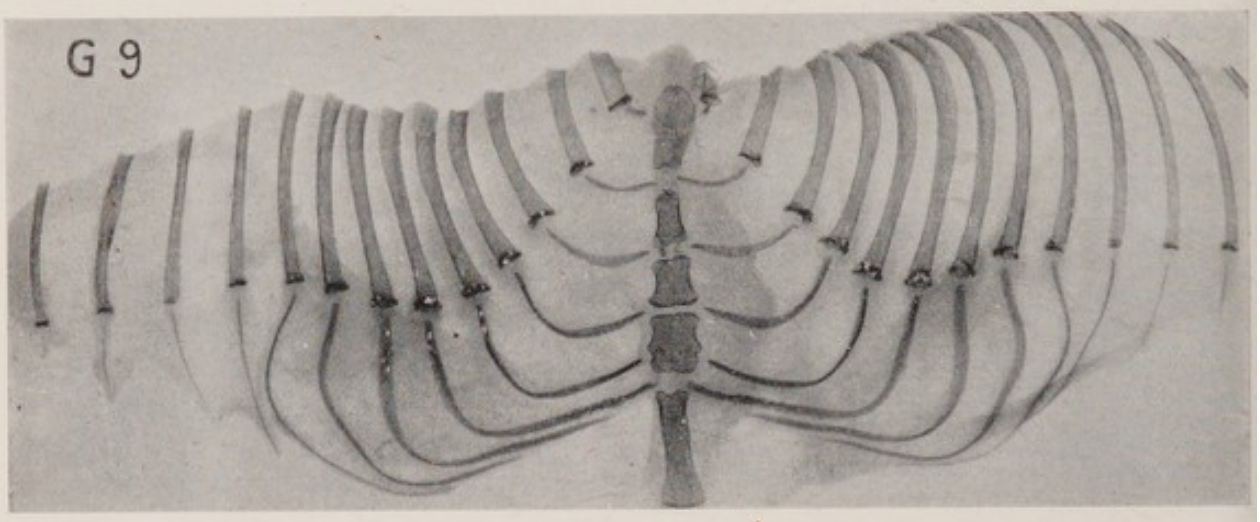

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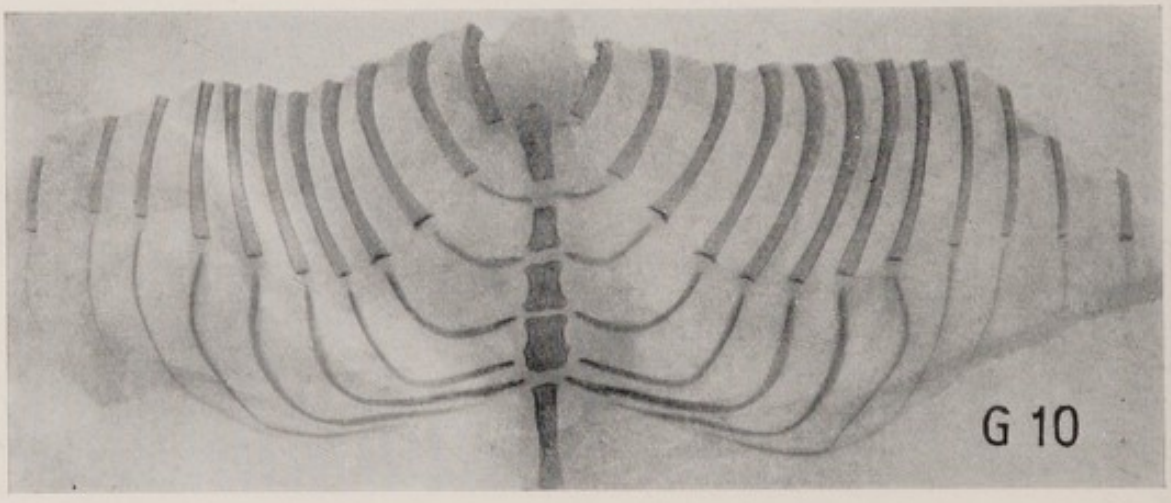

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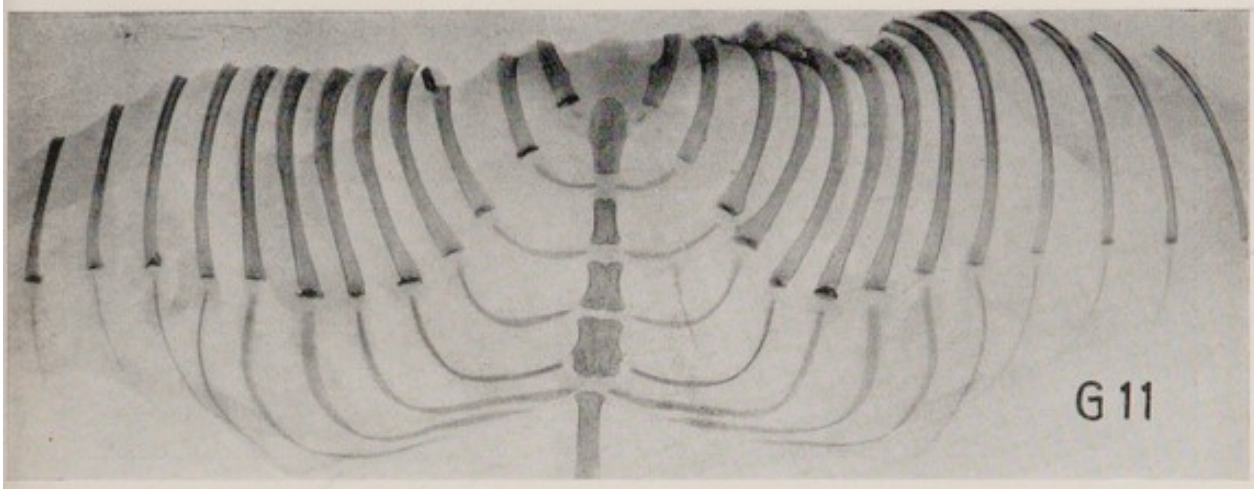

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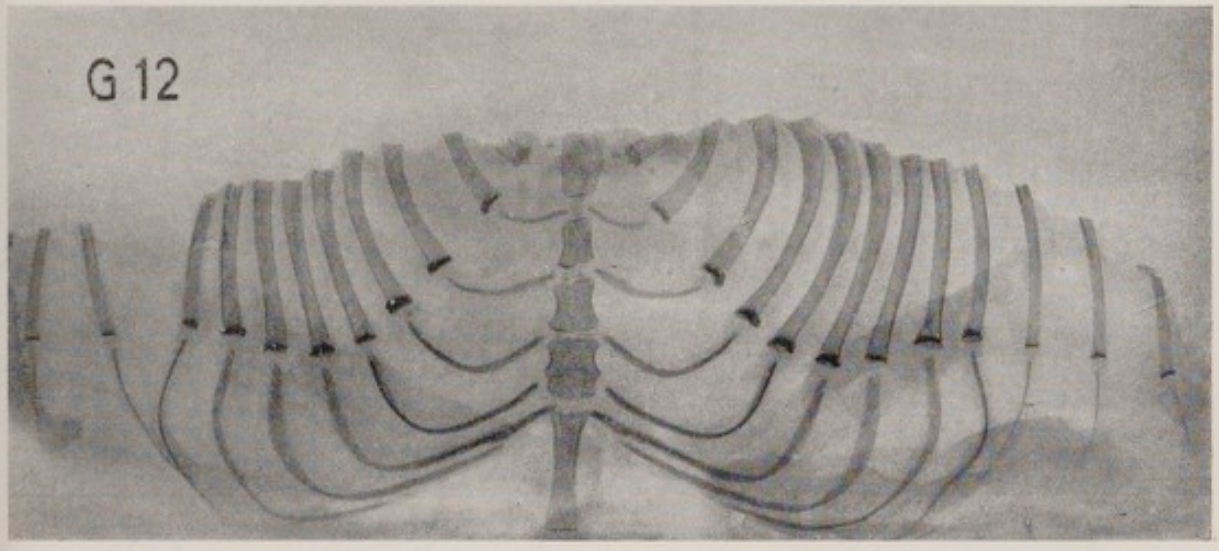

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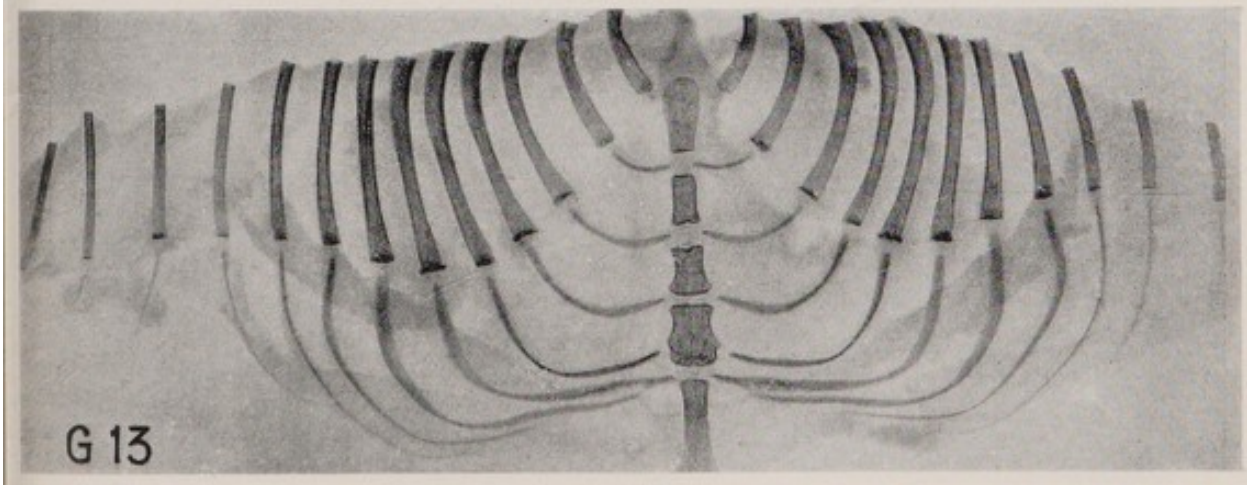

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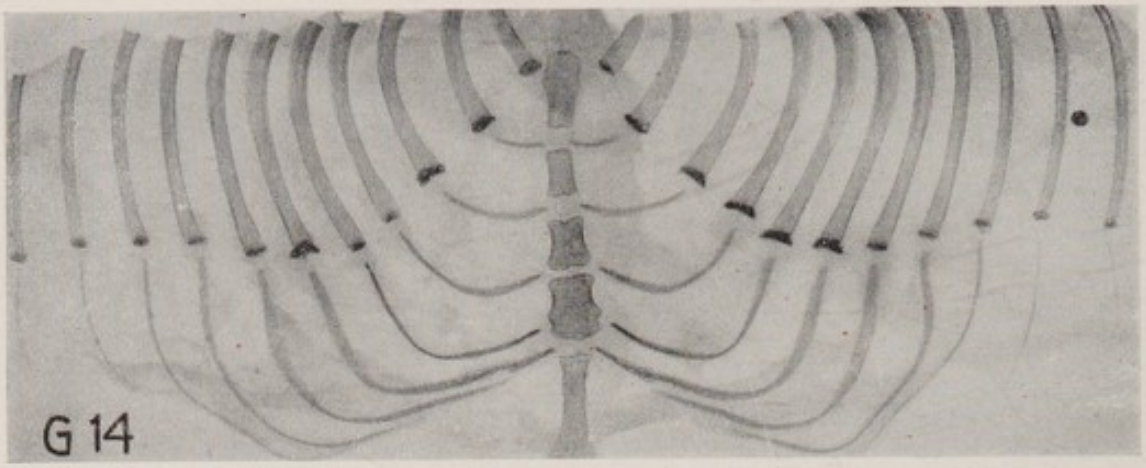

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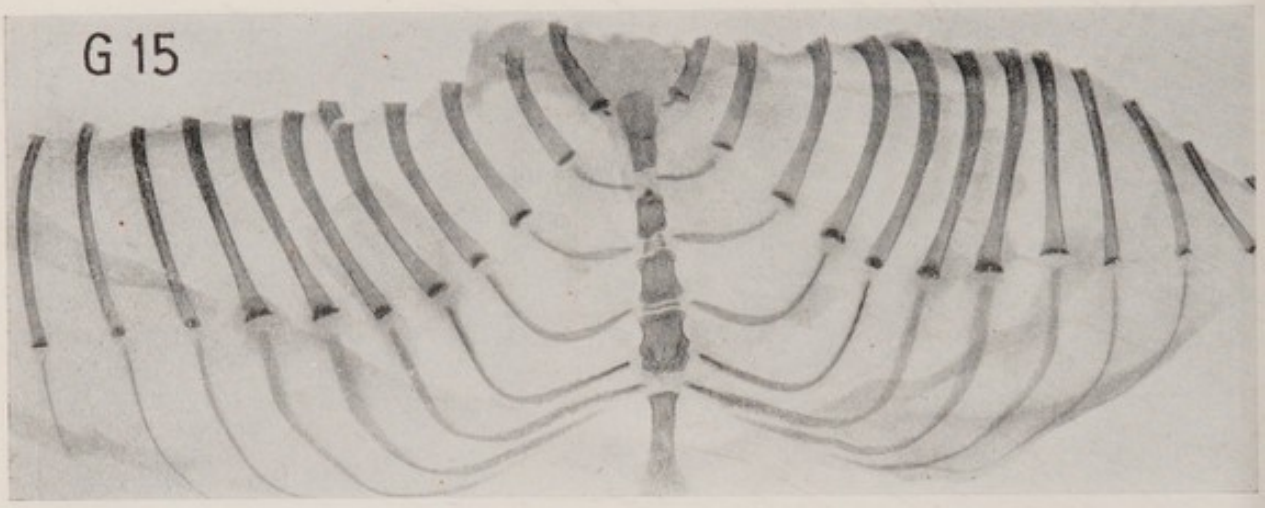

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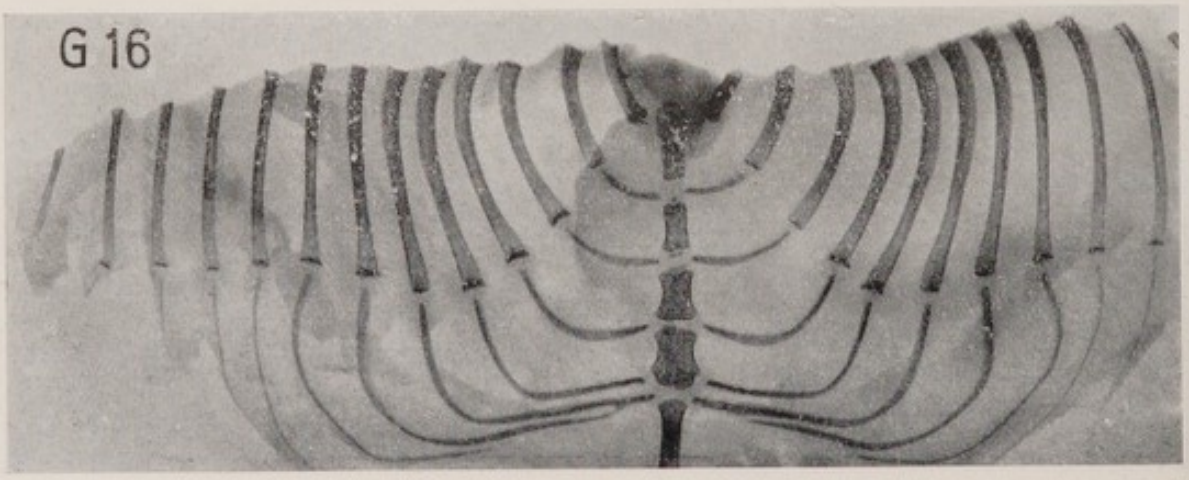

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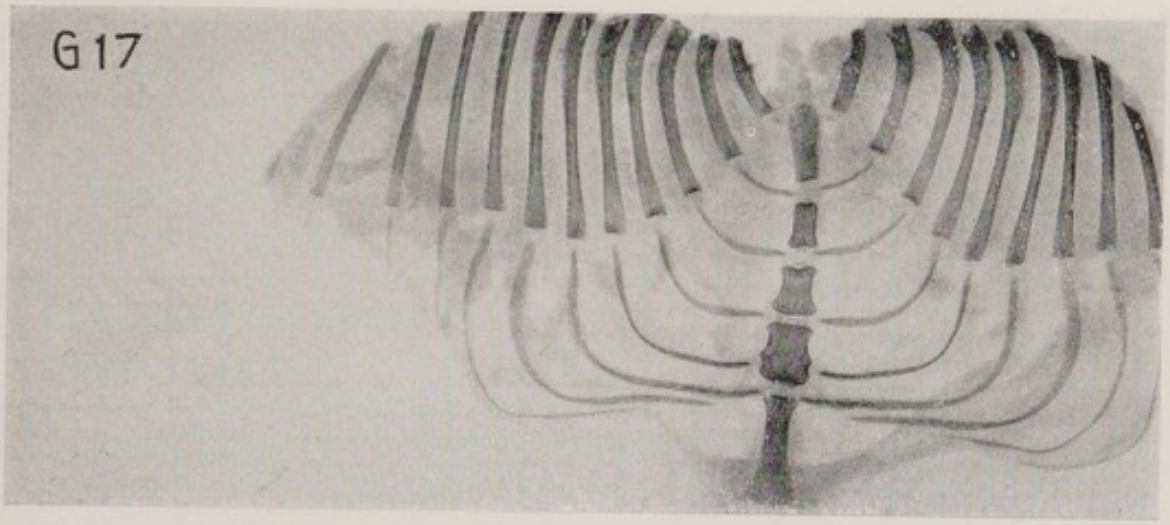

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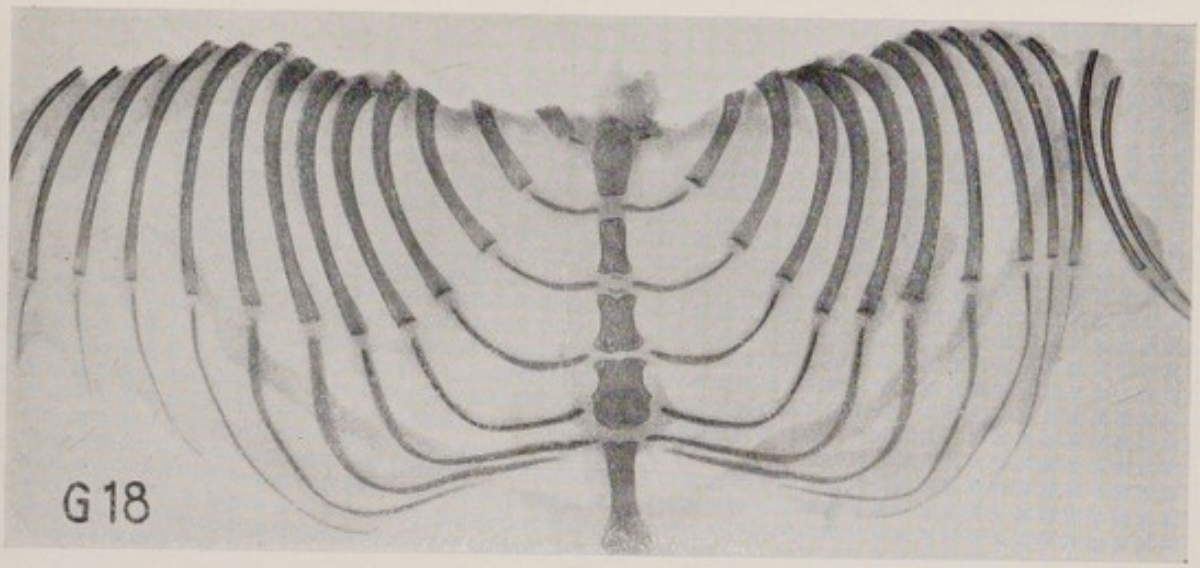

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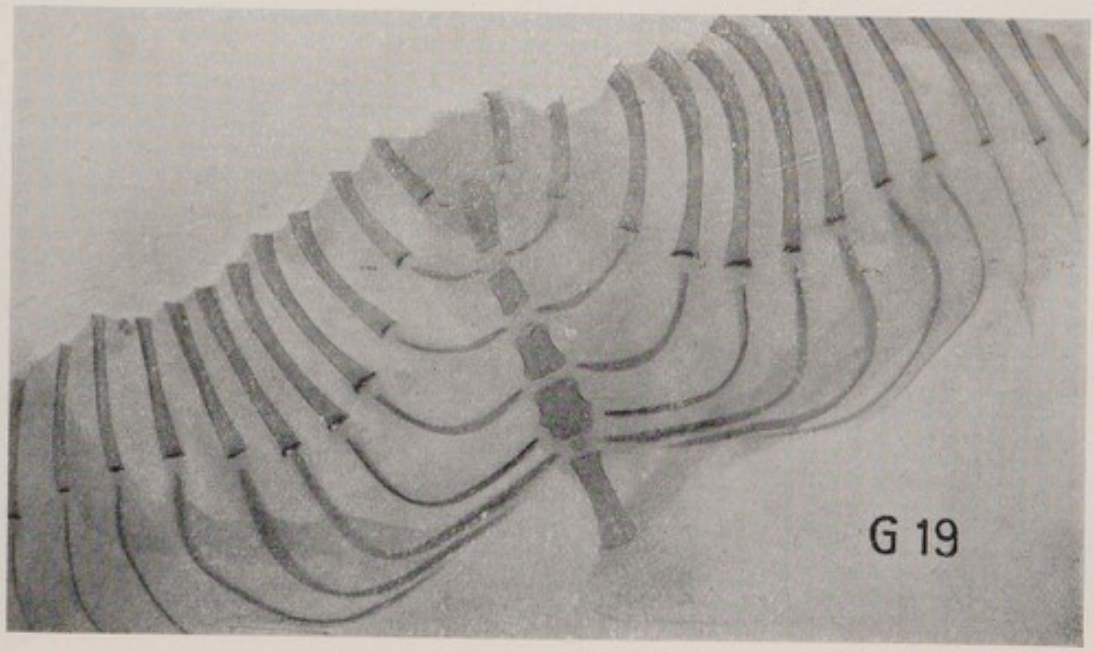

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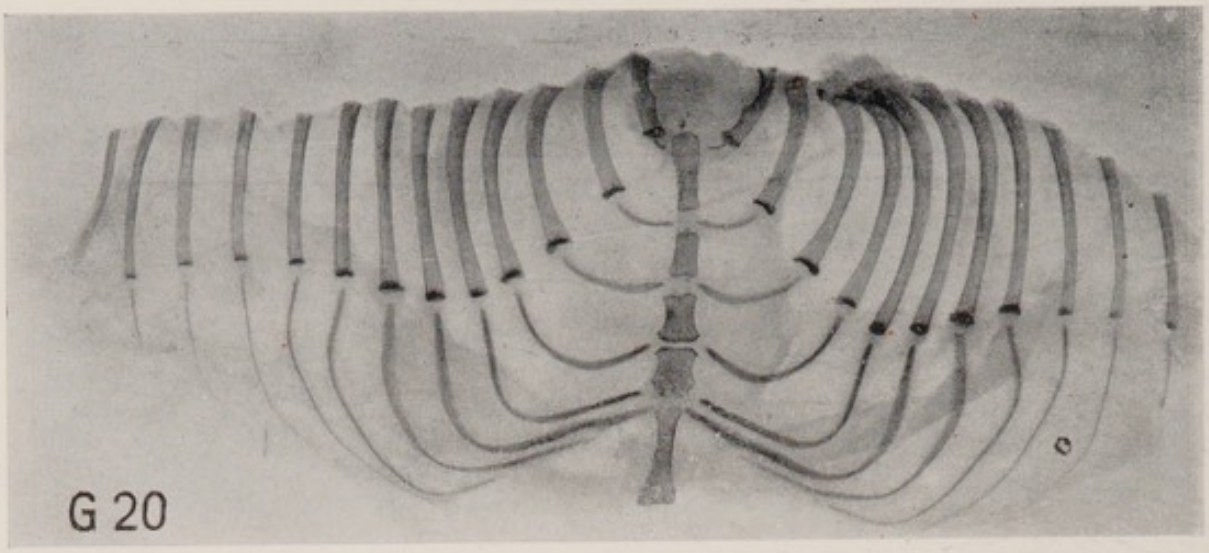

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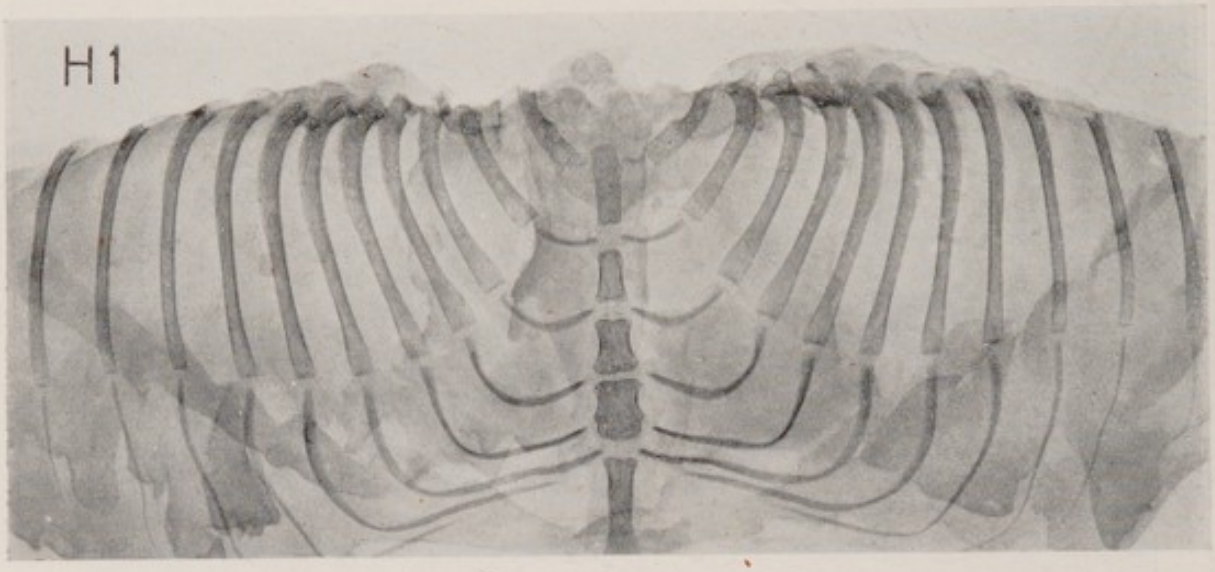

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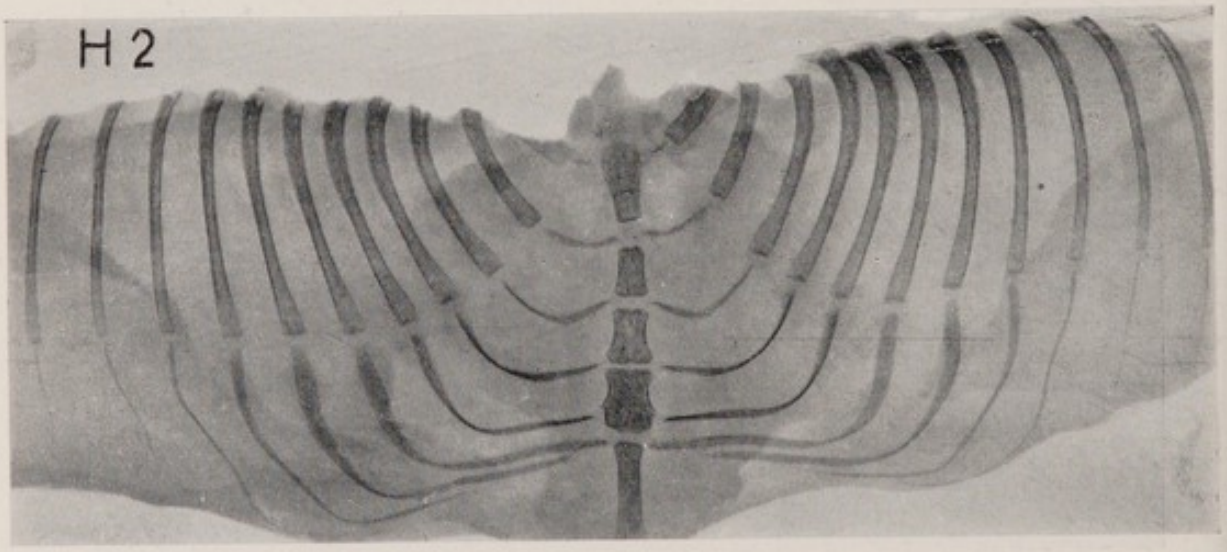

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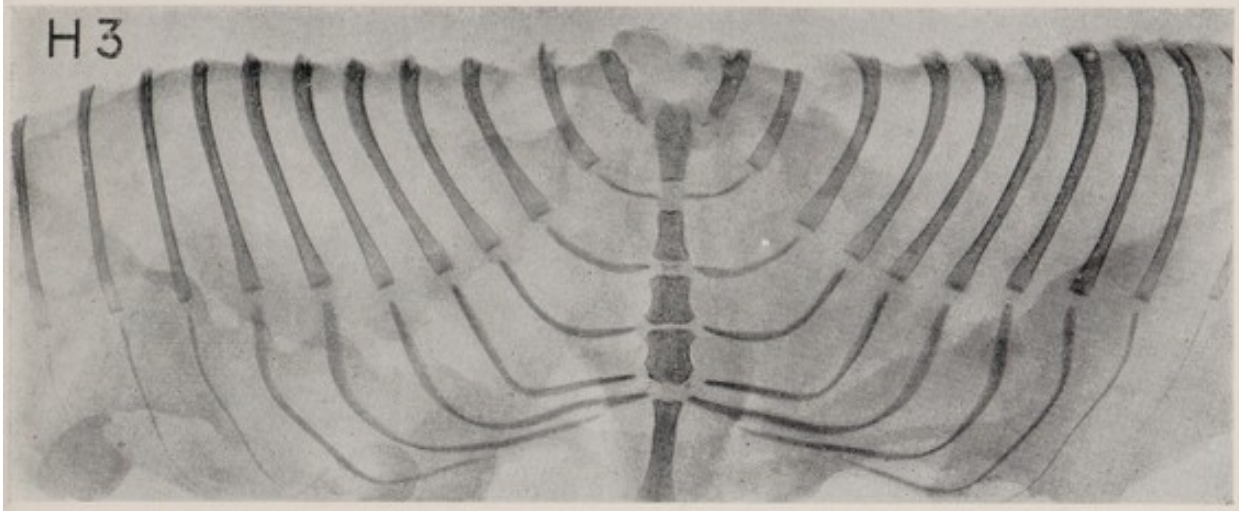

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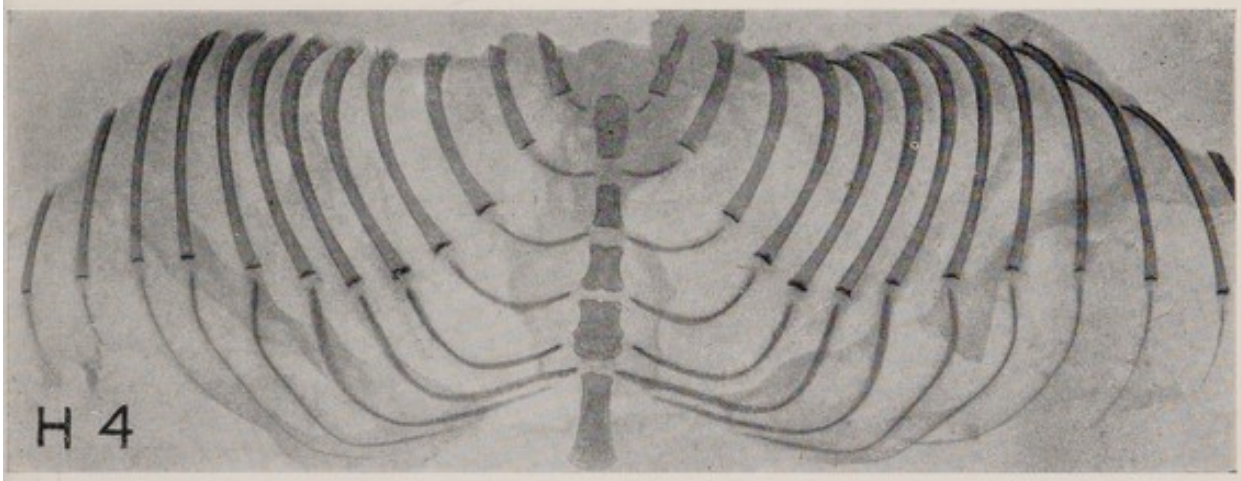

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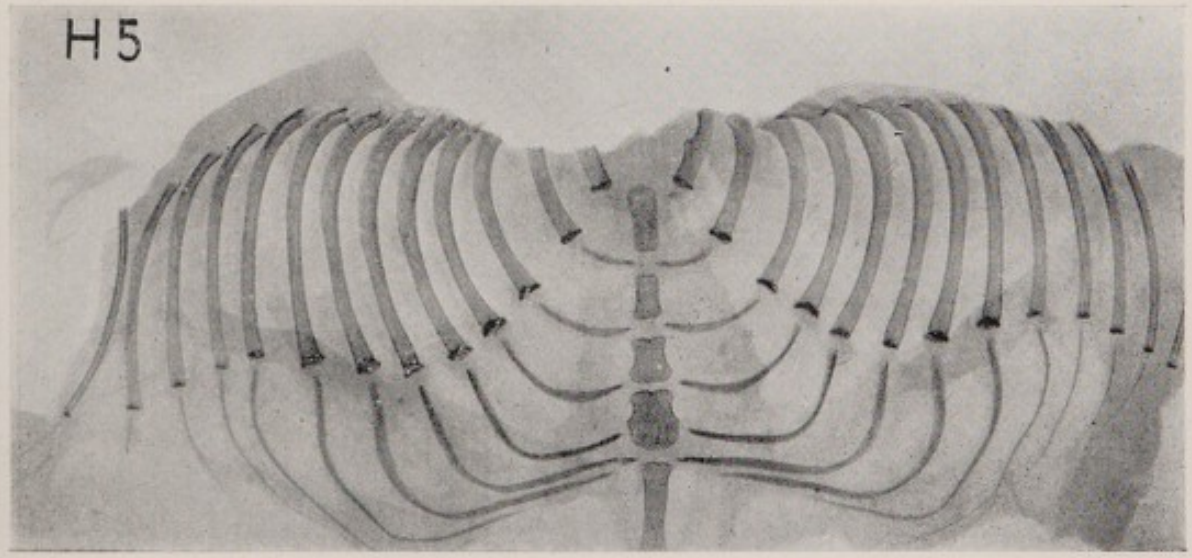

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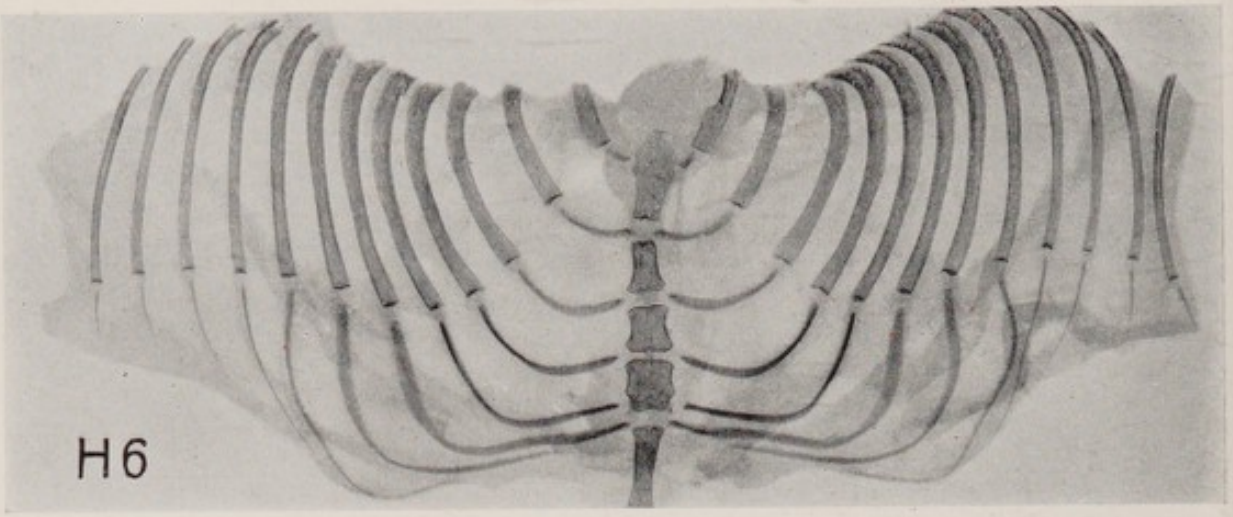

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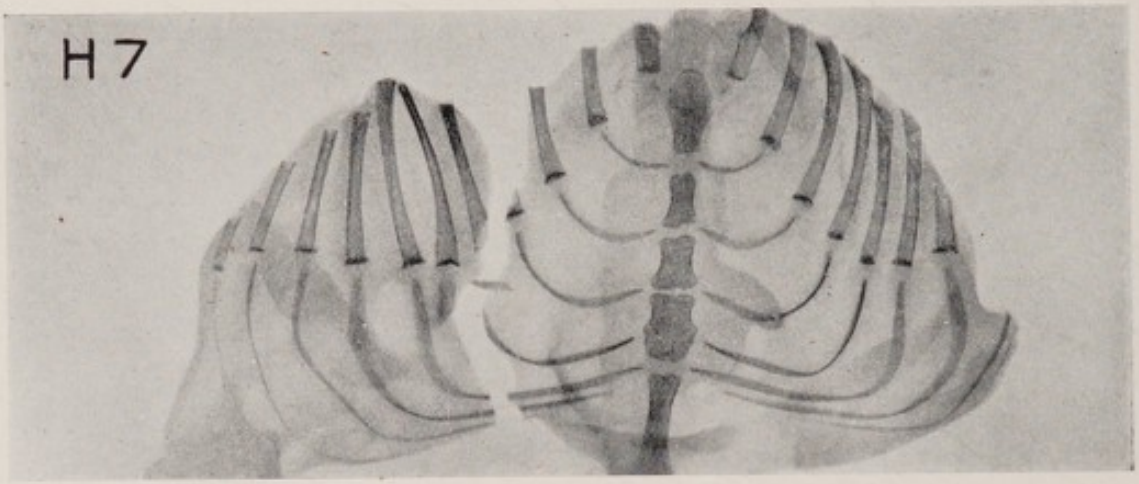

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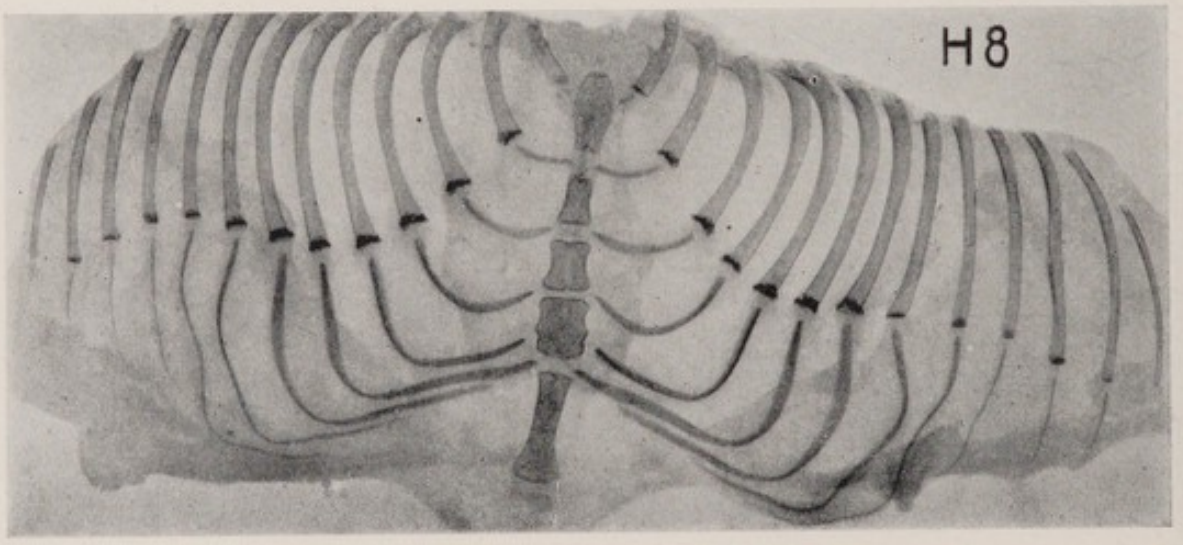

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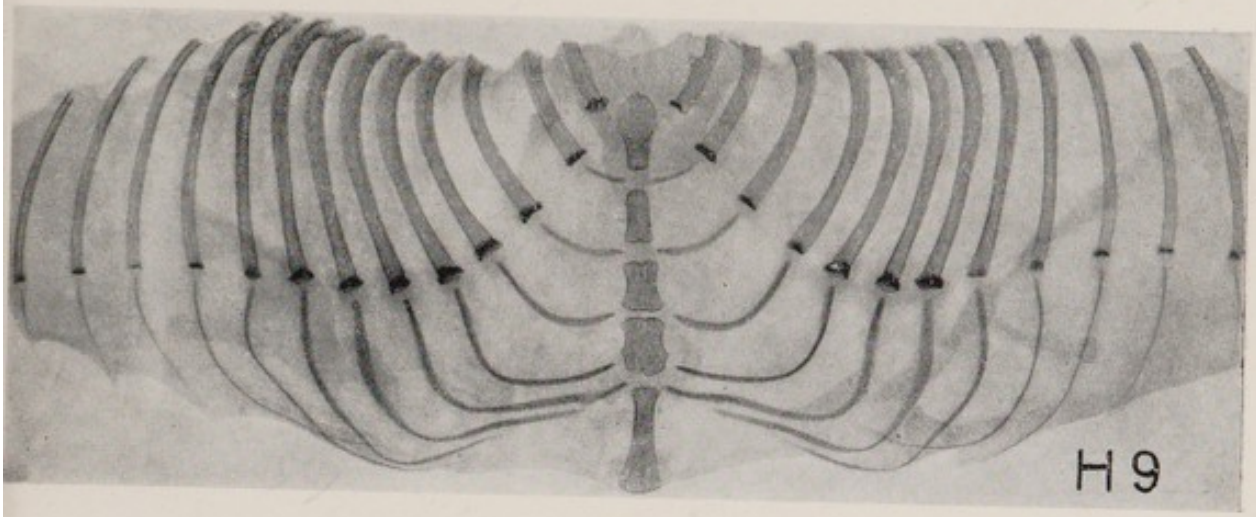

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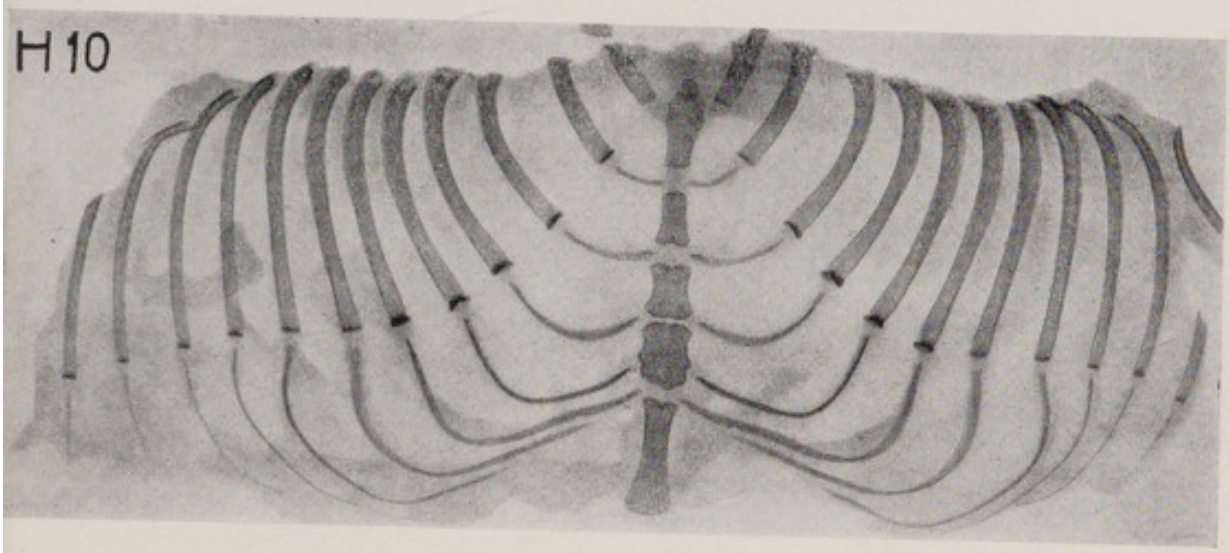

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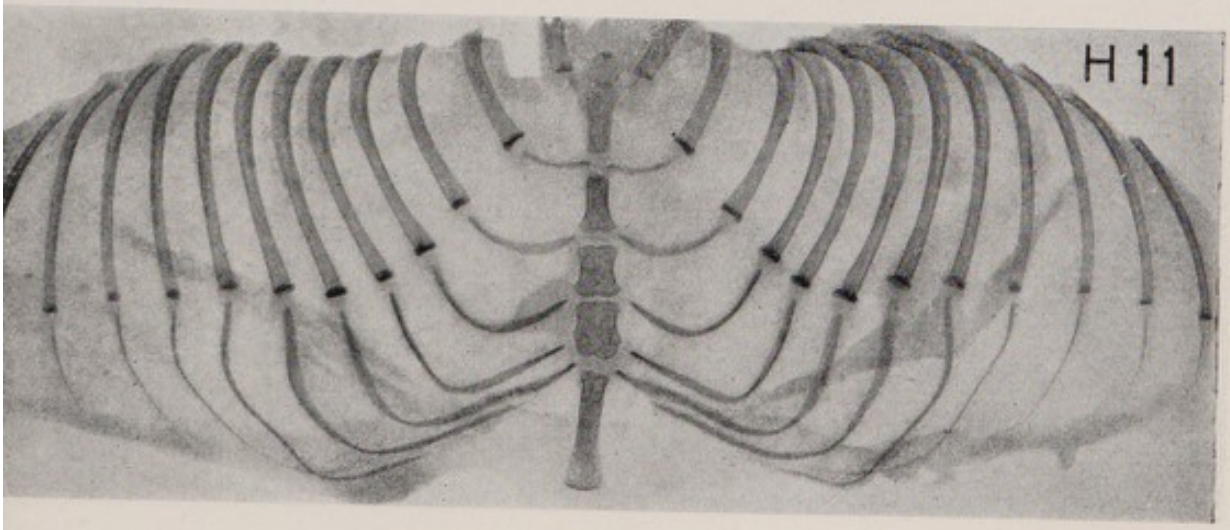

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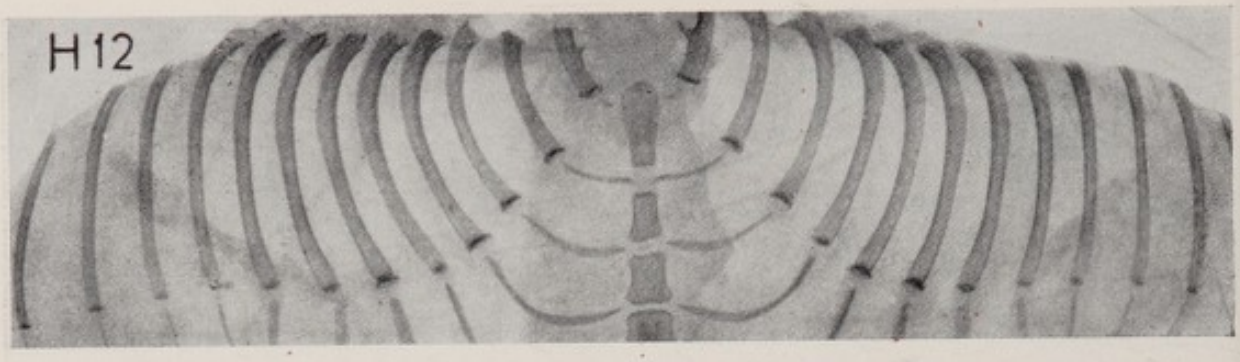

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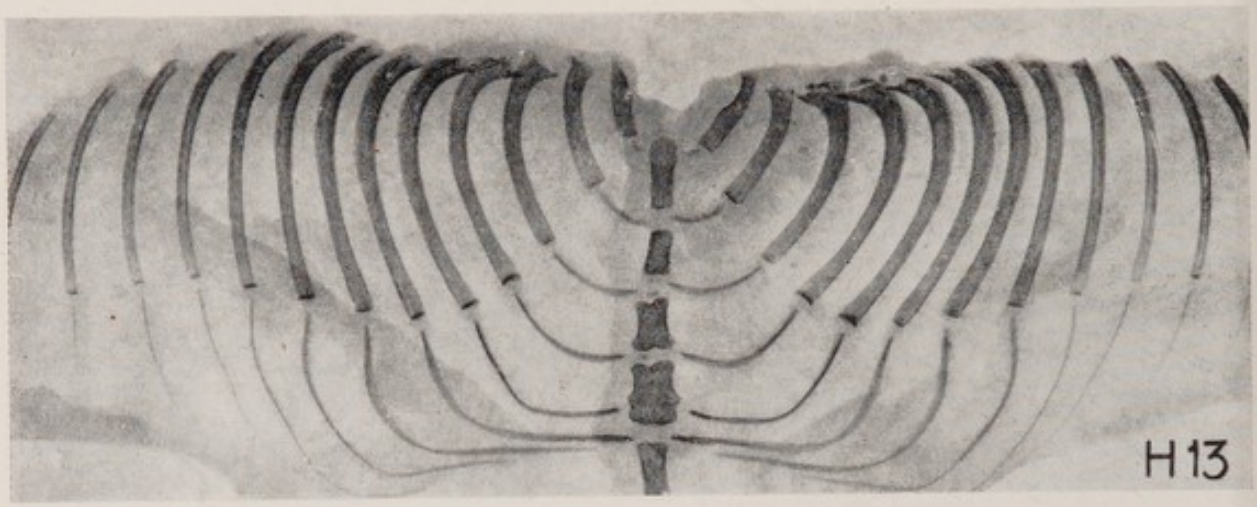

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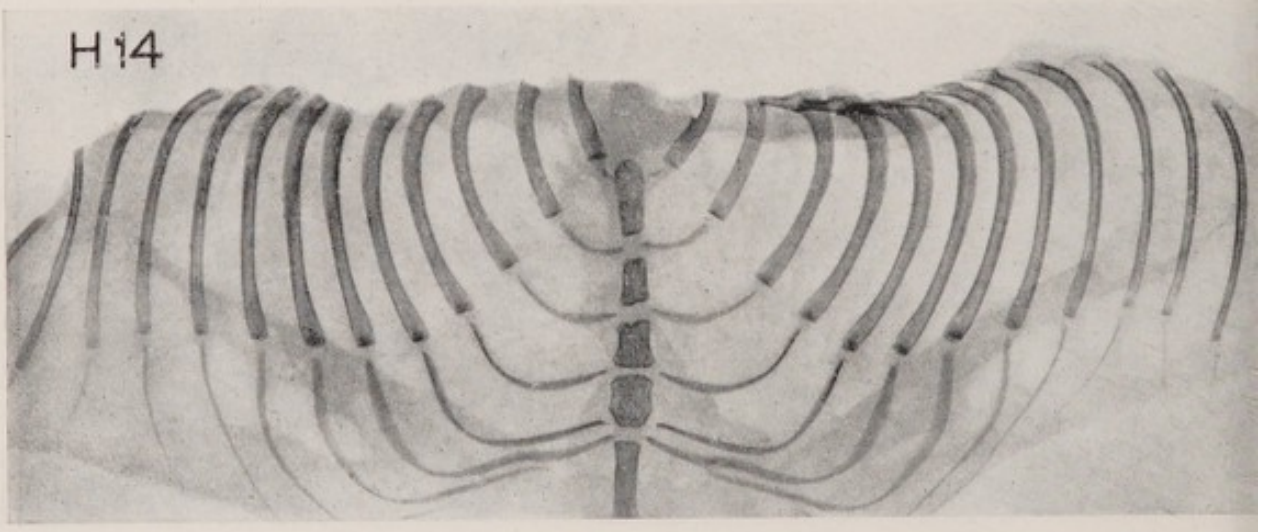

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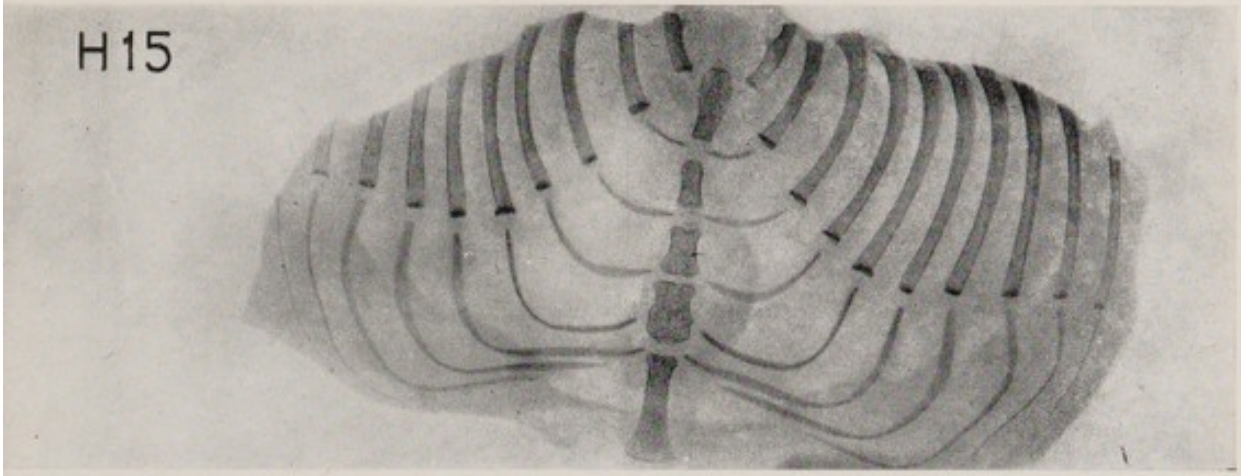

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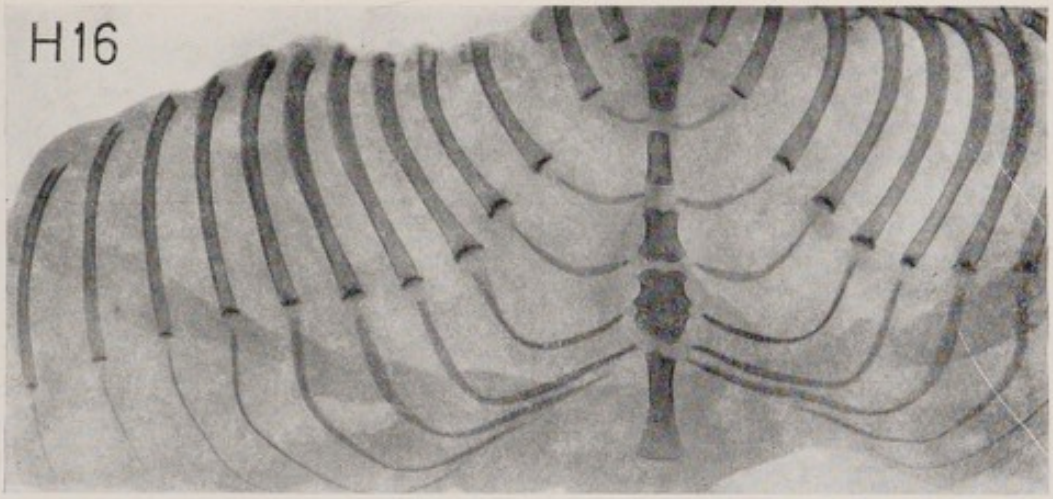

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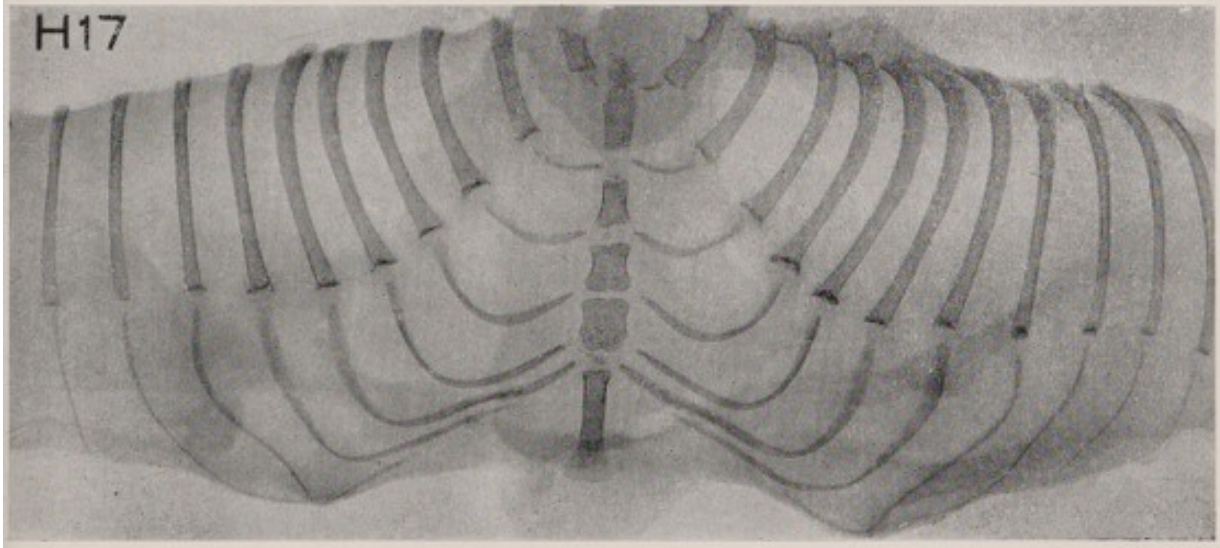
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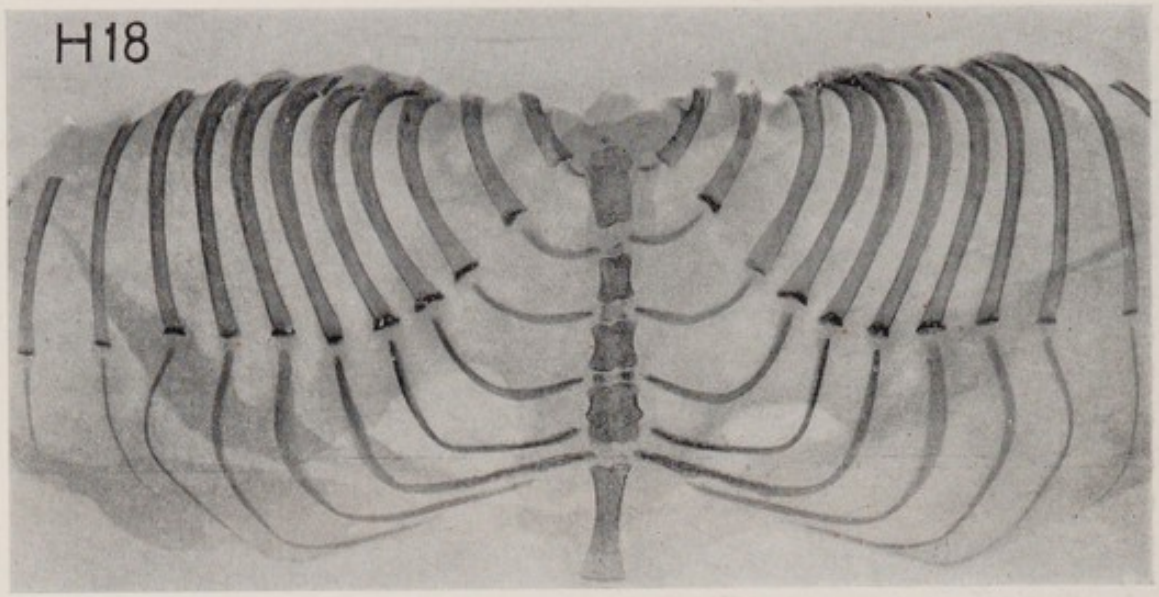


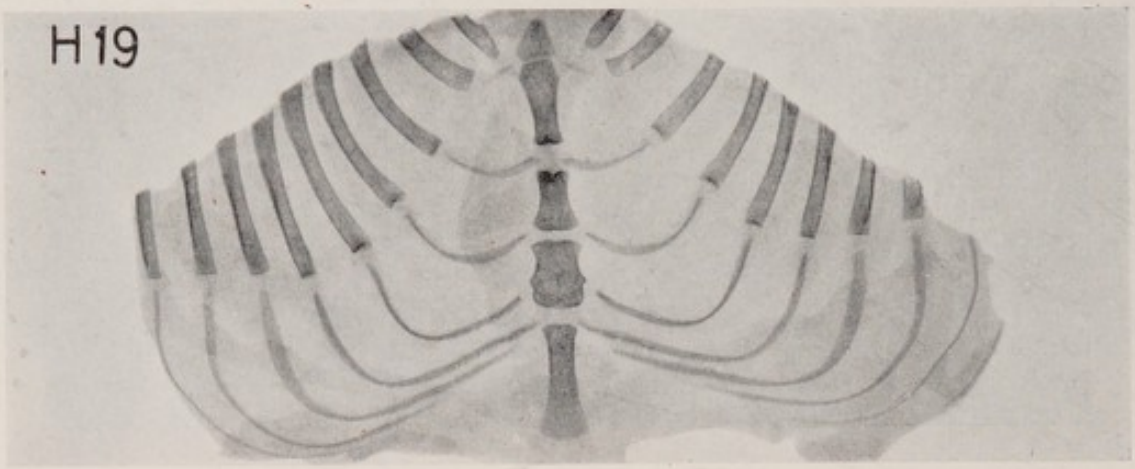
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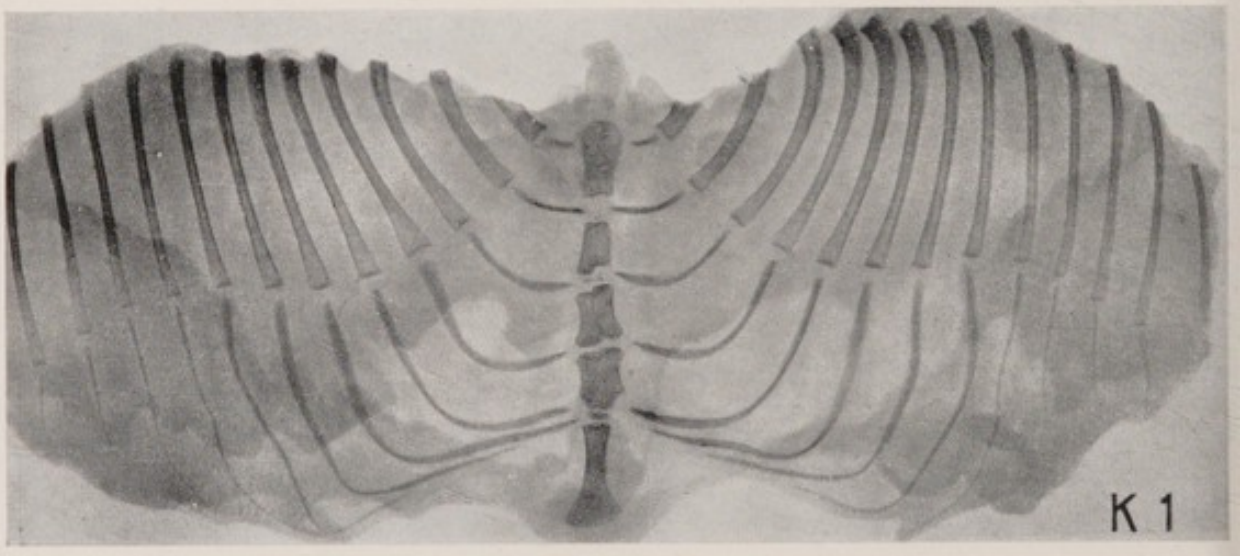


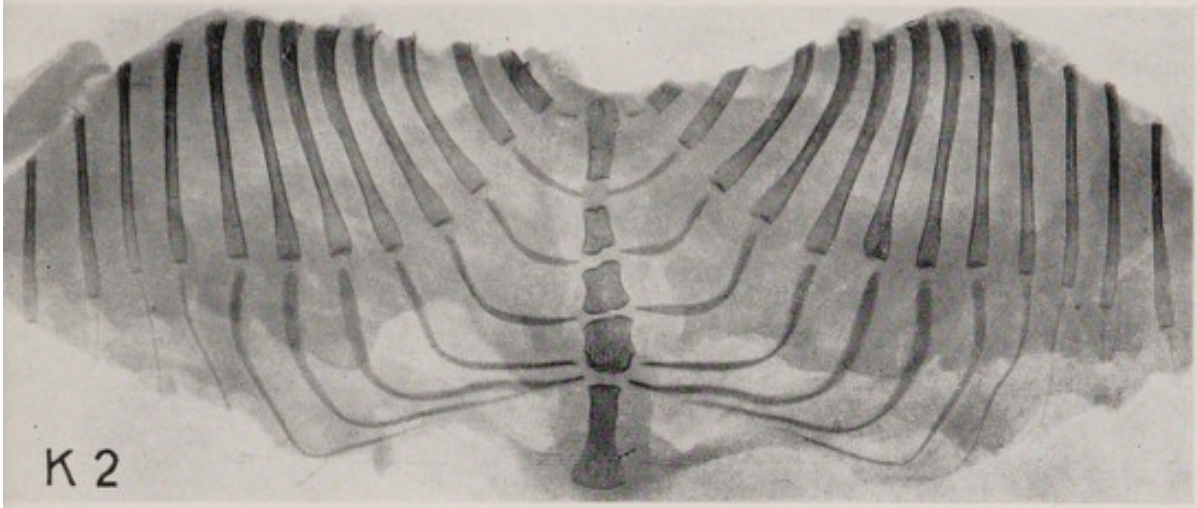
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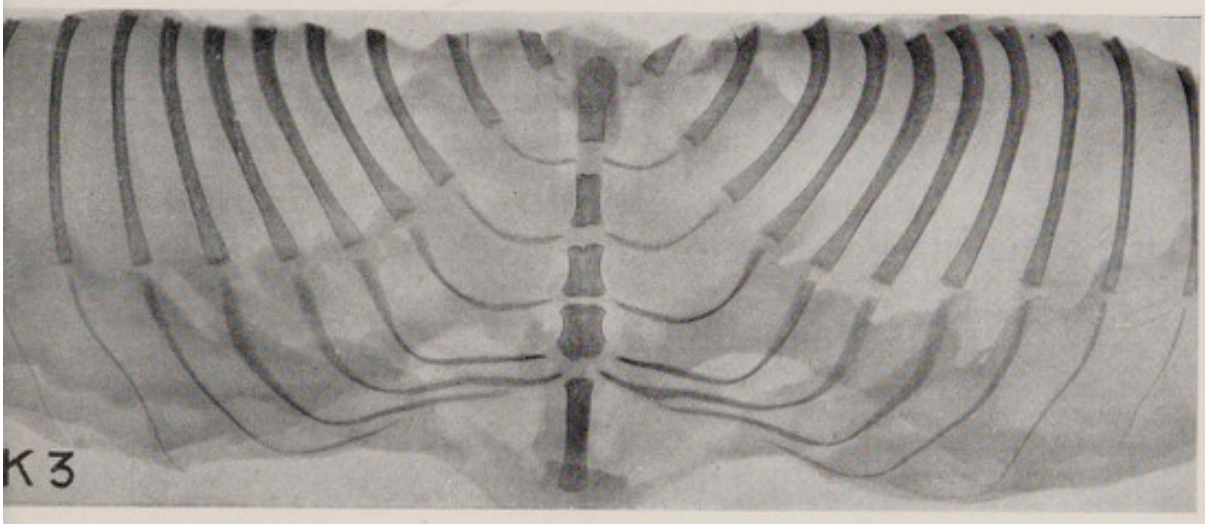


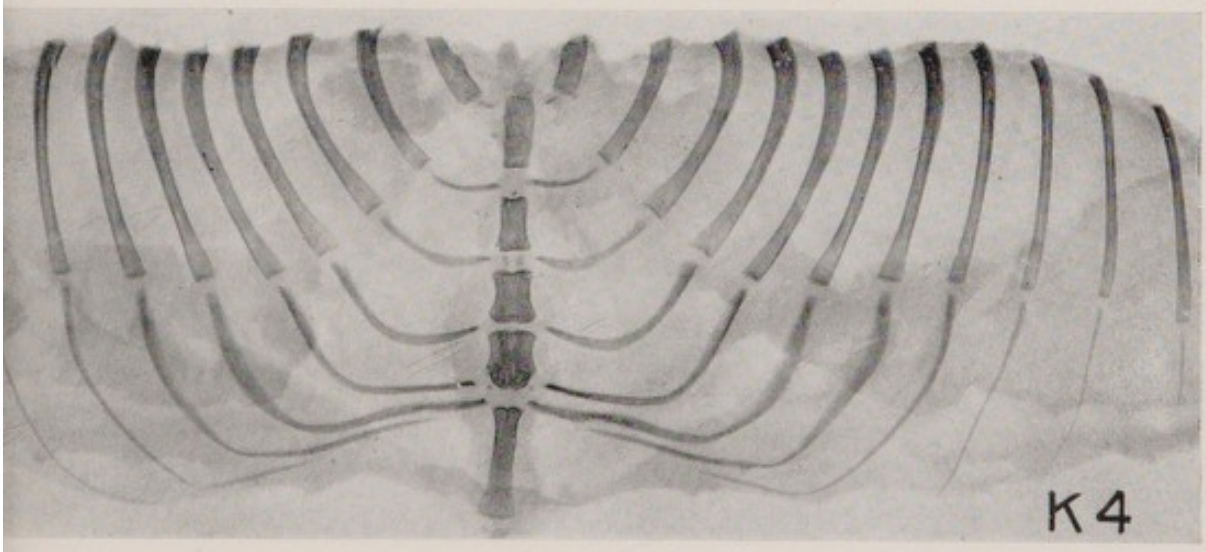

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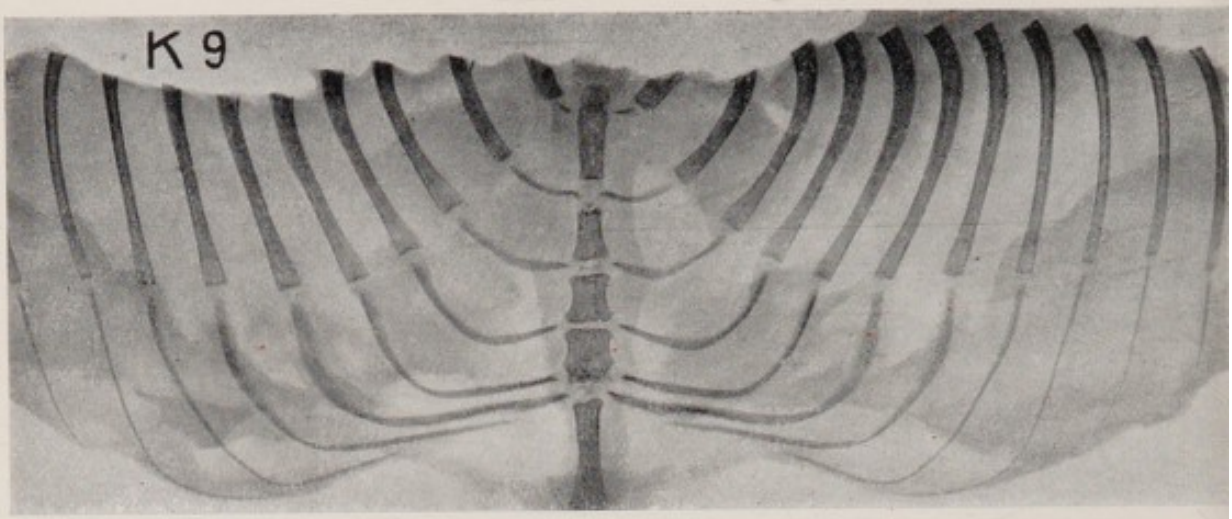

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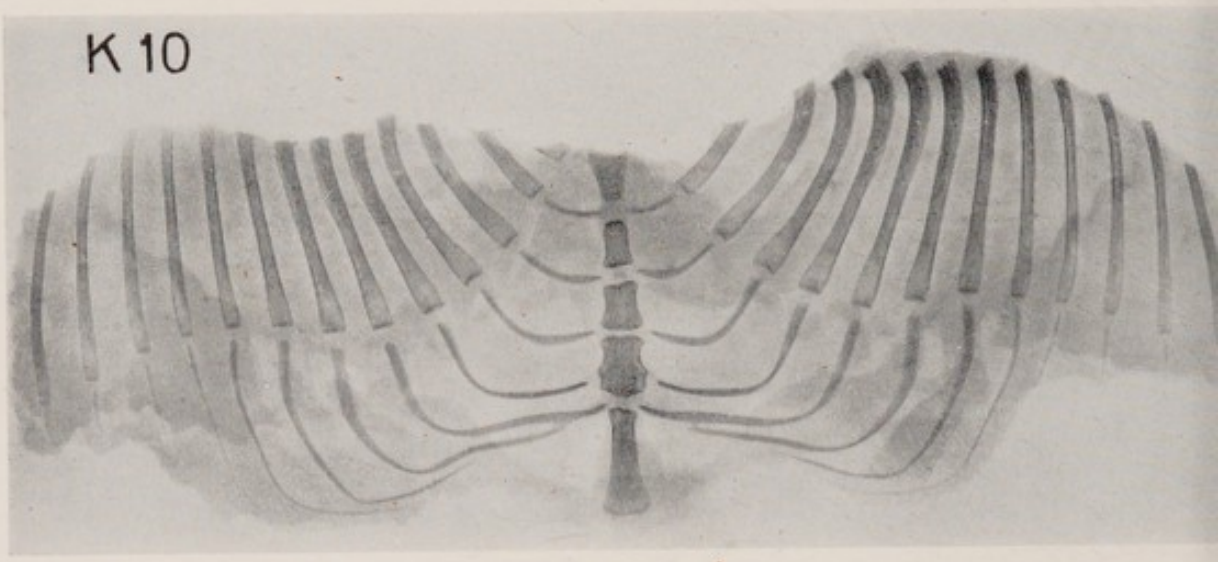

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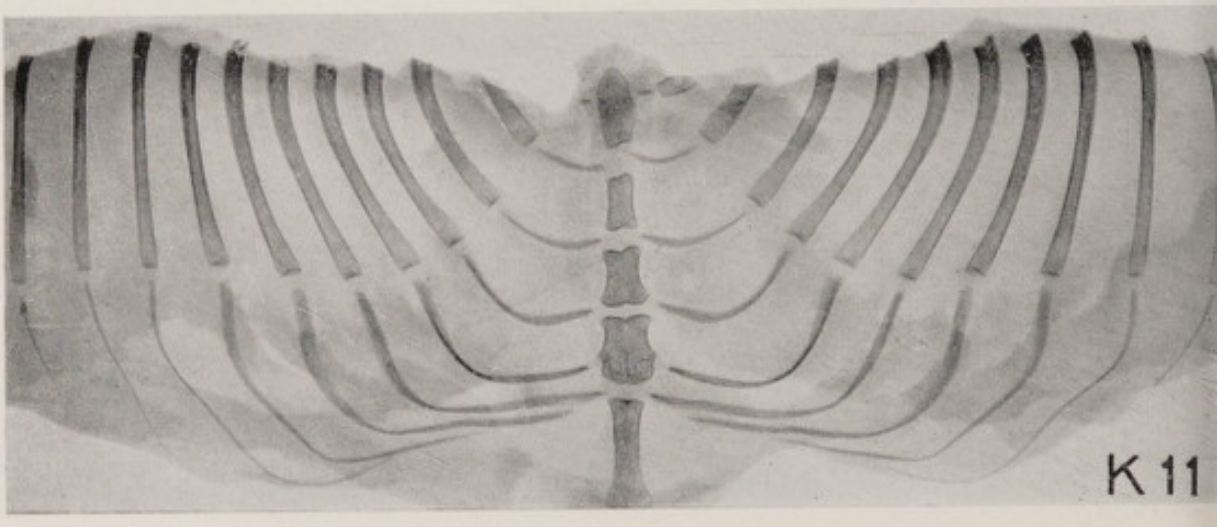

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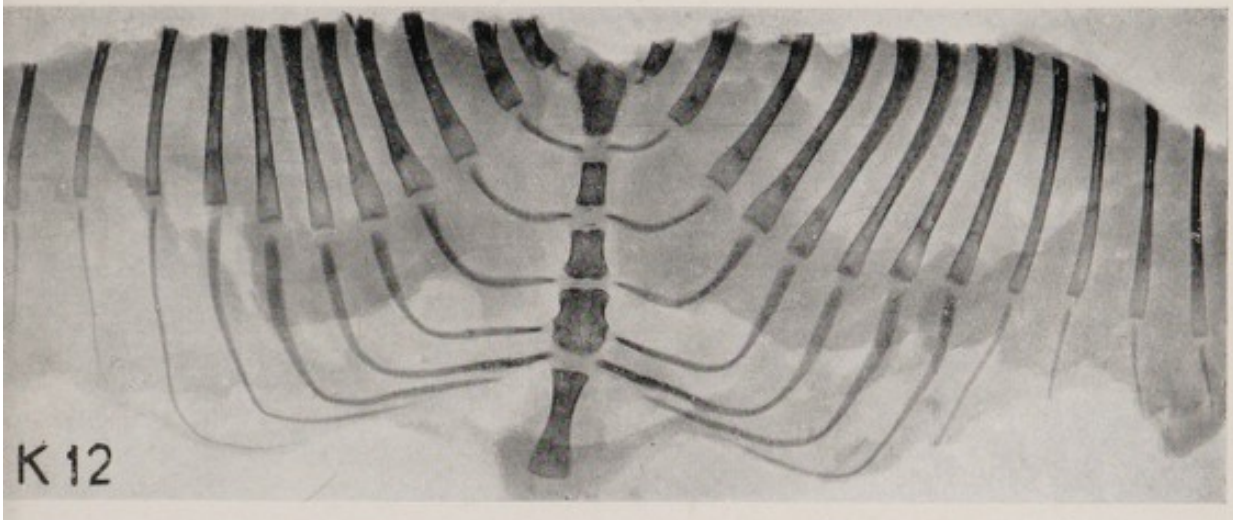

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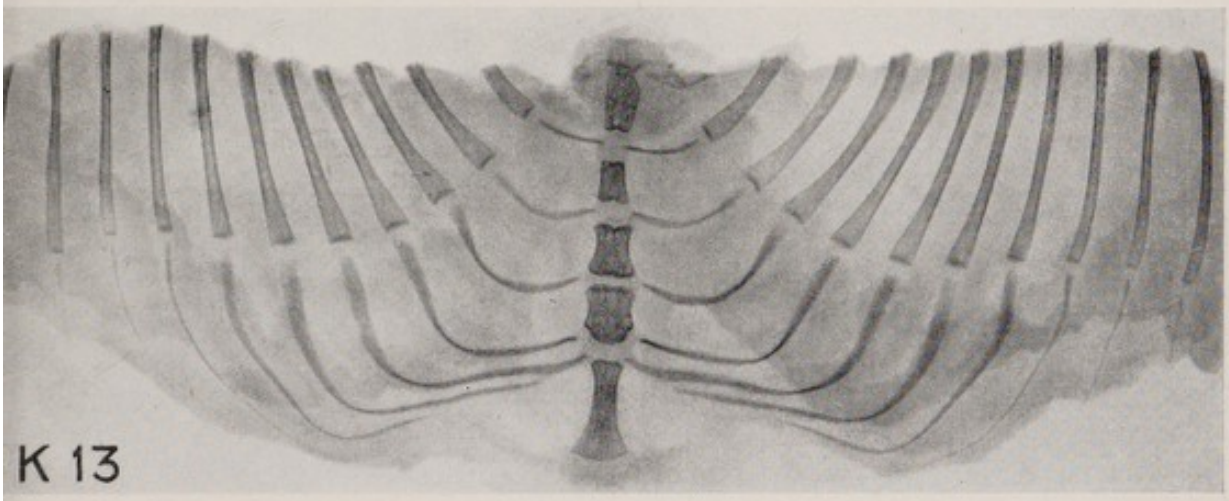

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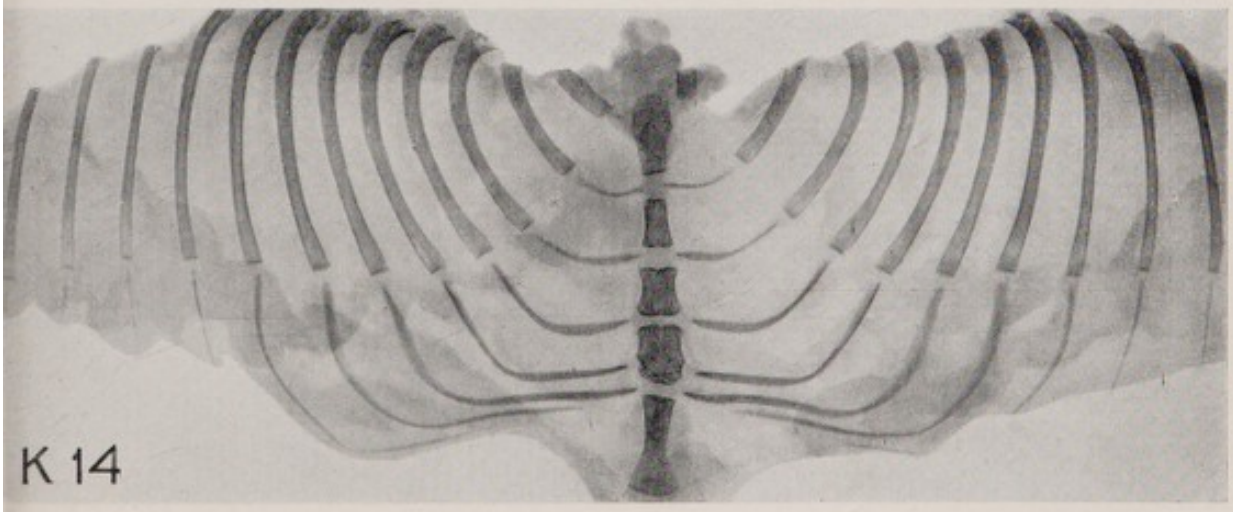

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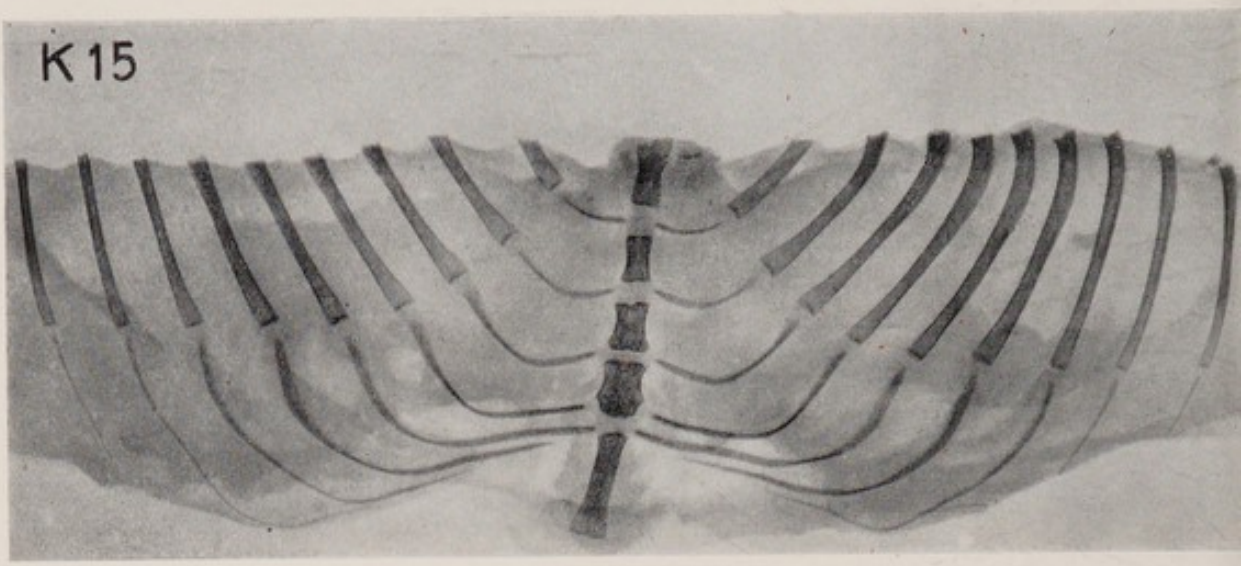
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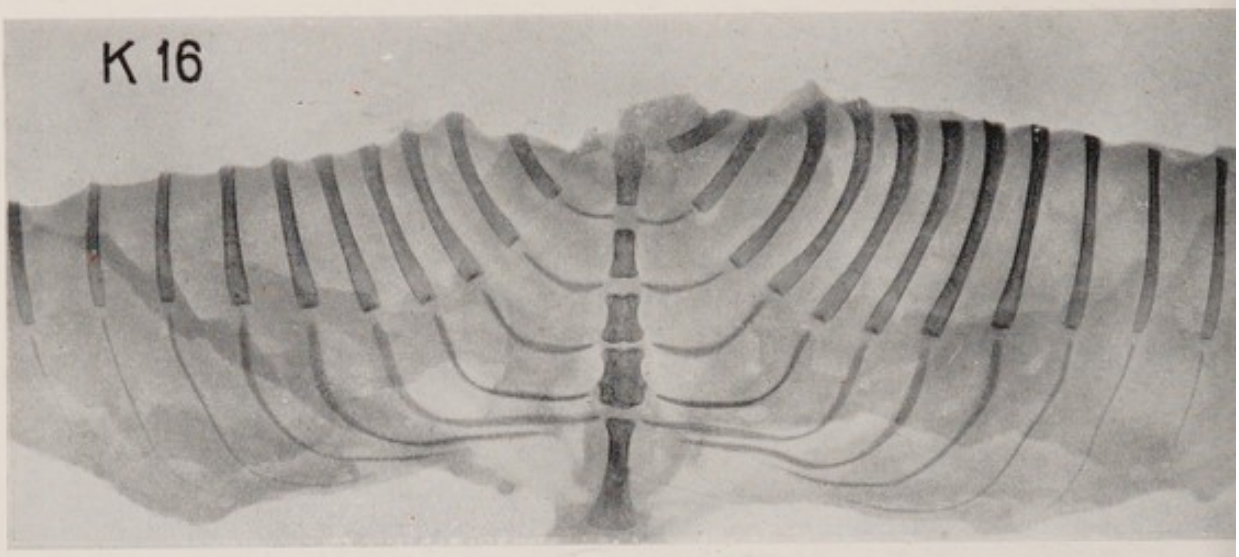


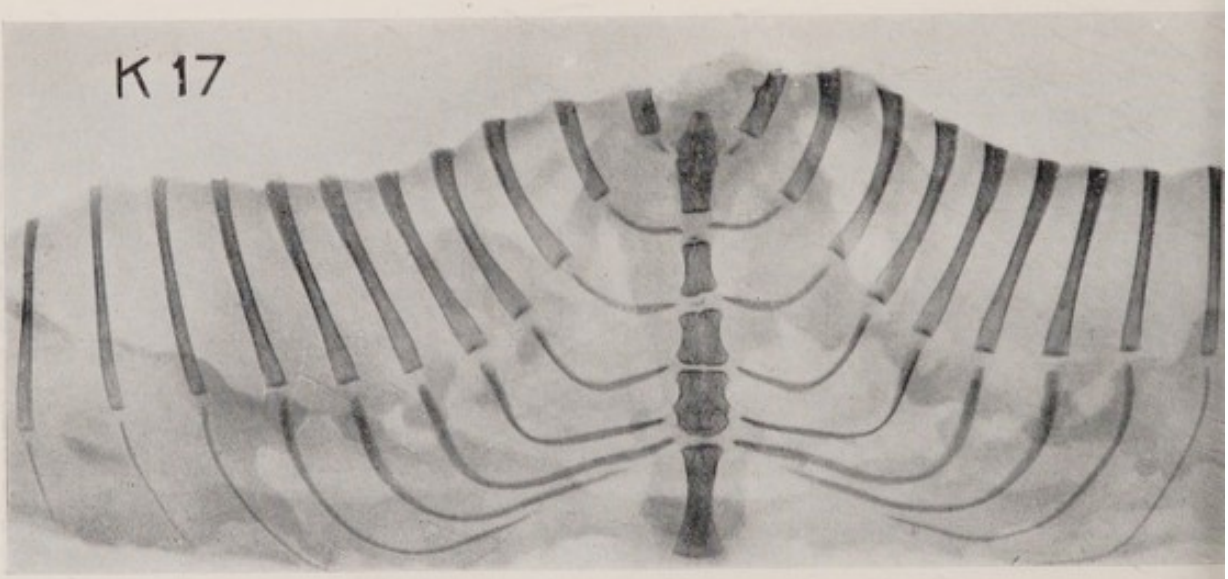
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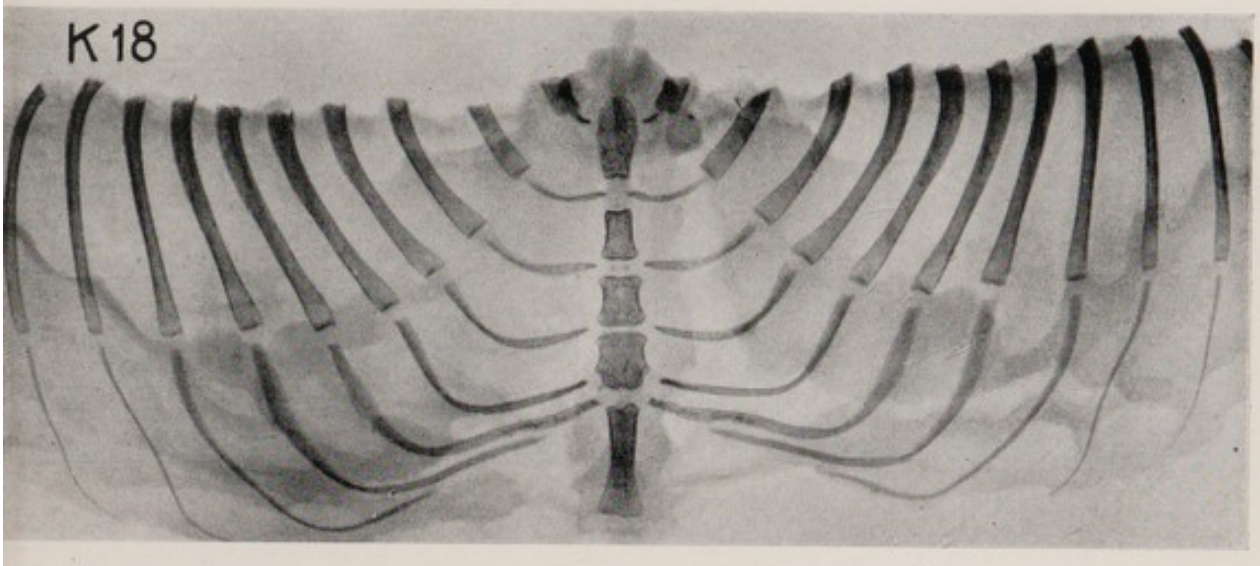


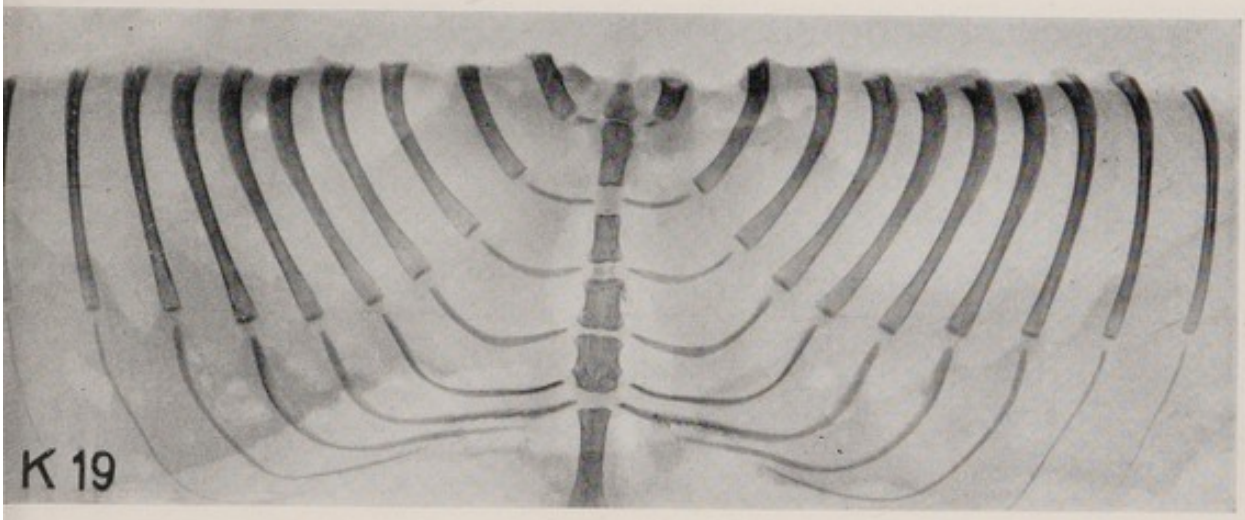
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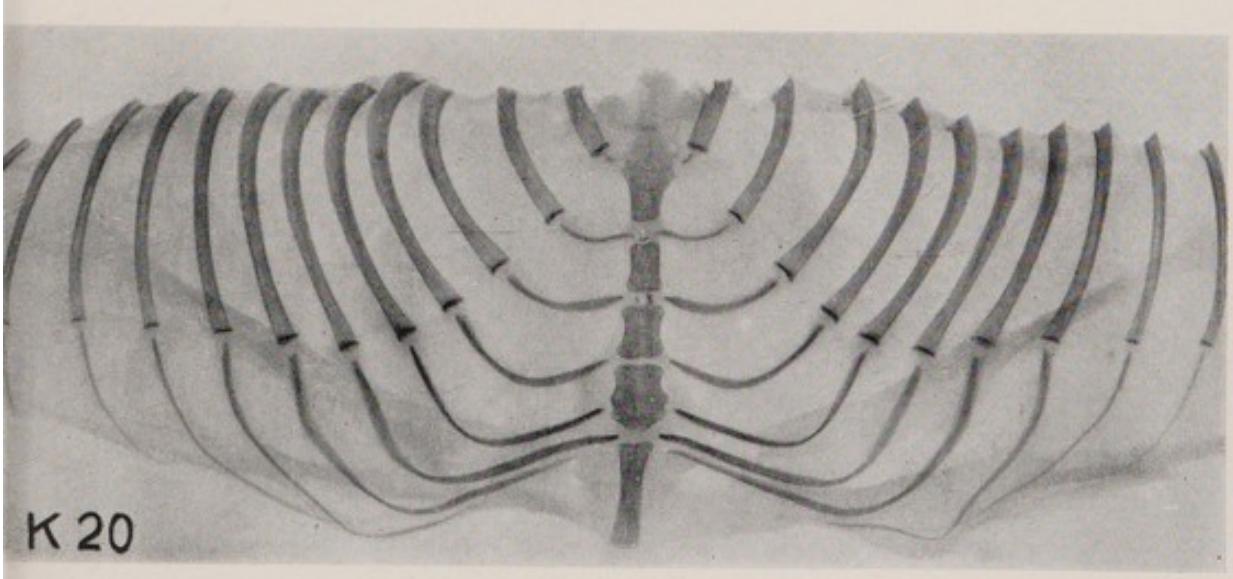

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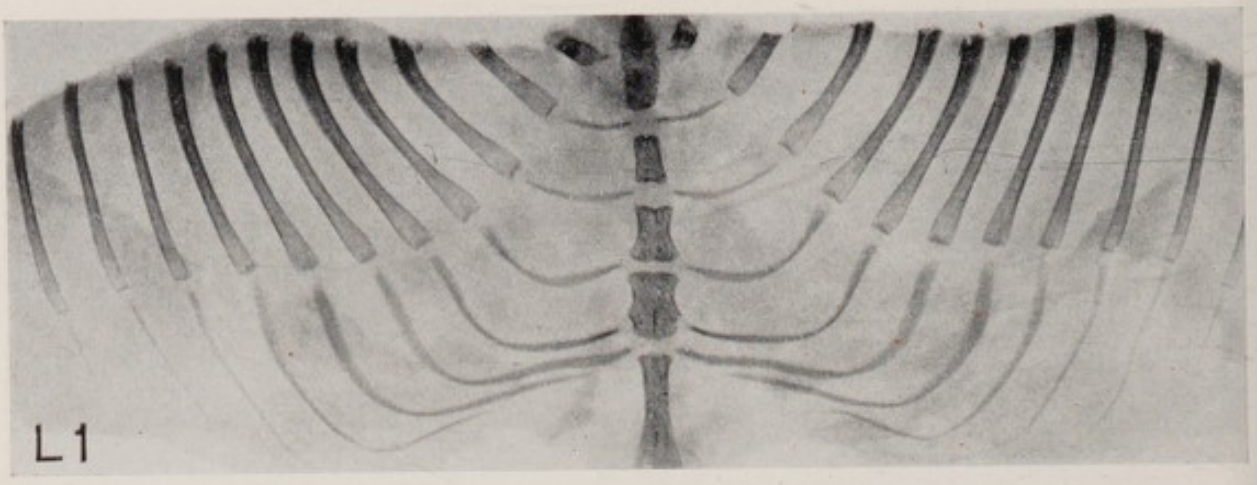

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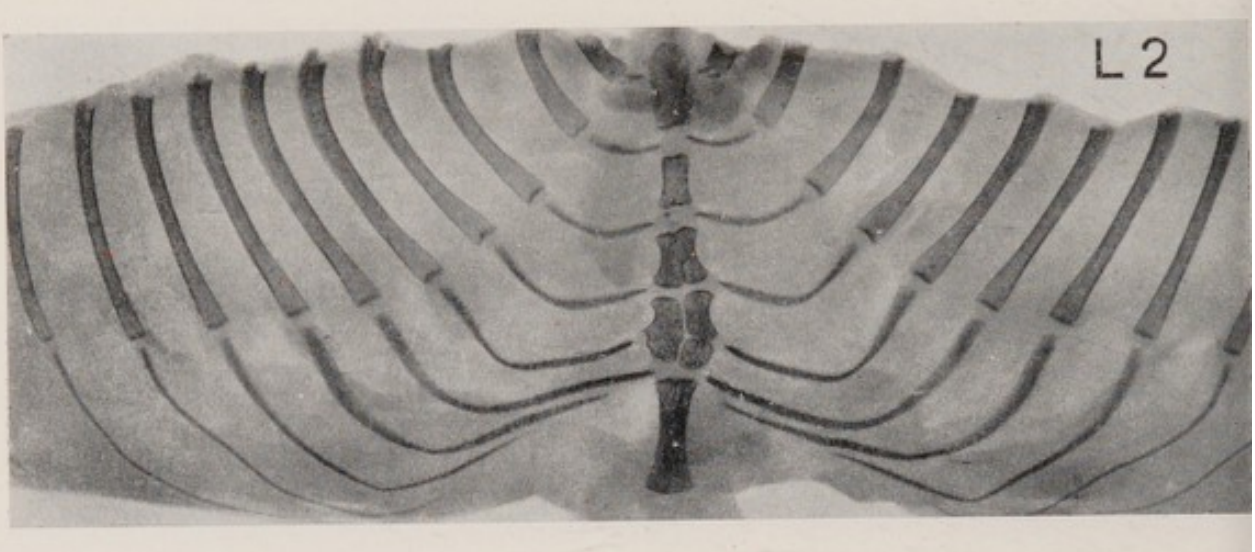

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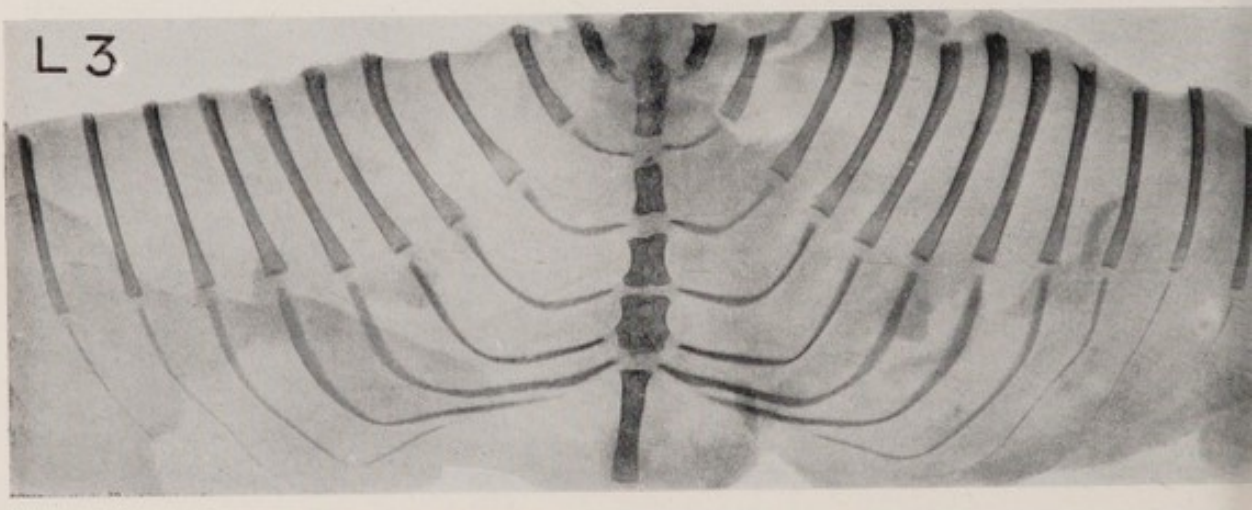

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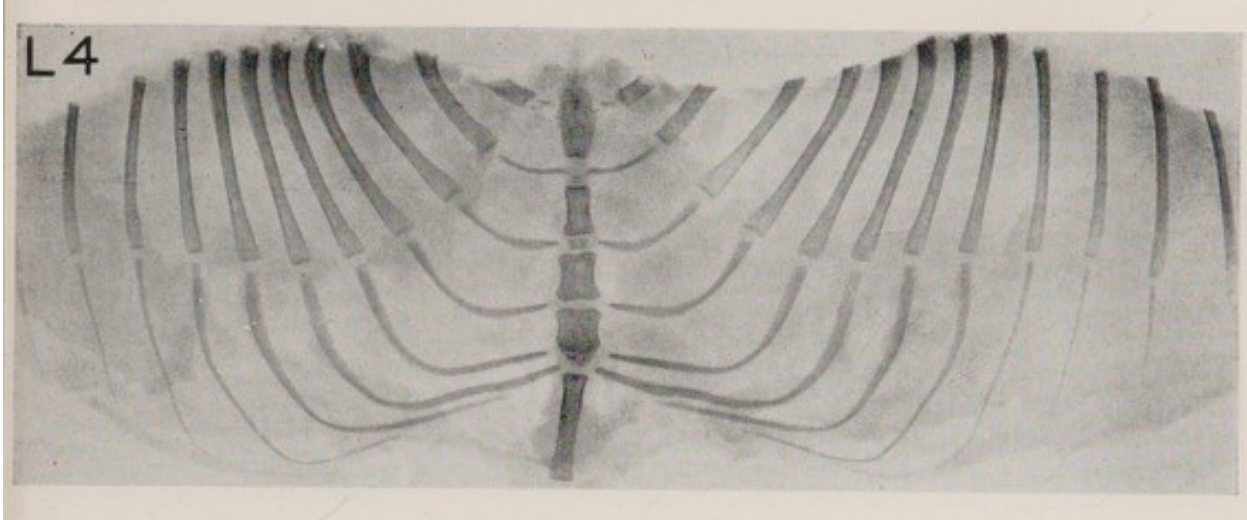

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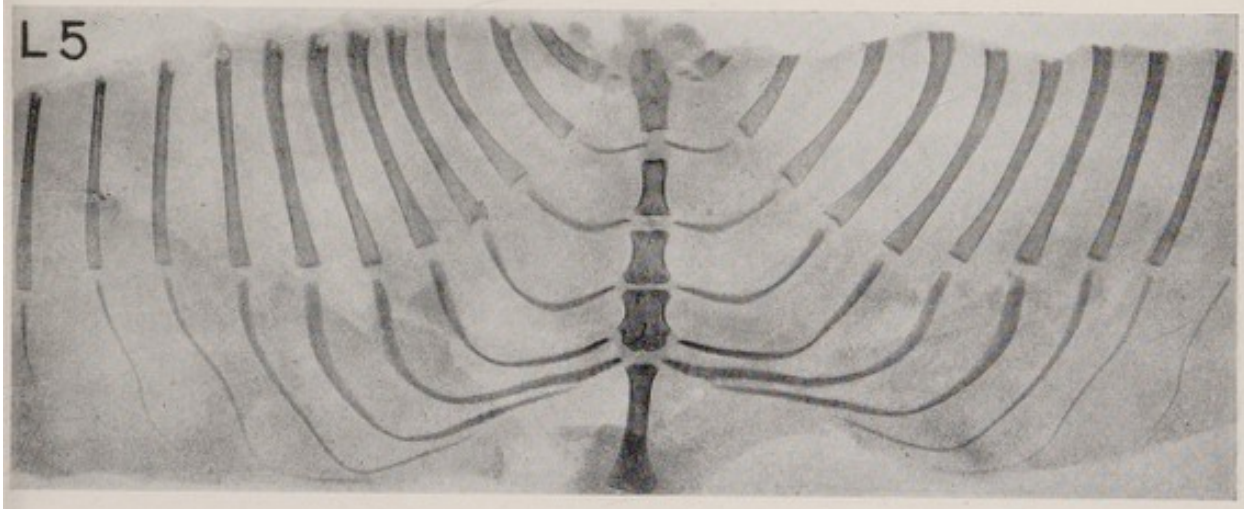

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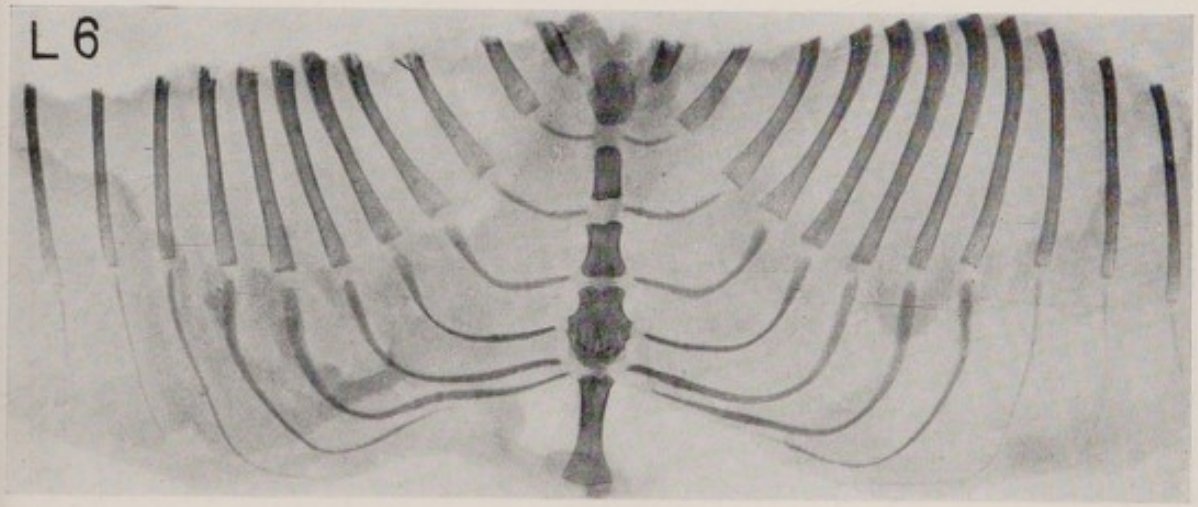

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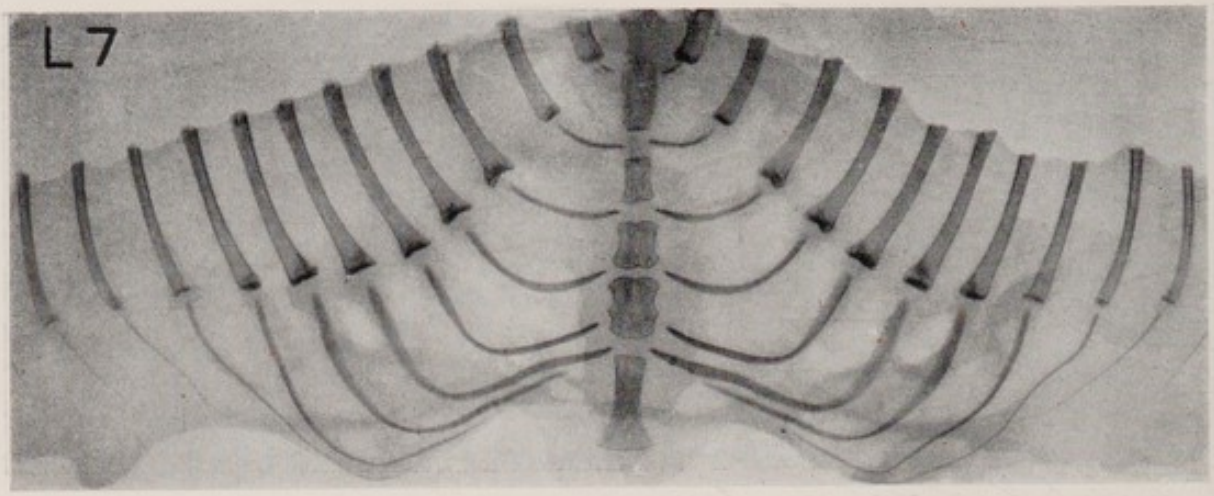

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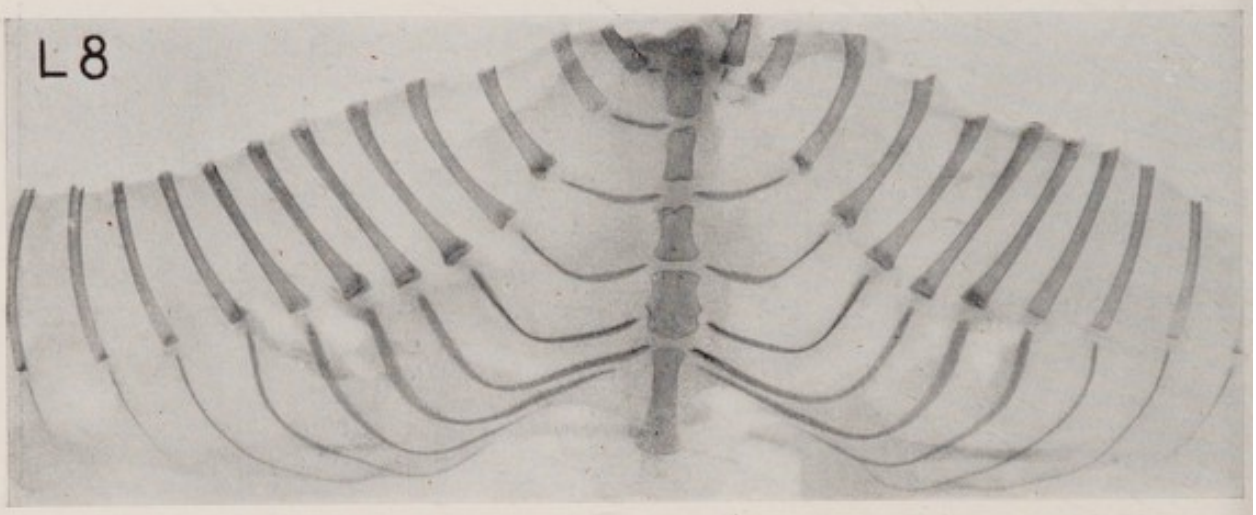

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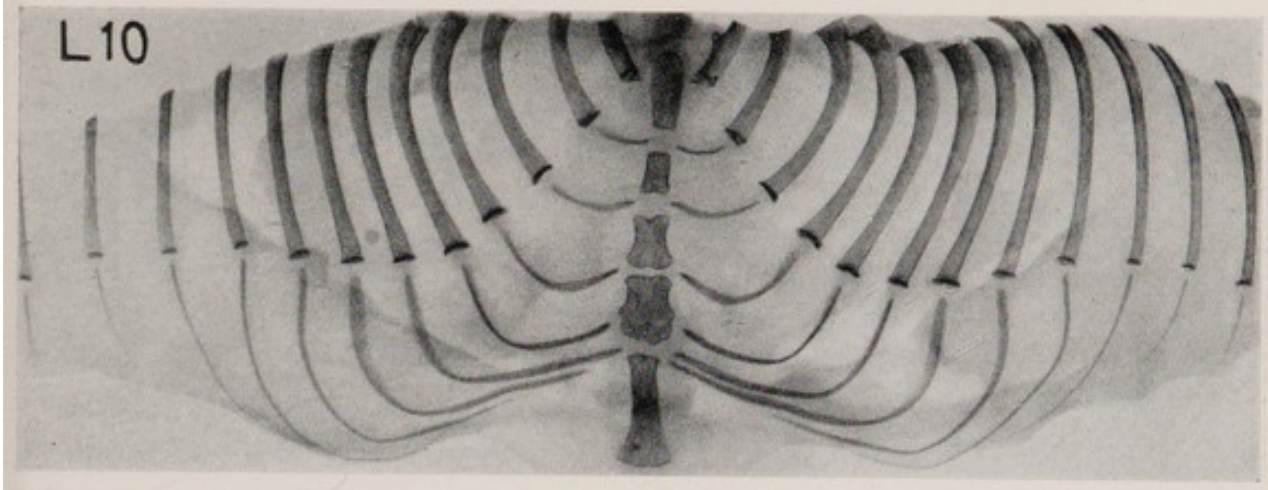

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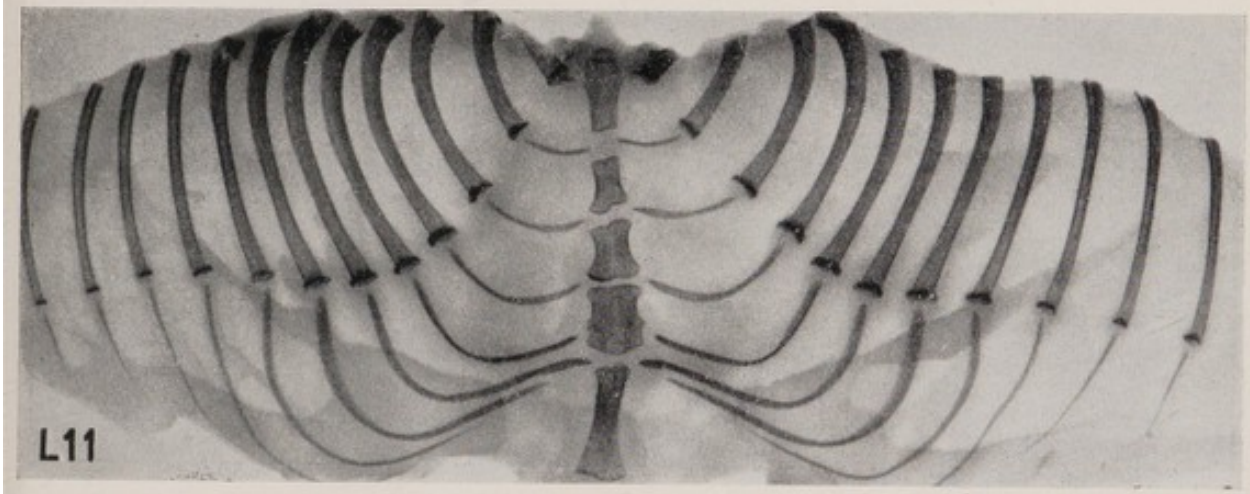

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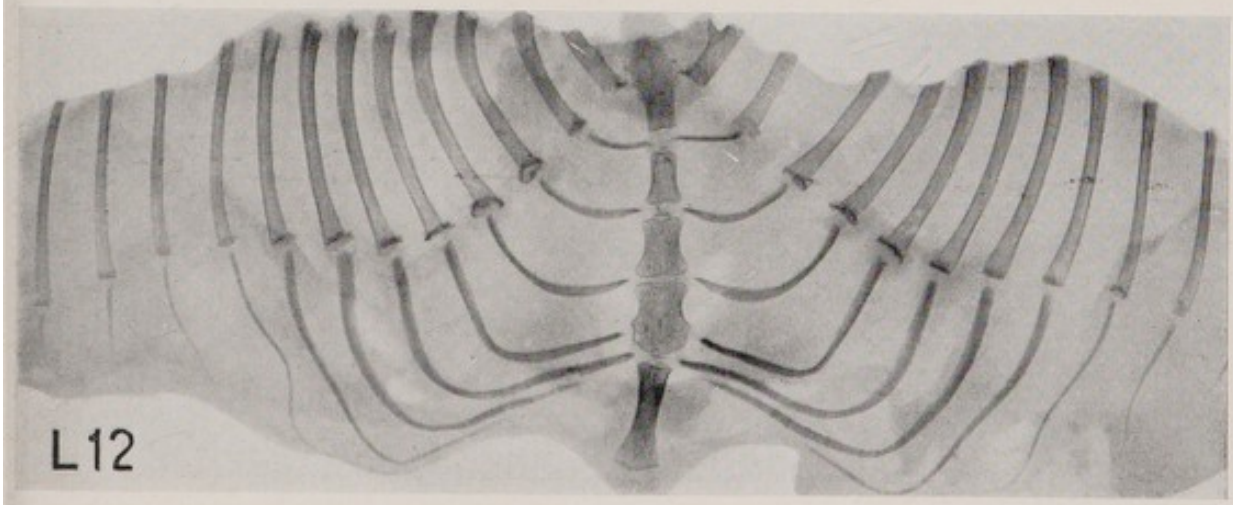

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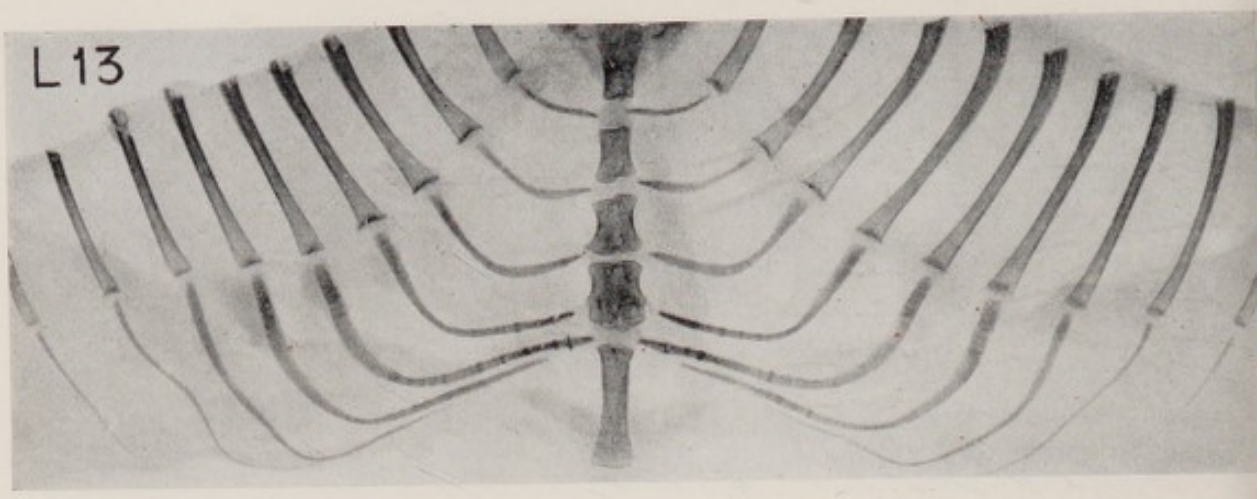

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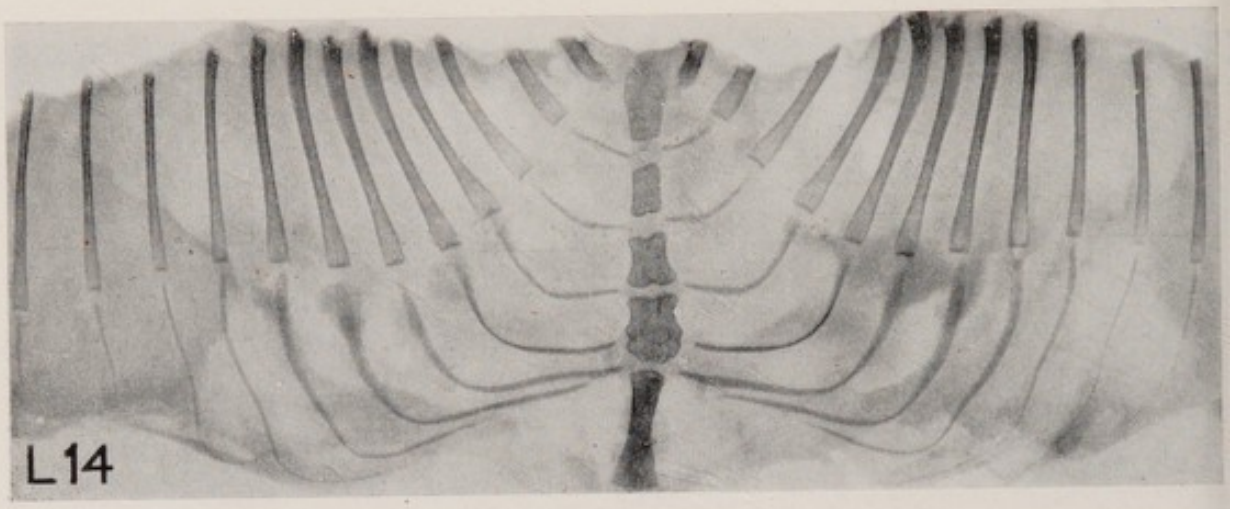

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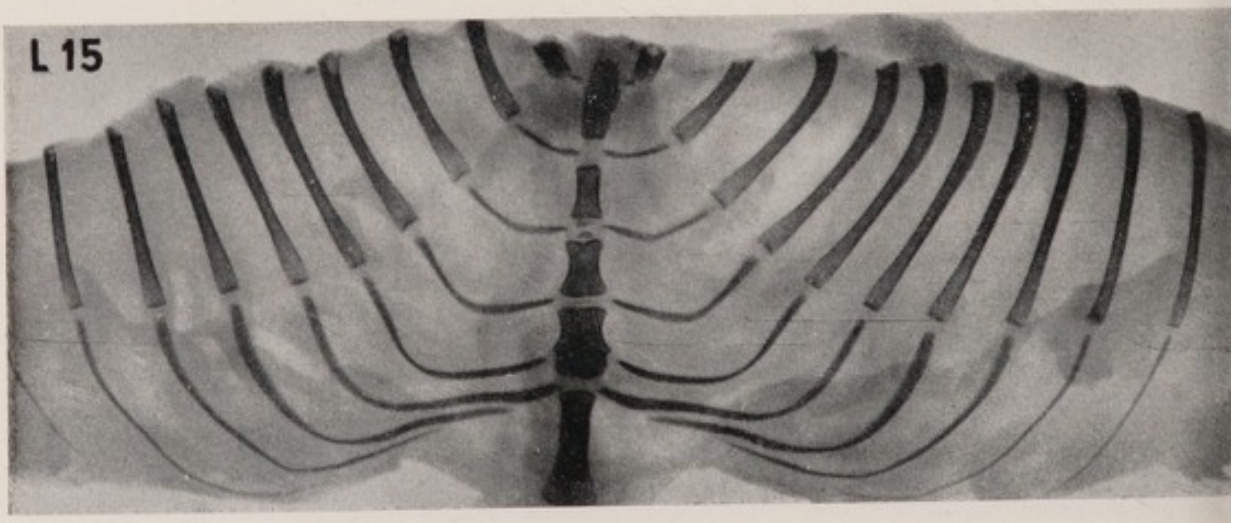

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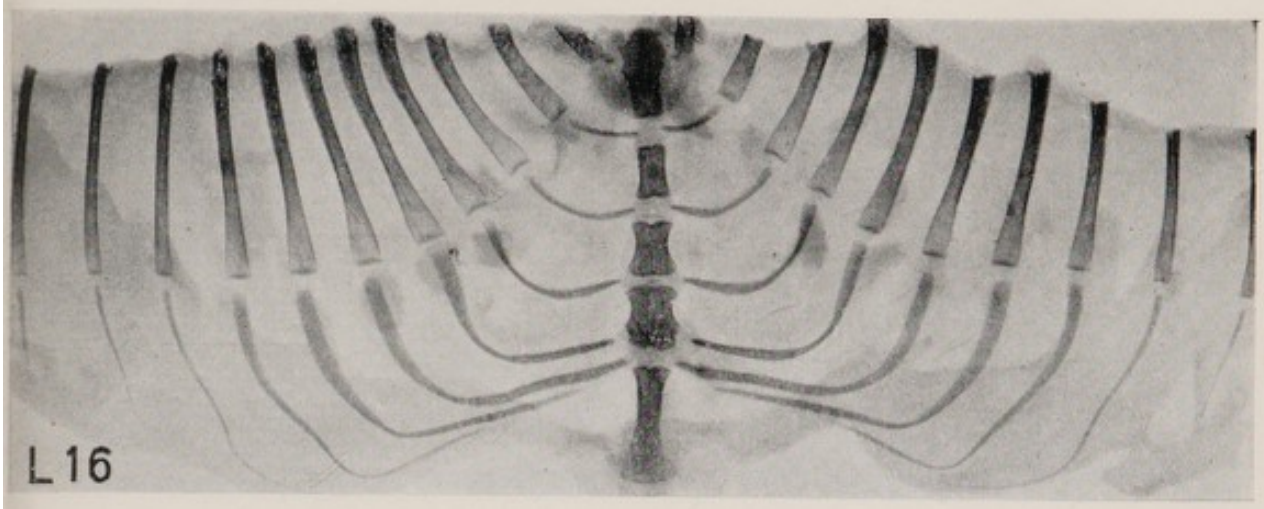

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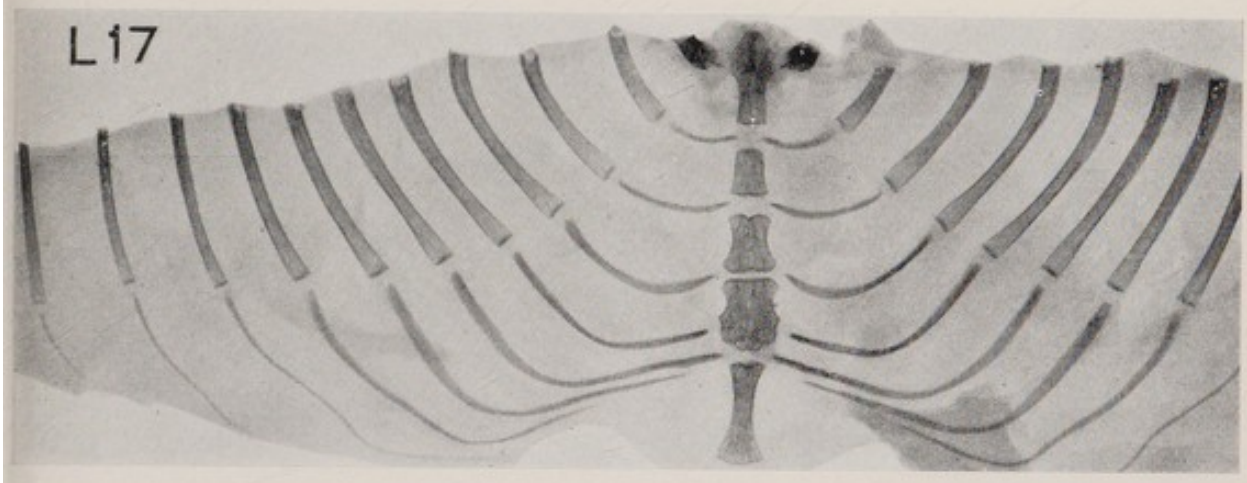

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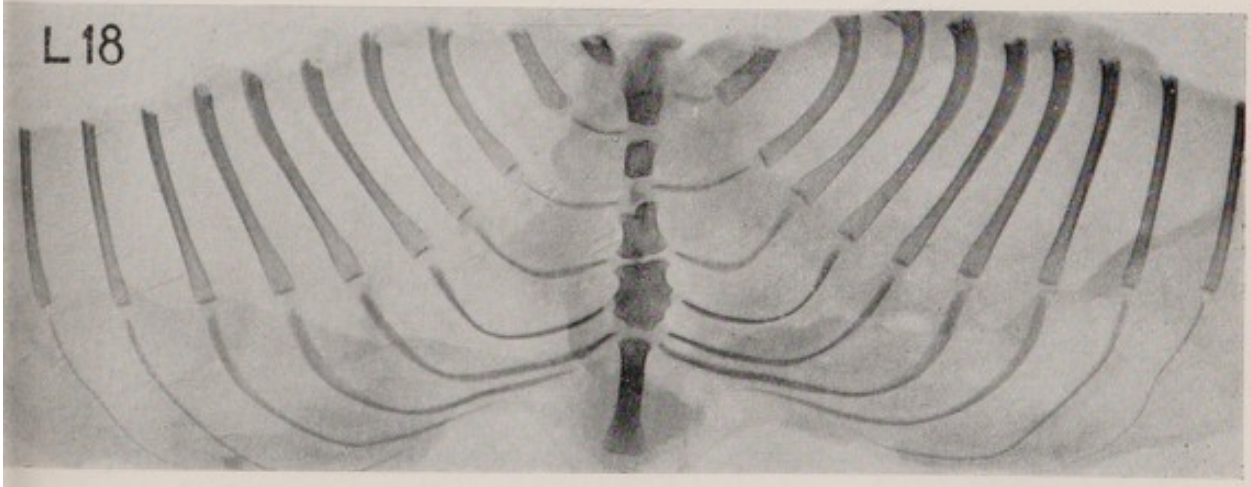

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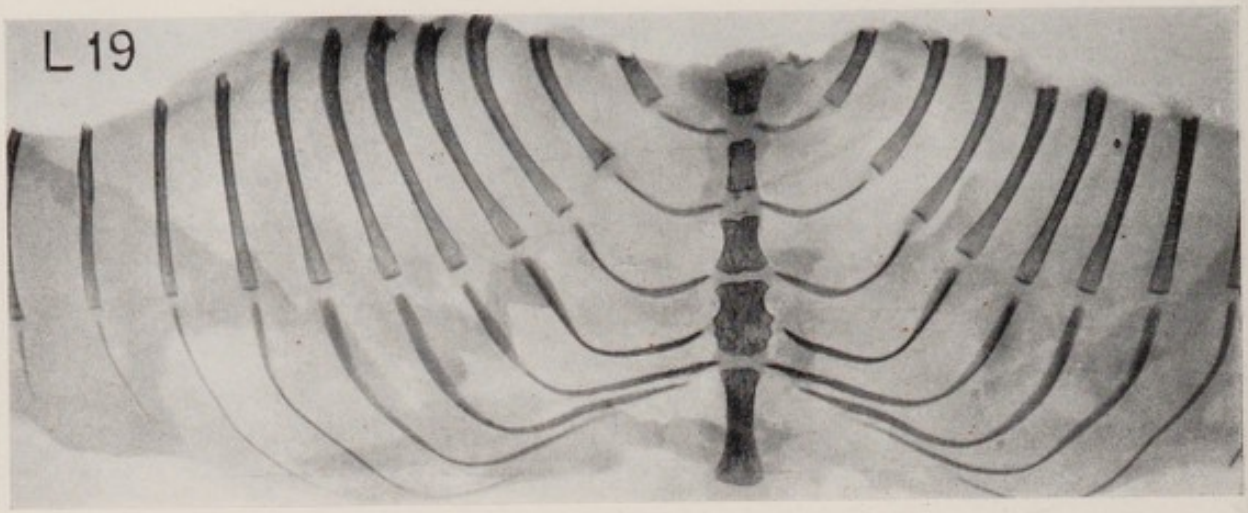

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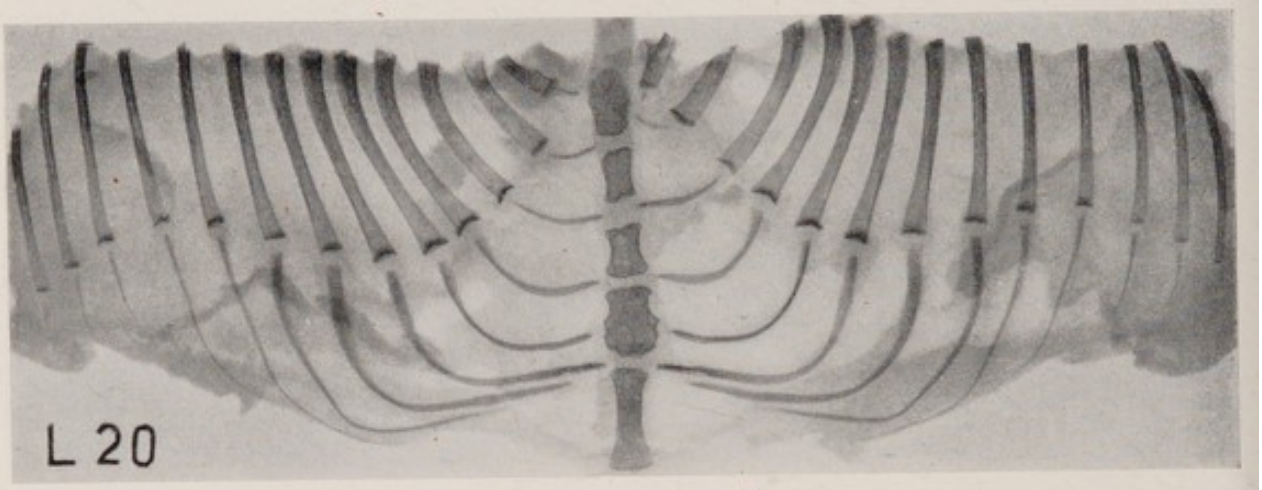

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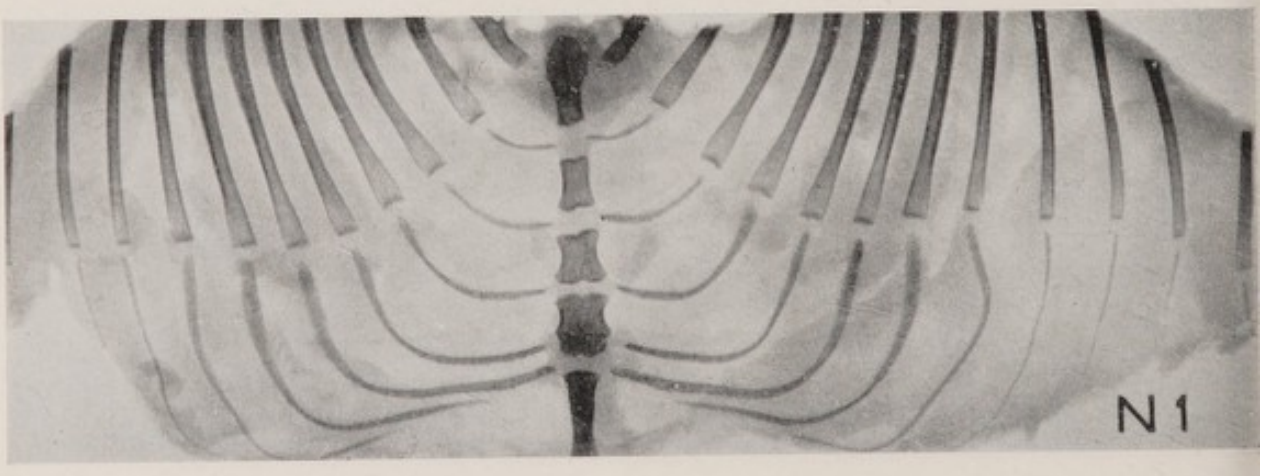

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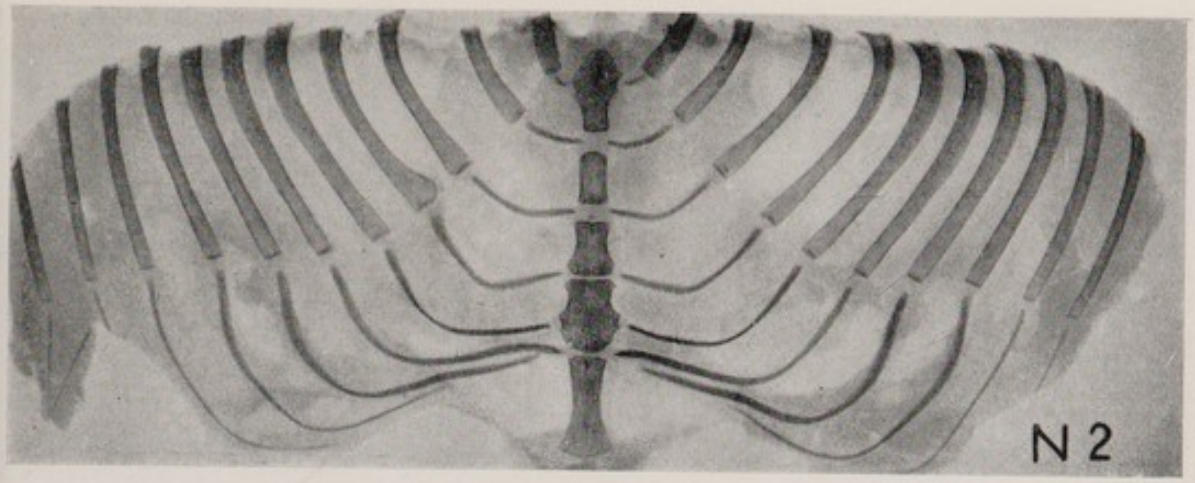

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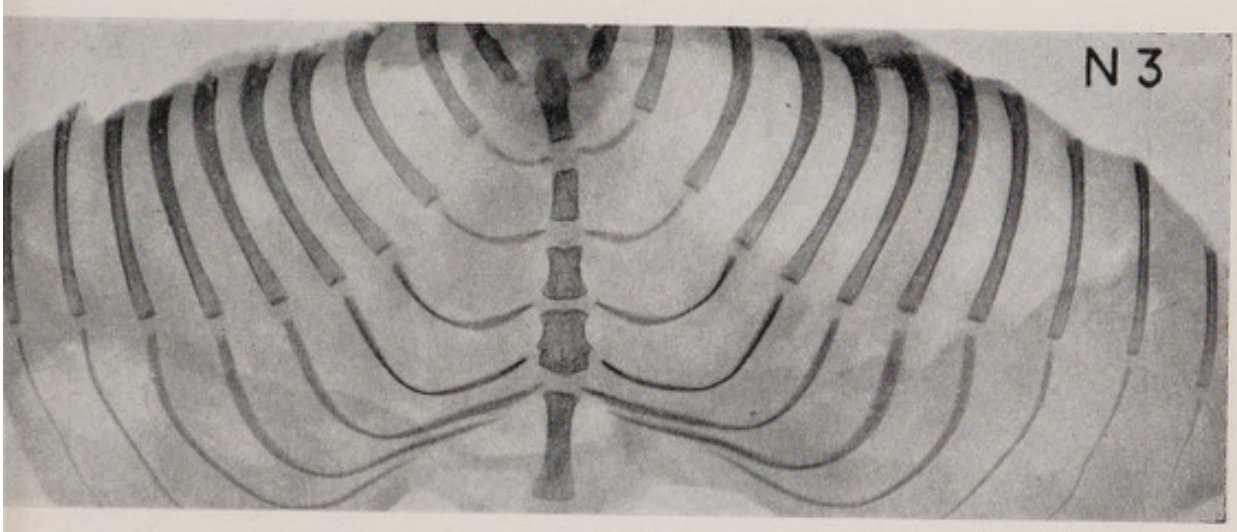

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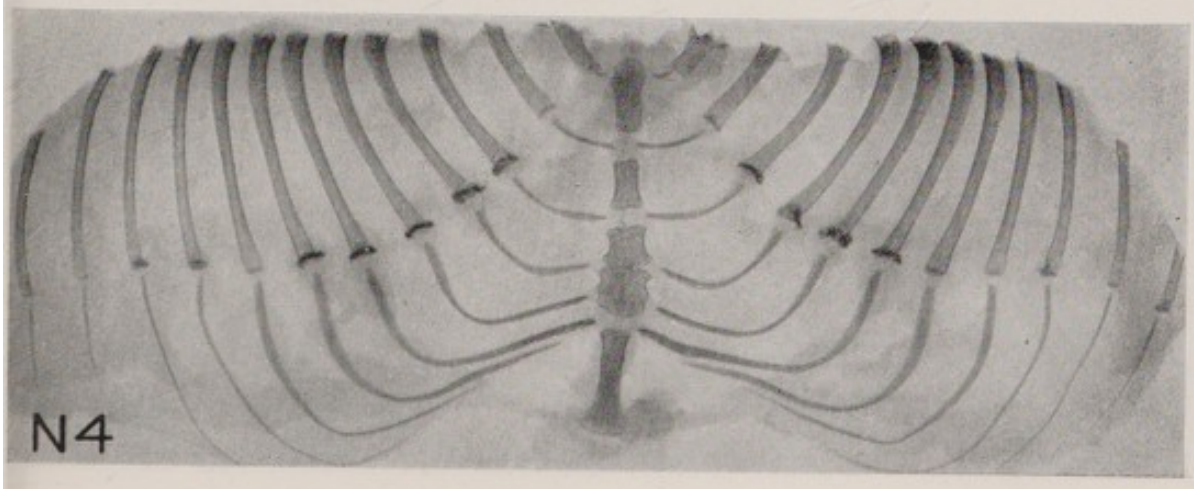

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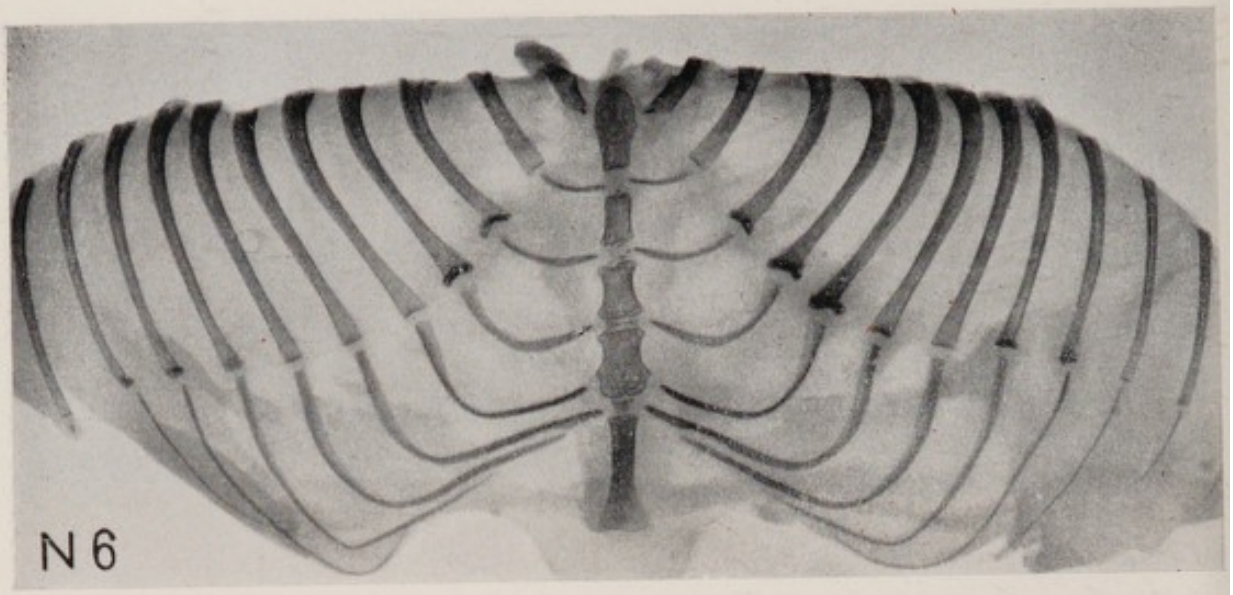

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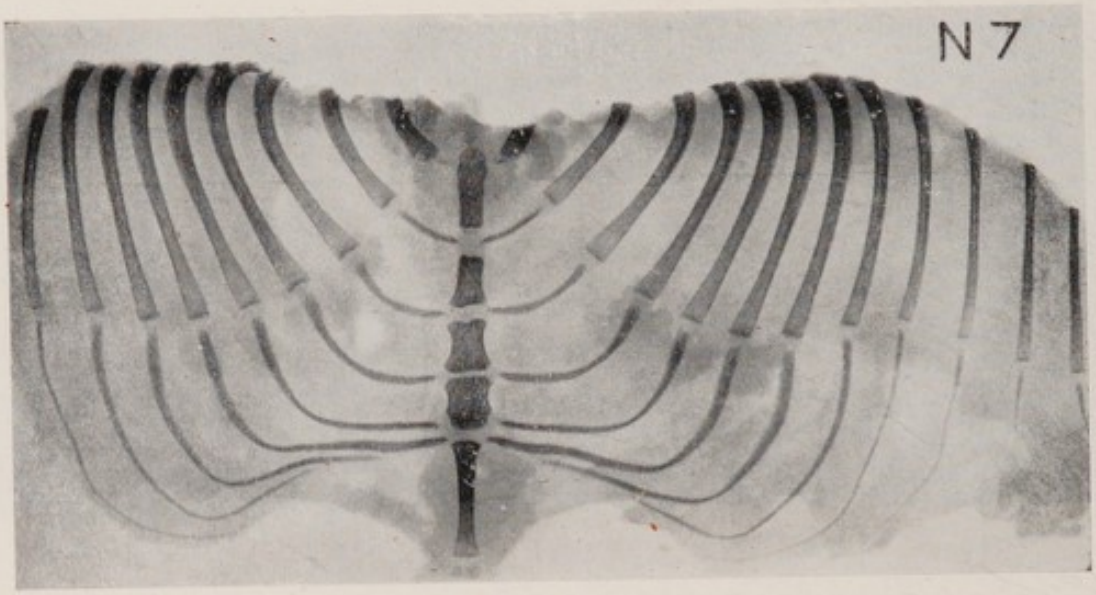

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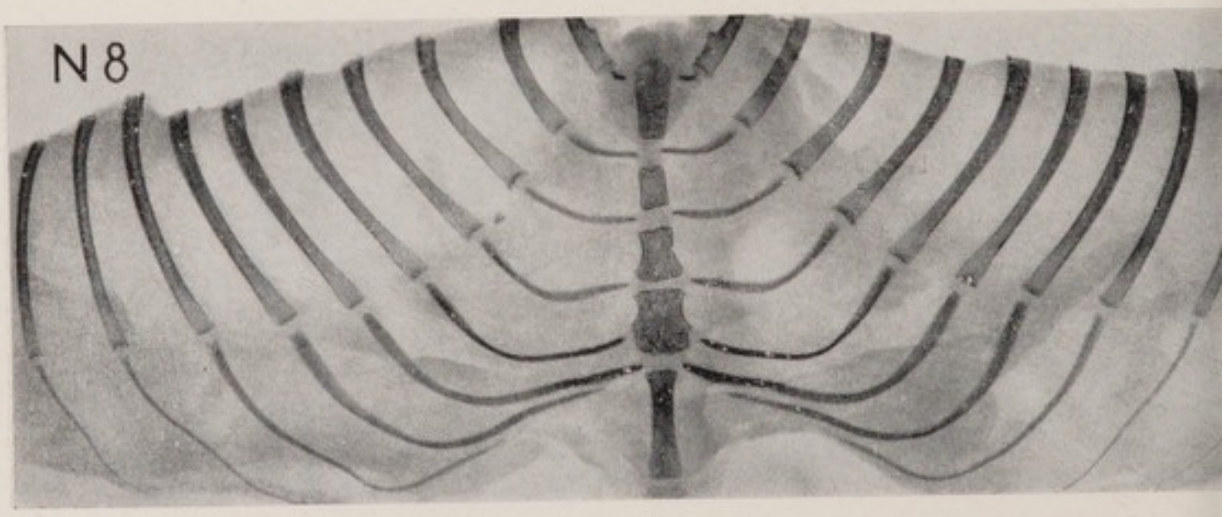

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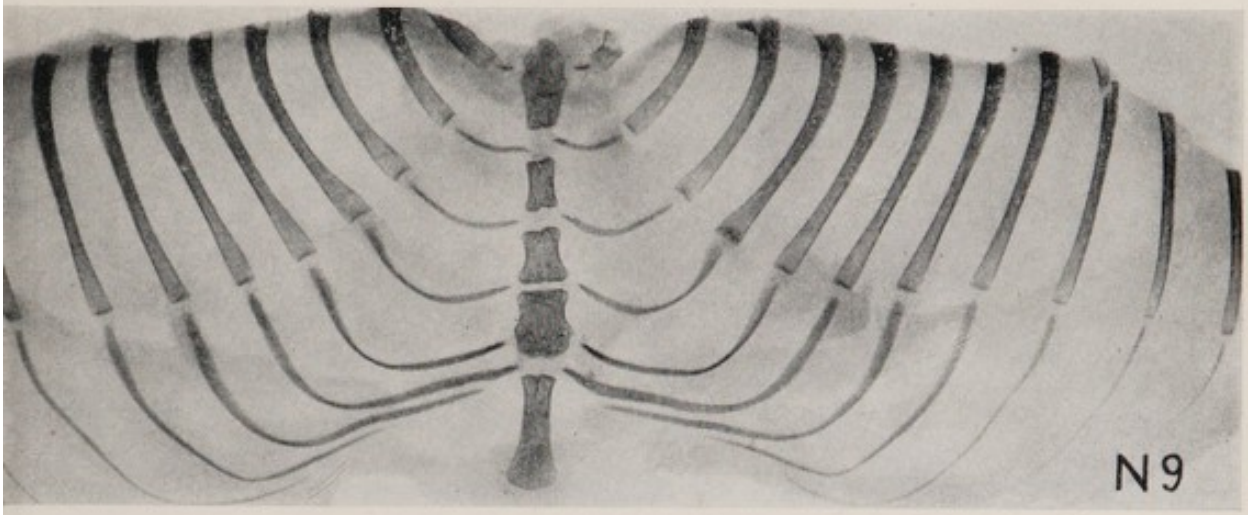

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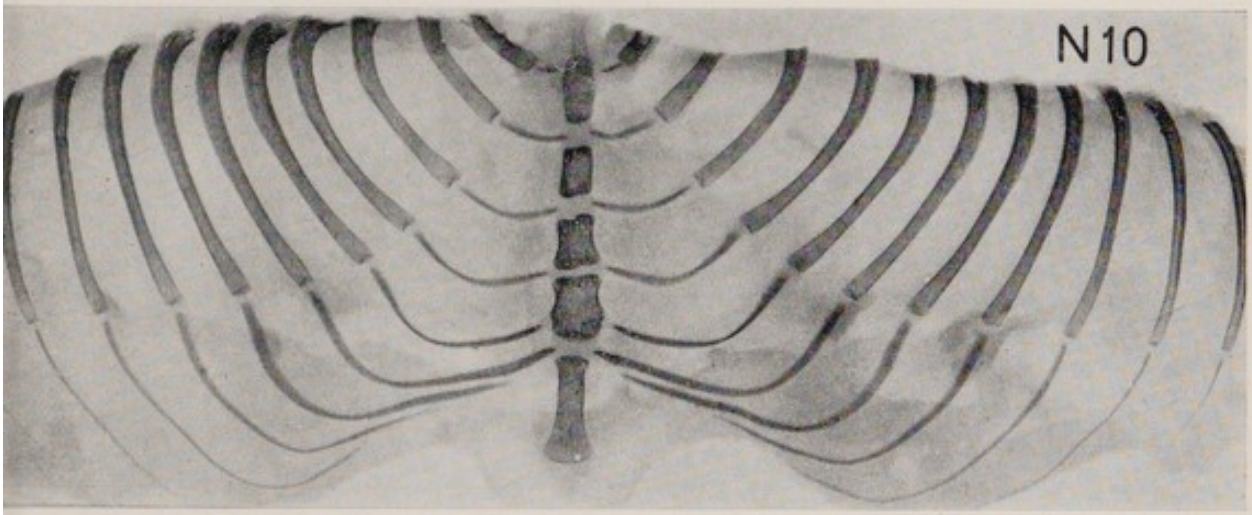

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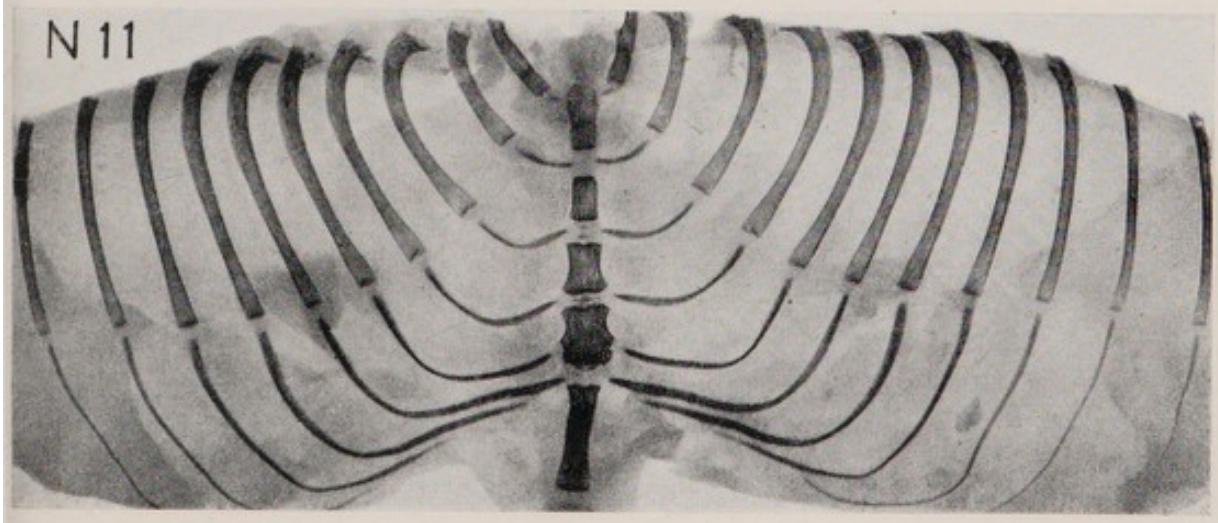

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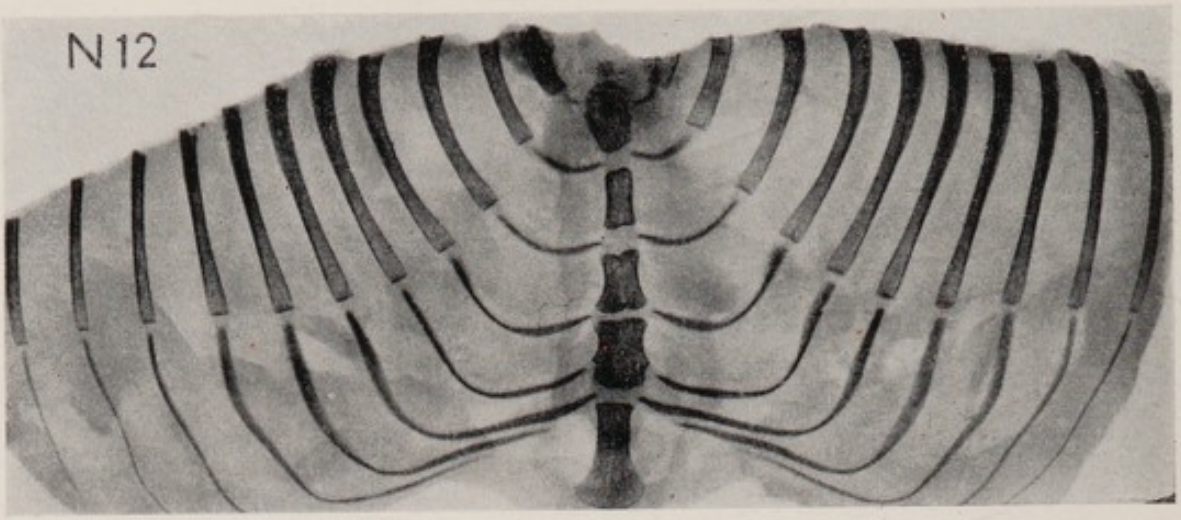

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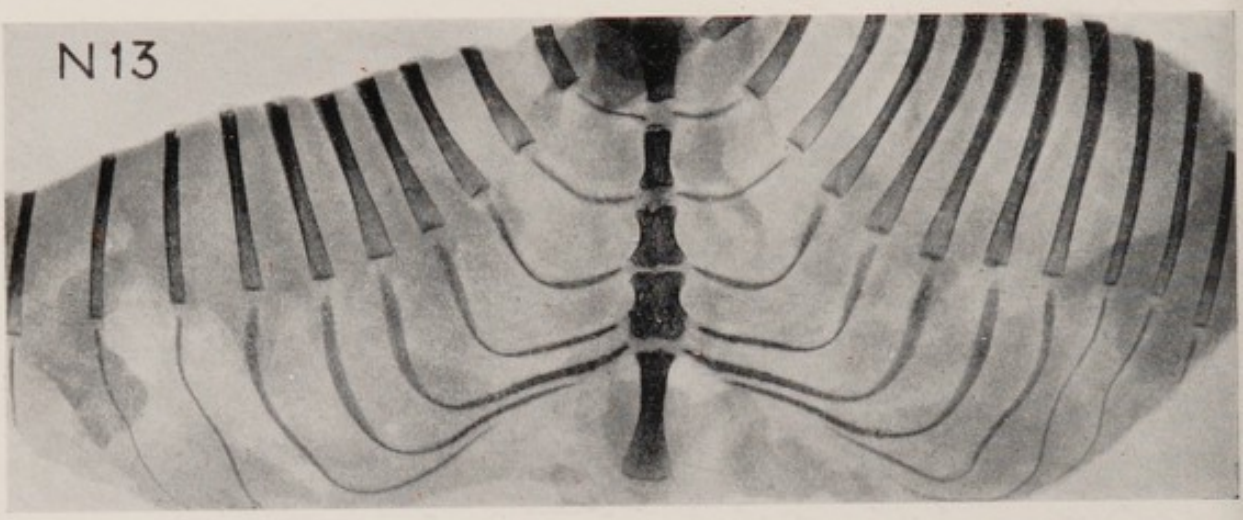

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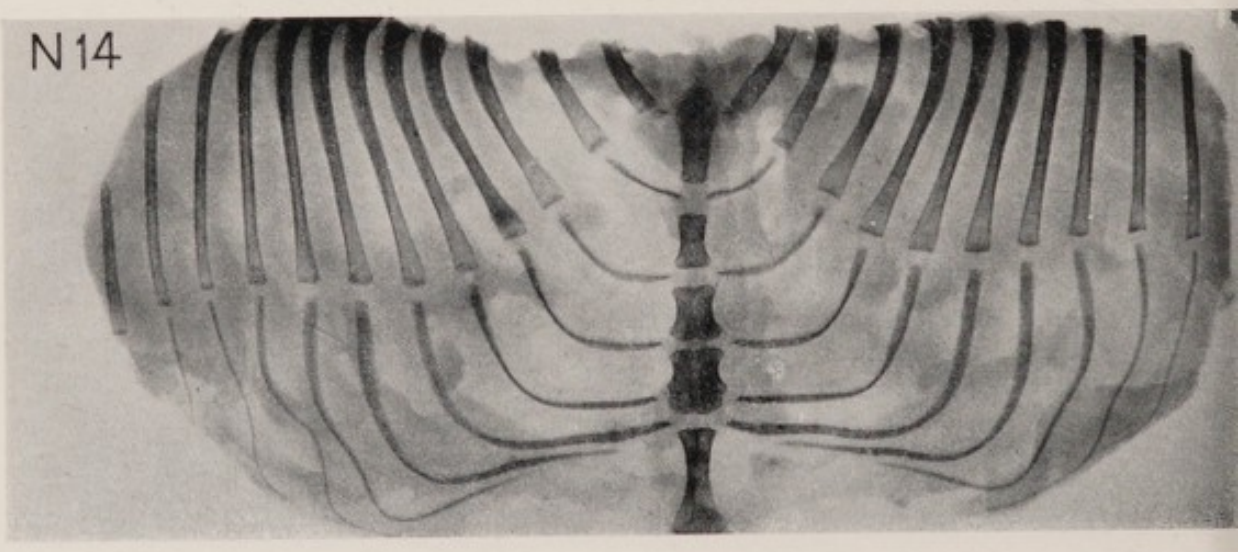

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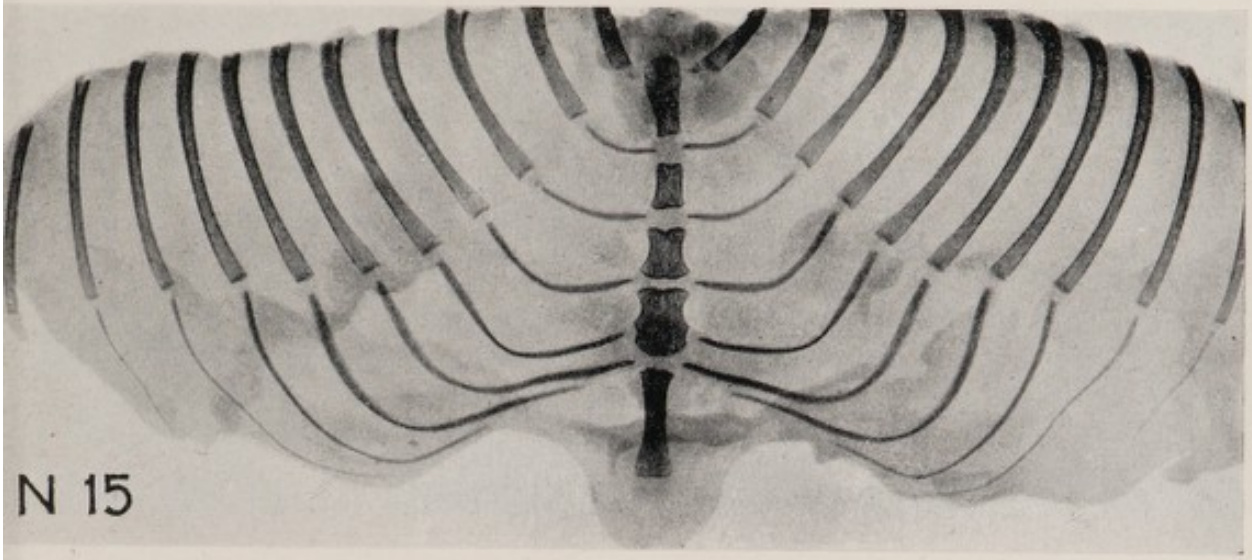

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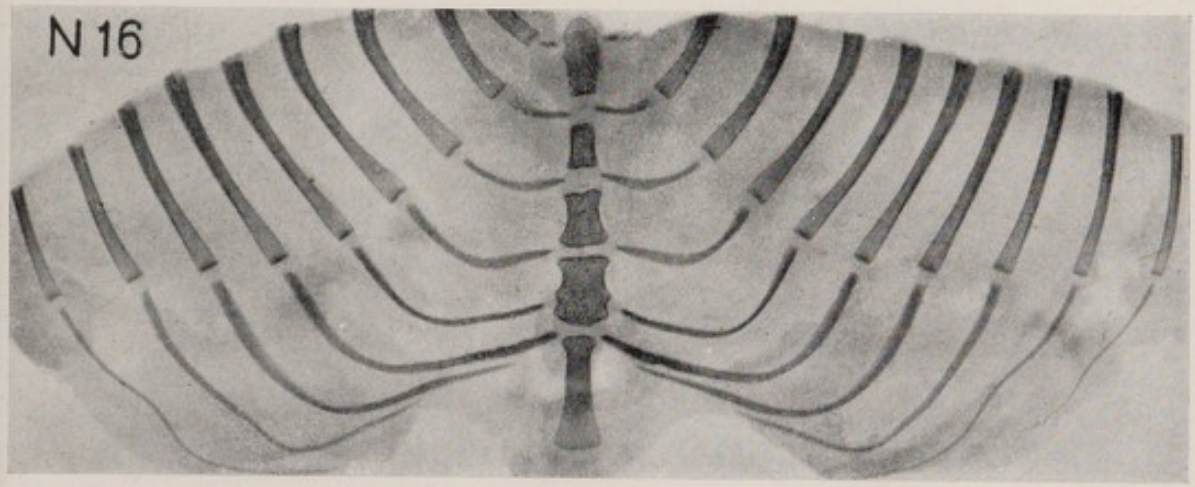
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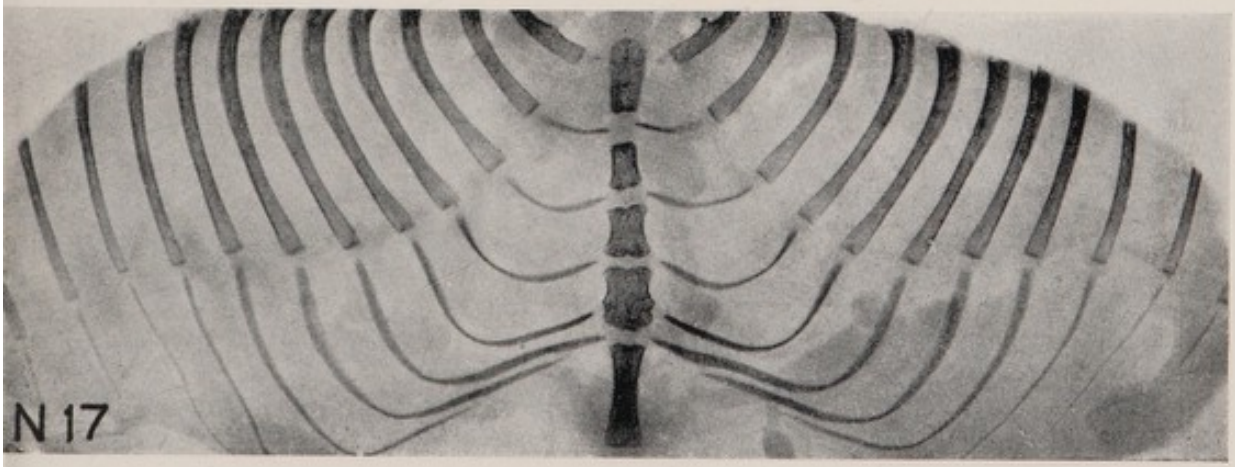


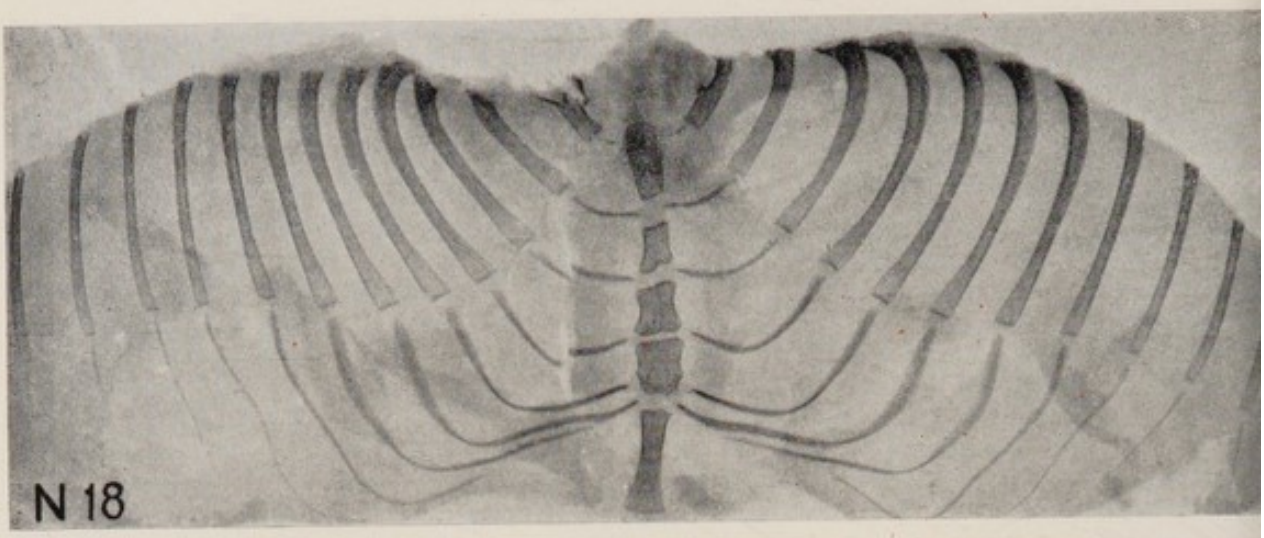


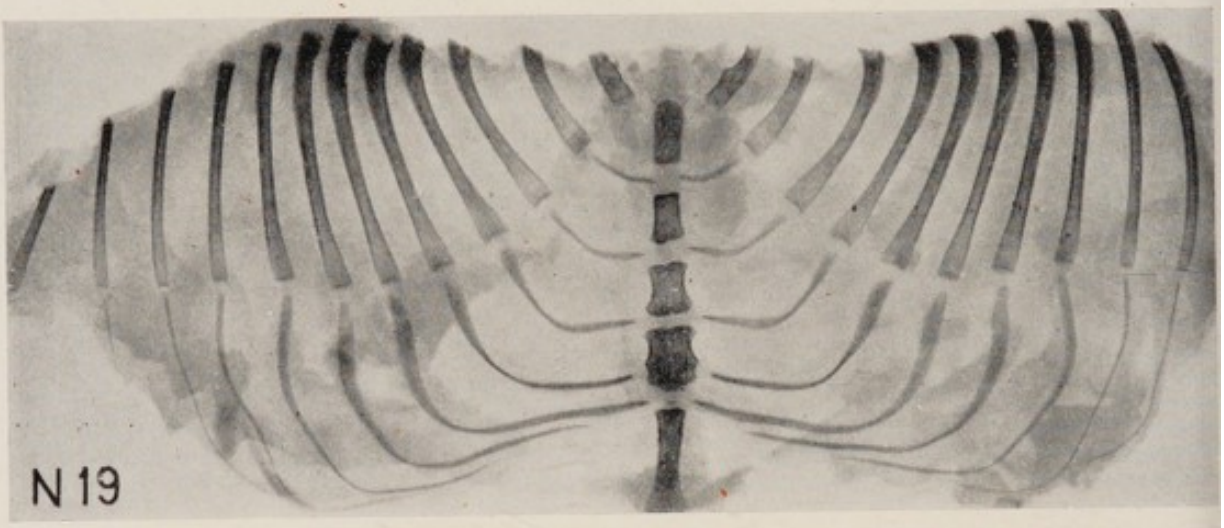


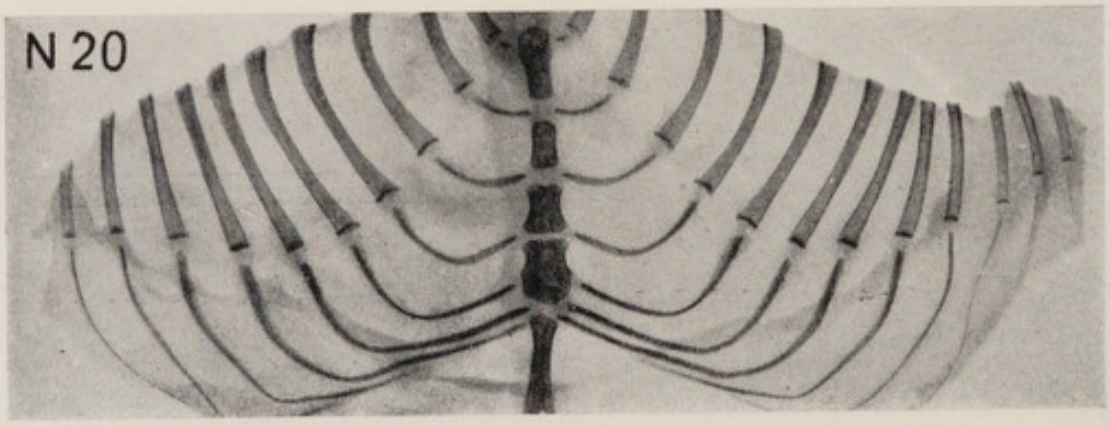

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PART V

RELATING TO IMPROVEMENTS IN HYGIENE, WITH SPECIAL REFERENCE TO UPPER NORRLAND OBSERVATIONS, SUGGESTIONS AND GUIDANCE

By

Nils Hellström, Director General, in collaboration with Gustav Ankarswärd, Chief County Medical Officer, John Byttner, Medical Counsellor, Josef Engvall, Counsellor to the Royal Board of Education, Dr. Harald Ernberg, Superintendent Medical Officer, Professor Gustaf Göthlin, Dr Martin Odin, Superintendent Medical Officer, Nils Sonesson, Assistant Principal, the Royal Board of Agriculture, and Gösta Westin, University Lecturer.

TABLE OF CONTENTS.

Page

Introduction 5

Chapter I. Existing Swedish institutions engaged in the promotion of public health and personal hygiene 7

1. General survey 7
2. The County Councils 14
3. The County Agricultural Societies 16
4. Elementary and Continuation Schools 19
   a. Instruction 19
   b. Measures for the promotion of health culture 21
5. School homes 22
6. People's High Schools 25
7. The Swedish Red Cross 27
8. The Swedish Anti-Tuberculosis Association 29
9. Housewives' Societies 30
10. The Västerbotten Society for Popular Educational Courses 30

Chapter II. Guidance and suggestions for improvements in hygiene 32

1. General observations 32
2. Suggestions for the organization of a public health service, centred in the County Councils 37
3. Special fields of work 41
   a. Maintenance and inspection of dwellings, and the housing problem 41
   b. Care of the health of infants and small children in their homes, and maternity welfare 69
   c. Care of the health of children of school age .. 80
   d. The diet problem in Upper Norrland 90
   e. Dental services for school children and adults .. 100
   f. Gardening, with reference to conditions in Upper Norrland 107

Chapter III. Concluding Observations 114

Introduction.

The advice and instructions given in the following pages are intended to serve as a guide for improvements in the promotion of public health which investigations made have shown to be desirable or imperative. As these instructions are based substantially on the results of the said investigations, those who have conducted them have been asked to assist in the compilation of this report. As indicated by the title-page, contributions have been made also by other experts.

In order to avoid any misunderstanding, it should be pointed out that the authors of this part of the report are responsible for its contents only in so far as their names are appended at the end of the several sections.

It should be evident from its nature that this part of the report is intended primarily for persons who, in view of their official position, as members of the Riksdag, County Councils, Boards of Health, Care Committees, or other such institutions, may be expected to take particular interest in these matters, as well as for others who have devoted special attention to such questions. Only the Appendix, »Guide for Housewives in Norrland»,[1] is addressed to the general public.

However desirable it might be to give detailed advice and instructions on the promotion of public health, it is not possible to do so here, owing to the vast extent of the subject. It must be left to those institutions which are actively engaged in this field to give advice on matters of detail. In these circumstances the lack of a bibliography of suitable handbooks, pamphlets, etc., which might serve as a guide on the subject of public health, may perhaps be regarded as a regrettable omission. After much consideration, however, we have refrained from making such recommendations, because the literature on the subject has

[1] This appendix is not included in the English edition.

become so voluminous that a good and reliable handbook published in one year is liable to be superseded by another, issued, say, in the year immediately following.

As pointed out in the preface to this edition, Part V is, in some measure, outside the scope of this work. But, whilst presenting in popular form the principal results of the diet and dental investigations,[1] it was considered desirable to draw the reader's attention to other cardinal questions of social hygiene, in regard to which certain observations, though of a less elaborate character, had been made. In this connection it seemed natural to give some information on the principal measures taken by the State in recent years in this sphere. Though such additions are scarcely consistent with the general plan of this work, they nevertheless seem warranted in view of the class of readers for which Part V is mainly intended.

Many of the observations made in this report are applicable to other parts of the country besides Upper Norrland. Evils similar to those to which we have directed attention are doubtless prevalent in many other places. It should further be noted that we have discussed certain questions of organization whose scope is by no means confined to those northerly counties with which this report is primarily concerned.

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[1] This popular summary has not been included in the English edition.

CHAPTER I.

Existing Swedish institutions engaged in the promotion of public health and personal hygiene.

1. General survey.

We have endeavoured to obtain a survey of the various institutions which are at present working in Upper Norrland, directly or indirectly, for the promotion of public health, in those branches with which this report is concerned. For this purpose we have addressed enquiries to the various authorities and societies engaged in this field, and have met with a most ready response to our requests for information.[1] A brief summary of the results of this investigation will now be given.

The institutions referred to above are the following: —

County Councils.
County Agricultural Societies.
Elementary and Continuation Schools.
School Homes.
People's High Schools.[2]
The Swedish Red Cross.
The Swedish Anti-Tuberculosis Association.
Housewives' Societies.
The Västerbotten Society for Popular Educational Courses.

It should be pointed out from the outset that this list is not to be regarded as exhaustive. It might be objected with good reason

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[1] The particulars obtained in the original investigation were mainly for the years 1932 or 1933. In the English edition, however, this information has been brought up to date as far as the year 1934, or, where possible, 1935.

[2] Adult continuation schools.

that we ought to have included *the State*. The chief reason why it has been omitted is that its inclusion would have involved much tiresome repetition. It may be observed, however, that the services performed by the State in this field are very considerable, so much so that it would otherwise be impossible to carry on important activities on the present scale. Apart from the large grants in aid of elementary education, the State, in a greater or less degree, subsidizes various institutions which serve to promote public health. Such are, for example, the county own-your-own-home committees, communal school homes and useful employment schools, tuberculosis dispensaries, etc. These State subsidies will be duly mentioned in relevant sections of this report.

The *Communal Authorities*, through their local health boards [1] and care committees, have, nominally speaking, very important duties, and are invested with wide powers, in regard to public health and the care of children. For the following reasons, however, they have not been included in this investigation. Broadly speaking, only the towns and the largest industrial communities have been able to accomplish much in this sphere. Most of the rural communes, even where their authorities show real interest in these matters, have such limited financial resources that their activities in this field are confined within very narrow limits. The realization of this fact has led, in Upper Norrland as well as in other counties, to the formation of large private organizations for the promotion of the care of children. This movement has been accelerated by the prospect of assistance from a central institution, namely the Public Orphanage,[2] which will be dealt with in the sequel. As is explained in Chapter II, other measures of social hygiene can scarcely be carried out on any large scale without State aid.

Although the importance of the two above-mentioned authorities for the administration of the health services in question is, as we have seen, comparatively small, they should by no means be overlooked.

The functions of the local *health boards* are regulated by the Public Health Act of 1919, those of the *care committees* by the Law of 1924 relating to the public care of children.

[1] Under the existing law, every commune must have a local health board. Communes with a population of less than 3,000 may transfer the duties and powers of the health boards to the rural district councils, which have important administrative functions.

[2] See p. 10.

Some of the principal duties devolving on the local health boards are defined in § 35 of the Public Health Act. In accordance with this section, it is incumbent upon them to see to it that the population of the local health district have easy access to a copious supply of pure water for drinking and cooking, and that water mains are laid down, more especially in places where the population are concentrated in any large numbers; that drains through which foul slops are discharged shall be so arranged as not to be a nuisance from a sanitary point of view; that a supply of sanitary dwellings is available for the population of the district; and that, where possible, facilities shall be provided for hot baths and for bathing in the open air.

As the district medical officer has the right and obligation to co-operate with the communal authorities on questions relating to public health and medical attendance, those authorities have access to expert advice on medicine and hygiene. In another part of this report attention will be drawn to the duties of the local health boards in regard to the inspection of dwellings etc., in accordance with §§ 43—50 of the Public Health Act (see p. 59 ff.). All that need be added here is that the existing regulations give the local health boards great facilities for the successful promotion of public health within their several districts.

It now remains to make some brief observations regarding the public *care of children*.

Under the existing law [1] every commune or group of communes must have a *care committee*. Its principal function is to promote the improvement of the care of children and young persons. To that end the committee should endeavour to encourage the establishment and development of children's homes and of institutions aiming at the improvement of the upbringing of children in their homes; it should also take other measures with a view to the welfare of children and young persons; and should carefully watch the existing conditions in regard to the care and upbringing of children.

The law relating to the public care of children has considerably extended the powers of the communes to take charge of children with the consent of the parents, or, in certain cases, without it. In addition, these committees have been given wider

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[1] The Law of the 6th June 1924 relating to the public care of children and the protection of young persons.

powers to control the care of foster-children. For example, sick or weakly children, or children who are being brought up by parents who are unable to give them proper care, may be taken charge of by the local committee. The practical execution of these measures had long been impeded by the lack, in most counties, of suitable children's homes. Nowadays, however, grants in aid of the maintenance of County »reception homes» for children are made by the Public Orphanage.[1] These homes are intended for the reception of children who, before being boarded out in private homes, require care and observation for some time. Such are, for example, underfed, weak, ill-treated, backward or nervous children. There are also special homes for solitary expectant mothers as well as for infants in arms accompanied by their mothers. Thanks to the grants made by the Orphanage, which may amount to half the maintenance costs, the communal expenditure on the care of children and mothers in these homes is, as rule, not higher than it would be in private homes.

The actual installation of these homes has been facilitated by large grants from the Inheritance Fund.[2] They have been established in most counties, and have met an urgent need. In the County of Norrbotten there are three homes for children and one for mothers and infants. Such homes will shortly be established also in the County of Västerbotten.

In order to facilitate the transfer of the children from »reception homes» to suitable private foster-homes, grants have been made by the Orphanage towards the pay of female *care visitors*, trained in the care of children. Such visitors have been appointed also in the two most northerly counties. Whilst the care committees exercise general supervision over the children in their respective communes, the chief function of the care visitors is to assist in the selection of suitable homes. A general survey of the

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[1] The Public Orphanage is a very ancient institution, possessing large funds. It founded the first children's home in Sweden, provided accommodation on its own premises both for sick and healthy children, and made arrangements for the boarding-out of orphans in private homes. When the above-mentioned law of 1924 came into force, the Public Orphanage abandoned these independent activities. Since then it has supported the local care committees in the discharge of their duties.

[2] A fund administered by the Treasury, accumulated out of the property left by persons who have no legitimate heirs and have not bequeathed their property by will.

conditions in which foster-children live is now being made by the care committees, in co-operation with the care visitors.

With a view to coordinating the activities of the local care committees, *»welfare associations»* have been formed in all counties, with the County Governor as president and the chief county medical officer and other experts as members.

These various institutions, which are of comparatively recent date, have provided facilities for considerable improvements in the care of children of different ages, especially those born out of wedlock.

It should be observed that the above survey does not include the *medical staff* whose activities have a bearing on hygiene, that is the *county medical officers, municipal medical officers, district nurses, dispensary nurses and midwives.*

The chief county medical officer is the principal adviser of the county authorities in matters of health. It is incumbent upon him to watch with close attention the observance of regulations relating to public health and to supervise local health conditions in general. He should, for example, endeavour to ascertain the factors which tend to impair the vitality of the people and to suppress habits, customs and prejudices which are inimical to health. His duties also include the inspection of schools and the supervision of the care of children and their education.

The other county medical officers — 24 in Västerbotten and 21 in Norrbotten — are under obligation to watch the conditions which may affect the health of the population. They should, for example, make themselves well acquainted with the mode of life of the population, their habits, customs and prejudices, the foods and stimulants to which they are addicted, as well as the care and education of children. The duties of the municipal medical officers are similar to those of the county medical officers.

All the medical officers now mentioned are under obligation to co-operate with boards and other authorities whose activities have a bearing on public health and the care of children.

The services rendered by these medical officers in regard to the improvement of hygiene are naturally performed in close connection with their daily duties of a purely medical character.[1] In the course of these duties they are brought into touch with the people in their homes, get to know their habits and conditions of life, and find many opportunities to impart useful advice. In accordance with instructions which came into force in 1931, medical officers are under obligation to pay regular visits to outlying

[1] The *chief* medical officer is under no obligation to receive patients.

parts of their districts with a view to the inspection of hygienic conditions.

The *district nurses* have the duty of giving information and advice in regard to the care of children, the maintenance of dwellings, hygiene, and other kinds of prophylactic treatment, as also in regard to all nursing which can be carried on in the homes. The qualifications for appointment as district nurse are (1) to have passed through an authorized school for nurses and (2) to have attended a complete course at a State school for district nurses. The course at the first-mentioned school is *at least* two years. The last-mentioned course is one year, and is intended to impart knowledge of subjects which are particularly useful in public health practice. The actual training of the district nurse in its first stage is concentrated on sick-nursing, and is carried on in State-controlled schools attached to large hospitals.

The general direction of the district nursing service in each county area is in the hands of a board (see below, 2. County Councils). The immediate supervision of this service devolves on the county medical officers within their several districts.

State grants in aid of the district medical service are made only to County Councils, and are not payable in respect of towns with a population of over 3,000. This service is thus intended primarily for *rural* districts. A condition for the receipt of a State grant is that the service shall be organized in accordance with a plan examined and approved by the Medical Board. A normal district is supposed to comprise a population of about 3,000.

The existing regulations on this subject, some of which have been summarized above, came into force at the begining of 1936. Whilst they are based in essentials on previous regulations, they are intended to create a more uniform organization of the district nursing services, to promote these services by larger State grants, and to stress the importance of social hygiene.

The organization of the district nursing services has hitherto been rather irregular. This is strikingly shown by the fact that, whereas in 1934 there were twenty-nine district nurses in Norrbotten, there were only six in Västerbotten. This disparity, it should be observed, is not due to any appreciable differences in the geographical features of the two counties or the size of their population. As trained district nurses are not at present available in sufficient numbers, it will take some years before the plan can be carried out in its entirety.

The services performed by district nurses in 1934 are shown by the subjoined table:

County	Number of district nurses	Nursing in the patients' homes		Short visits to patients' homes for nursing	Dressings etc.	Assisted doctors at consultations	Journeys with patients to and from hospitals	Disinfections	Particulars given regarding social hygiene work *not* connected with nursing [1]		
		Whole-day nursing	Nights on duty						Number of visits to homes, for care of children	Number of visits to homes, for advice on the care of dwellings	Number of visits to homes, for poor relief
Västerbotten	6	34	26	1126	1495	4	31	19	52	not reported	19
Norrbotten...	29	486	431	17923	7771	29	346	346	2296	209	740

In Norrbotten the district nurses have assisted in the instruction of school children in personal hygiene.

Most of the services rendered by the district nurses in regard to social hygiene are, as the table indicates, closely connected with their nursing functions. The services performed by them in this regard without any actual connection with nursing are shown in the last three columns of the table.

The *dispensary nurses* are employed at the various dispensaries for tuberculosis patients, and are under the superintendence of the dispensary medical officer. In Västerbotten there are 15 dispensaries, each with one nurse. In Norrbotten the number of dispensaries is 26; there are 21 dispensary nurses, besides which 9 district nurses are in charge of dispensaries.

As the services rendered by Swedish midwives are not confined to the actual accouchement, but comprise also the care of mother and child for some time after the birth, they discharge important functions in regard to personal hygiene.

The Medical Board have been engaged on an enquiry with a view to the reorganization of the dispensary service in conformity with the new observations made in the field of prophylactic tuberculosis. This enquiry has resulted in a report, in which the following plan has been drawn up: —

[1] The figures in the last three columns are for the year 1932.

Each county is to be divided into dispensary districts. In counties with a low incidence of tuberculosis and well-organized district nursing services, the district nurses shall also discharge the duties of dispensary nurses. In the other counties special dispensary nurses shall be appointed. In each county there shall be only one dispensary, which shall be superintended by a specially trained medical officer and be equipped with Röntgen apparatus of standard type. The dispensary service is to be maintained with the aid of State grants. Dispensary nurses are to have the same training as district nurses. (Hellström, Byttner.)

A brief account will now be given of the various institutions enumerated in the list on p. 7.

2. The County Councils.

The institutions called *Landsting* (County Councils) are of very great importance for the medical service of the country. For example, they own and maintain the hospitals intended for the treatment of somatic diseases. In regard to the maintenance of hospitals for tuberculosis and for infectious diseases as well as homes for chronic invalids, they are financially assisted by State grants. As the available accommodation for patients at private hospitals is extremely limited, hospitals in Sweden may be regarded, broadly speaking, as entirely public institutions.

The County Councils, with the aid of State grants, administer also other medical services, such as those of the district nurses and dispensaries.

The functions of the County Councils are regulated by laws and decrees. With the single exception mentioned just below, a county council area coincides with that of a county. The total number of counties is 24. But, as one of the counties (Kalmar) is divided into two areas, the number of county council areas is actually 25. The members of the County Councils are appointed at elections in each area.

The County Councils are entitled to levy a local tax to cover their expenditure. As the maintenance of the above-mentioned medical services is the principal function of the County Councils, and as the fees paid by patients are comparatively small, these medical services are the largest item in County Council expenditure.

When the population of a town has reached a certain size, it is entitled to withdraw from the county council area. Four towns are, practically speaking, quite independent in regard to the administration of their medical services. The expenditure on these services is met out of the taxes levied by the Municipal Council.

The supreme control of the public health and medical services in the whole country is in the hands of the Royal Medical Board (*Medicinalstyrelsen*), which is a State institution.

It was not until recent years that the County Councils in general began to recognize the importance of prophylactic measures with a view to the promotion of public health. For financial reasons, however, such measures have hitherto been taken only on a comparatively small scale. This is especially the case in the two most northerly counties, where there is a severe strain on the County Council finances. Even these County Councils, however, have adopted certain measures of a prophylactic character. The services performed by district nurses and dispensary nurses as well as the instruction in the theory of nutrition imparted at People's High Schools and rural domestic schools are dealt with in other sections of this report. It remains to mention certain additional measures of a hygienic or prophylactic character which have been taken by the two northerly counties.[1]

The *Västerbotten* County Council for several years has voted a grant of 500 kronor per annum for *demonstration courses in the care of infants.* These courses have been given in a number of the communes in that county. The County Council has also voted annual grants in aid of *summer colonies.* In recent years this grant has amounted to 2,000 kronor per annum. It should also be mentioned that the County Council, in connection with the dispensaries, maintains 9 *children's homes,* intended for the accommodation of children from consumptive families. Finally, it may be as well to add that this County Council supports the organization of ambulatory school *kitchen courses* by a tiny grant of 150 kronor per annum.

The *Norrbotten* County Council likewise votes a grant of 500 kronor per annum towards *demonstration courses in the care of infants.* These courses, which are planned by the Swedish Association for Poor Relief and Child Welfare, are reported to have attracted the greatest interest among the people. In addition, the

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[1] The figures are for the year 1932.

County Council makes the following annual grants: towards the organization and maintenance of *country holiday colonies* 20,000 kronor; towards the maintenance of two *children's homes*, for healthy children from tuberculous families, about 16,000 kronor; towards the maintenance of *Finnish vapour baths*, the establishment of which is supported by a large subsidy from the Pensions Board, 2,000 kronor; towards ambulatory *school kitchen courses* at various places in the county, 500 kronor (HELLSTRÖM, BYTTNER, ANKARSWÄRD).

3. The County Agricultural Societies.[1]

The following is a summary of a report from the *Västerbotten* Agricultural Society regarding its activities in the field of social hygiene: —

1. In connexion with the grant of loans for promotion of the own-your-own-home movement, the Society takes rather extensive measures with a view to improvements in the types of dwelling-houses to be erected, or the maintenance of old houses. The own-your-home committee set up by the Society, whilst exercising its function of examining building designs, brings some influence to bear on the structure of dwelling-houses by supplying model designs. Through its technical advisers and itinerant stewards, the Society is in a position to advise the farmers also on questions relating to the building of dwelling-houses. (See Chapter II, 3 a.) A grant is made by the Society's own-your-own-home committee towards the organization of courses in architecture.

2. Ambulatory courses in cookery, baking etc. (housewifery courses), in the preparation of preserves, and in gardening have

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[1] The county agricultural societies (*hushållningssällskap*) are voluntary organizations formed by Swedish farmers with the object of promoting technical and economic improvements in agriculture. The areas within which they operate correspond, as a rule, with those of the counties. There are 26 of these societies in Sweden, with altogether 135,000 members.

The county agricultural societies are now in receipt of large State grants, as they assist in the execution of Government measures for the relief of agriculture. The organization of these societies has thus acquired a rather marked administrative character. In this respect they may be compared with the German »*Landwirtschaftskammer*» of former days.

been organized by the Society. The number of these courses held in 1932—1935 and the extent to which they have been attended are shown in the table below:

Year	Housewifery Courses		Preserving Courses		Gardening Courses	
	Number of courses	Number of students	Number of courses	Number of students	Number of courses	Number of students
1932	9	120	32	279	8	475
1933	6	100	21	197	—	—
1934	8	99	27	381	8	300
1935	9	107	28	220	—	—

The duration of the housewifery courses was four weeks, of the courses in preserving three days (in a few cases a couple of days more), and of the courses in gardening three days. In the housewifery and preserving courses the number of working hours was about seven, the chief stress being laid on practical work. The gardening courses took the form of lectures for about three hours a day. In all these courses suitable literature was supplied at a reduced price or gratis. From 1933 onwards ambulatory courses in practical gardening have been organized with State aid. They have been held for two days in the spring (sowing), for two days in the summer (care of growing plants) and two days in the autumn (harvesting). In addition, instruction in gardening, on a considerably wider scale, is given at the Society's rural domestic school. At that school two 5 $^{1}/_{2}$ months' courses are held annually, with 16 students in each. The instruction is both theoretical and practical. The practical instruction includes cookery 510 hours, dairying 70 hours, gardening 70 hours, laundry work, dusting, sweeping etc., 125 hours. The theoretical instruction includes subjects such as the science of nutrition and foods 52 hours, household management 10 hours, dairying 14 hours, gardening 30 hours, hygiene, sick-nursing and care of children 20 hours. From 1930 to 1932 inclusive 21 rural science courses, with altogether 1,066 students, were held, on an average, at this school. These courses included occasional lectures on building questions and other subjects bearing on hygiene.

The following information on the same subject has been received from the *Norrbotten* Agricultural Society: —

1. Measures for the improvement of the types of dwelling-houses and for the maintenance of old houses have been taken in rural districts since 1905, and are still proceeding. As in the case of the Västerbotten Society, these measures are organized through the own-your-own home committees, as well as through the Society's advisers and itinerant stewards. Guidance in regard to the erection of more serviceable and sanitary dwellings is given also in connection with the annually recurring courses in rural science which have been held since 1904, as well as at other courses organized by the Society for the benefit of the rural population. Model designs and sketches are supplied by the Society.

During the years 1933—1935 9 courses in rural science were held on an average per year with a duration of one week and about 49 students per course, and 22 courses with a duration of three days, with 49 students, on an average, per course.

2. Other measures taken by the Agricultural Society: —

The Society's advisers in domestic economy have organized the following short courses. The figures are yearly averages:

Housewifery courses:

17 with a duration of six days and, on an average, 15 students.

Courses in the utilization of butcher's meat:

9 with a duration of six days and, on an average, 12 students.

Preserving courses:

22 with a duration of three days and, on an average, 10 students.

Gardening courses:

9 with a duration of six days and, on an average, 15 students.

At these courses suitable literature has been sold at half the bookseller's price, or distributed gratis.

The courses in the utilization of butcher's meat are intended to give instruction in the rational utilization of all the edible parts of meat, the preparation of tasty dishes, especially sausages, brawn, bread prepared with blood, etc., as well as pickling and preserving.

The courses in preserving and the utilization of garden produce include propaganda for the cultivation of kitchen-garden plants, instruction regarding the value of such plants for the rural home, practical instruction in the cooking of garden produce, drying, pickling, and preserving of vegetables, preparation of fruit syrups, preparation of compotes, fruit pulp and jellies, as well as in the preservation of meat and fish in hermetically closed tins.

3. At the Society's rural domestic school at Gran, near Öjebyn, courses in rural economy, with a duration of 5 $^1/_2$ months, were held during the years 1932—1934. The number of students attending these courses averaged 22. In addition, two courses in domestic science were held, with, on an average, 6 students in each. At the rural economy courses practical and theoretical instruction was given in the following subjects: cookery, baking, preserving etc., 385 hours, science of nutrition and foods 30 hours, dairying 60 hours, laundry work, dusting, sweeping etc., 138 hours, gardening 166 hours, hygiene and care of children 30 hours, tending of poultry and other small domestic animals 49 hours, needlework and weaving 26 hours, book-keeping 11 hours, etc. In the domestic science courses the instruction in the science of nutrition averaged 30 hours, in hygiene and the care of children 20 hours. Similar instruction is given at the rural domestic school at Matarengi, conducted by the People's High School in the Tornedalen district. (HELLSTRÖM, ANKARSWÄRD.)

4. Elementary and Continuation Schools.

a. *Instruction.*

Within the area covered by this report instruction in cookery, domestic hygiene, etc. has been imparted in elementary schools only in certain towns and other thickly populated places. These subjects, however, are taught in most of the continuation schools. The latter are an obligatory extension of the public elementary schools,[1] and are intended to impart instruction which will be useful in practical life. Thus the girls receive tuition in domestic economy, hygiene, the science of foodstuffs etc. (see below). The course is 360 hours, and at least half the time is devoted to instruction in domestic work. It has obviously been a very difficult matter to make satisfactory provision for the requirements of public elementary education in the thinly populated rural districts and desert regions of Upper Norrland. Simpler types of schools, which barely come up to the minimum standard, still occur to a considerably larger extent than in other parts of Sweden. Now,

[1] The course at the public elementary schools has long been six years. In accordance with a Bill passed at the 1936 session of the Riksdag, the course will be extended to seven years. The obligatory seven years' course is to be introduced within 12 years.

however, we have reached a stage in which all the children who have passed through the public elementary school can complete their education at the continuation schools.

The plans of instruction hitherto adopted by most of the continuation schools are based on a model scheme drawn up in 1919 by the Royal Board of Education. In accordance with these plans the curriculum in regard to cookery, domestic hygiene and domestic economy, is as follows: —

1. Practical work.

Cookery, baking, pickling and cleaning work; mending and altering of garments, as well as plain needlework or simple dressmaking, such as the making of children's clothes. Removal of stains; laundry work. The use and the care of the sewing-machine.[1]

2. Science of nutrition.

The metabolism of the human body and the substances, organic and inorganic, which it requires; the most common foods from the vegetable and animal kingdom; their origin, preparation, nutritive value and price; criteria for judging the quality of certain victuals; the vitiation of victuals and indications thereof; the keeping and preserving of foodstuffs; their use and treatment in cooking; spices, their origin and use. Luxuries (tea, coffee etc.), their use and abuse. Adulteration of foodstuffs, spices and luxuriès. Food for infants and sick-cookery.

3. Clothing.

The essentials regarding the preparation and qualities of clothing materials; the prices and durability of different stuffs; the design and neatness of clothing; the daily brushing etc., of clothes.

4. The Dwelling.

The practical equipment of the dwelling; the care and cleaning thereof; furniture and household utensils, their suitable appearance and design, the care and use thereof; bed-clothes, the designing, care and cleaning thereof; heating and lighting apparatus; water pipes and drains; cleansing materials, polishes, etc., and their use.

5. Hygiene.

Personal hygiene; the care of infants; simple rules for nursing in the home; infection, isolation and disinfection; first aid.

6. Designing of patterns for garments, drawing of patterns after the model of Swedish peasant costumes, all in connection with dressmaking.

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[1] Instruction in domestic science should be eked out by instruction in the tending of domestic animals, dairying and gardening. In order to allow time for the teaching of the latter subjects, suitable reductions should be made in the time devoted to other subjects.

7 a. Domestic Economy.

The principal items of expenditure; savings, insurance, cooperative societies; purchase on credit, purchase on the instalment system. Matters relating to household economy, such as the spending of the annual income in large and small families, buying in large lots and small parcels, arrangement of the dietary within certain price limits per week or month. Simple domestic book-keeping; information regarding the postal and telegraph services and railway communications, as well as the filling-up of the most common kinds of printed forms. The importance of domestic crafts; domestic industry associations.

7 b. The importance of work, from social and ethical points of view.

Work as a basis of the maintenance and development of the social community. Solidarity in work and the interdependence of the workers. Honesty and fidelity in work. Joy in one's work.

Communal school homes. The communal authorities, in most cases with the aid of State grants, have erected »school homes» at several places in Norrbotten and Västerbotten. The number of such homes already erected is 6 in Västerbotten and 13 in Norrbotten. They are intended for the reception, bringing-up and care of children who live at a considerable distance from a school, and especially for neglected children from poor homes. As, in accordance with the regulations, children admitted to a school home must be taught at a whole-time school, they receive their actual instruction in school subjects at the local elementary school. The girls, however, regularly take part in the domestic work of the school home. This, of course, is a very useful training, which subsequently facilitates their studies of domestic science at the continuation school. (Hellström, Engvall.)

b. *Measures for the promotion of health culture.*

Measures which have a direct bearing on the promotion of the health of school children are, unfortunately, still in quite an initial stage.

The great extent of the rural communes and the distance of many places from the residence of the district medical officer put great difficulties in the way of a satisfactory and systematic medical examination of school children. Such examinations therefore occur only at a small number of schools in rural districts. It should be noted, however, that, by the direction of the Government, provision has been made for the regular medical examination of school children in the communes bordering on Finland. It should

further be mentioned that certain communes, including some in thinly populated districts, without any assistance from the State, have made efforts, which, in view of their very limited financial resources, are highly commendable, to promote the health of school children by medical examinations and in other ways. For example, several school districts have made arrangements for the ultra-violet-ray treatment of children who require it, whilst some schools have organized the provision of meals for the children. School baths have been established in schools in Norrbotten, where, especially among the Finnish-speaking population, the use of the Finnish vapour bath, a very ancient custom, fortunately still survives. Also in other parts provision is being made for baths for school children. This, moreover, is a matter which is engaging the attention of the Government. Furthermore, there are several private societies for the promotion of the health of school children.

The whole question of the promotion of the health of children is at present very much to the fore in Sweden. Rather extensive Government measures in this direction are, in fact, in course of preparation (see pp. 80—90).

The *dental service* for school children is fairly well organized in towns and urban communities, especially in the mining districts, whilst in schools in country districts regular provision for the care of the teeth is quite exceptional. A committee appointed by the Government to enquire into this question have, however, proposed that facilities shall be provided for the care of the teeth of every child under obligation to attend school, the intention being that the children, on leaving school, shall have their teeth in perfect order. (See below, p. 103.)

In both counties arrangements have been made for summer colonies, where delicate children are well looked after. These colonies meet a crying need, and are a great boon to children from poor homes.

Finally, attention should be drawn to the important part played by the numerous school homes in promoting the health of school children. (Hellström, Byttner, Engvall.)

5. School Homes.

The school homes *(arbetsstugor)* organized by foundations in the Counties of Västerbotten and Norrbotten are of the same type. Most

of them provide accomodation for thirty children : some are a little larger, some slightly smaller. They are intended for the maintenance and education of children of school age who, owing to the distance of their homes from a school, the poverty of the parents, neglect, or, for other reason, would be debarred from receiving a proper school education. They attend the local elementary school, and receive instruction in handwork in the school home. By way of practical training, they take part in the domestic work of the school home.

The expenditure entailed by the maintenance of these school homes is met partly by State grants; the remainder of it is defrayed by private donations, church collections throughout the country, the interest on the foundation funds, and certain communal grants. The foundations are administered by a central council, and each school home is managed by a local board.

The following particulars, kindly supplied by the secretaries of the foundations, will serve to show how these school homes are conducted : —

Västerbotten. Apart from guidance in the preparation of lessons, no purely theoretical instruction is imparted in the school homes. Hence cookery and domestic economy are not taught as actual subjects. But the girls, in the course of their six years' training in domestic work, receive practical instruction in the proper cooking of such food as is available in their homes. They are taught, for example, to make the dietary as varied and digestible as possible. In this way they obtain some insight also into the theoretical aspect of the subject.

At one of the school homes gardening was practised for some years with such success that garden produce, after yielding abundant supplies for the table, was actually available for sale. This success has induced the central council to take steps for the laying-out of gardens at all the school homes. Not only do the children thoroughly enjoy the garden work, but they soon acquire a liking for carrots, turnips and other vegetables. It should be noted that in these parts milk and potatoes, fish and game are usually the principal articles of food. It is therefore important to induce the people to eke out this dietary with garden produce containing an abundance of vitamins.

Many, not to say most, of the children are under-nourished and mentally backward when they enter these homes. Plenty of good, nourishing food, practical clothing and sufficient night rest in separate beds and airy bedrooms soon work wonders. It occa-

sionally happens that a newcomer cannot stand the comparatively rich food of the school home, and may therefore have to be put on a special diet so as gradually to get accustomed to the regular fare. As for mental backwardness, it is soon dispelled by intercourse with the other children in the home and at the local school, as well as by the many new impressions produced by removal from an isolated cottage or a small roadless hamlet to a church village of some size.

The five school homes established by the Västerbotten Foundation now provide accomodation for 150 children.

Norrbotten. In the school homes instruction in personal hygiene and nursing is given only in the form of practical guidance, theoretical tuition in these subjects being left to the elementary school. Practical instruction in the care of the body is, however, all the more thorough. Daily ablutions, careful attention to other details of the toilet, and a vapour bath at least once a fortnight are prescribed by the school régime. Every school home is equipped with a vapour bath of the Finnish type. The children are so thoroughly drilled in the rules of hygiene that what at first seemed a most irksome drudgery eventually becomes a sheer necessity. They are examined by a doctor in the spring and autumn, and a report of these medical examinations is transmitted to the central council at Luleå.

The elder girls take turns at cooking, washing-up and laying the table. Meals are served punctually to the minute, in marked contrast to the habits in the children's own homes, where, generally speaking, there are no regular meals at all. The fare in the school homes is as rich as its plainness and cheapness permit.

Apart from minor variations, all the school homes have the same dietary. Coffee is served only on Sundays and special occasions. In order to eke out the vitamin content of the food, most of the school homes now grow their own carrots, which the children daily eat raw, and seem to relish. On their arrival at the homes the children are usually under-nourished, flaccid, undergrown, and greatly under weight. The increase in weight during the first terms is often marvellous. In Norrbotten these children come from the poorest homes in the most remote places in the county. It may nevertheless be contended that the children brought up in these school homes give greater promise of becoming capable, competent and trustworthy citizens than, perhaps, any others in these out-of-the way regions.

As the children return to their own homes for the summer, there is not much opportunity for instruction in gardening. Every spring, however, they help to plant potatoes and, at some of the homes, also assist in the laying-out of flower beds. At several of the school homes the children have formed junior sections of the Agricultural Youth Association, and they are given facilities for cultivating a plot of ground at their own homes and planting vegetables, often also flowers. These plots are inspected by the adviser of the Association or, where possible, by the manageress of the school home.

It may be as well to mention, in conclusion, that the Norrbotten Foundation has established an experimental farm, intended to enable boys and girls who have left the school home to receive practical instruction in farming and rural economy. This institution, where the number of pupils is at present eighteen, is most promising.

The number of children in the Norrbotten school homes is about 630. Some 100 children annually leave these homes. (Hellström, Ankarswärd.)

6. People's High Schools.

The People's High School at *Vindeln* (in Västerbotten) reports as follows in regard to instruction in subjects relating to hygiene (1935—36): —

The first year's course at the People's High School (21 weeks from November to April) includes some 20 hours' instruction in hygiene, special attention being given to rational dietary and sanitation. The female pupils receive instruction in sick-nursing, the men in first aid, for 20 and 14 hours respectively. In the second year's course, the structure and functions of the human body are studied in connection with biology. In addition, one of the study circles discusses questions relating to hygiene and nutrition in connection with the study of anatomy and physiology. The separate course for women at the People's High School (at present 13 weeks May—July) includes about 35 hours' instruction in a subject called »care of the home» (*hemvård*). It embraces instruction in the building, equipment and care of the home, hygiene and home nursing, hygiene for women and care of children. In connection with organic chemistry two or three lessons are devoted

to the theory of nutrition. It also includes instruction in gardening for about 12 hours for each pupil. In addition, there is a special course of horticulture (from May to September) for 4 to 6 students. The produce from the school garden is utilized in the school household, although it is not sufficient for this purpose.

The course at the rural domestic school includes practical instruction in cookery and related subjects (about 350 hours), and gardening (about 50 hours); also theoretical instruction in nutrition (30—35 hours), hygiene, the care of the sick and children (about 20 hours) and gardening (about 20 hours).

The women students do their rooms under supervision.

A new school-house is being built. It will contain a well-equipped and commodious school-kitchen, in which the women students will receive practical and theoretical training in cookery and other domestic subjects. A gymnasium is also under construction; its basement will be equipped with Finnish vapour baths, shower baths and a wash-house.

At the *Sunderby* People's High School, where the school year has a duration of 24 weeks, usually from the beginning of November till the middle of May, the instruction includes cookery and household work for the women students for about 30 hours a week. The students are divided into groups, and each female student participates in the instruction in household work for about one-third of the above-mentioned time. In the course of 1935—1936 two hours a week were devoted to the science of nutrition, one hour a week to »care of the home», and 32 hours in all to hygiene for the women students. During the summer term a special course is arranged in gardening, consisting chiefly of practical tuition. In the summer of 1935 the course lasted from May 6th till September 21st.

Certain aspects of domestic work are dealt with in study circles. Two »housewife circles» are usually arranged every year. The questions studied by these circles include domestic economy, domestic and personal hygiene, domestic life on holy-days and week-days, children in the home, work in the home and the servant problem. The pupils do their own rooms under supervision.

The *Matarengi* People's High School in Norrbotten reports that three school cookery courses with a duration of about 7 weeks each, with 5 hours instruction a day, are held during the winter course. The time devoted by each student is thus about 210 hours. Theoretical tuition in nutrition, in connection with cookery, is

given for about 35 hours. Men students receive instruction in hygiene for about 48 hours, stress being laid on the importance of well-proportioned variety in the composition of the dietary, and on the cultivation and use of vegetables. Attention is also devoted to domestic hygiene, especially to present-day requirements in regard to the equipment and use of bedrooms. The women students study this subject for about 72 hours, greater attention being devoted to hygiene in the home.

There is a separate course for rural economy during the summer, which includes instruction in gardening.

In *Lapland* there is an ambulatory People's High School, which in certain years is in receipt of a Government grant. The principal is the sole teacher, and the courses have usually been somewhat shorter than at any other institutions of this kind. The school, as a rule, has evening classes. It thus works on free lines, but does its best to carry out the People's High School programme also in regard to instruction in hygiene. (Hellström, Engvall.)

7. The Swedish Red Cross.

The organization of the Red Cross in both the counties in question is the same as in other parts of Sweden. Each county constitutes a separate district governed by a district board whose headquarters are in the town where the County Governor resides. The districts are divided into local sections and Red Cross Youth Societies, the Västerbotten district having 21 sections and 2 youth societies, the Norrbotten district 34 and 4 respectively, each with its board.

The following is a summary of the reports received from these two districts regarding their activities in 1934: —

In the *Västerbotten district* presents of clothes and infant outfits have been distributed by the sections in the Lapp territory, by deacons or district visitors, and wives of clergymen in co-operation with the medical officers concerned.

Most valuable services have been rendered by the ambulatory dental clinic organized by the district board of the Red Cross. A brief account of this clinic is given below in connection with advice and directions regarding the organization of a dental service for schools and for the people.

Several of the local sections in this district have organized, with the aid of communal grants, a dental service for school children on a comparatively large scale.

In this district the Red Cross have erected public baths, three small hospitals, situated in remote regions, and four maternity nursing-homes. The baths are frequented by a large number of adults as well as by school children. The number of patients admitted to the small hospitals has increased from year to year. Reckoning from the year 1926, when the first one was opened, the number of patient-days amounts approximately to 20,000. The nursing-homes have likewise been much frequented. They are maintained with the aid of communal grants.

The local sections of the Red Cross have made grants in aid of the summer holiday colonies organized by the dispensaries.

With a view to the enlightenment of the public on matters relating to hygiene, the Red Cross have published and distributed a number of pôpularly written and richly illustrated booklets on subjects such as the care of the teeth, public health, etc. They have also organized a number of courses on hygiene and sick nursing.

The assets of the Västerbotten district amounted at the end of 1934 to nearly 50,000 kronor in cash, approximately 120,000 kronor in real estate, and about 130,000 kronor in movable property. The number of members has been steadily increasing, and at the last-mentioned date was 2,800.

The Red Cross in the *Norrbotten district* have erected four small hospitals, situated in Lappmarken. Reckoning from the year 1922, when the first one was opened, the number of patient-days amounts approximately to 35,000. The annual number of patient-days in recent years has remained comparatively constant, being slightly more than 3,000 a year, which is about the maximum accomodation of these little hospitals. As there are no other institutions for the care of the sick in the regions in which they are located, these hospitals have been a great boon to the population.

Two maternity nursing-homes have been erected by the Red Cross in the Norrbotten district, with the aid of communal grants.

The local sections in this district also have made grants in aid of summer holiday colonies.

In Norrbotten also a number of courses in hygiene and sick nursing have been organized by the Red Cross. In connection

with these courses, so-called »health hours» have been arranged for school children in several places. In 1934, as in preceding years, courses in sick-nursing were organized, with the aid of Government grants, at the training colleges for elementary school teachers at Haparanda and Murjek.

The ladies in this district have shown much energy in the making and distribution of garments, especially infants' clothes, which are always badly needed in these parts.

In the wild regions of Norrbotten, where, owing to the great distances, doctors and nurses are, as a rule, not accessible, very useful services are rendered by the so-called »Samaritans». Twenty of them served in this county in 1934.

The assets of the Norrbotten district at the end of 1934 amounted to nearly 110,000 kronor in cash, 110,000 kronor in real estate, and 157,000 kronor in movable property. The number of members, which has been steadily increasing, was about 3,900 at the last-mentioned date. (Hellström.)

8. The Swedish Anti-Tuberculosis Association.

It has already been explained that a detailed account of the campaign against tuberculosis in Sweden is not within the scope of this report. The Swedish Anti-Tuberculosis Association cannot, however, be entirely ignored. It supports the maintenance of tuberculosis dispensaries by annual grants for various counties (for *Norrbotten* about 41,000 kronor, for *Västerbotten* about 19,600 kronor). In 1935 it made the following grants for the County of Norrbotten: 12,254 kronor towards the maintenance of children's homes (accommodation for 68 children), 3,059 kronor towards the maintenance of foundation school homes (accommodation for 25 children), and 930 kronor towards a country holiday colony. The Association has also organized an experiment on a large scale in the suppression of tuberculosis by Calmette vaccination.[1] In 1935 it made the following grants for the County of Västerbotten: 24,907 kronor towards the maintenance of children's homes (accommodation for 147 children) and 2,300 kronor towards a country holiday colony. The Association has also financially supported endeavours to improve the care of infants as well as the organization of lectures. (Hellström, Ankarswärd.)

[1] In 1935 this experiment cost the Association 11,644 kronor.

9. Housewives' Societies.

A society called the Swedish National Federation of Housewives' Societies has been formed with the object of uniting Swedish women in work for the home and the social community, and to serve as a connecting link between the local societies with the same aims. The National Federation and the societies belonging to it must be neutral in politics and religion.

In 1935 this federation had fifteen local branches in Västerbotten and Norrbotten. In the course of years they have played an important part in the promotion of domestic hygiene and public health. With a view to public enlightenment they have distributed popular literature on various subjects connected with health culture, such as domestic hygiene, the care of children and especially of infants, household work, food and domestic economy. They have organized cookery courses as well as demonstrations in the care of infants and nursing in the homes. They have also carried on propaganda for the development of gardening and a more abundant use of vegetables in the daily fare. Certain societies have provided facilities for tired mothers to receive a much needed rest during the summer, and have organized summer colonies for delicate children. They have distributed infants' clothes among poor expectant mothers or women who have recently become mothers. The question of the establishment of public baths has been an item in the programme of several of these societies. They have also promoted other endeavours for the improvement of personal hygiene. (Hellström, Ankarswärd.)

10. The Västerbotten Society for Popular Educational Courses.

In accordance with the regulations, societies which endeavour to organize popular courses in general and secondary education at different places within a large area are entitled to a State grant. Such courses have a duration of at least three weeks, with not less than ten hours of instruction a week in the form of lectures, exercises and work in study circles. Lectures and subjects of lectures must be approved in advance by the Royal Board of Education, on whom it also devolves to examine and approve the programme and inspect the work. The organizing committee,

in arranging courses of popular education, must co-operate with any State-subsidized organizations for popular education which may be working at the place where the course is to be held. The Västerbotten society, which was founded in 1930, has hitherto organized 45 courses, 17 of which have included subjects relating to hygiene and public health, as well as questions of special interest to housewives. The attendance at these courses has been excellent, more especially at those relating to hygiene and public health. With the help of the agricultural societies, so called »housewife weeks» have beeen organized. The programmes for the latter have also included instruction in hygiene. The number of applications for participation in these courses was so great that only a small percentage could be admitted. Societies of this kind therefore seem to have a great mission to fulfil. (Hellström.)

CHAPTER II.

Guidance and suggestions for improvements in hygiene.

1. General observations.

It will be seen from the preceding pages that our investigations have been confined to certain branches of personal hygiene. The following observations are restricted, broadly speaking, to these fields. It may seem to be an omission that we do not deal with the wide-spread disease of tuberculosis of the lungs. The reasons for this apparent lacuna have already been indicated. It must not, however, be concluded that the health culture which we are now studying has not been of value in the campaign against tuberculosis. Indeed, cleanliness in the home, proper care of the body, and a healthy life with a well-regulated dietary are considered to be the best prophylactics against tuberculosis. All endeavours for the improvement of hygiene may therefore be regarded as important features in the fight with this disease.

The reader, perhaps, may be inclined to think that the constructive suggestions submitted here are not so well elaborated as might have been desired. It should be noted, however, that several of the measures which we consider to be particularly urgent have been recommended in reports and observations submitted by various Government departments, or in the reports of Government committees. The Government have not yet determined their attitude to these recommendations.

Whilst this investigation has been limited in scope, measures to remedy the evils and defects which it has revealed must be of a far-reaching character. It will presumably take years before they can produce their full effects. It should be borne in mind that we are engaged in a field of work in which a certain economic standard is required for the attainment of the intended results,

and in which ideas transmitted from generation to generation and deeply ingrained habits still predominate. Even the most superficial study of the development of social hygiene will show that financial aid from the State or municipalities is a *sine qua non* for success. It is also obvious that the less exacting the conditions laid down by the public authorities for the receipt of grants, the further down in the social scale will the assistance thus rendered extend. How far we can go in this way is primarily a question of national finances, and the line where the limit is drawn will in some measure depend on the views of the granting authorities in regard to social policy.

Grants in aid of health services are voted by the three authorities, namely the State, the County Councils and the communes. The State grants are obviously the most important. As above indicated, they are indispensable for the maintenance of most of these services, and still more for their development. That the incidence of the expenditure on the health services should fall, in increasing measure, upon the State is indeed consonant with present-day views on taxation. In the following pages mention will be made of the various State grants for these purposes, and suggestions will be submitted for the extension of State aid.

As for the communes, it should be noted that, as a rule, they are themselves badly in need of financial aid from the other granting authorities. They should therefore not be required to make financial contributions, except in so far as may be necessary to induce them to observe due economy in regard to grants from the State or County Councils.

It may perhaps be supposed, especially in times of depression, that the most serious impediment to necessary improvements in hygiene is poverty. True that poverty, as pointed out above, may have quite a paralyzing effect in this respect. It should be observed, however, that in many cases no large sums are required in order to effect important improvements in the home, and that insight and alert interest are often far more needed than financial resources.

Public enlightenment is therefore a most important factor in this sphere. For, without a realization of the immense importance of health culture for the individual, the family and the social community, and without the desire and determination of individuals or members of families to observe the fundamental rules

of health, efforts for the improvement of hygiene will be largely wasted, and most of the seed will fall on stony ground.

The seed of enlightenment, if it is to germinate, must be carefully selected for the soil for which it is intended, that is, according to age, standard of education and range of knowledge. As this work must be carried on mainly among those who have been least favoured in the last-mentioned respects, those who engage in it should possess the rare gift of clear presentment. It is, however, of great importance that the problems at issue should not be simplified to such an extent as to give a distorted picture of existing conditions, and that specious promises should not be held out in regard to the efficacy of hygienic measures. Exaggerations of this nature are often found in propaganda lectures or literature. In the long run, however, they are of very doubtful value, not to say actually injurious. The disappointment caused by the non-manifestation of promised results is in fact liable to cast suspicion upon the entire campaign.

It has been indicated above that this service should be viewed from a wide angle. This applies particularly to propaganda. To be successful, it must appeal first and foremost to children in public elementary schools and to youth studying in continuation schools. But, in order to produce more immediate results in the homes, it should also be addressed direct to mothers and fathers.

The co-operation of doctors and nurses is indispensable for the success of any campaign for the improvement of public health. As previously mentioned, the duties of medical officers as well as of district and dispensary nurses in regard to the promotion of personal health have been defined in the official regulations. In many cases, however, these public servants have been prevented by a heavy burden of purely medical duties from devoting sufficient time to the promotion of hygiene. On the other hand, the advice and instructions given by doctors and nurses in visiting their patients have frequently acted as incentives to durable and fundamental improvements in the hygiene of the home.

Owing to the certain deficiencies in their training, the county medical officers and above-mentioned nurses have sometimes failed to grasp the importance of, and to take sufficient interest in, social hygiene. In order to remedy these defects, the Medical Board have taken steps to provide facilities for the extended training of medical officers in various branches of hygiene. On the basis of proposals submitted by the Board to the Government

in 1934, the Riksdag in 1936 voted a grant towards the organization of courses in social hygiene for country medical officers. As for the district and dispensary nurses, the reader is referred to the statements made on that subject in Chapter I (pp. 12—14). These measures will, in our opinion, conduce to make doctors and nurses better qualified than before to render valuable service in the promotion of hygiene.

It should be noted, however, that there is a divergence of opinion in regard to the organization of the public health service. Some people consider that each branch of this service should be in the hands of officers specially trained for the purpose. This would signify that medical attendance and sick-nursing in the homes would be separated from the health service proper, and that the latter would likewise be differentiated, there being, for example, a special visitor for child welfare, another for inspection and maintenance of dwellings, and so forth. Others take the view that the medical and health services should, as far as possible, be concentrated in one hand.

An organization on the first-mentioned lines (differentiation and specialization) would doubtless enable the officers to gain a deeper insight into their several spheres of work, and to produce reports, or submit observations, which would be a more satisfactory basis for the action to be taken by the superior authorities. Here, however, it must be remembered, we are treading on delicate ground. These are matters that vitally concern the homes. There are, in short, cogent reasons for concentration, that is for an organization under which the medical and health services in each district would be in the hands of a single officer. Such an officer would naturally have a considerably smaller district than would be assigned to one who specialized on a certain branch of hygiene. This would enable the doctors and nurses to become well acquainted with their clientele, which in Upper Norrland, with its sparse population, is a matter of special importance.

There is a still more weighty argument in favour of the unification of these services. People, as a rule, will be far more ready to listen to a doctor or nurse who has come to minister to them in time of sickness than to a health officer who makes an unexpected visit in order to proffer »gratuitous» advice on prophylactic hygiene. Furthermore, there seems to be no reason to destroy the good foundation that has already been laid for a health service. Despite many deficiencies and the survival of certain

old-fashioned methods, so much progress has been made in social hygiene in the course of the last twenty years or so, that a complete reorganization of the district nurse service does not seem to us to be warranted. We are of the opinion that it could serve as a basis for that important part of the public health service which would in any case devolve on officers with qualifications similar to those of the district nurses.

Although the district nurse service has been in existence only for about ten years, it has already proved its utility. Much useful work has been done also by the dispensary nurses, whose daily duties include the inspection of dwellings.

In making the above observations it is chiefly the rural districts that we have had in mind. We willingly admit that in towns with a population exceeding the normal range of a district nurse, that is from 3,000 to at most 4,000 inhabitants, as well as in thickly populated industrial communities, where the conditions are in some respects more complex than in the country, there are substantial reasons for the appointment of special officers.

As regards instruction in, and enlightenment on, social hygiene, the avenues of advance have already been marked out. The schools, at different stages, play an important part in providing for such instruction. The only additional measures that we can suggest are the distribution of suitable literature and the organization of courses of lectures combined with demonstrations. Such courses, properly organized and conducted, are obviously of special value for public enlightenment. It is particularly important that those who attend them should be afforded an opportunity of taking part in, or at any rate watching, the practical work. The impression produced will thus be more vivid and permanent. The value of such courses, however, is unfortunately limited in one important respect. It is difficult for poor housewives living in remotely situated places to absent themselves from their homes in order to attend the courses, especially if they are of long duration.

It is therefore highly desirable that some guidance and instruction in hygiene should be given to mothers in their own homes. This, however, requires great tact and an intimate knowledge of the character and mode of life of the population. Here, if anywhere, over-organization is a mistake. It is of great importance that this service should be concentrated as much as possible. As previously explained, we are of the opinion that in rural districts and in small urban communities, these duties should be discharged

by the district nurses. We accordingly consider that the recently issued regulations regarding the district nursing service, which have been summarized above, are well suited to conditions in this country.

But public enlightenment, however important in itself, needs to be supplemented by other measures. We are referring particularly to the medical examination of children of pre-school and school age, medical advice to pregnant women, care of the teeth, etc. As regards school children, however, co-operation between school, doctor and home is essential in order to ensure the efficacy of such measures.

The above is intended to be merely a general survey of the field. Further observations and more detailed recommendations regarding measures for the improvement of hygiene are contained in the sequel. (HELLSTRÖM, ANKARSWÄRD, BYTTNER.)

2. Suggestions for the organization of a public health service, centred in the County Councils.

It may be as well to reiterate that, however satisfactorily a health service may be organized, it obviously cannot remedy those conditions which in many cases are the ultimate cause of the most serious and glaring defects in personal hygiene, notably poverty. The solution of this difficult problem devolves on institutions other than those which are concerned with the promotion of public health. On the other hand, it can scarcely be too often repeated that the injurious effects of poverty on hygiene can be considerably mitigated by the observation of simple rules of health.

It will be seen from Chapter I of this Part that a considerable number of authorities, public institutions, private foundations, corporations and societies are already working in this field. The survey given in that chapter has probably surprised many people who were not aware that the workers were so numerous. It is evident that in this domain many good forces must co-operate if the goal in view is to be attained in a near future. But, however commendable the endeavours to raise the standard of health of a nation may be, there must not be too many cooks. For this would tend to scatter the forces of those who volunteer their services, lead them into barren fields, and duplicate the work, thus entailing needless expenditure, weariness and loss of interest.

In the preceding pages much stress has been laid on the necessity of assistance from the public authorities. This, however, must not be understood to mean that devoted work on the part of private persons or corporations is superfluous or, in itself, of inferior value. Our intention has been merely to point out that in Sweden, where there is a comparative shortage of private capital, private enterprise is often limited by lack of financial resources. We are therefore decidedly of the opinion that the principal mission of private enterprise in this field is to take initiatives, and tentatively to test the utility of new measures and the manner in which they are enforced, thus doing pioneering work which it is difficult to organize under the hard-and-fast rules and conditions which are usually attached to grants from public authorities.

In view of the legislation in this country with regard to public health and child welfare, it might seem at first sight that these services should be conducted by the boards appointed for the purpose by the communes. It has, however, several times been pointed out that the communes, in several respects, have not answered to the expectations of the legislators. This, it may be as well to repeat, applies mainly to the rural communes, by reason of their small size and very limited financial resources. The considerable extensions of the public health service which have been made since the issue of the regulations just alluded to have, therefore, been based mainly on institutions other than the communes. Moreover, some of the communes, realizing their limitations, have combined in order to be better enabled to discharge certain of their duties.

It should be evident from the above that the centralization of the public health service within large areas would be an inestimable advantage — not to say an imperative necessity. This idea is by no means new. The Medical Board some time ago recommended such centralization as one of the conditions for the grant of State aid towards the organization of the district nurse service. The Board suggested that this might take the form of a permanent commission appointed by each County Council. Like the Medical Board, we fully realize that the County Councils might well hesitate to undertake new duties in addition to the extensive medical service which they are already carrying on. It should be borne in mind, however, that the health and medical services are largely interdependent, and that improvements in hygiene might be expected, at any rate in the long run, to entail a reduction in

the number of hospital patients. This point of view has been largely overlooked in this country, and there is some justification for the contention that the medical service has beeen favoured at the expense of the health service. Whilst the medical service has been in the hands of the County Councils, which have larger financial resources and greater facilities for organization, the communes, most of which are of small size, have been responsible for the health service. In these circumstances it is only natural that the health service should have suffered in the long run. Another factor which has tended to retard the development of the latter service is that so many people have failed to realize its importance.

We trust that these observations may conduce to make it clear that there is no fundamental distinction between the health and medical services, and that thus there is no objection, in principle, to such extension of the sphere of action of the County Councils. A beginning has in fact already been made. A district nurse service has been organized by no less than eleven County Councils. The district nurses, as previously explained, have important functions in regard to the promotion of hygiene. Most of the County Councils appoint the boards which conduct the tuberculosis dispensary service. Grants are made by several County Councils towards the organization of demonstration courses in the care of infants as well as for other enlightenment of the public regarding the care of children. The medical examination of elementary school children in rural areas has been organized by five County Councils. Finally, three County Councils have organized a more rational inspection of dwellings in rural districts.

These measures may seem very modest, compared with the achievements of the County Councils in regard to the medical service. It is nevertheless significant that quite a number of County Councils have begun to realize the importance of giving their support to the public health service.

Co-ordination is of the greatest importance for the success of this work, and we are convinced that no corporations are better fitted for this purpose than the County Councils.

We accordingly propose the establishment of a *central health council* for the promotion of *social hygiene*, especially in those branches of it which are dealt with in this report. In accordance with the observations made above, we suggest that the initiative should be taken by the County Councils. We note that the County Councils of Västerbotten and Norrbotten, despite the inadequacy

of their financial resources, have already taken various measures in support of the health service.

In regard to the composition of such a council, we make the following suggestions. It is highly desirable that the active workers in the various branches of this service should be represented. That the County Council itself should have a strong representation is self-evident. It is also very desirable that the County Governor should accept appointment as president of the council. It is furthermore of great importance that medical science should be adequately represented. The Chief County Medical Officer should obviously be a member of the Council, and one of its leading forces. It should also include a dentist with social welfare interests. In view of the great importance of questions relating to the composition of the diet, particularly in the north of Sweden, it is most desirable that a superintendent medical officer should have a seat on the council. The other members of the proposed corporation might, we think, be appointed by the County Council itself.

It may be contended with some show of reason that such a body would be rather cumbrous. Presumably, however, it would not be necessary to convene the council in its entirety except on comparatively rare occasions. It would doubtless be found convenient to set up several small executive committees to prepare business. These committees might co-operate with representatives of various societies and foundations, whether represented on the council or not.

We trust that the above suggestions, which are based on the results of our investigation, may serve to induce the County authorities carefully to consider the organization of an improved health service, from a prophylactic point of view.

It may perhaps be objected that, in submitting these suggestions for the establishment of a central body in each county for the co-ordination of the health service, we have merely sketched its structure. But, had we entered into details regarding the functions of this proposed corporation and its auxiliary bodies, we should have incurred the risk that our suggestions, on close examination by active workers in the northerly counties, where the conditions in many respects are so peculiar, might have been found to be impracticable. (Hellström, Ankarswärd, Byttner.)

3. Special fields of work.

We shall now proceed to consider measures for improvements in the health services which come within the scope of our investigation. They will be dealt with in the following order:

a. *Maintenance and inspection of dwellings, and the housing problem.*
b. *Care of the health of infants and small children in their homes, and maternity welfare.*
c. *Care of the health of children of school age.*
d. *The diet problem in Upper Norrland.*
e. *Dental services for school children and adults.*
f. *Gardening, with reference to conditions in Upper Norrland.*

a. *Maintenance and inspection of dwellings, and the housing problem.*

Out of the questions referred to above, the one which seems to have most bearing on the economy of the individual is the provision of sanitary dwellings. If this requirement is to be met, it is indispensable that grants should be made by the public authorities, on suitable conditions, for the purpose of raising the standard of housing accomodation.

Before proceeding to consider the question of the maintenance and inspection of dwellings, which is the main theme of this section, it may be useful to review the various measures that have been taken in recent years towards the solution of the housing problem, especially in rural areas. We shall confine ourselves to measures taken by the Riksdag and the Government, as being incomparably the most important, and especially those which are intended to improve the housing conditions of the poor. It should be noted that a large number of poor people in Norrbotten live in so-called »*backstugor*», which are mere cabins or huts.

In order to place these measures in their proper setting, some information must first be given about the actual housing conditions in Sweden, especially in rural districts.

Medical men were naturally the first to stress the importance of sanitary dwellings, and to draw attention to glaring defects in housing conditions in various parts of the country. This is quite evident from the annual reports which have been submitted to the

Medical Board by the subordinate medical officers. It should be noted, however, that these matters have also attracted the attention of State authorities other than those directly concerned with public health, and that they have repeatedly taken measures with a view to the improvement of housing conditions. For example, housing censuses and other enquiries into housing conditions have been instituted at intervals. Before the war, however, owing to a combination of circumstances — the indifference shown by many people towards housing questions, the difficulty of gauging the economic consequences of radical measures in this field, a gradual improvement in the dwellings of agricultural labourers, ultimately connected with the higher standard of life of the working classes in general, and the fact that Sweden had happily been spared much of the misery found in the large towns and over-populated industrial districts in many other lands —, the measures taken by public authorities with a view to the improvement of housing conditions were on a comparatively small scale. They were concerned chiefly with the promotion of the »own-your own-home» movement (see below). But the economic depression which followed in the train of the war and its aftermath, in conjunction with a dawning realization of the importance of serviceable dwellings, from social and hygienic points of view, made it manifest that considerably larger State grants were indispensable if necessary improvements in housing conditions were to be effected within a reasonable space of time.

Two extensive enquiries into housing conditions have been instituted by the Swedish Government in recent years, and have led to important measures. In 1930 the Government appointed a committee to enquire into the practicability of improving housing conditions in rural areas, especially the dwellings of agricultural labourers. (This committee is referred to below under the name of the Rural Housing Committee.) In 1933 the Government appointed another committee to enquire into the existing conditions in regard to »slum dwellings», and to recommend measures for remedying the evils connected therewith. The policies recommended by the two committees, which were working on similar lines, naturally tended to converge. Both committees, for example, drafted regulations regarding the structure of dwellings etc., and made various suggestions for improving the arrangements for the inspection of dwellings.

As our investigation in Upper Norrland was mainly concerned with the diet and the way in which it affected the health of the population, we asked only for summary information regarding housing conditions in those regions. It should further be noted that the information thus collected was confined to a minor part of the area under investigation, namely to the housing conditions in the depths of the country. Furthermore, the material obtained was by no means uniform and, for financial reasons, was not statistically elaborated. The general results of this limited enquiry into housing conditions in rural areas are summarized in Part I, Chapter III.

The particulars given below are based on reports from various parts of the country, and are therefore not particularly characteristic of Västerbotten and Norrbotten. But, so far as the available material [1] has permitted, we have paid due regard to the conditions in those counties.

A glance at the maps in Part I, Chapter I will show that there are only six towns in the two counties, taken together. The population of the largest of these towns, at the end of 1935, was only 13,510 souls. As the towns in these two counties are thus of subsidiary importance, and as our investigation was concerned with the rural districts, only a few particulars will be given regarding housing conditions in the towns.

The first extensive housing census in rural areas was made in 1912—1914. It was followed up by an enquiry on a minor scale in 1926—1927. There is no available material of this nature of quite recent date.

The Rural Housing Committee, on the basis of official statistics, estimated the number of dwellings in the rural areas of Sweden, the population of which in 1934 was 4,131,000 souls, at about 983,000, of which about 601,000 were occupied by the agricultural population. The number of small dwellings, consisting of one or two rooms and a kitchen, was estimated at about 650,000, of which some 400,000 were tenanted by the agricultural population. The latter figure included some 100,000 dwellings provided by the farmers for their agricultural labourers and for crofters.[2]

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[1] It consists largely of summaries of the results of the housing census and other enquiries into housing conditions, embodied in the reports of the two above-mentioned committees.

[2] In 1930 the agricultural population was estimated at 2,135,000, of whom about 1,041,000 were specified as active workers.

At the time of the first-mentioned housing census, in 1912—1914, about two-thirds of the dwellings in rural areas were self-contained houses for single families. A comparatively small number of houses were occupied by several families. Most of them were built in two storeys, and had only a single staircase. They were devoid of halls, and the accommodation in the way of larders, clothes closets, etc., was bad, or non-existent. The walls and sound-boarding were badly constructed. Accommodation of this type, which has given cause for much well-grounded complaint, was, and still is, particularly characteristic of those dwellings (the so-called »wage-dwellings») which are occupied free of charge, but reckoned as part wages, by agricultural labourers, especially on large estates. About two-fifths of the dwellings of the normal type consisted of one room and a kitchen, and about one-fourth of two rooms and a kitchen. Dwellings (cottages) with one room and a kitchen predominated in the north of Sweden, but were usually so constructed that the air-spacing was considerably larger than in the south. As the measurements taken in this housing census were on quite a small scale, no general conclusions can be drawn in regard to the dimensions of the dwellings. According to one report, the net space available for accommodation in a self-contained house (cottage) in the rural districts of central Sweden averaged about 75 cubic metres.

If a dwelling occupied by more than two persons per room or kitchen is considered to be over-crowded, nearly one-third of the smaller dwellings (up to three rooms and a kitchen) were overcrowded. And no less than 47 per cent of the population lived in such dwellings. It should further be noted that 34 per cent of the rural population consisted of children under the age of fifteen. The figure for density of occupation for dwellings (cottages) of up to two rooms and a kitchen was 187 persons to 100 rooms. The corresponding figure for cottages with one room and a kitchen was 211. These figures are for rural areas proper.

It should be noted that this housing census was made more than twenty years ago and, in view of its general plan and rather limited scope, cannot be considered to come up to present-day standards. Nor can the investigations subsequently made be taken as a basis for a comprehensive report on the housing conditions of the poor.

In 1920 an investigation was made into the cost of living of families of agricultural labourers and small holders. It was on a minor scale, being confined to 372 families. They were asked to give rather detailed particulars regarding the size and character of the dwellings.

In this investigation it was again established as a fact that the average number of rooms per family was smaller in Norrland than in the south of Sweden, where dwellings of two rooms and a kitchen predominated, but that, reckoning in floor area and cubic contents, the dwellings were more spacious in the north. Whereas in the south of Sweden the measurements

averaged 35 square metres (floor area) and 89 cubic metres (cubic contents), the corresponding averages for the north of Sweden were 43 square metres and 111 cubic metres. The figures for density of occupation tallied fairly well with those for the years 1912—1914, the number of persons per room being estimated at 2.1. Nearly half (45.4 per cent) of the families inhabited dwellings with more than two occupants per room, and more than 58.8 per cent of the total number of members of these families occupied rooms which were thus overcrowded. Reckoning according to the number of rooms, there was less overcrowding in the south of Sweden (1.6 occupants per room) than in the north (2.5 occupants). On the other hand, the air-spacing per person was larger in the north of Sweden than in the south, the figures being 19.4 and 18.8 cubic metres respectively.

An enquiry made in 1920 into the housing conditions of agricultural labourers, by way of preparation for an international conference on that subject which was to be held in the following year, yielded the following results:—

Dwellings with two rooms and a kitchen still predominated in the south of Sweden. In regard to floor area, the dwellings under investigation, generally speaking, were in accordance with the minimum measures prescribed in the collective agreements then in force between employers and workers. According to reports from the chairmen of the rural district meeting,[1] covering 1,544 dwellings, 9 of those dwellings contained only a single room, 950 one room and a kitchen, and 585 two rooms and a kitchen. The particulars in regard to the north of Sweden were sparse, but seemed to bear out the data given above in regard to the proportion between one-room and two-room cottages. The floor area averaged 39.1 square metres and the height 2.5 metres. The air-spacing thus averaged about 98 cubic metres.

In the replies to the questions put in this enquiry the above-mentioned tenement houses in several storeys were subjected to severe criticism. Complaints were also received to the effect that the dwellings for the so-called *statare* (farm labourers receiving part of their wages in kind) were badly fitted up, draughty, cold, damp, and infested with vermin. Another complaint was that the dwellings were often devoid of clothes closets, larders and other storage accommodation. About 80 per cent of the workers, in various forms, expressed the view that the accommodation for *statare* was most unsatisfactory. Fourteen of the chairmen of rural district meetings who took part in this enquiry recognized the justice of this complaint. It may be added that a large number of the dwellings provided for unmarried farm hands were extremely unsatisfactory from a hygienic point of view, being often located in cow-houses, not properly isolated from stables, and badly provided with appliances for heating.

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[1] A communal institution, one of the functions of which is to determine the taxation of the commune.

An investigation with the special object of ascertaining the housing conditions of the *agricultural* (and fishing) population was made in 1926—1930 by Professor ALFRED PETTERSSON and Dr G. STÉNHOFF. It was planned in such a way as to throw light on questions of hygiene, and yielded valuable information also from social points of view.

In the report [1] on this investigation an interesting attempt has been made to determine the character of a dwelling on an objective basis by a system of marks or points.

The investigation extends only to a minor part (about one half per cent) of the dwellings and population of the rural districts of Sweden. Its value, however, is enhanced by the fact that the districts selected were representative. Thus those containing industrial communities were, as far as possible, excluded.

For reasons of space, our summary of the results of this interesting investigation must be confined mainly to particulars which may serve as a basis of comparison with the data given above.

The investigation covered altogether 22,497 persons. Out of this number 14,780 persons (inclusive of children) represented the population engaged in agriculture and forestry (and fishing). The number of households in the last-mentioned group was 3,202: 121 persons lived alone.

As the group of persons engaged in agriculture etc., included independent farmers and tenant farmers as well as agricultural labourers, the annual income of the occupants of the investigated dwellings showed considerable disparity. In order to differentiate the labouring classes within this group, a line of demarcation was drawn. Persons with an income exceeding 300 kronor per annum (in certain expensive places 350 kronor) were regarded as being above that line. Two children under age were reckoned as equivalent to one adult. It was found that no less than about 23 per cent of the entire group fell below the line.

The housing conditions of the above-mentioned poorer section (the 23 per cent) are, in themselves, of special interest. But the figures are, unfortunately, too small for our purpose. For this reason, the particulars given below, unless otherwise stated, will refer to the entire number of homes under investigation, being 5,671 in all.

Out of the population comprised in the investigation 88 per cent lived in self-contained houses (cottages). In 9.1 per cent of the dwellings the total net available accommodation measured less than 50 cubic metres. In 45.6 per cent of them the air-spacing in the rooms used for sleeping purposes was likewise *below that measure*. The air-spacing available for each occupant was merely 5—9 cubic metres for 12.6 per cent of the total number, 10—14 cubic metres for 28.8 per cent, 15—19 cubic metres for 23.9 per cent, and 20—24 cubic metres for 15.8 per cent. The height of the rooms was unduly small; in no less than 17 per cent of them it was below 2.10 metres. Most of the dwellings were badly lighted by day: only in

[1] ALFRED PETTERSSON and G. STÉNHOFF: On the Housing Conditions in Rural Districts of Sweden. Acta societ. medica suecan. Vol. 55, p. 89.

38.3 per cent of them did the window surface amount to 12 per cent of the floor area, which was considered to be the minimum measure for lighting purposes. No less than 30.9 per cent of the dwellings were designated as being damp, cold or draughty, and about one-fifth of them had no fireplaces. Only in 23.6 per cent of the total number of dwellings was the floor at a sufficient height above the ground to make them damp-proof. The air-spacing available for each occupant was less than 15 cubic metres in respect of 21.5 per cent of the total number.

The general conclusions drawn by these investigators were that 14.5 per cent of the dwellings must be designated as being distinctly below the standard, and that 17.8 per cent of the occupants lived in such dwellings. They point out that the investigation convincingly shows that a large section of the Swedish rural population live in unsatisfactory dwellings. They had also observed in numerous cases that the available accommodation was badly utilized from a hygienic point of view.

In 1931 the Swedish Board of Social Welfare submitted to the Government a report on an extensive investigation into housing conditions in rural areas, with suggestions for improvements. For lack of space, we must confine ourselves to a brief indication of its contents.

The vast majority of the persons to whom enquiries were addressed maintained that there had been a decided improvement in the housing conditions of agricultural labourers and their equals, as compared with the state of things a quarter of a century ago. When the basis of comparison was taken only ten years back, there was considerable divergence of opinion. According to reports from several quarters, the agricultural crisis had stood in the way of building activity on any extensive scale. Some people, whilst recognizing that the importance of satisfactory dwellings had now been borne home to wider circles, stated that the failure of the population at large to realize this had, to some extent, barred the way to a higher standard of housing accommodation. From some parts of the country it was reported that the little interest shown by employers in the improvement of housing accommodation was one of the most serious obstacles. On the other hand, it was pointed out that this indifference was quite explicable, in view of the scandalous way in which a number of tenants had neglected their dwellings. It was reported that the above indicated evils in regard to the accommodation of unmarried farm labourers still existed in the southern and central parts of Sweden, whilst in Norrland the conditions in this regard had apparently improved. The reports showed that the conditions also in other respects varied considerably in different parts of the country. As want of space prevents us from entering into details on this subject, we must refer the reader to the general description of the deficiencies in housing accommodation in Upper Norrland which has been given in Part I, Chapter III.

Some additional information regarding housing conditions is contained in the annual reports of the Medical Board as well as in the reports annually submitted to the Board by the subordinate medical officers. These reports, however, are not intended to give statistical material. Their chief purpose is to draw attention to abuses from a hygienic point of view, whether due to the nature of the dwellings or to objectionable habits. As the medical officers are not all equally interested in questions of hygiene, as the terms which they use vary considerably in shade of meaning, and especially as no rules have been drawn up in regard to the classification of dwellings, their annual reports are somewhat lacking in homogenity. They are taken as a basis for the annual reports of the Medical Board itself.

A condensed *resumé* of these reports will not add very much to the knowledge of the reader who has studied the above summaries of the investigations into housing conditions in the rural districts of Sweden. He will learn that such simple measures as the utilization of the available accommodation in order to give sleepers sufficient air and to provide separate bedrooms for boys and girls after a certain age, the utilization of existing facilities for ventilation, and the cleaning of floors and walls, are still largely neglected. The reports draw attention to overcrowding in the dwellings of the poor, to the common occurrence of damp and draughts owing to cracks in walls and floors, and to the lack of such conveniences as cellers, larders, clothes closets etc. They show that there have been many complaints about the supply and quality of drinking-water.

It should be pointed out, however, that this rather gloomy picture is by no means representative of the state of things everywhere, and that during the last twenty or thirty years there has been some improvement even in the housing conditions of the above-mentioned *statare* and unmarried farm hands.

Finally, it should be mentioned that statistics as a basis for the setting up of certain minimum standards for dwellings have been compiled by the Rural Housing Committee of 1929.

These statistics confirmed previous reports to the effect that the height of the rooms in many places was unduly low. There were dwellings in which it was not more than 1.70—1.90 metres; in one district this state of things was found in as many as one-third of the dwellings under investigation. The reports from several counties showed that a number of the cottages contained small rooms with an air-spacing of only 15—20 cubic metres. It was reported even from the north of Sweden that some of the living-rooms actually had no fireplace. It was happily ascertained that the rule in accordance with a dwelling-house should be detached from stables, cowhouse, etc., had been complied with almost everywhere.

And it was considered that infringements of this rule would soon be a thing of the past. The requirement that the floor of living-rooms should consist of wood with sound-boarding had not been complied with in some of the dwellings, especially those in old buildings. It was ascertained that in the southernmost parts of Sweden dwellings (cottages) with two rooms and a kitchen were quite as common as those with one room and a kitchen.[1]

We shall now proceed to review the measures taken by the State for the improvement of housing conditions, especially in *rural areas*.

One of the earliest and most important measures taken by the State for improving housing conditions in rural districts is the *grant of loans in aid of the establishment of »own homes»*.

These loans are granted, on favourable terms, to persons of small means to enable them to acquire an agricultural holding or to erect a house of their own on a non-agricultural site.[2]

The central authority for the administration of this service as well as of other Government measures for the improvement of the housing conditions of persons of small means is the State Own Home Board. The local organization is in the hands of committees subordinate to that Board. There is one such committee for each county.

From 1905, when this service was instituted, down to the present year (1936) 75,000 personally owned homes have been thus established, 40,000 of which are agricultural holdings. The State loans granted for the purpose during this period amount in the aggregate to some 300 million kronor.

Attention should also be drawn to the interesting efforts that have beeen made by the Government to provide better housing conditions for the crofters, etc., on the Crown lands in Norrland and to organize new settlements there.

In order to enable the crofters etc., in the Norrland Crown forests to erect cottages of their own, they have received building grants amounting to 2,000 kronor (in exceptional cases 3,000 kronor), besides being supplied with timber gratis. In this way some two thousand new homes have been established in the forests of Norrbotten and Västerbotten.

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[1] See Supplement I page 117.

[2] This is merely a brief indication of the »own home» movement in Sweden, which is of a rather complex character. Its leading aim was originally to counteract the depopulation of the country.

The Government have also taken steps for the establishment of allotment holdings in the Norrland Crown forests. The settlers on these allotments receive building grants of up to 3,500 kronor (in exceptional cases 4,500 kronor), in addition to free timber. The number of allotment holdings in Norrbotten and Västerbotten, taken together, is about four hundred.

It should furthermore be mentioned that a State lending fund has been instituted for the purpose of improving the housing supply, especially in Upper Norrland. Holders of certain settlements on the Crown lands in Norrbotten are entitled to obtain loans not exceeding 2,000 kronor from this fund, for building purposes. Holders of certain other landed property in the two counties, may, under certain conditions, receive loans not exceeding 1,000 kronor for reconditioning purposes.

The above-mentioned measures, however, have by no means sufficed for the improvement of housing conditions in rural areas. On the basis of proposals submitted by the Rural Housing Committee, the Riksdag in the course of the years 1933—1936 voted altogether 40,500,000 kronor for subsidies and loans for this purpose.[1] The Government regulations in regard to the grant of these subsidies are to the following effect :—

State subsidies in aid of the improvement of housing conditions in rural districts are of two different kinds, namely (1) reconditioning allowances and (2) building loans.

Reconditioning allowances are granted to owners, and other persons responsible for the maintenance, of house property, in aid of repairs or other improvements in existing dwellings which may be necessary from the point of view of sanitation, as well as for the rebuilding of existing dwellings in bad condition. In order to obtain such a subsidy the owner etc., must show that he is in need of financial assistance for the reconditioning. Dwellings after reconditioning must be in conformity with the rules laid down in the Public Health Act.

These allowances, on which no interest is charged, are deemed to have been repaid when the reconditioning has been duly carried out. It is prescribed that the amount of the allowance, as a general rule, should be less than 50 per cent of the costs of reconditioning, and must not exceed 1,000 kronor for each separate dwelling.

Building loans are granted mainly by way of supplementation of reconditioning allowances, but also to persons who are not in need of such allowances. They are granted in aid of large repairs or other im-

[1] In the Budget for the fiscal year 1937/1938 additional grants of 5,500,000 kronor for reconditioning allowances and of 3,000,000 kronor for building loans were voted by the Riksdag.

provements, as well as for the erection of new buildings in connection with reconditioning.

These loans, on which interest is charged, must be paid off in instalments in the course of twenty years. They may not exceed 70 per cent of the building costs, nor 3,000 kronor per dwelling. If the borrower is also in receipt of a reconditioning allowance, the total sum may not amount to more than 80 per cent of the costs, and the loan may not exceed 2,000 kronor per dwelling.

As one of the principal objects of the grant of these subsidies is to counteract unemployment, it is prescribed that reconditioning or building must be completed within a certain space of time.

The grant of reconditioning allowances and building loans devolves on the local »own home» boards, which, as previously mentioned, are subordinate to the State Own Home Board. Before making grants they are expected to consult the chief county medical officer or other experts on sanitation. As is explained below, preliminary investigations as a basis for the grant of such subsidies are made by the local health boards.

Regulations have been issued by the State Own Home Board with the object of affording better facilities for owners of house property who are particularly badly off to recondition their dwellings, as also with a view to greater uniformity in the local organization of this service.

This Board, for example, have prescribed that it shall devolve on the local health boards, after due investigation, to submit to the communal authorities proposals for communal grants to owners of house property which is in such a bad state that intervention is necessary, but who are not in a position to defray the expense of reconditioning, nor to carry out the work themselves. In submitting such proposals the health boards can expect that the State grant, in such special cases, will amount to 80 per cent of the estimated costs of reconditioning, though not more than 1,000 kronor per dwelling. It is also made a condition that the communes shall supply any additional requirements for the reconditioning, in the form of cash allowances, building materials, transport of labour, etc.

The State grants hitherto voted by the Riksdag for these subsidies, as previously mentioned, amount altogether to 40,500,000 kronor. There has been such a demand for reconditioning allowances that these large sums have by no means sufficed for the grant of all the applications. It is calculated, however, that they will enable some 55,000 dwellings to be reconditioned, including about 5,000 »wage dwellings» for farm labourers. The total cost of these works is estimated at approximately 80,000,000 kronor.

It was a disappointment to the Government to find that the sums voted by the Riksdag for reconditioning allowances had been utilized to such a small extent for the improvement of the »wage dwellings» for farm labourers. In view of this circumstance, and

as the main object of these subsidies was to provide work for the unemployed, the Government requested the Rural Housing Committee to submit proposals for additional measures of a more permanent character. The principal recommendations made by the committee in response to this request are in the nature of proposals (1) for the institution of a State lending fund in aid of improvements in the dwellings of agricultural labourers and (2) for State grants in aid of the continuous improvement of housing conditions in rural districts. The first-mentioned proposal was adopted by the Government, and passed by the Riksdag in 1935. In regard to the second proposal the Government have not yet taken a definite decision, though they have approved it in substance.

Regulations regarding the *lending fund for the dwellings of agricultural labourers* have been issued in the form of a Royal Decree. The stated purpose of the fund is to promote the erection of serviceable dwellings for agricultural labourers, which shall be satisfactory both from social and from hygienic points of view. It is prescribed that the loans shall be granted in such a way as to facilitate the efforts of the local health boards to provide sanitary dwellings for the rural population of their districts.[1]

Loans from this fund are granted to owners or holders of agricultural property in aid of (1) the erection of new dwellings for their agricultural labourers and (2) the rebuilding or reconditioning of existing dwellings. These loans — unlike the above-mentioned building loans — may be granted not only for building in connection with reconditioning, but also for the erection of completely new dwellings.

The loans may not exceed 3,000 kronor for each separate dwelling, nor 70 per cent of the estimated costs of the entire building work. Where several dwellings are to be built or rebuilt, the amount of the loan in respect of each dwelling must in no case exceed the quota of the costs which is represented by that dwelling. In such cases, unless some other basis of calculation is considered desirable, the building costs are reckoned relatively to the floor area of the several dwellings.

The loans run at 3.6 per cent interest from the date on which the proceeds are received by the borrowers, and must be paid off in instalments of one-twentieth annually as from the third calendar year in which they were granted.

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[1] In the Budget for the fiscal year 1937/1938 a grant of 400,000 kronor towards this fund is voted by the Riksdag. In 1936 the Riksdag voted 500,000 kronor for the same purpose. It is intended that grants towards this fund shall be voted according as interest is received on the above-mentioned loans for rural districts in general.

The borrower must produce an acceptable security for the loan. The security generally demanded is a mortgage on the property of up to five-sixths of its then assessed, or otherwise, certified, value.

Another important measure with a view to the improvement of the conditions of the life of the rural population is the establishment of a *State lending fund for workers' small holdings*. It was instituted in 1933 in accordance with a Government Bill passed by the Riksdag in that year. The principal object of this fund is to enable persons who, owing to the lack of sufficient means of their own, cannot obtain loans under the regulations issued by the State Own Home Board, to acquire personally owned small holdings. It is, in short, intended for the benefit of industrious and capable workmen whose earnings are too small to enable them to procure serviceable dwellings by their own efforts.

With the aid of loans from this fund on very favourable terms, persons without means, such as forest labourers, floaters, agricultural labourers and youths living at home, can now acquire small holdings of their own, which will enable them to eke out their earnings from work of a seasonal or otherwise temporary character.

It is prescribed that dwellings erected on such small holdings shall be sanitary and otherwise serviceable.

The support given by the State to the »own home» movement was extended in 1934 by a Government Bill relating to so-called *tenants' own homes*, which was passed by the Riksdag. In accordance with this measure new, completely laid out, agricultural holdings on Crown lands can be leased to persons without means, or in poor circumstances, the tenant having the right ultimately to purchase the holding. In connection with the lease tenants may be granted loans to enable them to procure agricultural stock etc.

Finally, it should be mentioned that the Government in 1936 appointed a committee to submit proposals for the reorganization of the entire system for the support of the »own home» movement, as well as regarding other matters connected with State social welfare measures relating to land. This committee is expected to submit its report in 1937.

As regards *housing conditions in towns*, it should be observed that slum districts, in the proper sense of the term, happily do not exist in Sweden. Nevertheless many defective and insanitary dwellings are found scattered here and there in the towns. In Swedish towns, however, the most serious evil that has to be

combated is overcrowding. This is largely due to the fact that — except in the south of Sweden, where apartments with two rooms and a kitchen predominate — the majority of families live in apartments consisting only of a single room and a kitchen.

In 1935 the previously mentioned committee on urban housing conditions made an investigation in regard to small apartments (of up to two rooms and a kitchen) in fourteen provincial towns in Sweden. They found that 20 per cent of the apartments under investigation were damp, and that about as many were not provided with proper arrangements for warming. About 45 per cent were devoid of halls. Some twenty per cent of the dwellings had neither water pipes nor house drains within the apartment itself. It is remarkable that no less than 80 per cent of the families under investigation had no access to closets within their apartments. In the great majority of these cases the use of the closets in the courtyards was shared by two, three or more families. Altogether only one-third of the families had closets of their own within or outside the apartment.

Defects such as these are all the more serious as many of the apartments of the worst type are inhabited by families with a number of children. In the above-mentioned investigation a group of apartments in particularly bad condition were selected for special examination. These were apartments which had at least three so-called »fundamental defects», for example, those which were at the same time cold, draughty and damp. This group amounted to 12 per cent of the total number. No less than 20 per cent of the families who had three or more children under twelve years of age lived in such dwellings.

Another evil to which large families with a number of children are, of course, particularly exposed is overcrowding. In an investigation made in 1933, which extended to all types of apartments, it was found that 50 per cent of the total number of apartments contained at most one room and a kitchen. No less than 40 per cent (among the labouring classes fully 50 per cent) of the families who had three or more children under the age of 15 lived in such tiny dwellings. If a dwelling is considered to be overcrowded in case it houses more than two »person units»[1] per »room unit»,[1] 13 per cent of the total number of apartments fall under this designation. For families with three or more children under the age of 15 the corresponding figure is no less than 47 per cent.

In the above-mentioned investigation of small apartments, in 1935, it was found that 40 per cent of all the children under the age of twelve who lived in such apartments had their beds in a room or kitchen where at least four persons slept, and more than 30 per cent of them slept in rooms where the air-spacing per person was less than 10 cubic metres.

In spite of the existence of such glaring defects, it must be recognized that the conditions have greatly improved in recent

[1] An adult = a whole »person unit», a child under the age of 15 a half »person unit»; an ordinary living-room = a whole »room unit», a kitchen = a half »room unit».

years. As the result of the intensive building and rebuilding which has been going on since 1923, many new houses have been erected, and many apartments have been modernized. Nowadays about 30 per cent of the apartments are equipped with central heating, and 15 per cent with bathrooms or douches. There has also been a marked decrease in overcrowding. This, however, is largely due to the decline of the birth rate and the consequent diminution in the number of persons per household.

Improvements in the urban housing supply have been stimulated by State loans and subsidies. For example, sums amounting to 83 million kronor were lent to house-builders in the course of the years 1920—1930 out of the State Housing Loan Fund, in the form of second-mortgage loans. In addition, subsidies in aid of house-building for residential purposes have been granted since 1917 up to the amount of 20 million kronor. In 1930 the grant of second-mortgage loans was taken over by the Swedish Housing Credits Fund, the foundation capital of which has been supplied by the Government.

These measures, however, were not considered sufficient to maintain building activity during the late economic crisis. In 1933, 1935—1937 the Riksdag voted sums amounting altogether to 11,5 million kronor for the grant of third-mortgage loans (up to 90 per cent of the value of the property) in connection with the building or rebuilding of residential houses in towns.

These grants, however, were mainly intended to provide work for the unemployed. Other measures have been taken, or are being planned, with the direct object of improving housing conditions, the leading aim being the suppression of overcrowding. Seeing that overcrowding is mainly due to poverty, subsidies were obviously required in order to enable spacious and otherwise serviceable apartments to be provided, at moderate rents, for families of small means. Not until such apartments have been procured, will the authorities be in a proper position to condemn dwellings as uninhabitable. For under existing conditions it is not, as a rule, possible to offer families living in such dwellings any other apartments at a reasonable rent.

For financial and other reasons, it is evidently impracticable to grant subsidies on such a scale as would enable all those families who are now living in overcrowded apartments to procure better accommodation. It has, however, been decided, in accordance with a scheme which has now been adopted, that assistance shall be

given to poor families with several children under age, living in overcrowded apartments. The total number of such families in towns and urban communities is estimated at about 20,000.

It has been agreed that the Government and the municipal authorities jointly shall make arrangements for the building of houses containing apartments of two or three rooms and a kitchen, for the accommodation of these families. The total estimated cost of this undertaking is 200 million kronor. The State is to contribute 90 million kronor in the form of supplementary mortgage loans, whilst the municipalities are to provide free sites, etc. The rents payable by these families will not be based on the actual costs of building: certain reductions will be granted. Thus families with three children will have a reduction of 30 per cent, families with four children 40 per cent, and families with 5 or more children 50 per cent. The percentages will be calculated on the basis of normal rents. These rent allowances are to be defrayed by the State. When the system is completely organized, they will entail an annual expenditure of about 5 $^1/_2$ million kronor.

The execution of this plan has in fact already commenced. In 1935 and 1936 the Riksdag voted altogether 25 million kronor for housing loans, 500,000 and 650,000 kronor respectively for rent allowances. It has furthermore been decided to take steps with a view to the clearance of slum-like quarters in towns.[1]

The municipalities likewise are carrying on an extensive housing policy in the form of loans in aid of cooperative house-building societies, so-called »house-building foundations» (with public utility aims), the »own home» movement etc., besides the grant of actual subsidies. This policy, however, varies greatly in different towns, and it would carry us too far to enter into details on the subject.

It would be beyond the scope of this work to attempt an analysis of the factors and conditions which have led to the above indicated deficiencies in housing accommodation. We must confine ourselves to the following observations. Many occupants of apartments, owing to their lack of appreciation of the value of a satisfactory dwelling and their propensity to cling to old habits, have

[1] In the Budget for the fiscal year 1937/1938 additional grants of 5.5 million kronor for housing loans and of 1 million kronor for rent allowances are voted by the Riksdag.

taken too little interest in these matters to move with the times. It would, however, be unjust to assign paramount importance to such factors. In the course of the twenty years or so preceding the above-mentioned extensive investigations into the housing problem, housing conditions had shown a very considerable improvement, despite the fact that the support given by the public authorities, according to our present lights, was comparatively small.

Another explanation of the slow progress previously made in this field is that the possession, or acquisition, of some capital was usually required as a basis for the receipt of State assistance. The economic crises to which Sweden, like other countries, has been exposed since the war, and whose effects have been felt most severely by the farmers, have also conduced, in a marked degree, to retard developments. It should be noted that during the late trade depression unemployment had spread, on an alarming scale, to agriculture.

One of the principal reasons why the public health authorities have been unable to take such effective steps as they would have desired with a view to raising the standard of housing accommodation is that serious consequences might be entailed by their intervention. The local health board, before condemning a dwelling as uninhabitable, should be in a position to offer the occupant better accommodation, in case he lacks the necessary resources to have the dwelling put into a satisfactory condition. In many cases the only outcome of the intervention would be that the occupant was thrown on the parish.

As will be seen from the above, the measures taken, or planned, by the Government with a view to subsidizing improvements in the housing conditions of persons of small means — setting aside the »own home» movement and the settlement in the Crown forests of Norrland — are, generally speaking, of quite recent date. The new forms which such measures have assumed are marked by the endeavour to reach those classes of the population who have been unable to avail themselves of State assistance in accordance with previously issued (and still existing) regulations. Another aim of the housing policy of recent years is to afford facilities for the farmers to build or rebuild dwellings for their agricultural labourers. Generally speaking, the measures taken by the Government and Riksdag in this field have shown that the housing question in Sweden is one which mainly concerns the rural areas.

It is naturally difficult to express any definite opinion on the

results of the State housing policy of recent years. Broadly speaking, however, we may be warranted in stating that the effects of this policy are manifesting themselves in almost all the rural communes in Sweden. In addition, most of the rural districts in the immediate environment of towns, as well as many urban communities, are feeling the benefits of the State grants for the improvement of housing conditions. Thousands of old tumble-down dwelling-houses are being put into good repair, or are being replaced by new ones. This building work has been on a scale which would have been inconceivable in former days.

It has naturally been difficult effectively to guide and supervise building and reconditioning work on such an extensive scale. It may be stated, however, that the hopes which have been centred on these endeavours to improve housing conditions are already on the way to be fulfilled. There is therefore reason to presume that, with the cooperation of good forces, this building work will in course of time be more effectively planned and executed. Thus the measures taken in view of the late economic crisis have been largely instrumental in improving the hygienic conditions of persons in poor circumstances. The numerous insanitary, tumble-down cottages which have disfigured the country-side have been replaced by new serviceable dwellings. This has been done on such a scale that the aspect of many places marked by these dingy abodes has undergone a wonderful transformation.

Seeing that financial resources are obviously required in order to enable the individual to procure a serviceable dwelling, and as the earning capacity of the rural population cannot be expected in the near future to increase to such an extent that existing deficiencies could in general be remedied by their own efforts, it seems that State grants in aid of improvements in housing conditions will still be required. Such grants would furthermore place the public health authorities in a position to discharge their duties more effectively. State measures of a permanent character with a view to the furtherance of developments in this field must therefore be considered to be warranted both from social and economic points of view.

It has been indicated, in the introduction to this section, that the two housing committees have submitted proposals for amendments in the regulations regarding hygienic requirements and the inspection of dwellings. It would carry us too far to give a

detailed report on the recommendations of these two committees, which in some respects have taken different points of view. We shall therefore confine ourselves to *a brief summary of these recommendations so far as they have been adopted in Government Bills* passed by the Riksdag.

It has previously been pointed out that the local health boards have been prevented by certain economic conditions from effectively enforcing the provisions of the Public Health Act and from duly exercising their powers under that Act. Another reason why this Act has not been effectively applied, especially in rural areas, is that its present provisions, as is averred, are too vaguely worded and have not afforded sufficient guidance to less experienced health boards. Furthermore a considerable number of communes have availed themselves of a clause permitting them to delegate the duties and powers of the health board to another communal authority. This has indubitably led to the result that the health service has been relegated into the background.

On the basis of certain recommendations made by the housing committees, the Government in 1936 introduced a Bill providing for a number of amendments in the Public Health Act, mainly intended to clarify and give a more concrete form to its existing provisions. It was passed by the Riksdag. For want of space, we shall confine ourselves to citing those provisions which will be applicable to country districts. This limitation seems to be of minor consequence, as the regulations are, broadly speaking, similar in substance for town and country.

In regard to rural areas the new regulations run as follows:—

§ 43. 1. Buildings containing living-rooms shall have a healthy situation. Where necessary, the ground shall be drained.

Buildings of this nature shall be arranged, fitted up and maintained in such a way as not to cause injury to the health of the occupants.

2. Living-rooms shall be of such a size that the health of the occupants is not injured by overcrowding.

Every living-room shall have a window, which should be of sufficient size, suitably placed, and look out direct on to the open in such a way that the room receives sufficient light. Living-rooms should have facilities for ventilation through a window or other equally suitable arrangement.

Living-rooms shall have proper arrangements for heating. Where sufficient heat is not supplied in other ways, they should be provided with a serviceable fireplace or other satisfactory apparatus for the proper warming of the room. During the cold season of the year windows in living-rooms should be air-tight.

Living-rooms shall be so arranged as to be damp-proof. The floors of living-rooms shall be of suitable material. The floor shall be of

such a character and have such a situation in relation to the surface of the ground as to afford protection against any injurious effects of the soil.

A living-room which is situated above, below or adjoining premises or other place exposed to bad air, steam, intense heat or cold or disturbing noise shall be provided with arrangements which, so far as possible, will afford protection against such nuisances.

The above rules in regard to living-rooms shall be applicable also to kitchens which can be used as living-rooms. In regard to any other room specially intended for cooking purposes the above rules concerning ventilation, heating, freedom from damp and protection against the injurious effects of the soil or nuisances from adjacent premises shall be applicable.

3. Dwellings shall be provided with an entrance hall (landing) or a porch. They shall also be provided with clothes closets, and, if they have a kitchen or other room specially intended for cooking, with a larder, unless other suitable accommodation for clothes and foodstuffs is available.

Dwellings should be provided with a closet, and the occupants, so far as is necessary, should have access to a wash-house and drying-room.

Dwellings shall have a supply of good drinking-water.

4. Dwellings and the premises belonging to them shall be looked after in such a way as not to cause injury to the health of the occupants.

5. Dwellings may not accommodate such a large number of persons that the health of the occupants may be injured by overcrowding. If the dwelling consists of more than one room — the latter term being understood to include a kitchen which can be used as a living-room —, this rule shall be applicable to each of the rooms.

6. Premises ordinarily used for large gatherings shall be provided with the necessary appliances for ventilation and in other respects be so arranged and looked after as not to cause injury to the health of the persons assembled there.

The premises referred to above include churches or other buildings used for divine service, schools, law courts, public halls, theatres, cinemas, dancing halls, restaurants, bars, cafés etc., doss-houses, work-houses and hospitals.

7. If it has been found that any of the rules laid down in paragraphs 1—6 of this section have not been complied with, and if the matter is not rectified on the admonition of the health board or of any of its members acting on behalf of the board, the board shall *either* fix a time limit, adjusted to the circumstances of the case, within which the fault shall have been remedied, *or*, in cases where defects in living-rooms are found to be of such a nature that they cannot be remedied, prohibit any further use of the room for living purposes, *or*, where the board consider it desirable to defer such injunction or prohibition and where there is no manifest peril to the health, notify the offender that the matter has been postponed for a certain period, or, in exceptional cases, until further notice. In cases where the health board have directed that a deficiency in regard to a living-room shall have been rectified within a certain time limit, the board, if they consider it necessary, may order the room to be evacuated pending rectification.

Where the nature of dwelling so warrants, the health board may prohibit its occupation by more than a certain number of persons or its use for the accommodation of children under age: where, the board consider it warranted, they may approve such dwelling only for the accommodation of adults or a single adult. In special cases the health board may permit a dwelling which has been condemned as uninhabitable to be used for residential purposes so long as the person occupying it for the time being remains there. The health board may also prohibit the use of a dwelling for residential purposes during a certain season of the year.

If a deficiency of the nature referred to in this paragraph is due to a serious defect in building, the building control board, if such an institution exists in the district, should be asked for its observations, or a building expert should be consulted.

In cases where the dwelling or premises are occupied by a tenant, injunctions or prohibitions of the nature referred to in this paragraph shall be communicated, according to circumstances, to the house-owner or tenant or both.

8. The occupier of a dwelling in a building which contains living-rooms may not cause injury to the health of his neighbours by lack of cleanliness, disturbing noise, or in any other way.

9. If the health board consider it requisite, and if there are no special objections, the board may direct that the necessary steps should be taken to prevent the introduction, or to eradicate, vermin in respect of living-rooms and appertaining clothes-closets etc., as well as furniture and apparel.

It will be seen from the above that the Public Health Act in its revised form does not contain any detailed regulations regarding measurements of rooms, window space, etc. The intention is that the Medical Board shall lay down rules on the subject in the form of recommendations and directions.

In accordance with the new regulations the local health committees are under obligation to investigate cases in which the housing regulations have not been complied with; but in taking action they may pay due regard to the practicability of the enforcement of the regulations in each specific case. There is thus nothing to prevent the immediate issue of more rigorous housing regulations, applicable also to existing dwellings.

It will be observed that the revised Act contains a clause explicitly declaring the obligation of the occupier of a house or apartment to take proper care of his dwelling. Though regulations to that effect are found in Swedish common law, this matter has been considered to be of such importance from a hygienic point of view as to warrant the insertion of a special clause in the Health Act.

It need scarcely be reiterated that the housing problem in Sweden — as indeed in most other countries — is mainly concerned with overcrowding. In the revision of the housing clauses of the Health Act due attention has been paid to this fact. Whereas according to the previous regulations the local health boards had the *right* to intervene in cases where overcrowding was considered to be perilous to health, under the revised Act they are under *obligation* to take action in such cases. The clause to that effect is so worded as to be applicable also in cases where overcrowding is due to bad utilization of the existing accommodation.

In the revised Health Act special regulations regarding the *inspection of dwellings* are contained only in that part of it which is applicable to towns and certain thickly populated communities. In such areas it is incumbent on the local health boards to make arrangements for periodical inspections of dwellings, special attention being paid to the condition and maintenance of dwellings where violations of the rules of sanitation are most to be apprehended. Detailed instructions regarding the inspection of dwellings are to be issued by the local health boards on the basis of directions given by the Medical Board.

These enactments in substance are quite in conformity with the existing rules. Indeed, most of the Swedish towns have made arrangements for the inspection of dwellings on lines similar to those now prescribed. In Stockholm and Gothenburg this inspection is superintended by special medical officers, in other towns by the municipal medical officer.

But, as the housing committees have pointed out, the practical *application* of the regulations regarding the inspection of dwellings has not proved satisfactory. They consider therefore that the supervision of dwellings in town and country needs reorganization. As the supervision and care of dwellings can scarcely be separated from other branches of the health service, the supervision of dwellings, as is actually the case in most places of Sweden, should, in their opinion, be mainly the concern of the health authorities and under medical direction. Obviously, the committees point out, building experts should be consulted on such matters by the health boards, especially in regard to new buildings and reconditioning, as well as the maintenance of

dwellings. The new organization which they recommend is based on these leading considerations.

The urban housing committee propose that district nurses, whose duties are to include the inspection of dwellings, should be appointed also in towns. In towns with a population of more than 5,000 souls special officers for the inspection of dwellings would, in their opinion, be required in addition. In all places the inspection of dwellings should be guided and superintended by the local medical officer. The committee recognize that this organization, despite its uniform basis, would assume divers forms in different towns, especially in view of their size. This observation applies both to the inspecting staff and to the technical experts which the health boards may consult or permanently engage. The duties of the district nurses in this field are set forth below.

In rural districts proper the conditions differ greatly from those in towns. For various reasons, indicated above, the inspection of dwellings has been neglected by the local health boards. It has been left chiefly to the local medical officer and, in some measure, to the dispensary and district nurses. Furthermore, there have been no special regulations regarding the periodical inspection of dwellings in country districts. This is largely due to the small size of many of the rural communes, a number of which have a population of less than one thousand.

As all the local health boards are under obligation to take action against insanitary conditions in dwellings, they have obviously not only the right but also the duty to inspect houses and apartments. In such small communes, however, the health boards are naturally lacking in experience and in many cases cannot afford to employ the services of qualified technical experts. It should further be noted that the local medical officer, whose district in most cases extends to several communes, is often too busy to give much time to the health board.

Two of the County Councils have appointed experienced housing inspectors for the whole county. This is a move which might well be followed up.

It has previously been mentioned that one of the duties of the district nurses, since the foundation of that institution, has been to give advice and information regarding domestic hygiene. In accordance with new regulations, the qualifications of these nurses in this respect will be raised by improved training in domestic hygiene and related matters.

In the motives which have been adduced in support of these regulations, the importance of these duties of the district nurses has been stressed. In the course of the discussions on this subject, however, the desirability of employing the services of district nurses for the inspection of dwellings — or rather, the supervision of the maintenance of dwellings — to the extent contemplated has naturally been called in question. It has been asked whether this would not encroach on their other duties, more especially the care of children, and whether they are really qualified for such work.

As for the above indicated apprehension lest the district nurses under the new regulations would be too heavily burdened and their time too much cut up, it should be noted that their districts would be so limited in size as to enable them to cope with their work. A population of 5,000 in towns and of 3,000 in rural districts is considered to be a suitable upper limit.

People may nevertheless have misgivings about the desirability of imposing both medical and health duties on the same nurse. It has been proposed, however, that special nurses should be appointed by the County Councils to attend cases requiring lengthy treatment. In such circumstances the medical duties of the district nurse would be confined mainly to short visits.

A distinct advantage of the new organization is that the number of health officers who will visit the homes will be reduced to a minimum. As has previously been observed, people will be much more ready to listen to a nurse who has come to assist them in time of sickness, or has previously got into touch with them in this way, than to an unknown health officer who suddenly appears to examine and inspect the premises.

It has also been objected that a district nurse, by being saddled with duties which might lead to the intervention of the health authorities, would be liable to incur impopularity. This is a point of view which well deserves consideration and throws into sharp relief the great importance of tact in inspecting homes. On the other hand, it should be noted that, as district nurses are not permitted to accept private remuneration for their medical services, they would not be tempted to refrain from making justifiable complaints for fear of pecuniary loss. In doubtful cases a district nurse would presumably consult the local medical officer and look to him for support.

As regards the qualifications of district nurses, they obviously

cannot be expected to possess a thorough knowledge of building technicalities. It should be observed, however, that the supervision of dwellings has a twofold aspect: firstly the inspection of buildings, especially new ones, from technical points of view; and secondly the inspection of dwellings with a view to ascertaining how they are looked after and maintained, how available accommodation is utilized etc. It is these latter duties, the principal qualification for which is a knowledge of hygiene, that would primarily devolve on the district nurses.

It should be noted that the district nurse is not entitled to give orders, which must be left to the local health board. She must confine herself to enlightenment and advice. Should her advice be spurned, she should report the matter to the health board. The duties of the district nurse being thus delimited, there seems to be no reason why she should not be able to discharge them satisfactorily.

It should be added that the new regulations contain a clause explicitly indicating that the services of district nurses in regard to the supervision of dwellings should be supplemented by the appointment of more highly qualified housing inspectors, nominated by the County Councils.

Building in Sweden is regulated not only by the Health Act, but also by the Building Act. In accordance with the latter, no building may be erected in a town or urban community without the authorization of the competent authority. A corresponding regulation in regard to rural districts proper would have been desirable from several points of view. But, for reasons indicated in the observations made above on the health boards in rural communes, the enforcement of such a regulation has not been considered advisable. It is expected, however, that the central authorities will take steps to make up for this loop-hole in the law by the issue of recommendations and directions regarding the erection of houses of the prevailing type in rural areas.

Finally, it should be mentioned that the health service in the country, including, of course, the inspection and maintenance of dwellings, has been furthered by a new regulation to the effect that every commune with a population of 1,500 or more shall have a separate health board.

The subsidies voted by the Riksdag in 1933 to 1936 — namely no less than 40 million kronor for reconditioning and building in rural districts and 35 million kronor for loans in aid of building and reconditioning in towns — appear, as above indicated, to be answering to expectations. They show that the Government and Riksdag are alive to the immense importance of a higher standard of housing accommodation for the masses. It is not only on account of the magnitude of these sums that the period under review must be considered to mark an epoch in the history of social hygiene. The measures in question redound directly to the benefit of large groups of the population living in very poor circumstances, and aim, in a far greater degree than before, at basing improvements in housing conditions on the rules of hygiene.

The above observations are largely a reproduction of views set forth in the course of the housing investigations. The following additional comments may be added.

The greater the financial assistance rendered by the State, the more important it is, with a view to the attainment of durable results, that dwellings should be properly looked after. The lack of the necessary resources will doubtless be pleaded as an excuse for shortcomings in this regard. In drawing up rules for the maintenance of dwellings, due consideration should naturally be paid to the fact that we are primarily concerned with families living in very needy circumstances. There are, however, two conditions which must be insisted on, thorough cleanliness in the dwellings and in the person, and a proper utilization of the dwelling from a hygienic point of view. Thus arrangements should be made whereby the available accommodation will really be made use of for the benefit of each member of the family, particularly at night. These points of view have been taken into consideration in proposed regulations for the maintenance of dwellings.

Though it obviously costs something to keep a dwelling clean, the expenditure on this count is so small that it is quite compatible with *very limited* financial resources. It could moreover doubtless be counterbalanced by savings on other counts.

As another excuse for shortcomings in the maintenance of dwellings, it may be pleaded that the housewife in many cases cannot spare the time. The reports sent in by the various medical officers who took part in the investigation in Norrland tell the

same story, that many a housewife in poor homes in the country has such a heavy burden of work on the farm, in addition to her indoor duties, that her strength gets prematurely exhausted. The Norrland housewife doubtless shares this hard lot with her fellow-sisters in other inhospitable parts of the country. In any case, such conditions cannot but stand in the way of her household work. Some improvement, however, might be effected in this respect if husband and wife more clearly realized the importance of domestic hygiene. The children too, especially the elder ones, might assist the parents in looking after the home.

In endeavours to improve the maintenance of dwellings enlightenment and instruction are, of course, of great importance. Useful service could be rendered by infant schools and public elementary schools by impressing on the children the great importance of personal cleanliness. At a more advanced stage in education instruction in the elementary rules of hygiene might be linked up with tuition in anatomy and physiology. Such instruction would be much more effective if steps were taken to institute a general obligatory medical examination in schools in conjunction with a school nursing service. This would tend to bring about closer cooperation between home and school. Further observations on this subject are contained in the following section (c.).

It has previously been mentioned that domestic hygiene is one of the subjects studied by girl students in continuation schools, and that the curriculum includes the study of the following matters: the serviceable equipment of homes; care of the home and cleaning; furniture and household utensils, their appearance and quality, the care and cleaning thereof; heating and lighting apparatus; water pipes and drains; polishes, scouring agents, etc., and their use. This subject is taught also in schools for young women, in People's High Schools and in rural domestic schools. Attention has previously been drawn to the housewifery courses organized by the county agricultural societies and the lectures arranged by the housewives' societies. Let us hope that these useful endeavours will be maintained and developed.

The lessons learnt and the habits acquired by children in school homes (see p. 22) have an important bearing on domestic

hygiene. Though they do not receive any actual instruction in that subject, the regime in these establishments engenders in the children a love of cleanliness which their own homes in many cases have not fostered, and which they retain after they have returned to the family circle. In this way the children may become little pioneers for improvements in the hygiene of their own homes.

In the previously mentioned »Norrland Housewife's Guide», which has been printed in pamphlet form and distributed gratis, some advice has been given in regard to the maintenance of dwellings and matters connected therewith. In view of its popular character, the instruction given there in this subject is quite elementary. It will therefore by no means suffice for those who teach such subjects, or who have to perform work connected with reconditioning etc., without any previous training in building technique.

We consider it very desirable that the teachers in continuation schools should improve their knowledge of this subject. As is indicated by the extract from the curriculum given above, questions of building technique need not figure prominently in this instruction. The essential matters are the general requirements in regard to a sanitary dwelling, the cleaning and maintenance of the dwelling, the utilization of the available accommodation, proper heating arrangements, and, as a leading theme, the fundamental importance of a serviceable dwelling for personal hygiene and for the morals of the rising generation.

The instruction required by those who have to carry out repairs and bulding work on a minor scale in connection with reconditioning will, of course, be of a rather different character. Here directions regarding purely technical matters would naturally occupy the first place.

The observations made by the county medical officers have made it perfectly clear that many deficiencies in housing conditions which are injurious to health could be remedied with comparatively simple means, with cheap materials, and without resorting to the services of outside persons. In addition to financial assistance, what is needed is instruction regarding drainage, flooring, insulation of walls and roofs against cold and damp, cheap and serviceable materials for repairs, etc. As has been mentioned in the first chapter of this Part, such instruction and guidance has already been organized by the

county agricultural societies. It should further be mentioned that the Government have made a grant in aid of the publication of a guide to the erection and maintenance of rural dwellings, compiled by the Swedish Architects' Association. It is intended for distribution among those who are in receipt of the previously mentioned reconditioning allowances and building loans. This publication will, we think, meet the requirements of these persons in regard to the technical side of the housing problems with which they have to deal.

The publication of a small handbook for the use of the local health boards is, as above indicated, contemplated by the central authorities. It should, of course, contain explanations regarding the powers and duties of those boards in accordance with the Public Health Act. An exposé of the obligations of the child welfare committees in regard to the housing conditions of their clientele should also be included. The handbook should thus be in the nature of a full commentary on the existing regulations on these subjects, illuminated, where necessary, by the citation of precedents or references to other legal decisions. Its value would obviously be enhanced if it also contained a guide to building technicalities, as well as general observations regarding the importance of sanitary dwellings from social and hygienic points of view.

In conclusion, it may be observed that hygiene in the home is perhaps the most important feature in the care of the health. A serviceable dwelling and its proper maintenance provide the conditions requisite for the development of the rising generation, whilst affording to parents and other grown-up members of the family the home-comfort and facilities for rest and recreation which are necessary in order to sustain their vitality and capacity for work. A dwelling adapted to the family and well looked after is of inestimable value not only for the individual but also for the social community at large. (Hellström, Ankarswärd, Byttner.)

b. *Care of the health of infants and small children in their homes, and maternity welfare.*

Negligence and other shortcomings in the care of children, and particularly of infants, is a theme which runs through the

reports of all the medical officers who took part in the Norrland investigation. The defects to which they draw attention are unserviceable clothing, unsuitable food for infants, neglect of airing, keeping children indoors when they are old enough to move about in the open air, and a sudden transition from the unvaried milk-meal diet for infants to the food prepared for adults. Such shortcomings are by no means confined to Upper Norrland. But they undoubtedly assume greater proportions according to the poverty and deficiencies of the homes.

The observations made in the course of the investigations in rural districts, which serve to confirm views previously held on the subject, show that the improvement of the care of children is a cardinal feature in the health service in Upper Norrland.

Though the material obtained in these investigations is on a comparatively small scale, it is borne out by the annual reports submitted by medical officers.

The care of children should commence from the prenatal period. The future mother should have a sanitary dwelling, should be cleanly in person, live a regular life and have suitable food.

In the care of infants and children of pre-school age there are likewise many things to be considered, such as a clean dwelling, free from draughts, with good ventilation and a well-regulated temperature (17—18 degrees centigrade), a good bed for each child, suitable clothing, open-air life when weather and temperature permit, a well-regulated diet, good principles in upbringing, and when the child has reached the frock-stage, suitable occupation.

The care of children on these rational lines naturally presupposes a certain economic standard. Such a standard cannot, of course, be expressed in figures, nor defined in any other way. But, if there are serious impediments of an economic nature, it will devolve on the poor relief or child welfare authorities to take the necessary action.

Another *sine qua non* for the rational care of infants is that the mother, or the person who has the custody of the child, has the necessary knowledge and experience. Here the health authorities and schools have an important mission to fulfil. It is, as a rule, in the home that girls get their first insight into the tending of infants, especially in poor families where they are

obliged at an early age to assist in looking after their small brothers and sisters. Whilst such assistance may be of the greatest use if given on rational lines, it may do the greatest harm if it is based on antiquated, or otherwise erroneous, views. In these circumstances it seems very desirable that girls should receive at an early age some elementary instruction in the care of infants.

As will be seen from the first chapter of this Part, there are several institutions that are working more or less actively in this field.

The question whether the elder girls in the public elementary schools should receive some rudimentary instruction in the tending of infants has been a very controversial one in this country. Nor is such instruction included in the standard curriculum for the elementary schools. On the other hand, it should be noted that some experiments made in Finland in this line have yielded favourable results. The Finnish school authorities in several places have afforded facilities for the »health sisters», (whose functions somewhat resemble those of the Swedish district nurses) to demonstrate simple rules in the tending and clothing of infants. Similar attempts might well be made at suitable places in Sweden.

The curriculum of the continuation schools includes the following obligatory subjects for girls: the tending of infants; personal hygiene; some rules for nursing in the home; infection, isolation and disinfection. This instruction is imparted by female teachers attached to the schools. The continuation schools are now organized in such a way that practically every girl who has attended a public elementary school of any kind can receive such tuition.

Obviously, however, the value of instruction in these subjects is largely dependent on the competence and practical experience of the teacher. In view of the great importance which must be attached to practical experience in imparting vividness to the teaching, the idea naturally suggests itself that it would be very useful to have the assistance of a district nurse. This would moreover afford facilities for practical demonstrations. Seeing that the school for district nurses provides for some training in the imparting of information, these nurses are not unfamiliar with pedagogic methods.

Many of the girls between the ages of thirteen and fifteen,

for whom the continuation schools are intended, will perhaps be at too early a stage of development to take serious interest in the care of infants, so that what they have learnt on the subject may soon evaporate. For this reason, we consider that the People's High Schools and agricultural schools should continue to keep this subject on the syllabus of their course for girl students.

Seeing that only a small number of girls have the opportunity to attend these higher schools, such instruction can scarcely suffice. We consider it therefore to be of the greatest importance that the voluntary courses in the care of children, general health culture and domestic hygiene for adult women should be encouraged and supported. This should be done at any rate pending the execution of the plans which the Medical Board, as is explained below, have drawn up for the organization of the care of children in the home by enlisting the services of the district nurses, or until other satisfactory arrangements have been made. Such courses have hitherto been organized on a voluntary basis by certain associations, notably the Swedish Poor Relief and Child Welfare League, the Swedish Red Cross, 'housewives' societies, and the societies for popular educational courses (see p. 27, 30). Grants in aid of such courses have been made by the County Councils.

The Swedish Government have long had their attention drawn to the shortcomings in the care of the health of expectant mothers and of infants, especially those born out of wedlock. A committee appointed by the Government to institute an enquiry into questions connected with maternity welfare submitted its report on the 26th September 1929.

The question of maternity welfare was not included in the Norrland investigation. It is, however, of such importance that it should not be entirely passed by in this report. It is a well-known fact that an enceinte woman, even if she has not previously been suffering from complaints such as tuberculosis, organic heart disease, kidney disease, etc., has to take greater care of her health than other women. It is therefore within the scope of a rational health service that special care should be bestowed on women during pregnancy, accouchement and confinement. The report of the above-mentioned committee contains proposals for improvements in these respects and for financial aid to women who have borne a child.

The maternity welfare committee recommend that young women and girls in training colleges for teachers, girls' schools and certain continuation schools should receive some instruction in these subjects. As many girls would not receive such instruction during their school days, lectures for grown-up women, if properly organized, would, they consider, be of great utility. Suitable leaflets and booklets would also be very useful.

The committee further propose various measures for improvements in the care of mothers before and after child-birth as well as in the care of infants. They recommend that in rural areas and small urban communities these duties should be discharged mainly by midwives, as a rule by those who have been officially appointed. The care of expectant mothers should take the form of one or more external examinations, as required, and of periodical urinalysis. These examinations should as a general rule be made by the widwife, who should also give any necessary advice or information. The patient should pay a minor fee for each examination.

The committee, after animadverting on the shortage of beds in the maternity nursing-homes in this country, recommend measures to remedy this serious deficiency and submit proposals for legislation regarding private nursing homes.

In connection with their observations on the subject just mentioned, the committee draw attention to the need of maternity homes and of home-helps for mothers in confinement. They emphasize the importance of keeping the fees charged by such institutions and by home-helps as low as possible.

In addition to compensation for loss of earnings for certain childbed women employed in factories etc., the committee recommend a maternity benefit of 50 kronor for women of limited means.

Provision for maternity relief has been made by regulations contained in a Royal Decree of 1931.

In accordance with this decree, any woman who is a member of an approved, State-subsidized sickness relief society, and has been a member of such society for a continuous period of 270 days immediately preceding childbirth, is thereby automatically insured not only against sickness but also against maternity. Maternity relief is payable subject to the condition that the woman abstains from wage-earning during a period of at most 56 and at least 30 days; it is intended to cover the expenses of the midwife's attendance at a certain rate, or for nursing in the public ward of a maternity hospital, and includes a maternity benefit. The latter, which shall not be less than 2 kronor per day, is payable for not more than 14 days preceding the birth of the child. Where the sickness relief society defrays the expense of nursing at a maternity hospital, it will as a rule be entitled to reduce the maternity benefit for that period by an amount corresponding to the cost of the nursing.

State contributions are payable in aid of maternity relief, as a rule at the rate of half the expenses.

Also women who are not members of an approved sickness relief society are entitled, under certain conditions, to receive so-called

»maternity allowances» (*moderskapsunderstöd*), payable by the State. One of these conditions is a certain limit of income. Reckoned according to an approximate general average, this limit works out at 1,850 kronor for a self-supporting woman and 2,700 kronor for a family with two children. It has been estimated that, according to this rule, maternity allowances would be payable to the majority of female workers and wives of workmen who have normal wage earnings in industry, building, commerce and carrying trade, practically all the wives of agricultural labourers etc., and most of the wives of small holders and farm-tenants. Maternity allowances are payable at the rate of one krona per day for at most 56 days to women employed in factory work, building or transport, and for at most 30 days to other women. During this period the woman must abstain from wage-earning. These allowances are to be used in the first place for defraying the expenses of the midwife's attendance and nursing at a maternity hospital.

A Government committee appointed by the Government to institute an investigation into the population question and to submit proposals for increasing the birth rate have recently made certain recommendations in regard to improvements in maternity relief etc. They are partly based on reports of previous committees and observations made by the Medical Board.

This committee recommend the reorganization of the existing institutions for maternity nursing. The organization which they propose is on the following lines: (1) A maternity ward, combined with a ward for women's cases, under the superintendence of specialists, at the largest hospitals; as a general rule at least one such combined maternity department in each county. (2) Smaller maternity wards at medium-sized and small hospitals, under the superintendence of a medical officer attached to the hospital. (3) Maternity homes with 6 to 8 beds, not connected with hospitals. (4) Maternity nursing rooms connected with the residence of the district midwife. These latter, which would have only 2 to 5 beds, are intended for the benefit of women living in thinly populated localities, remote from a hospital. The institutions mentioned under (3) and (4) would as a general rule be under the charge of the district medical officer. The midwives attached to them would also be entitled to attend other mothers in the district.

As regards maternity aid outside hospitals etc., the committee propose that it should be provided for, similarly as at present, by employing the services of the district midwives. There are now over 1,600 midwifery districts, each served by at least one officially appointed midwife. The extensions recommended by the committee will involve certain changes in the division into districts. It is intended that the district midwives should not only give first aid in connection with accouchement and confinement, but should also assist in the prophylactic care of the health of expectant mothers.

The committee propose certain State grants in aid of the erection and equipment of maternity wards, homes etc. They also recommend annual State grants in aid of the maintenance of these institutions,

payable subject to certain conditions. The principal condition is that the charge for maternity nursing shall not exceed one krona per day, in the public ward. It is proposed that this State contribution shall not exceed an amount equivalent to the additional cost of ten day's nursing for one and the same woman. The maternity aid of the district midwives is to be given free of charge.

According to these proposals, maternity nursing (inclusive of prophylactic care) in each county is to be in the hands of the County Council. This would not prevent the maternity hospitals and homes which have already been established by private initiative from receiving State contributions in aid of maintenance, provided that the charge to the women nursed there does not exceed the sum mentioned above, and that these private institutions adapt themselves to the plan of organization drawn up by the County Council and approved by the Medical Board, which is the supervisory authority.

The committee propose the following additional measures for financial assistance to mothers.

They recommend a reorganization and extension of the existing system of maternity relief, on the following lines: The State contributions to the maternity benefits granted by sickness relief societies to be withdrawn, with the consequence that these benefits, at the same premium rates, would be reduced to half. The State maternity allowances in their present form to be at the same time abolished. In lieu of the State aid thus withdrawn, a so-called »maternity bounty» (*moderskapspenning*) to be granted by the State to *every*[1] woman who bears a child, irrespective of her financial position. This bounty to be in the form of a fixed sum of 75 kronor for each such woman, and to be paid as soon as possible after the accouchement by a central institution which is to be established under the name of »The State Family and Child Board». A midwife or doctor who has assisted at the accouchement to be under obligation to report the birth to this Board.

The proposed maternity bounty is intended to be used to cover expenses normally entailed by the birth of a child, such as for travelling, extra help in the home, clothes required by the future mother during the last stage of her pregnancy, as well as bedding and clothing for the child.

Additional economic assistance to be given to mothers who are so needy that the maternity bounty would not suffice for them. This assistance to take the form of a so-called »mothers' relief benefit» (*mödrahjälp*) to be defrayed entirely by the State. The amount of this benefit to be adjusted to individual needs in each specific case, but, for financial reasons, not to exceed 300 kronor. The benefit not necessarily to be paid in cash, but, so far as is possible and desirable, in kind, especially in the form of provision for housing accommodation and nursing.

The »mothers' relief benefit» may thus be regarded as a kind of way of escape from poor relief. It is based on the view that the special need of relief entailed by pregnancy and child-birth, for various reasons,

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[1] With the exception of women who are inmates of public asylums etc., of various kinds.

and particularly with a view to the suppression of artificial abortion, should be provided for otherwise than by poor relief.

This service to be administered by the local child welfare committees. Final decisions in regard to the grant of mothers' relief benefit to be taken, however, by the above-mentioned central board.

The committee furthermore propose measures for improving the prophylactic care of expectant mothers and infants. This, it should be observed, is a matter that entails special difficulties in Sweden, owing to the very marked differences in the density of the population. These measures are to the following effect:

In rural areas, small towns and small urban communities — where, as a rule, there are no gynaecologicists or pediatrists —, the prophylactic care both of expectant mothers and of infants to be in the hands of the district medical officer. In towns and large urban communities, on the other hand, the care of mothers and of infants respectively to be under the charge of such specialists.

For the purpose of the organization of these services, the country to be divided into districts, which, as a rule, would coincide with those of the county medical officers. Small towns to form one district, larger towns, according to their size, two or more districts. A central department for the prophylactic care of mothers and infants, installed in the out-patient premises of a hospital or in premises fitted up for the purpose, to be established in every urban district. An institution of a similar character but on a minor scale (named a »station»), installed in the consulting-rooms of the district medical officer, to be established in all rural districts.

Special nurses and, if necessary, also midwives, to be attached to the above-mentioned central departments, with the obligation, when required, to visit homes. At the so-called »stations» in rural areas the medical officer to be assisted by the local district nurse and midwife. In addition, all the district nurses and certificated midwives in the medical officer's district to be under obligation to assist in this service. Required visits to homes to be made as a rule by midwives.

This prophylactic service to be administered by a board appointed by the County Council, and to be supervised by the Medical Board.

In order to avoid any misunderstanding, it should be pointed out that this proposed organization is in the nature of a *health* service, not a medical service, its primary aim being to endeavour to prevent the development of disease.

The committee recommend that consultations at the above-mentioned central departments and »stations» shall be free of charge, and that the expense entailed by this service shall be borne mainly by the State. For financial reasons, it is to be concentrated on the prophylactic care of infants.

The realization of this plan could be greatly facilitated by the reorganization of the district nurse service, on a basis of State aid (see p. 12). Unfortunately, however, the number of district nurses is still too small to permit of the scheme being effectuated in its full extent for some time to come. But, by greater intensity

in the training of district nurses and by the organizing of supplementary courses for those who have already completed their training, the period of transition might be considerably reduced. The committee on the population question estimate that the proposed organization could be completely carried out within five years from its adoption by the Riksdag.

It should be noted that, as these proposals have not yet been embodied in a Government Bill, it is uncertain how far they will be realized. Authorities and corporations who have been requested by the Government to submit their observations on the proposals regarding maternity nursing and the prophylactic care of mothers and infants, have, however, generally speaking, taken a favourable attitude.[1]

That the realization of this scheme would be greatly to the benefit of the health service is, in our opinion, beyond question. True that Sweden is in a favoured position in regard to maternity nursing and the care of infants. This is strikingly shown by our statistics of mortality. But, without any desire to cast discredit on that gauge of the health of a nation, we feel constrained to point out that favourable mortality statistics may conceal many defects which could be greatly ameliorated by State measures, if not entirely eliminated. Our investigation into the diet in the two northernmost counties of Sweden — the main objective of the entire undertaking — has glaringly exposed one of these deficiencies. The observations made by the medical officers who took part in the investigation in regard to the treatment of infants strikingly show that there remains much to be desired in this respect, and that the abuses are not solely due to poverty and distress. The marked differences in infant mortality in various parts of the country are highly significant. They are shown by the table overleaf.

Without a thorough investigation into the causes of mortality, no conclusions can be drawn as to how far this marked disparity in different parts of the country might be effaced by improvements in the care of infants. The greater incidence of tuberculosis in those counties where infant mortality is highest is, however, a factor which could undoubtedly be affected by measures for the improvement of hygiene. In regard to acute infectious diseases of an epidemic character it is more difficult to express an opinion.

[1] See Supplement II page 119.

Number of live births and deaths in the first year of life, in and out of wedlock, on an average for the years 1926—1930.

County	Absolute figures					Relative figures				
	Average population	Live births		Deaths in first year		Percentage of births out of wedlock	Live births per 1,000 average Pop.		Deaths in first year per 1,000 average Pop.	
		In wedlock	Out of wedlock	In wedlock	Out of wedlock		In wedlock	Out of wedlock	In wedlock	Out of wedlock
City of Stockholm	470,185	3,793	1,351	170	99	26.3	8.07	2.87	44.82	73.28
County of Stockholm	263,183	3,163	600	186	45	15.9	12.02	2.28	58.80	75.00
» » Upsala	139,435	1,790	386	99	27	17.7	12.84	2.77	55.31	69.95
» » Södermanland	190,820	2,376	401	121	27	14.4	12.45	2.10	50.93	67.33
» » Östergötland	309,871	4,033	826	195	54	17.0	13.02	2.67	48.35	65.38
» » Jönköping	231,159	3,223	318	142	21	9.0	13.94	1.38	44.06	66.04
» » Kronoberg	157,042	2,303	262	110	16	10.2	14.66	1.67	47.76	61.07
» » Kalmar	231,442	3,329	433	180	35	11.5	14.38	1.87	54.07	80.83
» » Gotland	57,172	819	150	45	14	15.5	14.33	2.62	54.95	93.33
» » Blekinge	147,004	2,170	380	140	33	14.9	14.76	2.58	64.52	86.84
» » Kristianstad	245,781	3,694	675	212	48	15.4	15.03	2.75	57.39	71.11
» » Malmöhus	506,472	6,423	1,480	362	123	18.7	12.68	2.92	56.36	83.11
» » Halland	149,887	2,141	236	101	16	9.9	14.28	1.57	47.17	67.80
» » Göteborg and Bohus	448,910	5,825	949	243	62	14.0	12.98	2.11	41.72	65.33
» » Älvsborg	312,010	4,339	506	199	40	10.4	13.91	1.62	45.86	79.05
» » Skaraborg	244,523	3,372	418	157	29	11.0	13.79	1.71	46.56	69.38
» » Värmland	270,223	3,557	705	168	44	16.5	13.16	2.61	47.23	62.41
» » Örebro	221,127	2,322	508	107	27	18.0	10.50	2.30	46.08	53.15
» » Västmanland	163,266	1,954	446	103	31	18.6	11.97	2.73	52.71	69.51
» » Kopparberg	251,895	3,094	616	160	33	16.6	12.28	2.45	51.71	53.57
» » Göteborg	279,138	3,477	1,205	214	89	25.7	12.46	4.32	61.55	73.86
» » Västernorrland	275,855	3,992	1,101	300	91	21.6	14.47	3.99	75.15	82.65
» » Jämtland	135,610	1,845	589	117	39	24.2	13.61	4.34	63.41	66.21
» » Västerbotten	200,111	4,097	436	271	33	9.6	20.47	2.18	66.15	75.69
» » Norrbotten	194,967	4,367	515	353	51	10.5	22.40	2.64	80.83	99.03
Whole of Sweden	6,097,088	81,498	15,492	4,455	1,127	16.0	13.37	2.54	54.66	72.75

Even if the decline of the birth rate in Sweden is taken into account, it seems to us very significant that the annual infant mortality (up to the age of 1 year) from acute bronchitis (*bronchitis acuta*) has decreased from 733 during the period 1911—1915 to 437 in 1926—1930, and that the infant mortality from acute gastroenteritis (*gastroenteritis acuta*) for the same periods has dwindled from 1,147 to 375. These figures urge us to make more determined efforts to improve the care of infants, especially in those parts of the country where the mortality is still comparatively high. Such efforts would doubtless conduce to bring about further improvements, which would be manifested not only in a reduction of mortality, but also in the better health of children of very young age. The fact that the annual infant mortality among illegitimate children has dwindled from 107.7 per 1,000 for the period 1911—1915 to 72.8 per 1,000 for the period 1926—1930 is unimpeachable evidence that the measures taken by the public authorities on behalf on these children, in conjunction with progressive enlightenment, have been of the greatest importance. In this field the health authorities will certainly still find much to do.

To give detailed advice regarding the care of infants is beyond the scope of this report. We must refer the reader to the copious popular literature on this subject and to the previously mentioned »Norrland Houswife's Guide» (Swedish edition).

Before bringing this section to a close, attention should be drawn to the powers of the child welfare committees to take charge of sick or delicate children who, for various reasons, may be in need of special care outside their homes. Such drastic steps will obviously not be taken, at any rate as regards children living in their parents' homes, except in cases of palpable neglect. The mere existence of these powers, however, is a remarkable step in advance. By cooperation with the district nurses the child welfare committees can make themselves thoroughly acquainted with the local conditions in regard to the care of children, whilst the nurses can look to these committees for support in dealing with negligent and contumacious parents. In this way the child welfare committees can render useful service also in promoting the care of children's health.

The provision and maintenance of *homes for the reception of*

neglected children ought, in our opinion, to be strongly encouraged. These homes are intended especially, but by no means exclusively, for illegitimate children. It should be noted that the infant mortality in Sweden among such children as late as 1930 was on an average 25 per cent higher than for children born in wedlock.

Mention has previously been made of the measures taken by the Public Orphanage (see p. 10), which will doubtless be of great benefit.

The above must not be taken to mean that we are in any way opposed to the bringing up of illegitimate children in the homes of foster-parents. For reasons which we need not enter into here, the upbringing of such children in private homes must be regarded as the normal procedure. This, however, implies a careful selection of foster-homes and of the children to be brought up in them. We consider that a system combining both these methods of upbringing will be the one which at present will yield the best results. (Hellström, Ernberg, Ankarswärd, Byttner.)

c. *Care of the health of children of school age.*

The attention of the public authorities has long been centred on *the care of the health of children of school age*. This, as Dr H. Ernberg has pointed out, is by no means due to »any intrinsic biological necessity». Rational measures for improving the health of the nation should embrace all the stages in the development of man. They should commence from the prenatal period, follow the child through the infant, pre-school and school stages, and through the age of puberty, in order to culminate in the physical and mental health culture of the adult. On the other hand, it should be noted that the enforcement of public measures for the care of children's health is greatly facilitated by the fact that, under the system of compulsory education, the children are assembled during their school years.

The observations previously made about the responsibility of parents and guardians and the important part played by *the home* in regard to the physical and mental health of children by no means lose their weight when applied to children at school. It may in fact be stated that but little can be achieved by school hygiene alone. In considering public measures with respect to school children, we should therefore ask ourselves how far it is necessary that the care of the health of children in the home

should be extended in the schools beyond the imparting of instruction.

School buildings, their equipment and other externals are, of course, matters which concern the public authorities. Some of the communes in Upper Norrland, many of which are in financial straits, have long been in receipt of State aid for such purposes, with very beneficial results. It is highly desirable, however, that this cooperation should be further extended. Whilst ungrudgingly recognizing that much has already been achieved in this respect by the existing school organization in Sweden, we cannot shut our eyes to the fact that there is very considerable room for improvement in regard to the structure, design and situation of school buildings. It cannot, of course, be expected that all school premises shall come up to the high standard which they have attained in many of the larger towns and urban communities in Sweden. Unfortunately, however, the annual reports of school inspectors, medical officers etc., have shown that in many places the design, heating, ventilation etc., of elementary school premises do not conform even to quite moderate requirements. Great improvements in this respect may, however, be expected as the result of a Government Bill for the partial nationalization of the public elementary schools, which was passed by the Riksdag in 1935. In accordance with this measure the expenditure on public elementary schools is to be divided in certain proportions between the State and the communes.

Owing to the sparse population of many districts in the north of Sweden, a number of children have a long way to go, sometimes over very rough country, from their homes to the school. The drawbacks thus entailed, especially for the smaller children, cannot, perhaps, be entirely eliminated. A great improvement in this regard has, however, been effected by the establishment of the State-subsidized school homes (see p. 22), which are increasing in number, and by the arrangements which have been made, with State aid, for the conveyance of school children from the more remote parts of school districts. Measures of this nature should be encouraged by the authorities and extended. As many of these children may have to live on the dry provisions which they bring with them from home, it is important that steps should be taken to supplement this monotonous food.

The above-mentioned arrangements for the conveyance of school children have rendered it possible for a larger number of children

to remain in their homes in term-time. But the endeavours made to develop school homes should not on that account be relegated into the background. It should be borne in mind that there are quite a number of homes where the children have only the barest necessities — and scarcely that. Competent judges are unanimous in testifying to the beneficial effects of the regime in the school homes on the physical development of the children and on their upbringing in general.

A matter of great importance for the hygiene of school children is the provision of school baths. Such arrangements have been made by a number of municipal authorities. School baths have also been installed in all school homes. It should be observed that regular school baths not only improve the children's health and conduce to greater cleanliness in their clothing, but also facilitate the cleaning and ventilation of school-rooms. In the kind of home from which most of the elementary school children come, school baths may also serve to encourage better care of the body in the whole family.

Finnish vapour baths, which are very hygienic, and with which the Swedish population in the regions adjacent to the Finnish frontier have long been familiar, could be installed in schools at quite a small cost.

The provision of school baths is a matter of such importance that it thoroughly deserves the financial support of the public authorities. Experience has shown that, given the necessary interest and enterprise, the municipal authorities find no great difficulty in making provision for school baths. Such undertakings have also received the effective support of the Pensions Board. And it is gratifying to note that preparatory steps in the same direction have now been taken by the Government.

The deficiencies in the diet of the population of Norrland indicate the desirability of improvements through the medium of the schools. In some places arrangements have been made for school-feeding, mainly for the benefit of the poorest children But, as our investigations have shown that deficiencies in diet are by no means confined to the poorest section of the population, the question suggests itself whether it would not be advisable to make arrangements for the feeding of *all* elementary school children, more especially in rural districts. This would conduce to rationalize the children's diet and indirectly tend to similar improvements in the homes. Such arrangements might

be made at least for some years ahead until the importance of a more rational diet has been generally recognized and a higher standard adopted in the children's homes.

We are well aware that, for financial and other reasons, it will by no means be easy to realize such a plan. The matter, however, seems to us to be of too much importance to be dismissed without careful consideration. As has been indicated above, the school authorities in certain districts have already shown that the scheme is not impracticable.

Whether it may be desirable for financial reasons to make a certain charge in the case of children whose parents can afford it, is a question which cannot be entered into here. It should be borne in mind, however, that even the fairly well-to-do classes, at any rate in a large part of Upper Norrland, show by their state of health that their diet is not rationally composed.

The reports of Dr Odin and Dr Westin (Parts II and III) indicate that the composition of the school dietary should vary somewhat in different parts of the country. Account should be taken of the fact that the milk-meal diet of the coastal population (the L diet) is extremely monotonous, whilst that of the population of the interior (the S diet) is more varied, but, like the L diet, very deficient in fruit and vegetables. The S diet, in addition, shows a shortage of milk. Unfermented barley bread, generally speaking, is included both in the S and in the L diet. This bread, which in a large part of this area is practically the only kind of bread eaten, is devoid of certain ingredients contained in fermented bread, the absence of which has been found to have some connection with certain disorders observed in the subjects examined. These facts indicate the lines on which school meals should be arranged in the various areas.

Thus the school meals should include fermented bread (*preferably unsifted, hard rye bread*), butter — or, if the expense prohibits this, margarine *mixed with butter* or possibly vitaminized —, and milk.

Fruit rich in C vitamin, especially berries, and vegetables should be included in every school meal. The simplest way of providing these foods would be to supply the children with an orange daily, or else the juice of a lemon. This, however, is scarcely possible for financial reasons, nor is it necessary. By organizing the gathering and preserving of Swedish berries (first and foremost cloudberries, secondly raspberries and currants)

and by the cultivation of carrots, cabbage and potatoes on a larger scale, it should be quite possible to provide the required additional supply of fruit and vegetables out of the *produce of the home country*.

A very important question is what amount of C vitamin is required to supply the needs of school children. This question is somewhat complicated by the consideration which must be paid to the different ages of the children. It should also be borne in mind that the children's requirements of C vitamin are to some extent provided for in their home diet, especially by milk and potatoes. This conclusion is warranted by the fact that *pronounced* symptoms of scurvy appear to be of very rare occurrence. In such circumstances it is difficult to estimate, on the one hand, the amount of C vitamin required by individual children, and, on the other, the amount which should be supplied by the school diet in order to cover these requirements. But, for practical purposes, one can reckon with about the same amount of C vitamin for the different ages, and arrange the diet so that about *half* the total estimated amount required per child is supplied. Noting that *carrots* are valuable for this purpose, we refer the reader to Professor GÖTHLIN's report.

The deficiency of *meat* could be easily supplied by sandwiches. Another way would be to include soup containing meat two or three times a week in the school dietary. These are mere suggestions. There are many other obvious ways of supplying the need of meat. We further suggest that, by dint of vigorous propaganda, the children's parents might be induced to introduce cheap meat, fish or egg dishes three or four times a week in the home fare. In that case it would hardly be necessary for the schools to supply meat or fish.

Recommendations of this nature have been made in »The Norrland Housewife's Guide».

Our investigations in Norrland have shown that there is also a considerable deficiency of D vitamin in the diet of the population. A cheap food, rich in D vitamin, is cod-liver oil. The school authorities would therefore do well to make arrangements for supplying cod-liver oil during the dark season of the year to children who need it and do not get it in their homes. It should be borne in mind that the amount of this substance thus required as special food is not more than a teaspoonful a day for each child. As we know, an over-dosage of cod-liver oil

is by no means desirable, or even permissible, from a hygienic point of view.

If school-feeding is expertly and uniformly organized by a central authority, it should not entail excessive expenditure. Furthermore, it may be hoped that, when the beneficial effects of an improvement in diet have been realized in the children's homes, and when this has led to corresponding changes for the better, school-feeding in the form envisaged here will become superfluous. It may thus be regarded as a temporary measure on the part of the authorities.

It may be considered that the measures which we have recommended for improving the health of the Norrland school children would too heavily tax the resources of the public authorities. We accordingly suggest that school-feeding on the lines proposed might be confined to the dark season of the year, that is, from about the beginning of November to about the middle of March, the period that is most trying to the children's health.

It may be taken for granted that the diet in the school homes (see p. 22) — if this has not already been done — will be arranged entirely in accordance with the rules laid down as the result of our investigation.

It seems unnecessary to give an account of the measures which have already been adopted by communal authorities for the above-mentioned purpose. It need merely be mentioned that not only municipalities but also certain rural communes have already made arrangements for school-feeding.

The measures which we have recommended for improving the health of school children naturally involve some medical control. Long before these measures were brought up for consideration, the desirability of the medical examination of school children, of a permanent character, had been recognized. At the time when the Swedish edition of this work was being compiled (in 1933) regular medical examinations of school children had been organized in about 10 per cent of the school districts in rural areas. And in a number of other school districts arrangements had been made for medical examinations of a more temporary character. In the two northernmost counties provision has been

made for obligatory medical examinations in some ten school districts in the area adjacent to the eastern frontier. The cost of these examinations is defrayed entirely by State grants. In a few other school districts in these counties medical examinations have been provided for at the expense of the communal authorities. In the course of the last few years the importance of these medical examinations has been increasingly realized, with the result that this service has been considerably extended. This is borne out by figures compiled by the Medical Board in 1935, which are summarized in the table below. It includes not only schools where medical examinations take place regularly every year, but also those in which only occasional arrangements are made for such examinations.

The table shows that provision for medical examinations in schools has been made by 28 per cent of the rural communes and 62 per cent of the municipalities.

Much still remains to be done in regard to the regulation and extension of the school medical service, and we share the views of all the school inspectors whose opinion we have consulted as to the great desirability of organizing regular medical examinations in all the school districts.

In view of the natural conditions in the north of Sweden and the financial position of the communes, this desideratum can scarcely be realized without the assistance of *the State*. Seeing that the rate of local taxation in this part of the country is already high, it is scarcely probable that the County Councils of Norrbotten and Västerbotten — as other County Councils have done — will involve themselves in much expenditure on medical examinations of school children. It is scarcely necessary, however, that every child should be examined every year. Experience has shown that two medical examinations for each school child may suffice, one during the first school year, and one, say, in the third or fourth year. The appointment of special school doctors will presumably be found desirable only in towns and the largest urban communities. In rural areas the medical examinations should be performed by the district medical officers.

It should be emphatically insisted that the utility of the proposed medical examinations will entirely depend on the action taken as the result thereof. For example, any diseases or physical defects detected in the course of the examination should as soon as

Number of rural communes and municipalities in each county which have made arrangements for the medical examination of school children.

County	Rural communes %	Municipalities %	County	Rural communes %	Municipalities %
Stockholm [1]	48	78	Älvsborg	11	85
Upsala	24	75	Skaraborg	32	65
Södermanland	18	79	Värmland	48	71
Östergötland	31	86	Örebro	61	79
Jönköping	14	75	Västmanland	60	75
Kronoberg	5	23	Kopparberg	40	64
Kalmar	40	65	Gävleborg	35	89
Gotland	41	100	Västernorrland	17	64
Blekinge	64	100	Jämtland	22	50
Kristianstad	20	51	Västerbotten	11	44
Malmöhus except city of Malmö	21	68	Norrbotten	64	70
Halland	15	83	Total	28	62
Göteborg except city of Gothenburg	19	20			

possible be put under the doctor's care, delicate and backward children should be placed under special supervision, and so forth. It is therefore highly desirable that the mother, or some other adult member of the family, should be present at the medical examination, in order to give any required information about the child and to take note of the doctor's instructions.

In view of the conditions which prevail in many homes, the control of the children's state of health in the periods intervening between the medical examinations is a matter which presents considerable difficulties. In accordance with a plan for the reorganization of the district nurse service (see p. 12), it will be incumbent on the district nurses to devote special attention to the control of the health of school children by regular visits to each class. The service of the so-called »health sisters» in Finland has indicated a practicable method for the control of the health of school children even in remote country districts. The district nurses in Norrbotten, even with their

[1] Year 1934.

present numbers, should, we think, be able to render considerable services in regard to the care of the health of school children. The situation is quite different in Västerbotten, where the number of district nurses is very small. This is most unfortunate, as the district nurses are befitted by their calling to serve as a connecting link between the school and the home as well as between the school and the doctors.

In Norrbotten, even under existing conditions, the question of the cooperation of the district nurses in the school health service might be taken up for serious consideration by consultation between the school and health authorities. Even if the financial situation does not permit of medical examination and medical control to the extent desirable, it may be expected that the district medical officers will realize the importance of this matter and do what they can to guide and support the district nurses in this service.

It should be noted that the chief county medical officer is under obligation to supervise the health conditions in schools, and that it is incumbent on the other county medical officers, so far as time and circumstances permit, to investigate the health conditions in the schools in their districts and to draw the attention of the authorities to any defects which they may have observed. In order to avoid any misunderstanding, we desire to make it clear that it is not our intention that the district nurse should replace the doctor. But, by her training and experience, she is naturally better qualified than the teachers to notice children who are in need of medical examination or treatment, besides which she can be a stand-by to the teacher in impressing on the children the importance of school hygiène.

In 1931 the Royal Board of Education submitted to the Government proposals for the organization of medical examinations etc., in all the infant schools and public elementary schools in Sweden. At the request of the Government, the Royal Medical Board in 1932 made their observations on these proposals. Both boards expressed the opinion that the organization of this service required effective financial support from the State. Though there are some differences in the plans of organization proposed by the two boards, they are fairly well agreed on the main lines of the scheme. The chief difference of opinion is in regard to the functions of the teachers and the district nurses: whereas the

Board of Education desire that this service should be centred in the teachers, the Medical Board consider that its routine duties should be discharged by the district nurses. In addition, the latter authority have laid stress on the central position of the medical officer in this service. Both authorities are entirely agreed that cooperation between school and home is absolutely necessary if this service is to yield the intended results. Indeed an organization of this character must obviously be based on close cooperation between the medical officer, the nurse, the teacher and the school authorities.

Another way in which the health of school children can be improved is by the organization of *country holiday colonies.* Arrangements of this nature have already been made on a considerable scale. In these colonies the children lead an open-air life during the summer, have facilities for bathing etc., and are supplied with nourishing food. They are, of course, mainly intended for poor children living in towns or large urban communities.

Our investigation in Norrland has drawn particular attention to the great need of a *dental service* for school children. In part III the reader will find a report on the nature and incidence of diseases of the teeth in that region. The causes of the widespread dental diseases have not yet been ascertained with certainty. It is evident, however, that we are confronted with a complex combination of different factors, the connection between which is, in some respects, very obscure. But our imperfect knowledge of the ultimate causes of the decay of the teeth by no means warrants us in excluding dental care from the health service in schools. On the contrary, we are convinced that dental care is one of the most important and pressing problems in the national health service. For further observations on this subject the reader is referred to the following section e. (p. 100).

In conclusion, attention should be drawn to the facilities afforded by the schools for disseminating knowledge of hygiene. Besides imparting actual instruction in that subject, schools can arrange for the distribution of suitable pamphlets and other literature in the children's homes.

As has been indicated above, it is very desirable that cooperation should be established between the various forces at work in this field. The great aim which all of them have in common — the improvement of the health of school children and more

favourable conditions for their development — must not be obscured by minor differences as to the way in which the goal is to be reached. (Byttner, Ernberg, Odin, Westin, Helström.)

d. *The diet problem in Upper Norrland.*

General observations. It has been shown in the foregoing pages that certain symptoms of disease which have been found in the population of Norrland are indubitably attributable to an unsuitably composed diet. The particulars given by the local population in regard to their diet in reply to careful enquiries addressed to several thousand persons, in conjunction with the results of food-weighing carried out by medical officers in the homes, indicate that the diet in many cases shows deficiencies which, though they do not necessarily give rise to actual symptoms of disease, involve the risk of their development. This latent state of disease is a rather serious matter, as there is good reason to presume that it greatly weakens the power of resistance to disease.

In discussing the problems which arise in connection with endeavours to improve the diet, consideration must be paid to the costs involved and the impracticability, in many cases, of procuring suitable food. In short, as in regard to other problems of social hygiene, the financial aspect and local conditions must be taken into account. Where the deficiencies are very marked, it should, however, be possible for the public authorities to remedy them in some degree, especially in the case of school children.

In the »Norrland Housewife's Guide» we have given, in addition to recipes, some general rules for the composition of the diet. It is pointed out there that the food should be sufficient, and that too much food, as well as too little, is injurious to the system; that the diet should be properly composed, and that it should contain the various nutritive substances in the right proportions. This is the essence of dietetics.

We shall now proceed to make some suggestions in regard to the composition of the diet, with special reference to the conditions in Upper Norrland.

The nutritive value of food is usually reckoned according to its caloric value, that is, the amount of heat which it generates.

Thus it is stated that the energy content of the food required by a grown-up man, »the average worker», is 3,000 calories. The corresponding figure for a grown-up woman is 2,500 calories, and for a child between the ages of six and fourteen 1,800 to 2,500 calories, according to age.

In practice, however, these figures do not tell us very much. The need of food shows very considerable variations under different conditions. Nor can a housewife be expected to calculate the caloric content of the various foods and to adjust the fare to the caloric requirements of the different members of the family. This would not be much use either. One must also be prepared for the objection that housewives for thousands of years have arranged their housekeeping without the slightest knowledge of caloric content and caloric requirements, and yet have reared vigorous generations. True. On the other hand, it should be observed that the production of foodstuffs on a manufacturing scale which has followed in the wake of civilization, especially modern milling processes and canning, involve risks of diseases due to diet which did not exist in former days. It should furthermore be borne in mind that diseases due to faulty diet, which were formerly quite common, have diminished in frequency or have disappeared thanks to our greater knowledge.

In Upper Norrland the proper *amount* of food is, as a rule, well regulated by habit and appetite. In that part of the country diseases due to over-feeding are seldom observed, and marked cases of under-feeding are likewise rare. It must accordingly be considered that the diet of the forest labourers, the caloric content of which exceeds 5,000 calories, is in accordance with their requirements. The large caloric requirements of this section of the population are due to the hard work these labourers have to perform, as well as to the severity of the climate. On the other hand, the small caloric content of the milk-meal diet of the coastal population, which is often not more than 2,000 calories, and sometimes even less, suffices for those people, on the assumption that the need of food is regulated by habit and appetite. Our investigation has, however, indicated that the low caloric content of this fare is due to certain deficiencies in the composition of the diet. So long as the latter is not improved, it would be wrong to advise a section of the population whose nourishment consists of an unvaried milk-meal diet, simply to eat *more*. They have in fact no *need* of more food. If, on the

other hand, the composition of the diet is modified, there is reason to expect that the craving for food with a higher caloric value will become so intense that it will certainly be satisfied. We can therefore dismiss the question of the proper amount of food and proceed to discuss its *composition*.

The principal ingredients in food are protein (or albumin), fat, carbohydrates, salts, condiments and vitamins. In regard to the amount of protein, fat and carbohydrates which should be included in the food there are no definite rules. It can be definitely stated, however, that a certain minimum quantity of these substances is necessary for maintaining health and upholding life. This minimum partly depends on the nature of the food-stuff. *Animal* protein, such as is found in meat, fish, eggs and milk, is of higher value than *vegetable* protein. In all probability a definite quantity of animal protein is invariably required. If the bulk of the requirement of protein is supplied by animal albumin, less protein is needed than if the main component in this part of the food is vegetable albumin. This is not due solely to the fact that animal protein is better utilized by the system. There is likewise reason to presume that certain kinds of fat, especially milk-fat, are of higher value than others. Such a differentiation in value cannot be made in regard to the carbohydrates.

It may be laid down as a general rule that what we call »mixed» diet contains a sufficient amount of the various nutritive substances. It should be observed, however, that, owing to special conditions, previously mentioned, such as climate, communications, etc., the diet of the population of Norrland is often extremely *monotonous*. Conclusive evidence has in fact been produced in support of the view that this lack of variety is an evil, which brings disease, or threat of disease, in its train. It would therefore have been of great value if we had been able to lay down definite rules as to the number of grammes of protein, fat and carbohydrates which should be contained in the daily food. On this matter, however, science has not yet said its last word. This is largely due to the fact that the need of these substances varies under different conditions.

Protein, or albumin, is the principal component of the living cell and must be included in the food in order to form new cells, replace those which have withered, and build up musele and blood. Man, like the animals, cannot develop his own albumin. When it is stated that a human being, provided that the diet

is otherwise suitably composed, does not require more than 23 to 35 grammes of albumin per day, this does not signify that such a small amount is what is desirable, even if it has been found to suffice for the maintenance of life, at any rate during the period in which the experiments have proceeded. There is more to be said for those who insist that 70 to 80 grammes of albumin is a minimum requirement. It should be noted that in all those races who live on a diet markedly poor in albumin, other deficiencies have also been observed.

Whilst the minimum requirement of albumin has not yet been scientifically determined, the evils of a too abundant supply of that substance have not been demonstrated either. There are races, such as the Eskimoes, who live on a very rich meat diet and nevertheless, so far as we can judge, are in a good state of health. The question as to a possible excess of meat and the evils which according to certain authors are thereby entailed (excess of acidity with a resulting deficiency of calcium in the bones and teeth etc.) is of no interest as far as the population of Norrland is concerned, as no such excess has been observed.

As regards fat, many investigators contend that an amount of 300 grammes per day is the maximum that the human system can stand. This amount, however, is frequently exceeded by the Swedish forest labourers, in whose food fat is the principal ingredient. Such observations, in conjunction with the results of investigations on cases of diabetes treated with a fat diet, show that this view is not of general validity. Despite the fact that the body has the capacity of itself forming fat out of the carbohydrates, fat is a necessary ingredient in the food, with respect to its taste and preparation. Fat is also of great importance as a component of the diet from another point of view. It is, as will be explained further on, the carrier of very essential vitamins. This observation applies especially to milk-fat and butter.

The carbohydrates are of chief importance as a source of heat. The caloric requirement is in fact supplied by this substance. Moreover, a number of foodstuffs rich in carbohydrates, especially fruit and vegetables, supply the system not only with vitamins soluble in water (the C vitamin), but also with minerals and salts, iron, phosphorus, calcium, etc. Provided that the food contains sufficient amounts of protein and fat, and especially if it includes fruit and vegetables, injurious effects

from a superabundant supply of cereal substances (apart from over-feeding) are scarcely to be apprehended. The position will be quite different if the caloric requirement is supplied by an *unvaried* cereal diet. We revert to this matter further on.

Mineral ingredients in the food are required in order to build up certain tissues of the body. Iron, for example, is one of the principal components of the blood: it takes part in the formation of the blood-pigment and is necessary for respiration. The great incidence of anaemia in Upper Norrland is partly due to a deficiency of iron. Calcium and phosphorus are the principal substances required for the building up of the bones and teeth. The metabolism of calcium and phosphorus, especially that required for building up the bones, is greatly dependent on the supply of D vitamin. Deficiencies in these respects are important factors in the development of rachitis and structural changes of the teeth, which are prevalent among the population of Upper Norrland. Other mineral substances required by the system are sodium and chlorine (common salt), potassium and iodine. Each of these substances has its special function. We cannot enter into details here.

Condiments, which, of course, are closely connected with cookery, are of the greatest importance for the assimilation of food, and perhaps particularly for the appetite. This is a matter of special interest in Upper Norrland. It has been dealt with in the previously mentioned »Norrland Housewife's Guide».

Our knowledge of vitamins is of comparatively recent date, and the study of vitamins is still in process of development. So far as we now know, »hypovitaminosis»[1] in man may be produced by a deficiency of any of the A, B, C, or D vitamins. The investigation in Norrland has shown that the population in this part of the country exhibit symptoms of, or are menaced by, the development of D and C hypovitaminosis, probably also B hypovitaminosis.

It is a well-known fact that sunlight plays an important part in preventing the development of D hypovitaminosis. Whether sunlight, as is surmised, can also affect the C hypovitaminosis is a question which remains to be cleared up.

Special deficiencies in the Norrland diet. Our investigations have shown that in Upper Norrland there are, broadly speaking,

[1] More or less marked deficiency in the supply of vitamins.

two unvaried diets, namely the milk-meal diet, and that of the forest labourers, both of which represent most of the deficiencies indicated above.

The milk-meal diet, which has been found to be a factor of paramount importance in the development of the diseases which are specially rife in Norrland, exhibits in its extreme form a very marked deficiency of animal albumin and iron, and, in view of its composition, entails the risk of the development of B, C and D hypovitaminosis. Where the supply of milk is plentiful, the risk of the development of C hypovitaminosis is lessened. An abundant consumption of butter in the summer seems to conduce to diminish the risk of D hypovitaminosis. If the food contains an abundance of cereal substances, the need of the B and D vitamins will increase. In supplying the need of calcium and phosphorus, the consumption of milk is of paramount importance.

The fare of the forest labourers, which, from a dietetic point of view, seems to be far superior to the unvaried milk-meal diet, entails the risk of the development of C and D hypovitaminosis, but seems to supply the need of B vitamins. The necessary amount of iron appears to be well provided for. In this diet likewise the supply of calcium and phosphorus is dependent on the individual consumption of milk. In some cases the content of protein in the fare of the forest labourers is also markedly low. The amount of cereal substances supplied in this diet is, absolutely speaking, often very large, even more so than in the milk-meal diet. But, as it is comparatively small in proportion to the total caloric supply, there is little to be said against it.

In the more mixed diets, especially in certain of the districts under investigation — notably the zone from Stensele to Dorotea — there is a noticeable deficiency of C vitamin, which is doubtless due to the scanty supply of milk and potatoes. A feature which all the typical diets in Upper Norrland have in common is the lack of fruit and vegetables containing C vitamin. Also in the case of the mixed diets the risk of a D hypovitaminosis and a deficiency of calcium and phosphorus will partly depend on the consumption of milk and butter.

In Upper Norrland the lack of sunlight during the long winters conduces to the development of a D hypovitaminosis.

The excessive consumption of coffee and the habit of chewing

snuff, which are characteristic of this part of the country, do not appear to be factors of decisive importance in the development of the typical Norrland diseases. Nevertheless, as our investigation has indicated, they seem to have unfavourable effects on the individual state of health.

Measures for the improvement of the diet. It has happily been found that the above indicated deficiencies in diet are, in most cases, not mainly due to poverty. Were that the case, it would be rather futile to give advice regarding improvements in diet. The principal causes of these deficiencies, as has been shown in the foregoing pages, are the local conditions, the severe climate, isolation and lack of knowledge. The result of isolation is that the population are largely left to their own resources, being dependent on the produce of an inhospitable nature, in a severe climate. According as this isolation is broken, deficiencies in diet will remedy themselves. We have observed striking examples of this in recent years in the decrease of the incidence of achylia and the mitigation of anaemia. Moreover, the effects of isolation and environment can be greatly reduced by wider knowledge of the way in which deficiencies in diet can be remedied. There is some truth in the statement that a capable housekeeper out of the same materials as those in the hands of a less capable one can produce a superior diet. Knowledge overcomes difficulties by better utilization of existing resources and the creation of new ones. The cultivation of vegetables on a larger scale, better arrangements for the picking and preservation of the berries of the forest, and the extension of pig-breeding and poultry-breeding — vigorous propaganda for which has been carried on with success in recent years — should create better facilities for providing suitable food for all sections of the population in Upper Norrland.

It will be seen from the above that the deficiencies observed in the various areas are due to the *lack of variety* in the diet, and that symptoms of disease are the result of this lack. Hence, in order to remedy these deficiencies, it is first and foremost necessary to eliminate this monotony. The risks entailed by an unvaried diet are well-known: they have been observed in many places and among different races. In brief, if we wish to prevent the development of diseases due to dietary deficiency, we must first wage a campaign against monotony in diet.

The principal thing to be observed in regard to the milk-meal diet is that it should be eked out with animal protein — notably,

meat, cheese and eggs — as well as with fermented bread made of coarse meal.

The diet of the forest labourers, in cases where it is particularly monotonous, should be rendered more varied by an increased consumption of meat, cheese and eggs.

In the case of both these diets the general rule to be observed is that the food should be more carefully prepared and better spiced. This will also conduce to remedy the lack of variety.

The improvements suggested above will go far to remedy some of the deficiencies in the diet and thus also to prevent the diseases to which they give rise. Other defects which require rectification are the following:

a. *Deficiency of C vitamin.* This is remedied by the plentiful supply of milk, potatoes, esculent roots, fresh vegetables and fruit rich in C vitamin. The local resources in this regard should be utilized as far as possible.

b. *Deficiency of D vitamin.* The injurious effects of this deficiency can be counteracted by the supply of butter and whole milk. During the long dark season, however, this source of the D vitamin is most unreliable as regards children and growing youth. In the case of the latter the supply of this vitamin can be provided for by the administration of cod-liver oil (maximum dosage 4 grammes a day). The question of the raying of milk is perhaps of minor importance in practice for remote and thinly populated areas. As regards meat and fish, the value of viscera should be observed.

c. *Deficiency of B vitamins.* Any steps taken to improve the diet in regard to variety will in themselves conduce to remedy this deficiency. A larger supply of meat and eggs and of coarse, fermented bread is to be specially recommended.

d. *Deficiency of iron.* Can be overcome by a larger supply of meat, viscera, fruit and vegetables.

e. *Deficiency of calcium and phosphorus.* This shortcoming is lessened by a larger consumption of milk and cheese. This is of special importance in regard to the rising generation, whose requirements of calcium and phosphorus are scarcely satisfied by the comparatively small amounts of milk with which many children are supplied. It is still more important in the case of expectant mothers.

As is indicated by this concise summary, the foodstuffs which

are of primary importance for improvements in the Norrland diets are the following:

1. *Milk* in sufficient amounts, by all means up to one litre a day. It is presumably owing to the great value of milk as a food that the effects of the dietary deficiencies are not worse than they are.

2. *Butter.* In many cases, and especially in the feeding of small children, the amount should be increased.

3. *Eggs, cheese, fish, meat and viscera.* These foods should be included in the fare at least twice a week.

4. *Bread made of coarse meal.* Should, as far as possible, replace bread made of fine wheaten flour and barley meal. The unfermented hard bread called *tunnbröd* should, at any rate in part, be exchanged for fermented hard bread.

5. *Potatoes.* The consumption of potatoes and milk mean the salvation of the Swedish people from scurvy. The cultivation and consumption of potatoes on a larger scale are to be recommended. Potatoes should be eaten at least once a day: this is a minimum requirement.

6. *Other esculent roots* (especially carrots and turnips), *other vegetables, berries and other fruit.* These foods should be included in the daily fare to a considerably greater extent than heretofore. The cultivation on a larger scale of vegetables and fruit adapted for the soil and climate of Norrland should be organized, and better arrangements should be made for the marketing of these foodstuffs. The existing supplies of berries and herbs should be better utilized.

The above recommendations are applicable to all kinds of diet and all sections of the population. But, on the basis of the results of the investigation, special suggestions may be made in regard to certain groups of the male population, women and children.

In the case of those sections of the population where the men are away from their homes during the day, working in the forest or on the land, stress should be laid on the importance of well-regulated housekeeping. This is the only way to remedy the monotony and the deficiencies of their diet and to prevent the consequences which these evils entail. The establishment of cooperative households for forest labourers is to be strongly recommended.

Snuff-chewing, which is a vice of the men, should be discouraged, so that it is at any rate kept within bounds. The

excessive consumption of coffee should likewise be discountenanced. In regard to this indulgence greater moderation should be shown by women than by men. It is specially important that the consumption of coffee by children should be restricted.

The investigations in Norrland have shown that the diet on which women live is inferior to that of the men, and that the symptoms of disease produced by dietary deficiencies are more widespread and more marked in women than in men. This is all the more unfortunate as the state of health of the mother is a factor of the greatest importance in the development of the child. Deficiencies in the mother's diet have a repercussion on the child's health. We therefore consider it to be our bounden duty to impress upon the public that it is highly important that the above rules of diet should be observed by women, especially by expectant mothers and mothers with infants. During pregnancy and during the suckling period the need of greater variety in the diet and a larger supply of vitamins is particularly marked. This is a subject of far-reaching importance, in which we can discern great possibilities for improving the health of the nation.

The diet problem of *children* likewise deserves the greatest attention. The importance of breast-feeding has been stressed by Dr Ernberg. During pregnancy it is highly important that the mother should have an adequate diet, so that the milk is of satisfactory quality. During the weaning period the infant should have a sufficient supply of the A, D and C vitamins as well as of foodstuffs containing calcium and phosphorus, especially if that period sets in during the winter. During the years of growth the child's food should be as varied as that of adults. This is a matter the importance of which can scarcely be over-emphasized. In this period the growing child needs a large supply of albumin, vitamins, calcium, phosphorus and iron. Attention should once more be drawn to the importance of greatly restricting the consumption of coffee.

Finally, the risks involved by the feeding of children on an unvarying cereal diet must once more be stressed.

A matter closely connected with diet is insolation. The effect of sunlight on the naked body is of special importance for women and children. Insolation promotes the supply of D vitamin, the calcification of the bones and teeth and the growth. Mothers are recommended, both on their own account and for the benefit of their children, especially infants, to spend more time in the

open air and in this way to avail themselves of such sunlight as Upper Norrland can supply. The child's first years of life must not be spent indoors. (Odin, Westin, Hellström.)

e. *Dental services for school children and adults.*

Measures hitherto taken and committee enquiries. As late as the beginning of the present century only a very small part of the population of Sweden were able and willing to have their teeth looked after. The corps of some 300 dental surgeons (dentists) then practising was in fact found to be quite sufficient for the requirements of those days. A marked change in this regard has, however, taken place in the course of the past thirty years.

The keen interest taken in dental care during the last-mentioned period seems to be connected with two circumstances.

Firstly, in the early years of the present century the Swedish Dental Society conducted investigations on a large scale in regard to the teeth of school children. These investigations led to efforts for the enlightenment of the public on this subject and to systematic arrangements for the care of the teeth of school children, especially in the larger towns. Secondly, researches had indicated the possibility of a connection between pulpal and paradental infectious conditions in the teeth and certain acute and chronic infectious diseases in other organs.

In these ways endeavours to extend dental treatment to the masses were encouraged and intensified, and the demand for the assistance of the State, county and communal authorities became more and more insistent. The question of organized dental treatment is in fact being regarded in increasing measure as a very important branch of social hygiene.

The practical measures hitherto taken to meet these growing requirements and the needs of the general public have nevertheless been sporadic and on a rather small scale. The number of dental surgeons has, however, been very considerably increased by the extension of the State Dental College. Dental clinics have been established, and committees appointed to enquire into the organization of the dental service. It is estimated that, with the present facilities for training, the number of dentists in Sweden will have increased to some three thousand by the year 1943.

It is chiefly for elementary school children that a dental service has been organized out of public funds. The method generally

adopted is that dental clinics have been installed in elementary schools by the communal authorities. The dental treatment, which usually begins with the first school class, has been extended year by year to other classes, until all the school children have been attended to. This treatment, as a general rule, is free of charge (in exceptional cases a fee of from 1 to 5 kronor per child and school year is paid), but not obligatory. About 20 per cent of the total number of dentists are now engaged in the school dental service (1934).

Endeavours to organize a dental service have resulted in many proposals. A Government committee appointed in 1913 to institute an enquiry into the practicability of organizing a dental service for school children submitted its report in August 1917. Another committee appointed in 1924 to enquire into the organization of a public dental service presented its report at the end of April 1928. Finally, a committee appointed in 1934 to conduct further enquiries into the last-mentioned subject published its recommendations at the end of August 1935.

The 1924 committee recommended that dental services for school children and adults should be organized, in rural districts and small towns, by the communes. They proposed that the communes should be grouped for this purpose in »dental districts»; that in each of these districts the communal authorities should establish a dental clinic for school children and adults; that dentists, aided by qualified nurses, should be permanently attached to these clinics; that a small fixed charge should be made for adults; that State contributions should be payable in aid of the dental service for school children, and that the dental services in their entirety should be controlled by the State.

The main lines of this scheme were approved by the Medical Board, the Federation of County Councils and by the two dental associations. The Medical Board suggested certain modifications, the principal one being to the effect that it should devolve mainly on the State and the County Councils to organize the proposed dental services. A similar modification was recommended also by the Federation of County Councils.

As a preparatory step, with a view to gaining practical experience as to how a public dental service should be organized, the Government made grants to the Medical Board and to the Swedish Red Cross in aid of the organization of experimental dental services.

The trial service organized by the Medical Board was started in 1930 and proceeded for three years. For this purpose four »normal districts» were selected with different geographical

situations. Each of these districts was supposed to have a population of 7,000 to 8,000 persons. A permanent dental clinic for school children and adults was established in the largest and most central place in each district. A small charge, being merely 2 kronor per school year, was levied on parents and guardians. The travelling expenses of the children were defrayed by the communes jointly. The dental surgeons received a salary, of 6,000 kronor per annum, for the school dental service as well as the gross receipts of the dental service for adults. They devoted four hours a day to the dental treatment of school children and at least as much time to the adults. The dental surgeons paid their dental mechanics and defrayed the cost of materials, but had the free use of the premises. The County Councils contributed 2 kronor per child and school year. The intention was that the teeth of school cildren (inclusive of milk-teeth) and of adults should be put in perfect order. The children's teeth were examined twice a year.

This trial service, which was based, broadly speaking, on proposals made by the 1924 committee, worked on the whole satisfactorily, and showed that the system adopted was well suited for the dental requirements of rural districts.

The Swedish Red Cross since 1928, with the aid of the above-mentioned grant, have endeavoured to devise satisfactory methods of organizing a public dental service. The principal steps which they have taken in this direction are the experiments which they have made with ambulatory dental clinics in Jämtland [1] and Västerbotten.

In Jämtland these ambulatory dental clinics were installed in school-rooms and other premises. The rent of the required premises was defrayed by the communes, and a small charge, ranging from 1 to 10 kronor per child, was levied on parents and guardians. In Västerbotten so-called »rolling dental clinics», that is to say, motor buses equipped for dental treatment, were arranged for the benefit of school children living in out-of-the-way places.

Furthermore, the Swedish Red Cross have endeavoured to organize a dental service for an entire county area, namely in the County of Kalmar,[2] by cooperation with the dentists. For

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[1] The County of Jämtland is immediately south of Västerbotten.

[2] The County of Kalmar is situated in the southern part of Sweden.

this purpose the county was divided into 19 districts, according to the places where the dentists carried on their practice. The school children had their teeth attended to in the dentists' own consulting-rooms at a charge involving a discount of 33 per cent, compared with the regular fee. But neither the permanent molar of the first dentition (in six-year-olds) nor any of the milk-teeth were treated in accordance with the rules of conservative dentistry. This, whilst considerably reducing the costs, greatly detracted from the value of the treatment.

The principal recommendations made by the committee of 1934 [1] are to the following effect:

The public dental service should be conducted, in the main, in accordance with the rules of conservative dentistry. It should aim, as far as possible, at the conservative treatment of the teeth, inclusive of the replacement of any lost teeth needed for mastication. For practical and financial reasons, the committee recommend that the dental services for children and for adults should be coordinated. They propose that the dental service for children should commence at the age of three years; that it should be supplemented by the prophylactic care of expectant mothers and infants; that, in view of the existing regulations regarding school attendance, the school dental service should terminate at the age of fourteen; and that an annual fee of 3 kronor per child should be leviable throughout Sweden, but not in respect of more than three children from the same family.

As regards the dental service for adults, the committee recommend that it should be organized as a direct extension of the school service, and that a very moderate scale of charges should be fixed by a State authority.

The committee propose that the public dental service should be organized by the County Councils; that each of the County Councils should appoint a »dental board» for the direction of these services; that dental treatment should, as a general rule, be given at permanently established dental clinics, available both for school children and for adults; that an ambulatory dental service should be organized only in districts where, in view of the sparseness of the population, it would be useless to establish permanent dental clinics; that the ambulatory service should be conducted in rented premises (preferably in schools), and that these premises should be fitted up with certain non-portable dental apparatus, whilst any portable instruments required should be brought by the dentist from the clinic.

For the purpose of the local administration of the dental services, the committee recommend that the counties should be divided into »dental districts»; that, with due regard to local conditions, the size of each

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[1] The report of this committee was submitted after the publication of the Swedish edition of this work.

district should be adjusted to the amount of work [1] a dentist might be expected to be able to perform, on the assumption of a medium incidence of caries; that a dental district should comprise about one thousand children of school age; that, if, in view of geographical conditions, communications, etc., it should be found desirable to organize districts comprising a larger number of school children, two or more dentists should be appointed for the same district, or alternatively, that the district dentist should be aided by an assistant dentist; that each dentist should receive an allowance for the remuneration of a qualified nurse; and that arrangements should be made for employing the services of dental mechanics.

On the lines proposed by the committee, there would be 425 dental districts with about 575 district dentists and 40 assistant dentists.

The committee recommend that the district dentists should be appointed, salaried and pensioned by the Government; that the assistant dentists should be appointed by a State authority and be paid out of Government funds and that the dentists should not be permitted to make any charge for their treatment of school children, but should be entitled to charge for other treatment in accordance with a scale determined by a State authority.

Special arrangements for the dental treatment of lunatics, mentally defectives etc., are proposed by the committee. As the district clinics, for financial and other reasons, would be equipped only for *general* dental treatment, they recommend that a specially equipped dental clinic should be installed in at least one hospital in each county.

The central administration and supervision of the public dental service, the committee suggest, should be in the hands of the Medical Board.

The expenditure on the dental services, in the opinion of the committee, should be defrayed mainly by the State and the County Councils, but some contribution to it should be made by the communes. It has previously been indicated that certain small fees are to be paid by the children's parents and guardians, and that a moderate charge will be made to adults.

As these proposals have not yet been adopted by the Government, it is uncertain how far they will be realized. Certain authorities have recommended that an extensive trial service should first be conducted for several years to serve as a basis for an organization of a more permanent character. Other authorities and corporations have approved the committee's recommendations in substance.

If the above measures and proposals for the organization of a dental service are passed in review, certain fundamental features common to them all will stand out in relief: the necessity of subsidies, division into districts, establishment of dental clinics,

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[1] The dentists' normal hours of work per annum are estimated by the committee at approximately 1,000 for the school service, and about 1,100 for the adult service.

etc. In regard to certain more or less important matters, however, such as the dental treatment of small children, the fees to be charged for the school dental service, inspection etc., there is considerable divergence of opinion.

Our investigations in Norrland have thrown additional light on the urgent need of measures to prevent the evils resulting from the great incidence of diseases of the teeth in that part of the country. The investigation has shown that such measures are of great importance for the public health in general. The researches concurrently conducted by doctors and by dentists, the correlation of their results, the diet problems involved in both investigations, and the numerous observations of the interacting diseases and interdependent pathological conditions have yielded cumulative and conclusive evidence in support of the view that diseases of the teeth are diseases of the entire organism, and that a medical service conducted with the aid of State or local grants should also include the treatment of diseases of the teeth and the jaw.

Dental care of children, in connection with diet, etc. The investigations made by doctors and dentists in Upper Norrland have not demonstrated any connection between the marked deficiencies of D and C vitamins in the diet and the incidence of caries. The effects of these deficiencies appear to be confined to »rachitic» or »scorbutic» disturbances in the substance of the teeth. It might therefore be concluded from this that the campaign against dental caries in the schools should aim only at the treatment of the injured teeth. It should be pointed out however, that this conclusion is not based on the whole truth. The investigations have in fact shown that the diet deficiencies observed have detrimental effects on the structure and calcification of the teeth as well as on the growth of the jaws and on dentition. That the decay of the teeth has not been definitely traced to these morbid conditions may be due to some unknown factor. It should further be noted that the amount of C vitamin in the diet has been found to have a decisive influence on the incidence of inflammatory diseases of the gums in school children. In short, as regards adults and presumably also children, there is evidently a connection between the incidence of caries and the unvaried milk-meal diet. Hence it follows that our efforts to prevent the dissemination of diseases of the teeth should proceed from the rule, valid in all medical hygiene, that known morbid

or abnormal conditions should as far as possible be precluded and combated. Any measures which can be taken against deficiencies in diet and other defects in hygiene among school children and the rising generation in general are, therefore, of great interest from a dental point of view. Stress should be laid, from a medical standpoint, on the injurious effects on the health of the marked lack of variety in the daily diet which is characteristic of a large part of the area under investigation, and special attention should be paid to the milk-meal diet. The latter also greatly promotes fermentation in the oral cavity, whereby the formation of lactic acid is considerably increased and conditions are created which conduce to further the development of acid-forming disease germs. The external causes both of caries and of diseases of the gums may perhaps be traced to such sources of infection.

It is accordingly desirable, also from a dental point of view, that a *school breakfast-lunch*, containing the nutritive substances which have been found, or are suspected, to be lacking in the local diet, should be supplied to school children. The food thus provided should contain the missing vitamins and calcareous salts, thus the substances considered to be most important for eking out, and giving variety to, the local diet. The principal ingredients of this school meal should be the following: well-buttered, fermented, hard bread of unsifted rye meal, milk (in some places also meat or eggs), as well as some fruit or fruit preparation with a large content of C vitamin, such as the syrup of cloudberries, currants or raspberries, hip soup, oranges, lemons, etc. The local school doctor and dentist should be able to judge how far such a school meal is needed, as well as the required proportion and amount of the various substances contained in the food.

Diseases of the teeth in children can otherwise be best precluded by a general and uniformly organized school dental service. It should be observed that the investigations in Norrland have borne out the great importance of the milk-teeth. The latter, therefore, should not be excluded from the treatment. It is thus very satisfactory that the above-mentioned committee of 1934 have recommended that all the children in the district should be regarded as school children from the age of three, so that from that age they can have their teeth attended to free of charge, or at the rate fixed for school children. The committee

have also proposed, with good reason, that *all* kinds of schools should be included in the dental service, thus also continuation schools, communal intermediate schools, secondary schools, high schools for girls, etc. In this way all children from the age of three would receive dental treatment on a uniform basis. The treatment should always aim at putting the teeth in perfect order, and in districts where the incidence of dental caries is high, the teeth should, if possible, be re-examined twice a year.

The organization of a school dental service meets with special difficulties in the mountainous region and other very thinly populated parts of Norrland. The immense distances between the inhabited places, the small number of children in each place and the poverty of the communes are, in many cases, serious impediments to the organization of an effective dental service.

The above-mentioned committee of 1934 have proposed that such dental equipment as is adapted for packing and conveyance should be transported from place to place within the district for use in schools or other communal premises, and that non-portable equipment should be installed in such premises. This proposal seems to us to meet reasonable requirements in regard to the thinly populated districts.

As above mentioned, there has been a considerable divergence of opinion in regard to the proposals of this committee. Without entering into controversies, we wish to stress the great desirability of establishing as soon as possible a dental service for the whole country. It should be observed that the value of a school dental service for the health of the nation is ultimately dependent on the organization of a dental service for the adult public. (Westin, Hellström, Odin, Byttner.)

f. *Gardening with reference to conditions in Upper Norrland.*

The possibilities of gardening in Norrland. Nowhere in Sweden is the soil so unfertile that vegetables cannot be grown: the most arid sandy soil, the driest gravel hill can be manured so that it can be used for growing some garden stuff. Nor is the climate in Norrland too severe to permit of the cultivation of such vegetables even on the Arctic circle. On the contrary, the possibilities of cultivating vegetables and berries are very great in Norrland. In spite of these favourable conditions, the total area of gardens in the two vast counties of

Västerbotten and Norrbotten is not much larger than that of an average farm in Skåne (southernmost part of Sweden). A comparison shows that the garden area of the County of Malmöhus (part of Skåne) is about 31 times as large as that of Västerbotten and Norrbotten, taken together. According to the statistics for 1927, the County of Malmöhus has a garden area of 10,614 acres under cultivation, whilst the Counties of Västerbotten and Norrbotten have altogether only 343 acres. In the latter counties there are only 4.2 square yards of garden per capita, as against 101.2 square yards in the County of Malmöhus. In addition, the County of Malmöhus includes considerable areas with pleasure grounds, as well as castle and manor parks to which there are no equivalents in Norrland.

The vegetation period is much shorter in Norrland than in Skåne; in the coastal region of Norrbotten it averages 150 days, in Skåne 250 days. But the duration of the vegetation period does not alone determine the development and ripening of plants; sunlight and temperature are the factors which have most effect on the assimilation. For each kind of plant there are, however, certain limits beyond which no assimilation can take place; the temperature and amount of light must attain certain values.

The temperature during the brief vegetation period in the coastal regions of Norrland differs but little from the summer temperature in Skåne, and it may happen that the latter is lower than the former. The following is an example:

Monthly mean temperature at 2 p. m.

	May	June	July	August
Malmö (in Skåne) 1933	11.7°	13.3°	20.0°	16.1°
Piteå (in Norrland) 1925 ..	10.0°	15.5°	22.1°	16.0°

This temperature seems to be satisfactory. But what about sunlight? In this respect Norrland is especially favoured. During the summer season the sun is above the horizon 438 hours longer at Luleå (Upper Norrland) than at Malmö.

As above mentioned, different kinds of plants have different needs of sunlight and warmth. Some tardily developing plants even under favourable conditions — suitable temperature and sun radiation — require 5 to 6 months and more to ripen. Naturally such plants cannot be cultivated in Norrland. Others, on the other hand, reach full development in a shorter period.

Furthermore, the development of some plants is considerably more rapid if they receive more light per day. Such plants also become more vigorous and much richer in dry content. Some of our principal vegetables, such as various kinds of cabbage, carrots, and red beets, belong to this group.

At the Government Institute at Alnarp for experiments with vegetables and its local experimental stations investigations have been made in order to compare the development of vegetables in various parts of the country. Since 1921 the products have as far as possible been chemically analysed. The crops obtained at the various stations in Norrland are almost without exception satisfactory in quantity, and some of them even mark a record. For example, the crop of white cabbage at Alnarp (in Skåne) during the period 1917 to 1926 had never exceeded 478 cwt per acre, but in one of these years it reached 638 cwt per acre at Luleå (in Upper Norrland). Similar records have also been attained for cultivated strawberries and shallot. It happens quite often that the crops of potatoes in Norrland are twice or three times as rich as on the average for the whole country. Still more surprising is the quality of the vegetables in Norrland. For example, the white cabbage gathered at Luleå and Östersund during the period above referred to had about 25 % more carbohydrates and dry content than the crops at Alnarp. Similar results have been recorded for edible roots. To quote Dr H. Lamprecht [1], researches have shown that better keeping quality for winter storage goes parallel with the percentage of dry content. Hence white cabbage grown in Norrland, with its larger dry content, would be better fitted for winter storage than cabbage produced in Skåne. Tests have also shown that a larger dry content gives greater resistance to cold.

The favourable results of the cultivation of vegetables in Norrland must no doubt chiefly be attributed to the large number of hours of sunlight during the short vegetation period, and this is borne out by the high production of carbohydrates.

With regard to quantitative as well as qualitative development, the prospects of the cultivation of vegetables and berries must be regarded as very favourable in Norrland. The small garden area is in striking contrast with this fact. By a better utilization of the existing possibilities of growing vegetables and berries, Norr-

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[1] *Svenskt Land* 1926, p. 600 ff.

land would no doubt become more independent of imported foodstuffs. This would also tend to improve hygienic conditions in that region.

Professor H. von Euler has investigated the caloric value of various garden products which can be cultivated in Norrland; according to him the number of *net calories per pound* is as follows:

Berries:		*Edible roots:*	
Strawberries	137	Artichokes	318
Raspberries	146	Kohlrabi	182
Red currants	146	Turnips	182
Black currants	159	Carrots	182
		Parsnips	250
Vegetables (not being roots):		Potatoes	436
Horse beans (Vicia faba), unripe	363	Red beets	182
Kidney beans, unripe	227	Celery, root	250
Pumpkin	137	Skirret	318
Rhubarb	41	Black beets	318
Salad (endive)	73		
Spinage	136		
Peas, unripe	318		

Measures for promoting gardening in Norrland. The lack of interest in their work which is rather frequent among farmers is probably to be attributed in no slight degree to the discomfort in their homes. In some parts of Sweden where one observes the enlivening effect of gardens and flowers round dwellings, one realizes what a beautiful and pleasant garden plot, lovingly tended, would mean for joy and delight in all parts of the country, and how this would attach the individual to the soil and its cultivation. There is nothing more cheerless than the numerous farms and small cottages where no vegetables or berries, much less any flowers, are to be seen.

It is therefore of great importance that gardening should be considerably extended in Norrland, so much the more as the possibilities there are as great as in other parts of the country.

The measures taken by the county agricultural societies etc., show that it is not owing to lack of interest that gardening in this vast territory has lagged behind. Rather it is the difficulty of carrying on effective enlightenment in view of the immense size of Norrland and the sparsity of its population. For the last-mentioned reason it will be necessary to decentralize the instruction

by extending the services of advisers and by arranging practical courses of short duration, but accommodated to the special needs of the general public. Owing to the great distances and short but intensive vegetation period, the existing number of county gardeners does not suffice to meet the requirements of instruction and assistance in the laying-out and tending of gardens. If the practical work were better organized, the county gardeners could spare more time not only for planning gardens, but also for short courses.

Although the efforts of the county agricultural societies have been comparatively successful, it should be borne in mind that the problems in Norrland are different from those in southern and central Sweden. On large and small farms and in cottages one cannot discern the same interest in gardening as, for instance, in the environs of the scattered towns of Norrland. On the whole stretch from Haparanda to Gävle, the northernmost and southernmost towns in Norrland, the number of gardens is surprisingly small.

A central institution in Norrland for horticultural instruction. The Norrland Gardening School at Söråker, near Härnösand (a port in Norrland), which started in the spring of 1932, will be an important centre of instruction. It has therefore been considered of great importance that the County Councils of Norrland should be both morally and economically interested. An agreement has consequently been concluded between the Government and the agricultural societies of these County Councils in accordance with which school property has been placed at the disposal of the latter.

In addition to this school, with its various plantations, other measures are required in order to lay a good foundation for the development of horticulture in Norrland. It will be necessary to continue the investigation of the species of plants best suited for cultivation there, and to carry on an extended campaign of public enlightenment, based on scientific experiments organized on a large scale.

Courses for gardeners. With a view to the promotion of gardening in Norrland, the Royal Board of Agriculture, since the beginning of 1933, have organized courses for gardeners, in cooperation with the County Agricultural Societies, and with the aid of a State grant. One of these courses, with a duration of 24 days, was arranged in 1933 at the above-mentioned gardening

school at Söråker, and will presumably be continued year by year. In this instruction stress is laid on the laying-out and tending of small gardens. After passing through the complete course, the students should be qualified to perform such work, under the superintendence of the county gardeners in the several districts.

Ambulatory courses. In view of the variations in the climatic conditions and soils of Norrland and the sparsity of the population, other forms of public enlightenment are also required. Since 1933 ambulatory courses have been organized in villages and small urban communities, with the aid of State grants. These courses are of a practical character, and are led by the county gardener. They are held in the spring, summer and autumn, and have a duration of two days each. In the spring course instruction is given in the preparation of the soil, manuring, the laying-out of the garden, sowing and planting; the summer course is intended for continued instruction, the correction of mistakes made in the tending of plants etc.; in the autumn course instruction is given in the harvesting, winter storage and utilization of the produce, the preparation of the soil for the winter, etc. The instructor also arranges exhibitions of the produce harvested, and demonstrates its utilization for household purposes. There is reason to presume that courses of this nature, more than thirty of which were organized in 1933, will serve to illustrate, in a practical way, the meaning and purpose of horticulture.

It is highly desirable that the instruction in gardening at the rural domestic schools and at the summer courses of the People's High Schools, in Norrland, should be considerably extended. As a general rule, the natives of Norrland scarcely understand the use of garden produce, especially vegetables. The elder generation have not been accustomed to the consumption of vegetables from childhood, and are reluctant to change their food habits, especially as vegetables are often badly cooked. It is therefore very necessary to enlighten the public in Norrland in regard to the utilization of garden produce. A simple and effective way of arranging this would be to extend the instruction in gardening etc., at the rural domestic schools and at the summer courses of the People's High Schools. It should be noted that at some of these schools such instruction is given on quite a small scale.

It is desirable that the practical instruction in gardening (inclusive of the utilization of the produce in the household) at the summer course of the rural domestic schools should be extended to

at least 200 hours per student, and the theoretical course to at least 40. The tuition in gardening at all the People's High Schools in Norrland should be arranged on similar lines. But, in order to facilitate the organization of demonstrations and practical instruction, it will be necessary to engage expert gardeners to tend the gardens of these schools.

It should be observed that these schools are, so to speak, the centres of large districts, and are visited by a large number of persons of different age and social status. Well-tended gardens, with vegetables, fruit and flowers, would, therefore, serve as instructive models and have a stimulating effect on the visiting public. Furthermore, the school garden could supply the vegetables required by the students. It is, therefore, very important that gardens of considerable size should be laid out at all these schools. The students themselves would thus learn not only to cultivate garden produce, but also to appreciate vegetables as ingredients of the diet.

All these schools in Norrland, which altogether number about 77, should be in receipt of a State grant. It should be of sufficient amount to enable the schools to engage an expert to look after the garden and to direct the practical and theoretical instruction of the students. With such facilities it would doubtless be possible to put the instruction in gardening on a more satisfactory basis: more time on the school curriculum could be devoted to horticulture, and better arrangements could be made for demonstrations and short courses for the general public. (Sonesson.)

CHAPTER III.

Concluding Observations.

As has been pointed out in the preface and elsewhere, the planning and execution of our investigation in Norrland was complicated by the fact that we had no previously existing models on which it could be based. It must therefore be regarded as an attempt on a large scale to investigate as scientifically as possible the diet question in the two northernmost counties of Sweden.

The reader will have observed that the original scope of the investigation was extended during its progress. This applies particularly to the dental researches.

In connection with the main investigation, two other factors having an important bearing on public health were taken into consideration, notably housing conditions and the care of children. Opportunities for observations in these two fields had in fact presented themselves in the course of the principal investigation.

The researches made have yielded evidence in support of the view that diet has an important bearing on the development and dissemination of diseases among large sections of the population in the area under investigation. For various reasons, however, these researches had to be confined within certain narrow limits. These limitations affected not only our studies of the diet but also our attempts to elucidate the morbid symptoms.

We ardently hope that the researches reported in this work may lead to subsequent investigations which will supplement our studies in various respects.

Our investigation in Norrland has revealed our lack of knowledge in regard to many diet problems. We are confronted here with a wide field of investigation, in which much work is now being done in many lands. There are several matters in regard to which the need of further knowledge has been thrown into

striking relief. The clinical and latent symptoms of hypovitaminosis and their bearing on public health are questions which are still in an early stage of investigation. These questions are complicated by the simultaneous occurrence of hypovitaminoses of different kinds, interacting on one another. The occurrence and significance of a latent B hypovitaminosis in man is indeed a quite unexplored field, where theoretical studies and practical experiments seem to be required.

We consider it desirable that the staff of the medical departments of hospitals should devote their attention to diet problems to a greater extent than heretofore, with a view to observing and remedying possible deficiencies and the symptoms which follow in their train. In this way a basis might be provided for wider knowledge in regard to the diet problems in the country at large, and for a better appreciation of their importance. Measures taken on such a foundation would certainly contribute in a great measure to the improvement of the public health.

These researches have clearly shown the need of better cooperation not only between doctors and dentists, but also between dental clinics and hospitals. Such cooperation could be facilitated by the instalment of special dental departments in hospitals. In this way facilities would be provided for a more comprehensive study both of the connection between diseases of the teeth and the general state of health and of the bearing of the local diet on structural changes of the teeth.

The diet may affect the teeth in various ways. The diet on which an expectant mother lives may affect the manner in which the embryonic teeth tend to develop in the fetus as well as her own teeth during pregnancy. Special attention should also be paid to the diet of children and young people.

The above indicated researches are of such a nature that they can well be conducted in hospitals and by scientists, without requiring the assistance of the authorities.

On the other hand, there are certain investigations which could scarcely be carried out without the aid of the authorities. It is, for example, very desirable that funds should be provided for continued investigations into the local diet in certain districts of central and southern Sweden, where, in view of poverty or other reasons, there is reason to believe that the diet of the population shows a marked lack of variety. The support and cooperation of the authorities is, in our opinion, also required for

the continued investigation of the burning problem of dental caries.

We desire once again to point out that, as shown by the results obtained, these problems of social hygiene are of a highly complex character, and that even after thorough investigations it is difficult to form conclusive opinions on the subject. Our efforts therefore should conduce to show how important it is that measures in these fields, especially if they are on a large scale, should always be preceded by the most careful deliberations.

True that the conclusions which can be drawn from our investigations are, in some respects, rather limited, and that certain questions which we have eagerly endeavoured to solve have been left open. These researches, however, have revealed such glaring deficiencies in social hygiene that we feel warranted in expecting that our efforts will soon lead to improvements in the homes and to action by the public authorities as well as by private corporations.

Since the publication of the Swedish edition of this work, the Swedish Government, in accordance with a proposal submitted by the present Director-General of the Medical Board, Dr Axel Höjer, have appointed a Medical Food Council of thirteen members, representing expert knowledge in various branches of the science of nutrition. This council is to be regarded as an expert advisory body on matters relating to the food of the nation. One of its special functions is to conduct investigations on behalf of the Medical Board and the Health Organization of the League of Nations, and to submit reports and observations to those institutions.

The appointment of this health council is a step which must be heartily welcomed. In view of its composition, there is every reason to expect that its labours will bear the mark of thorough and many-sided knowledge, and that its advice and directions will be based on that solid scientific foundation which is a *sine qua non* for rational efforts in this field. This is all the more important as in recent years, when the vitamin question has loomed so large, unconsidered statements and dangerous propaganda, prompted by greed, have been widely disseminated, and have served for many people as the sole source from which they have derived their knowledge of questions of nutrition. (Hellström, Byttner, Ernberg, Odin, Westin.)

Supplement I.

(Addition to Chapter II 3 a.)

When this book was ready for the press, certain preliminary results of a housing investigation in rural districts, forming part of the general census of 1935/1936 were published.[1] It comprises 100 rural communes of a mainly agricultural character, with altogether 32,000 dwellings and a resident population of 123,000 persons. It has therefore been considered desirable to supplement the foregoing account with some of the fresh particulars contained in this investigation.

As regards *accommodation*, it has been found that the smallest dwellings, that is, those consisting of not more than one room and a kitchen, are less common in rural areas than in towns. Thus, in the 100 rural communes comprised in the investigation they constitute only 33 par cent of the total number of dwellings, whereas the corresponding figure for towns and urban communities is 50 per cent. If, however, we deduct the living-rooms not provided with any direct heating apparatus, the figure for rural districts rises to 41 per cent.

But, as the households living in these rural dwellings are on an average larger (3.8 persons) than in the towns (3.3 persons), overcrowding there is quite as marked as in urban distrits. The number of dwellings with more than 2 »person units» (a child = half a person unit) per »room unit» (a kitchen = half a room unit) is thus 12 per cent of the total number, and the number of persons living in such dwellings is 19 per cent of the total resident population; no less than 28 per cent of all the children under fifteen are members of such overcrowded families. All these data coincide closely with the corresponding figures for urban districts. The most marked overcrowding has been noted in Dalarna and Norrland. Here no less than 44 per cent of all the dwellings included in the investigation consist of at most one room and a kitchen, and 20 per cent of the dwellings must be regarded as overcrowded in the sense indicated above.

If, moreover, we take into account the way in which the accommodation is actually utilized, overcrowding in rural districts, at any rate so far as small dwellings are concerned, will be found,

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[1] Befolkningskommissionens Betänkande i sexualfrågan (Report of the Population Commission on the Sexual Question), Annexe 7 (Standard of life in Swedish families) p. 248 ff. Statens Offentliga Utredningar 1936: 59.

relatively speaking, to be *greater* than in the towns. In 31 per cent of all the dwellings of one room and a kitchen only the latter was used as a bedroom. As a consequence of these conditions, no less than 29 per cent of the entire population living in small dwellings slept in a room or kitchen where at least four persons spent the night. As regards families with three or more children under the age of fifteen no less than 63 per cent of their members slept in such overcrowded bedrooms or »bedroom-kitchens». The evil effects of this overcrowding, from a hygienic point of view, are aggravated by the ventilation conditions, which in many cases are glaringly bad. Thus in no less than 38 per cent (in Dalarna and Norrland 53 per cent) of the dwellings under investigation the windows, so it is reported, could not be opened in winter.

As for the character of the dwellings, it was found that 12 per cent of the living-rooms (in dwellings inhabited in *winter*) had no arrangements for heating. In 44 per cent of the dwellings there are no clothes-closets and in 15 per cent no larders. In regard to 13 per cent of the dwellings the distance to the nearest well or spring is at least 100 metres. In 13 per cent of the dwellings the floor is built direct on the ground, and 23 per cent of the dwellings are located on the ground-floor of houses where there is no ventilated space under the floor. In 9 per cent of the dwellings damp is reported to occur »in a high degree», and in 21 per cent of the small dwellings the height of the rooms is less than 2.1 metres.

No less than 15 per cent of the dwellings comprised in the investigation are considered to be *in bad repair*, which seems to indicate that there must be considerably more than 100,000 such dwellings in the entire rural area of Sweden. Out of the small dwellings no less than 32 per cent were either out of repair or had at least two fundamental defects, for example, that they were both damp »in a high degree» and had the floor built direct on the ground. Out of the small dwellings inhabited by families with three or more children under fifteen a still larger number, relatively speaking, or 37 per cent, were of such a character.

The general impression produced by these particulars is that, from the point of view of the health of the population, the housing question in rural districts is a still more serious problem than in the towns. Partly because the deficiencies in the housing standard are more marked in these districts, partly because the vast majority of families with many children live in rural areas. (Hellström.)

Supplement II.

(Addition to Chapter II 3 b.)

Just before this work was ready for the press, a Government Bill relating to improved maternity nursing and the organization of the so-called prophylactic care of mothers and infants was introduced in the Riksdag (1937). This Bill is based substantially on the proposals summarized above. Thus it is proposed that State contributions shall be payable, subject to certain conditions, to County Councils, communes, societies or foundations in aid of the maintenance of (1) maternity hospitals, (2) maternity wards, (3) maternity nursing homes and (4) maternity nursing rooms on the premises of a midwife, as well as towards the maintenance of (5) so-called »waiting-homes» for expectant mothers in the desert regions of Sweden, and for home-help to mothers staying at such homes.

The term »maternity hospital» is understood to mean an intirely independent institution for maternity nursing, with more than 15 beds, »maternity nursing home» an independent institution with not more than 15 beds. »Maternity wards» are departments of general hospitals.

The State contributions in aid of the institutions mentioned under points (1) to (4) are to be at the rate of two kronor per nursing day and child-bed woman, but not for more than ten days. The contribution towards the »waiting-homes» referred to under point (5) is to be at the same rate, but not for more than fifteen days. This latter contribution is payable subject to the condition that the expectant mother resides at a considerable distance from the »waiting-home», or can show special reasons for being nursed at such a home.

The State contribution in aid of »home-help» is to be at the rate of one krona per day, but not for more than fifteen days. The need of home-help must be attested.

The principal conditions attached to the grant of State contributions in aid of the maintenance of maternity hospitals or homes are the following. They shall be payable only in respect of women nursed in the general ward or on the premises of a midwife; the fee charged to patients (mother and infant) shall not exceed one krona per day; the institution in question shall be included in a plan drawned up for maternity nursing in the county or town concerned and approved by the Medical Board.

In regard to State contributions in aid of the costs of the *erection* or *establishment* of institutions for maternity nursing no definite rules are laid down in the Bill, except that there shall be no statutory claim to such State aid. The Minister for Social Affairs (the sponsor of the Bill) recommends, however, that such State contributions shall be granted, after due consideration in each specific case, in aid of the establishment of maternity wards in general hospitals. He further proposes that the Government shall also be entitled, in case they consider it desirable, to grant State contributions in aid of the erection of maternity homes. In both cases the contributions are to be payable only to County Councils or to municipalities not represented on a County Council (that is, to the larger municipal corporations). On the other hand, the costs of the establishment of maternity nursing rooms are to be defrayed solely by the County Councils.

The Bill further provides that every woman who has given birth to a child *in her home* shall be nursed free of charge. Consequently the district midwives — who in their several districts are responsible for maternity nursing outside hospitals or other such institutions — are not to be entitled to charge any fee to the women they nurse. They are to be remunerated for their services solely out of public funds.

Also in regard to the so-called prophylactic care of mothers and infants, the Bill is based substantially on the proposals outlined above. Thus State contributions are to be payable in aid of such medical attendance, subject to certain conditions. This service, which is to be free of charge, is to be organized by the County Councils, or by the large municipalities not represented on County Councils, which for this purpose shall establish local institutions in one of the following forms:

(a) In the larger towns, »centres» for the care of mothers and infants, organized separately. As regards the care of *mothers*, this service is to be carried on, as a rule, in the outpatient departments of maternity hospitals or of general hospitals with maternity wards, under the superintendence of a specially qualified gynaecologist. In regard to the care of *infants*, the service is to be organized, so far as possible, in connection with a hospital for children or a children's ward in a general hospital,

or in special premises, and is to be superintended by a qualified children's doctor, assisted by a nurse. Both these institutions, which, as above indicated, are intended for the larger towns, where there are hospitals with special wards, are designated in the Bill as type I.

(b) In smaller towns or thickly populated industrial districts, centres for the care of mothers and infants, as a rule in premises arranged for *both* purposes. The service to be under the superintendence of a medical officer, assisted by a nurse, or, as regards the care of mothers, by a midwife. These centres are designated in the Bill as type II.

(c) In smaller urban communities and in rural districts, »stations» for the care of mothers and infants, under the superintendence of the district medical officer, and as a rule arranged in the latter's consulting-rooms. The medical officer to be assisted by a district nurse, or as regards the care of mothers, by the district midwife.

In aid of the fitting-up and equipment of premises for these centres for the care of mothers and infants, a non-recurring grant of 1,000 kronor is to be paid by the State. In addition, annual State contributions are to be granted towards the salaries of medical officers, nurses and midwives, as well as towards the travelling expenses of the staff. These contributions are to be at the rate of 1,500 kronor for medical officers (at least two consulting-days a week), and of 500 kronor for midwives or nurses, in respect of each centre for the care of mothers, type I; at the rate of 2,000 kronor for medical officers (at least three consulting-days a week) and of 1,000 kronor for nurses, in respect of each centre for the care of infants, type I, and each centre for care of mothers and infants, type II; and at the rate of 15 kronor for each consulting-day in respect of medical officers in charge of stations for the care of mothers and infants: the number of consulting-days to be determined by the State Medical Board.

The prophylactic care of mothers and infants is to be organized in accordance with a plan approved by the State Medical Board. State contributions are to be payable only in respect of the number of centres and stations comprised in such a plan. The nursing is to be free of charge. (Hellström.)

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