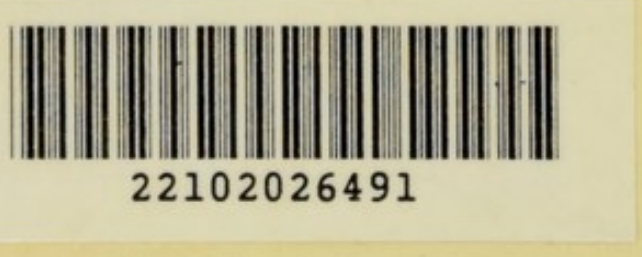
Protein and nutrition : an investigation / M. Hindhede.

PROTEIN AND NUTRITION

AN INVESTIGATION

HINDHEDE



PROTEIN AND NUTRITION

An Investigation

BY

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ESTABLISHED BY THE DANISH GOVERNMENT

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PREFACE

THE present work was written in the year 1905, and appeared in the Danish language in 1906. But I had by this time left the views therein expressed a long way behind me; I had already published them in cursory form in a Danish treatise which I wrote in 1904 in Report 55 of the Laboratory for Agricultural Research of the Royal Veterinary and Agricultural High School in Copenhagen. The main purpose of the treatise was to show that the value of protein in the feeding of milch-cows is exceedingly overrated by scientists. In 1905 I developed and confirmed these views in a special Danish work, which I concluded with a summary containing thirteen statements which I sought to substantiate. The first three of these were as follows :—

1. For the production of milk much less protein is necessary than science has supposed hitherto.

2. The amount of protein hitherto accepted as the standard for proper maintenance has, likewise, been fixed too high.

3. My opinion, based on the above contentions, is that in the feeding of milch-cows a smaller quantity of oil-cake than has hitherto been usual would be sufficient. The question whether a larger or smaller quantity of oil-cake should be used pertains primarily to urine, and not to milk.

I contended urgently in favour of the use of turnip fodder—from 90 to 110 lbs. a day. I held that only half the quantity of oil-cake prescribed by German rules for the feeding of live stock was necessary, and subsequent experiments on the lines of my suggestion have proved that I was right, and much profit was to be gained thereby.

These facts, together with my researches in human nutrition, prompted the Committee of Agriculture to take action in recommending that the Danish State should give me a laboratory of my own in Copenhagen. The recommendation was

favourably entertained, with the result that since January 1st, 1911, I, with the co-operation of five assistants, have been devoting myself exclusively to the study of human nutrition.

The somewhat polemical nature of the book arose from the fact that it was issued partly as a challenge. It was written at a time when feeling was running very high here in Denmark, and I was the subject of violent abuse. Were I writing the book at the present day, now that my views are well on their way to recognition in my native country, it is very probable that the tone of it would be more subdued.

The present edition, containing certain alterations and additions, was prepared in 1912. The additions, etc., are the result of the special investigations carried out by me in my laboratory in Copenhagen, experiments which I could not have accomplished at the time the original edition of this work was taken in hand.

Although this book is necessarily scientific, I have tried to explain myself in a way which may be understood by any intelligent layman. The book, upon its appearance in Denmark, attracted great attention, and excited as much interest among the general public as among members of the medical profession ; and I venture to express the hope that a similar reception will be accorded its appearance in the English language.

M. HINDHEDE.

COPENHAGEN,
May 1st, 1913.

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A BIOGRAPHICAL NOTICE OF DR. HINDHEDE

Dr. Hindhede was born on February 13th, in the year 1862. His father, who is still living, being now in his seventy-seventh year, was a farmer in West Jutland, Denmark. Devoting himself assiduously to the active management of his property, he succeeded in the course of forty years in redoubling its value many times, and was thus in a position to give his children a first-class education. Nevertheless, Dr. Hindhede, during childhood and early manhood, was accustomed to a most frugal way of life—as narrated by himself in Chapter II. of this work; and, as he remarks, it was observation of the wonderful working ability of the West Jutland farmers which first set him in opposition to the claims of the advocates of so-called "strength-giving" foods.

Dr. Hindhede became a medical student, and passed his final examination in 1888, gaining distinction by securing the highest honour (*Laudabelis prae ceteris*) which has been gained at the Copenhagen University since 1847.

It was the desire of his tutors that he should remain at the University; but Dr. Hindhede had other views. Even while yet a college student, he had begun to conceive doubts concerning the truth of certain teachings. He left Copenhagen and set up in practice for himself among the farmers of Jutland, continuing with them for twenty years.

But, meanwhile, two years after obtaining his degree, he had been appointed chief physician to the newly opened hospital in the town of Skanderborg. Here he found himself ever more in conflict with established medical treatment, and also, in some measure, with the too frequent, as he felt convinced, surgical use of the knife. It must be understood that he had by no means thrown in his lot with the modern nature-healers, whose fundamental doctrine is the rejection of medicine, operations, inoculation, etc. Dr. Hindhede was one of the first doctors in Denmark to adopt antidiphtheritic serum treatment.

It was not long before he became interested in the great

and important question of nutrition, of both man and animals. Applying himself diligently to research in this field, he came to the conclusion that the value of protein as a food had been much overrated, and that man, as well as animal, could very well live on half the amount of protein prescribed as necessary by accepted scientific authority. He induced many farmers to feed their cattle in accordance with his views, with most satisfactory results from both hygienic and economical standpoints. The consequence of which was that the Committee of Agriculture petitioned the Danish Government to provide Dr. Hindhede with the means to devote himself entirely to scientific research. The Government granted the petition, with the result that Dr. Hindhede resigned his practice, and, since January 1st, 1911, has been installed in a laboratory of his own in Copenhagen. The laboratory, which is exclusively devoted to experiment and research in human nutrition, is remarkable in that it is the first and only one of its kind in Europe to be opened and maintained by State aid. The numerous exhaustive experiments which Dr. Hindhede has thus been able to undertake have confirmed, even more thoroughly than was anticipated, the theories which the doctor had already founded on his previous experience and observations.

The present book has already appeared in Danish and in German editions, and in both these countries has won marked recognition, especially from medical men. It is certain that never before has this important question of nutrition been so thoroughly and searchingly investigated; but it must be conceded that few men have been so well fitted for the task as the author, who is not only a man of high standing in the medical profession, but one who throughout his life has devoted himself with untiring zeal to the study of the subject. Perusal of the present work will be evidence enough that Dr. Hindhede can have left no stone unturned toget at the truth.

That this volume will not only prove of the greatest assistance to medical practitioners both in prophylactic and therapeutic treatment, but that its appearance will go far to provoke a general and beneficial reform of our nutrition, is the confident prediction of the publishers.

THE TRANSLATOR.

PROTEIN AND NUTRITION

AN INVESTIGATION

CHAPTER I

PROTEIN, FATS AND CARBO-HYDRATES (SUGAR AND STARCHES)

are the principal forms of our food material. They are composed essentially of the following elements :—C (carbon) ; H (hydrogen) ; O (oxygen) ; N (nitrogen) ; and S (sulphur). The two latter substances are found only in protein. The proportions are as follows :—

	C	H	O	N	S
Protein . .	53%	7%	22%	16%	2%
Fats . . .	76%	12%	12%		
Carbo-hydrates .	40%	7%	53%		

The first three of the above elements leave the body as carbonic acid (CO_2) and water (H_2O) ; and as the fats and the carbo-hydrates contain nothing else but these three elements, it is said that they are entirely consumed within the body. The same applies to the sulphur contained in protein, which leaves the body per the urine as sulphuric acid (H_2SO_4). Nitrogen, however, leaves the organism mainly as urea (CON_2H_4), which is capable by combustion of developing a considerable amount of heat. It is customary nowadays to calculate the value of our food-stuffs in calories ; *i.e.* heat-units. One calory is the quantity of heat required to raise one kilogram of water to 1° Centigrade.

By combustion of a portion of any food-stuff in a special apparatus (the Bomb-Calorimeter), and calculation of the heat thereby evolved, the nutritive value of the food can be ascertained. It is presumed by this that the nutritive value is in accordance with the heat energy. But it is certain that

no one will be prepared to maintain that the value of a food can be determined solely by means of the calorimeter. The gross value may indeed be estimated; but the net value is only to be arrived at when it has been ascertained how many calories go to waste with the fæces and urine. Stohmann and Rubner * give, for pure animal protein, fats and starches (as the result of experiments on dogs), the following figures per gram of dry substance :—

	Gross.	Net.
Protein . .	5·754 cal.	4·424 cal.
Fats . .	9·423 ,,	9·423 ,,
Starches . .	4·116 ,,	4·116 ,,

As a mean estimate of human nourishment derived from ordinary mixed diet—averaging the net value of one gram of substance—Rubner gives the following figures :—

1 gr. Protein . . .	4·1 cal.
1 gr. Fats . . .	9·3 ,,
1 gr. Carbo-hydrates . .	4·1 ,,

The last figures are now almost universally employed whenever the caloric value of a food-stuff is to be calculated. If these figures be applied to the old diet-standard of Voit (118 grs. protein, 56 grs. fats, and 500 grs. carbo-hydrates) for an adult, energetic man, we have the following :—

Protein . .	118 × 4·1 =	483·8 cal.
Fats . . .	56 × 9·3 =	520·8 ,,
Carbo-hydrates .	500 × 4·1 =	2,050·0 ,,
	Total—	3,054·6 cal.

Three thousand calories, therefore, are usually cited as a convenient standard for an adult man of ordinary occupation. While at leisure, about 2,000 cal. would suffice; but during strenuous employment one would require from 4,000—5,000 cal.

* Rubner in E. von Leyden's "Handbuch der Ernährungs. Therapie," Berlin, 1897, Vol. 1, p. 31.

Now, everybody is agreed that the proportion of alligation of the three forms of food is not exactly equivalent. Either the carbo-hydrates or the fats may serve, to a large extent, as a substitute, the one for the other ; and it is also possible, theoretically, at least, to employ protein in the place of the fats and carbo-hydrates—practically, it is, of course, not to be accomplished ; for to produce 3,000 cal. by the consumption of lean meat, about $7\frac{3}{4}$ lbs. would have to be eaten—but protein cannot be entirely replaced by the fats and carbo-hydrates, either in theory or in practice.

The tissues of the body are constructed essentially of albuminous substances ; and as the cell tissues are being incessantly destroyed, a continual reconstruction of them must also be taking place. But this reconstruction cannot result from the fats and carbo-hydrates alone ; obviously, the accomplishment of this depends also on substances containing nitrogen, *i.e.*, protein or nitrogenous compounds (amides, etc.). But how much protein is necessary as a minimum ? And how are we to determine that minimum ? These are the great and much-debated questions with which it will be the chief purpose of this book to deal.

If for no other reason than that of economy, it is generally conceded that it is unpractical to make use of more protein than is necessary for the maintenance of the body in full health and vigour. As we shall see hereafter, the richly albuminous food-stuffs are by far the most expensive, and it is, therefore, sheer extravagance to squander the housekeeping money on a superabundance of protein.

CHAPTER II

PERSONAL EXPERIENCE

More than twenty years ago I learned from the late Prof. Panum, of Copenhagen, that 4·2 ozs. (120 grs.) was the smallest amount of protein which would suffice an adult, vigorous man. It would not do to depend on the vegetable kingdom alone for this amount, because vegetable protein is too difficult of digestion, and too large quantities of vegetable food-stuffs, relatively poor in protein, would have to be consumed in order to obtain the required amount of protein. For this reason the necessary 4·2 ozs. should be drawn, to a certain extent, in equal measure from both the vegetable and animal kingdoms; and thus it was that our attention was directed to the supreme importance of meat.

This doctrine took me by surprise. I was born and reared in simple circumstances in West Jutland; and during the first sixteen years of my life my fare had consisted of milk-porridge and beer-soup for breakfast; thick slices of bread, sparsely buttered, with very thin slices of meat, or with none at all, for lunch. Dinner began with porridge, milk, cabbage and pea-soup, followed by potatoes and bacon, fish at times, meat very rarely, and then only in very small slices, while there was no limit to the quantity of potatoes provided. In the afternoon we had a meal of bread and butter, as in the forenoon; and in the evening "sour porridge"—groats cooked with large barley corns in buttermilk—an excellent dish, and relished by most people once they have become accustomed to it. This very monotonous fare contained, therefore, only a negligible quantity of that form of food which my teacher held to be the most important—meat. I explained to my astonished father that all this rye-bread, as well as all those potatoes, meant pot bellies, flabby muscles, and, consequently, deficient energy. The Irish and Japanese were cited as deterrent examples. It was only later that I became aware

that the majority of West Jutlanders were, in truth, anything but pot-bellied; that their energy was actually prodigious (working from fourteen to sixteen hours per day). The Irish, who are, notoriously, potato eaters, are very virile, and in America, where they are often to be seen serving as policemen, their physical appearance is very imposing. The Japanese, also well known as being mostly vegetarians, have proved themselves to possess wonderful powers of endurance allied with keen mental qualities.

To return to myself, I lived as a medical student in Copenhagen, and prepared my own breakfast and supper. As this fare contained little protein and no meat at all, I made up for it by dining in cheap restaurants. In such places, fortunately, one could choose the various courses at will. To make doubly sure, I would order a double portion of a main course, and I looked with the superior scorn of a scientist upon my poor, ignorant fellow citizens, who were stuffing themselves with thin soups. Strange to relate, instead of becoming muscular, as I expected, I grew weaker and weaker. My cousin, who lodged with me, and who followed me through thick and thin, was the first to cry halt. To my horror, he began to eat soups; I held out for some time, but gave in at last. The demon of doubt began to torment me; and when I had finished with Copenhagen, and had settled down in West Jutland with the intention of reforming existing conditions there, those connected with nutrition among others, there was hardly anything left of my physiological wisdom but a great perplexity. But no one can be a reformer who is himself in doubt; and thus reformation was delayed. Then came vegetarianism, into the study of which I threw myself with eager zeal. But in vegetarianism I found too many contentions, either unproved or impossible of proof, and the catch-phrase "Back to Nature" I conceived to be untenable. I could not bring myself to recognise that, considered by itself, it is more natural to eat baked bread than cooked meat. Our teeth, to be sure, indicate that we are fruit eaters; but a strict fruit diet is unpractical for an inhabitant of the north, banished from the paradise of the south.

Finally, our kitchen-middens (domestic refuse heaps of

primitive peoples) do not point to any particularly marked vegetarianism in our ancestors. We must go right back to the apes, and even these, our far-away progenitors, are reputed to have been eaters of young birds, to say nothing of eggs. As already remarked, I could not agree with vegetarianism in theory ; but for all that, there might be some virtue in it. I gave it a practical test. For one month I restricted myself to pure vegetarian diet ; and what is more, selected only those vegetarian foods as poor in protein as I could think of. I lived chiefly on butter, bread, potatoes, sugar and fruit—especially strawberries. I wanted to find out how long I could live on such a limited quantity of protein. Of course, it was not my intention to prolong the regimen until death threatened ; I merely wished to keep to it until I felt myself becoming really weak. To make more certain, I applied myself, meanwhile, to vigorous physical exercise, such as gardening, cycling, etc. But, strange to say, no infirmity evinced itself ; to the contrary I experienced excellent health. I never had that feeling of tension and sluggishness which usually follows the consumption of a good beef steak. With the end of the strawberry season I relinquished my assumed part. But these experiments, which were afterwards repeated with many variations, had convinced me of one fact, and that was that the little story of the 4·2 ozs. of protein is nothing but sheer fable ; since which time—now some seventeen years ago—very little meat is eaten in our house—most days we have none at all ; and I am always exhorting my children to eat plenty of porridge, bread and potatoes, and very sparingly of meat, eggs, etc.

We adults, as well as children, eat a great quantity of potatoes not only at dinner, but also at supper. In the evening, if there be no potato salad or potatoes served in some other way on the table, we are sure to hear a loud cry from the children present, " Are there no potatoes ? " One of the reasons why the potato has earned such an evil name must certainly be that there are so many bad potatoes on the market. Watery or unsound potatoes make a truly dreadful dish ; but good, sound potatoes form, in my opinion, a palatable and easily digestible food which, for no reason at all, has come to be despised.

1.—Karen, Daughter of the Author, at ten years of age.

My youngest daughter, who was born after my "half-vegetarian period," receives, according to old ideas, very poor and insufficient nourishment. She has never been urged to eat meat (many children, as is well known, have to be persuaded, or even forced, to take meat), and is nearly always satisfied with gravy and potatoes.* Yet it is remarkable that she is very strong and well built for her age. All my children, despite their "improper" diet, are particularly well developed physically; all of them are a good deal taller than their comrades of the same age. In evidence of this, I will give the weights and measurements of my four children, without their clothes, taken in August, 1905, and compare the results with the scale of weights and measures usual with children of the same ages as set forth by the Danish General Medical Association. The figures refer to pounds and ounces, and feet and inches.

	Jens 16 yrs.	16—17 yrs.	Christian 14 yrs.	14—15 yrs.	Anna 12 yrs.	12—13 yrs.	Karen 10 yrs.
Weight (lbs. and ozs.)	135·9¾	77·3—132·5	104·11¾	66·5—99·4	81·9½	55·2—88·3	72·12
Height (ft. and ins.).	5·10½	4·9—5·8	5·3	4·4¾—5·3	5	4·1½—4·11	4·6
Chest (ins.) . .	34¼	27½—31½	32¾	26—29½	28⅛	21⅝—27½	28

As may be seen, the children were not only able to compete easily with the mean figures given for children of six months to one year older, but, with one single exception, surpassed the maximum in every case. For Karen (who is almost a pure vegetarian) I had no figures for girls of the same age with which to draw comparison. Yet although at the time she was still wanting three months to complete her tenth year, she compares favourably in every respect with the average figures given for children of from twelve to thirteen years—her chest circumference, as a matter of fact, surpasses the maximum given for children at this age. It is remarkable enough that the child Anna, whose weight does not so markedly exceed that given for children of her own age, is also the one most partial to meat.

* There cannot be many children in the whole of this country who would be allowed to live as "poorly" as Karen. When on a visit she has to force herself to eat meat, because her aunts think it so dreadful that she does not eat as other human beings.

I do not wish to contend that the above proves that simple living results in vigorous children ; but, nevertheless, it shows that protein-lacking fare is no hindrance to good physical development during childhood ; and yet it is just during childhood that we place the greatest importance on an abundant supply of protein.

It must be remembered that it was seven years ago when the foregoing was written. The ages of my children now range from seventeen to twenty-three years, and though I am personally reluctant to sound the praises of my own family, I may be pardoned if I mention that I have often heard from other people such remarks as the following : " The best recommendation of your ideas is that your children are so physically robust and mentally active." I may add that, with the exception of whooping cough and measles, which attacked them very lightly, and a slight tonsillitis in one of them, I do not remember that any of my children have ever been really ill. (For further evidence see later.)

I do not deny that there are many children of poor families who have developed badly, both physically and mentally ; but I doubt that the cause of it is to be ascribed to an insufficiency of albuminous food ; rather do I hold that the evil is the effect of too much coffee—not to mention cigarettes. It is notorious that coffee and Vienna bread form the staple food in the back streets of Copenhagen, added to which it should be mentioned that fresh air and sunshine are known only by name in such places.

On comparing the experiences related above with the results of experiments on patients, I gradually came to the conclusion that nearly all of us more or less over-eat ourselves. It is certain that we could be satisfied with less aliment and particularly with less protein than we think. I have a suspicion that a vast number of ailments—disorders of the stomach, nerves, liver and kidneys, not to mention gout—are to be attributed simply to over-feeding. I believe that in this respect we physicians have done infinite harm to our patients. When all those dyspeptic and nerve-weary people come to us complaining of drowsiness, debility, general disgust with life, how often have we not exhorted them to eat plentifully ! " Take plenty of

invigorating food : meat, eggs, etc. ! " We sometimes recommend " Port wine and quinine," " Stout," or " Burgundy " to be taken with the food in order to help it down. But the more the food is thus assisted on its downward course, the weaker do our patients become ; while it is certain that with the aid of an apparent " hunger diet " we should in many an instance have been able to restore them to strength. Rich meat has a singular power of tempting the palate, and we are thereby induced to overload our poor stomachs. It strikes me as not at all so improbable that the undoubted triumphs of vegetarianism over certain ailments are to be ascribed partly to the circumstance that a " lentil beef steak " does not induce to over-feeding.

My convictions are the result of many separate observations, of little account when taken apart, but which assume their importance when considered in combination.

Meanwhile, I do not expect that my subjective feelings and limited experiences will convince anybody, although, at all events, they have satisfied me. Much reading on the subject of nutrition must tend to inculcate scepticism. There is always the question as to what is really the truth. And in the end a man places most faith in himself. I am convinced that if only my colleagues would repeat all the experiments which I have carried out for years past, they would obtain similar results, and thus be brought to regard with suspicion the science of nutrition as it finds favour to-day, and which is based, according to my ideas, on over-feeding.* But as there are not many of my colleagues whom I could persuade to try my simple diet, I have decided on another plan of action. I will examine the old doctrines, as to how they arose and on what they are founded. I believe that I shall be able to prove that they are built on sand—on sand and nothing but sand.

* During the past few years I have travelled a good deal, and have thus come in contact with men who pose as experts on this subject. I have asked those with whom I have been unable to agree if they have ever experimented upon themselves, and the reply has invariably been : " No, I have not actually tried it myself." After such an admission, one can well imagine that their arguments have little weight against that of my own seventeen years' experience. I may add that those who have given the matter a practical and personal test are of the same opinion as myself.

CHAPTER III

LIEBIG AND VOIT

VOIT'S EXPERIMENTS ON DOGS

[This chapter will, I think, interest those who want to understand how it was that Voit came to make such mistakes as he did ; others may find it too technical and, therefore, tedious, wherefore, it may be remarked that it may be passed over without disturbing the sequence.]

JUSTUS VON LIEBIG was really the first man to propound a theory on the importance of protein. His theory may be expressed in condensed form as follows :—

" Exercise of the muscles entails decomposition of protein, and the only task before the protein contained in the food is to replace that which has been used up. Protein is the only tissue-building material, and the katabolic product of the protein—the urea—is the measure of the metabolic change. The carbo-hydrates and fats, by union with oxygen, supply heat. They are only respiratory foods (fuel)."

Thus to protein was given a pre-eminence which, despite criticism and change, it has never since lost. It is as if Liebig's spirit still hovered near, and although Voit criticised Liebig in much, it would seem as if he could never free himself from his forerunner's exaggeration of the value of protein. The practice of estimating by the urea the quantity of protein used up, or katabolised,* has continued unchanged to the present day.

* Experiments in protein metabolism are always carried out, not to determine by chemical analysis the amount of protein itself, but that of nitrogen present in the aliment, fæces and urine. As it is presumed that protein contains 16 per cent. nitrogen, by multiplication with the factor $6\frac{1}{4}$ it is calculated how much protein the quantity of nitrogen discovered represents. In this manner various nitrogenous compounds are reckoned as protein. There are many low compounds in food-stuffs and the fæces ; but in urine no albumen at all is normally present, only urea, uric acid, etc. For practical reasons it has been found convenient to designate the quantity N (nitrogen) $\times$ $6\frac{1}{4}$ as " calculated protein." And as it is reckoned that " flesh " (lean muscle-tissue) contains 20 per cent. protein, the amount of " flesh " which

According to Liebig's theory, protein katabolism must be in accordance with the expenditure of muscular energy, the amount of which may be estimated by the nitrogenous secretion in the urine. But as soon as experiments in metabolism were begun, it became evident *—probably to the great surprise of physiologists—that protein katabolism during rest and during work was exactly the same. Liebig's theory must have collapsed in face of this fact had not he himself and his followers,† Lehmann, Frerichs, Bidder and Schmidt, modified the theory to the extent that katabolism of protein that is really necessary for use is always in accordance with the expenditure of muscular energy; but if there be a surplus, this is consumed in the same way as the fats and carbo-hydrates, relatively without profit. There ensues, rather, so-called "*luxus consumption.*"

the subject of experiment (man or animal) is said to have gained or lost, is calculated by multiplication of the protein by five. Thus the nitrogen is translated into "calculated flesh" by multiplication with $6\frac{1}{4} \times 5 = 31\frac{1}{4}$. Now, there is no object in allowing oneself to become confused by all this talk about gain or loss of flesh. That a man has lost 50 grs. of nitrogen is a long way from saying that he has actually lost 1,562 grs. of muscle-substance. It is more likely that the "circulating" protein in the tissues has decreased. The conception that it is flesh—the valuable muscle-substance itself—that has been lost, has been the cause of dreadful alarm at the loss of even a trifling amount of protein. In reality, it is rationally conceivable that a loss—small and of short duration, at least—of protein may be beneficial in certain circumstances; while larger and prolonged losses must, of course, be harmful.

To ascertain, therefore, whether the individual experimented upon is in nitrogen equilibrium on a particular diet, the amount of nitrogen present in the aliment, fæces and urine has to be determined. If the sum of the nitrogen present in the fæces and urine be greater than the quantity in the food, it is said that the individual shows a minus balance; *i.e.*, that he is "losing flesh." Furthermore, Voit does not reckon exactly according to the above given formulæ. Instead of $N \times 6\frac{1}{4} \times 5$, he calculates thus: $N \times 7 \times 4{\cdot}2 = 29{\cdot}4$. Unless this is borne in mind, Voit's figures will be found to disagree with those of the present day. As has been already mentioned, in many food-stuffs a large part of the contained nitrogen (about one-third in potatoes) proceeds from low compounds—amides; thus, in reality greater mistakes are made when using the formula $N \times 6\frac{1}{4}$ = protein, especially as the opinion has hitherto been held that the amides cannot replace protein.

By revision of the German experiments I arrived at a directly opposite result (M. Hindhede, "Feeding of Milch-cows," in "Milchwirtschaftliches Zentralblatt," Leipzic, 1906, Vol. 2, p. 67); and now, in 1913, it is generally acknowledged that the amides are able to replace protein.

* Concerning Voit's experiments, referred to in this and following instances, information may be obtained from several volumes of the "Zeitschrift für Biologie," especially Vols. 2, 3, and 4, in which will be found his celebrated experiments. Subsequent volumes are mostly polemical.

† Literary examples will be found in Voit, "Physiologie des allgemeinen Stoffwechsels," Hermann's "Handbuch der Physiologie," Leipzic, 1881, Vol. 6, I., pp. 269 *et seq.*

Upon this expression Voit threw himself with the greatest ardour. His catch-phrase was: "There is no '*luxus consumption.*'" And although it is quite certain that there is some truth in the designation, Voit, thanks to his authority and superiority in debate, succeeded in quashing the idea for some considerable time. Voit's argument against "*luxus consumption*" appears to me to be very interesting and instructive, wherefore I reproduce it here at some length.

According to the theory of "*luxus consumption,*" the protein katabolised during starvation must serve as the standard for the quantity of protein required. If this actually necessary decomposition was always in accordance with the work done, it is obvious that, if a human being or an animal, deprived of protein, perform a certain amount of work, it would entail the loss of an amount of flesh-substance from the body of the individual demanded by the energy expended. How much flesh-substance has been consumed is ascertained by measuring the nitrogen secreted in the urine. By this means is obtained the exact quantity of digestible protein that must be supplied in the aliment. To supply more would be extravagance. This theory, derived from the "*luxus consumption*" theory, that the protein katabolised during starvation should be taken as the standard of what is needed, Voit attacked with might and main. He professed to be able to prove by experiment that a dog, losing

190 grs. of flesh-substance in a state of starvation

requires at least

500 grs. of meat in its food to maintain protein-equilibrium; and if at another time it loses

170 grs. of flesh-substance during starvation

it requires at least

400 grs. of meat in its food for its proper maintenance.

Hereupon Voit established the rule which he was for ever defending: "The quantity of protein necessary for maintenance is (with dogs, at least) no less than two and a half times as much as that consumed during starvation." That this rule is false we shall, later on, prove overwhelmingly. But Voit was by no means content with this extravagance. Thus, he is able to maintain a dog (dog A.) in equilibrium on 500 grs. of

meat as a minimum. But the same dog can also be brought into equilibrium with 2,500 grs. of meat as a maximum. Between 500 and 2,500 grs., equilibrium can be established at any and every point. The dog katabolises 190 grs. in a state of starvation ; but 500 grs. is obviously not "*luxus*," because they constitute the minimum necessary supply for maintenance of the equilibrium. But, says Voit, with astounding assurance, neither are 2,500 grs. "*luxus*." The 2,500 grs. are just as necessary as the 500. Thus if, after the 2,500 grs., the dog be given only 2,400, it will lose protein for a time until it comes into equilibrium again at a lower protein level. A high protein equilibrium demands a rich supply. Voit compares the situation with that of fire in a stove. By continual increase of the fire by the addition of fuel, the heat rises ; then when the fire is very fierce, it is only possible to maintain it at that level by an incessant supply of fuel ; if less be laid on, the fire will abate. Finally, equilibrium can be established at a lower stage of heat. Can it be said, therefore, that it is luxury to build up a big fire ? Certainly not. It is not extravagance or luxury to build up a big fire in the stove if it be needed to warm the room, any more than it is extravagance to pile on fuel in the fire-box in order that a locomotive may keep up a high steam-pressure. On the other hand, it is extravagance to make a big fire when no warmth is required, or when full steam-pressure in a locomotive is not needed. Voit concludes as follows :—

" Frerichs quotes an observation by the historian, von Müller, to the effect that freedom thrives where cheese is made ; or, in other words, where plenty of protein is eaten. The adherents of '*luxus consumption*' must, in conformity with his views, declare freedom to be a luxury."

Voit's opponents were disarmed by his brilliant eloquence and ponderous polemics. I find it interesting to note how a pre-eminently gifted man can secure recognition, through several decades, of a false doctrine. One would really think that Voit's own discovery—that muscular work does not increase protein katabolism—would have dealt a mortal blow at the views expressed above ; but Voit contrives to evade responsibility by the following argument * :—

* " Zeitschrift für Biologie," Vol. 3, p. 33.

"Katabolism in the cells ensues in the same way whether the individual be working or not. A rich supply of protein means merely that plenty of work can be accomplished. Strenuous labour demands powerful and well developed muscles; or, in other words, a high protein level. Therefore (and not because protein is broken down to a certain extent by work), for protracted, arduous labour a rich supply of protein is necessary."

Voit puts it thus: a rich supply of protein = a high protein level = powerful muscular strength. It only remains to inquire whether this comparison is correct. At least, it ought to be proved. But Voit does not worry himself about proof.

What is still to be proved is taken as established fact. Voit drew right away from Liebig, but his footsteps were dogged by that little imp—over-estimation of protein. Voit did not care to break with the attitude of the time, and the watchword in his day was Protein. It is interesting to observe how Voit himself had some idea whence would come the deadly blow at his teaching. As a precautionary measure, he sought to avert the stroke by the following argument:—

"One might suppose that, such a quantity of meat (2,500 grs.) being absolutely necessary for the greater abundance of protein in the body, a part of it might be replaced by the fats and carbo-hydrates without any consequent loss of flesh-substance. This, however, is not possible; I will prove, indeed, that fat can be substituted for a certain amount of protein, and that the body can be as well nourished for a time with a small quantity of meat and fat as with a large amount of meat alone; but if much meat has been previously supplied, the loss of flesh-substance is not arrested by the addition of fat or carbo-hydrates to a smaller allowance of meat; thus, for the maintenance of a high protein level which has been attained purely by means of meat, meat alone will suffice; no non-nitrogenous substance can take its place.

"I will append a few examples in support of this (the figures refer to grams):—

Dog A.—Experiment No. 29.

Date.	Meat Intake.	Fat Added.	"Flesh" Output.	Body Change.	—
18 to 19 Feb., 1861 .	1,800	0	1,809	— 9	
20 Feb., 1861 . .	400	200	634	— 234	
21 ,, ,, . .	400	200	564	— 164	
22 ,, ,, . .	400	200	498	— 98	— 615
23 ,, ,, . .	400	200	469	— 69	
24 ,, ,, . .	400	200	450	— 50	

Dog A.—Experiment No. 10.

Date.	Meat Intake.	Fat Added.	"Flesh" Output.	Body Change.	—
2 March, 1858 . .	1,600	0	1,553	+ 47	
3 ,, ,, . .	700	150	858	− 158	
4 ,, ,, . .	700	150	689	+ 11	
5 ,, ,, . .	700	150	776	− 76	− 386
6 ,, ,, . .	700	150	831	− 131	
7 ,, ,, . .	700	150	732	− 32	

"Whereas in ordinary conditions, therefore, in the case of dog A., the intake and output of nitrogen, on 400 to 700 grs. of meat with additional fat and carbo-hydrates, are able to balance, it loses, after a previous rich meat diet, a considerable quantity of flesh before it comes again in equilibrium."

From these and several similar arguments Voit arrives at the definite conclusion that "there is no such thing as *luxus consumption*." He introduces examples to show that rabbits and oxen always secrete more nitrogen while feeding than in a state of hunger; and ends by saying:—

"Likewise is it known that a man on a satisfactory sustaining diet never secretes a mere 18 grs. of urea (= 8·4 grs. nitrogen = 52·5 grs. 'calculated protein') as he does when in a state of hunger."

At the proper moment we shall prove the falsity of this assertion. Indeed, my greatest surprise has been to discover how groundless and untenable Voit's assertions are.

It is easy to understand how he arrived at such wrong conclusions, if we take into account the limited ability of the organism to store protein, and the fact that the protein introduced, or already present, must be consumed and secreted as quickly as possible—generally within a few days. For instance, if we were to give a man 100 grs. of digestible protein per day, it appears to me—purely projectively—that, on the first day 70 grs. would be katabolised; on the second, 20 grs.; and on the third, 10 grs. If 50 grs. be given, the quantities katabolised per day would be 35, 10 and 5 grs.; with 200 grs., 140, 40 and 20. Then, after allowing our man to starve for three days, if we were to give him 100 grs. during the first three days, 50 during the next three days, and 200 grs. during

the following three days, we might draw up the ensuing table of results :—

Intake of Digestible Protein.	Output per the Urine : N × 6¼ grams.									
	1st Day.	2nd Day.	3rd Day.	4th Day.	5th Day.	6th Day.	7th Day.	8th Day.	9th Day.	10th Day.
1 day 100 grs. . . .	70	20	10	—	—	—	—	—	—	—
2 ,, 100 ,, . . .	—	70	20	10	—	—	—	—	—	—
3 ,, 100 ,, . . .	—	—	70	20	10	—	—	—	—	—
4 ,, 50 ,, . . .	—	—	—	35	10	5	—	—	—	—
5 ,, 50 ,, . . .	—	—	—	—	35	10	5	—	—	—
6 ,, 50 ,, . . .	—	—	—	—	—	35	10	5	—	—
7 ,, 200 ,, . . .	—	—	—	—	—	—	140	40	20	—
8 ,, 200 ,, . . .	—	—	—	—	—	—	—	140	40	20
9 ,, 200 ,, . . .	—	—	—	—	—	—	—	—	140	40
Total . . .	70	90	100	65	55	50	155	185	200	60

It may be seen that in 100 grs. equilibrium is established on the third day. On the fourth day the output is down to 50 grs., and there is a minus balance. The man intakes 50 grs. and katabolises 65 grs. ; that is to say, he loses 15 grs. protein = 75 grs. of flesh substance. On the sixth day equilibrium is again established. On the seventh day the body on an intake of 200 grs. puts on 45 grs. of protein, which equals 225 grs. of flesh substance. On the ninth day we have equilibrium once more. That it is bound to happen thus appears to me so simple and natural that it is almost self-evident. I cannot grasp how it is to be considered as harmful that the man should secrete some of the refuse from the third day. If an alderman attend banquets on three consecutive days, and then restrict himself to meagre diet for the next three days, he will most certainly show a minus balance—which Voit would declare to be a calamity. Yet my opinion, to the contrary, would be that such treatment for our alderman would be highly beneficial. It is as easy for a man as it is for a dog to attain a high equilibrium. That which goes in must come out ! But there is not one vestige of proof that a high equilibrium is advantageous. Voit evidently thinks that dog A. on 2,500 grs. of meat is five times more able to work than the same dog on 500 grs. of meat

plus fat. True, thought is free ; but he ought not to say, and certainly has no right to expect, that others should think the same.

Could it not be generally agreed that the equilibrium during the days immediately succeeding a change of diet ought not to be taken into account ; and that there is no reason for regarding a high equilibrium as being of more advantage than a low one so long as the man, or the dog, at the lower equilibrium, continue in uninterrupted possession of complete health and vigour ?

Hirschfeld,* moreover, has pointed out several errors in Voit's deductions from his experiments on dogs. According to Voit, 190 grs. of flesh substance is the smallest amount katabolised by a dog of 35 kgs. in weight. This makes an output of

0·17 gr. nitrogen per kilogram of a dog's weight.

Voit asserts, firstly, that more is always secreted after each meal ; and, secondly, that for the maintenance of equilibrium at least 2½ times as much is secreted during fasting as is necessary. But against this Salkowski† points out that the nitrogen output of a dog fed on 150 grs. of bread, 50 grs. of condensed milk and 50 grs. of bacon was on the nineteenth day, for example, only

0·12 gr. nitrogen per kilogram.

Rubner‡ also shows that a dog weighing 6½ kgs., which secreted during fasting 1·90 to 1·97 grs. nitrogen (small dogs use up more in proportion than large dogs), after being fed on sugar, decreased its output from

1·64 ; 1·25 ; 1·10 to 1·04 grs. nitrogen.

Thus we may dismiss Voit's first contention.

As regards his second one, Munk § found from his experiments on the formation of fat from carbo-hydrates that a dog which had become very thin through prolonged fasting, and which weighed 25 kgs., actually lost flesh on food which consisted of 200 grs. meat and 250 grs. carbo-hydrates ; but on being given

* Pflüger's "Archiv für die gesamte Physiologie," Vol. 44.
† Salkowski, "Zeitschrift für physiologische Chemie," Vol. 1.
‡ Rubner, "Zeitschrift für Biologie," Vol. 19.
§ Virchow's "Archiv für pathologische Anatomie und Physiologie," Vol. 101, p. 110.

500 grs. of carbo-hydrates began to put on flesh. During one day the increase of flesh was as much as 78 grs., so that only 122 grs. of flesh was used up. That means that the output for 28 kgs.—the weight of the dog at the time—was

0·15 gr. nitrogen per kilogram,

while the dog, according to Voit's second assertion, ought to have been brought into equilibrium only by

$0{\cdot}17 \times 2\frac{1}{2} = 0{\cdot}42$ gr. nitrogen per kilogram.

This proves Voit's second contention to be absolutely incorrect. The fact is that Voit had not rightly appreciated the immense value of the carbo-hydrates in replacing protein. As we shall see hereafter, a great number of equilibrium experiments have failed because sufficient carbo-hydrates (calories) have not been given. If the non-nitrogenous food-stuffs do not yield calories enough, it is but natural that the organism should consume protein.

With which we will take our leave of Voit's dogs. I hope that the reader will have understood what a misleading influence these creatures have exercised on Voit, first of all, and afterwards on his contemporaries and on posterity. And yet there are no animals—and, one might add, no men in the whole physiological world—which have acquired anything approaching the fame accorded those dogs. It is impossible to avoid them when scanning the pages of any treatise on the physiology of nutrition. Even in popular publications they are to be encountered again and again. And wherefore ? Simply because those dogs constituted the foundation stone of that which has been, up to the present, the accepted doctrine of nutrition. And now, because the foundation was faulty, the doctrine itself has collapsed.

CHAPTER IV

VOIT'S EXPERIMENTS WITH MEN

The Diet-Standard.

These experiments are so few in number, and so short of duration, that they are quite insignificant if examined on their own merits. They acquired their importance only because they reflected on the experiments with dogs.

There are in all fifteen of them, of which fourteen are concerned with one and the same individual, and extend in each case only for the space of a single day (two only of the experiments outlast two days). Voit carries out but two fasting experiments, each of which was continued only for the day. These go to show that the subject used up about 70 grs. of protein (or about 80 grs., if one reckons with the factor 7 instead of with $6\frac{1}{4}$). Besides these, there are six other experiments in which the subject is supplied with a "generous mixed diet" containing about $19\frac{1}{2}$ grs. of nitrogen; with result that also about $19\frac{1}{2}$ grs. of nitrogen are excreted per the urine and fæces. As an example I will append the record of one of the experiments:—

Intake.	Nitrogen. Grs.	Protein. Grs.
Ca. 265 grs. Meat * . . .	8·50	53·12
One Egg	1·35	8·44
450 grs. Bread . . .	5·77	36·06
$\frac{1}{2}$ litre (·88 pint) Milk . .	3·15	19·69
One litre (1·76 pint) Beer . .	0·67	4·19
70 grs. Fat	—	—
30 grs. Butter	0·03	0·19
70 grs. Starches . . .	—	—
17 grs. Sugar	—	—
	19·47	121·69

* Voit puts it as 140 grs. of meat, but this must have been in roasted condition. 53 grs. protein in 140 grs. meat would mean 40 per cent. of the

Output.	Nitrogen. Grs.	Protein. Grs.
1,345 grs. Urine . . .	17·35	108·44
115 grs. Fæces . . .	2·12	13·25
	19·47	121·69

As is to be seen, the finest balance imaginable !

But what is there to learn from this equilibrium ? Nothing more than that the subject had, most probably, consumed the same fare on the preceding day ! But to obtain such a result there was no need to carry out metabolic investigations.

From the decomposition of 70 grs. on the first fast day there is nothing at all to be deduced. And here, also, the quantity corresponds exactly with the fare of the preceding day. Even Voit * himself proved that most emphatically by means of three parallel hunger experiments on one and the same dog. Previous to the first series of experiments the dog had consumed 2,500 grs. of meat daily ; before the second series it had been fed on mixed diet, poor in protein. The result was :—

Secretion of Urea in Grams During 24 Hours.†

	Series I.	Series II.	Series III.
1 Fast-day . .	60·1	26·5	13·8
2 ,, . .	24·9	18·6	11·5
3 ,, . .	19·1	15·7	10·2
4 ,, . .	17·3	14·9	12·2
5 ,, . .	12·3	14·8	12·1
6 ,, . .	13·3	12·8	12·6
7 ,, . .	12·5	12·9	11·3
8 ,, . .	10·1	12·1	10·7

The first glance will show that the secretion on the first fast-day does not indicate anything at all about the necessary

former in the latter ; but raw meat does not contain so much. Calculated as 20 per cent., 53 grs. of protein would represent 265 grs. of meat.

* Hermann's "Handbuch der Physiologie," Vol. 6, I., p. 89.

† To obtain the amount of protein katabolised, the quantity of urea must be multiplied by 2½.

protein decomposition. It is only after the lapse of four days that the secretion becomes rather uniform. But decomposition during fast can vary to the greatest degree in human beings. Cetti * consumed from the first to the fourth days of his fast about 86 grs., and on the ninth and tenth days about 68 grs. Ranke † consumed on his second day of fast 50 grs. of protein; while Succi ‡ secreted on the twenty-first day of his fast only 2·82 grs. nitrogen, which is equal to 17·62 grs. protein. It is easy to recognise that a diet standard based on Voit's 70 grs. in a state of starvation and 121 grs. on customary generous diet is absolutely of no value. If Voit experimented in a purely casual way on a man who ate largely of meat—with, perhaps, eggs or milk—he could have established equilibrium just as well on 60 as on 120 grs. Equilibrium can generally be attained on any quantity of protein, from 30 or 40 up to 200 grs. The whole business of the 120 grs. is, therefore, *quite fortuitous*.

Did Voit, then, construct his standard on nothing else but sheer accident? No, for the experiments just mentioned go to take up only one half of his demonstrative argument; the other half consists in that he points out what quantities of aliment different people consume on a diet of their own choosing. He draws attention, first of all, to Förster,§ who, by experiments with various kinds of food, after observations lasting several days, found the following quantities (in grams):—

	Protein.	Fats.	Carbo-hyd.
Workman . .	133	95	422
Joiner . .	131	68	494
Young physician .	127	89	362
,, ,, .	134	102	292
Vigorous old man	116	68	345

* E. von Leyden's "Handbuch," 1897, Vol. 1, p. 38.

† Tigerstedt, "Fysiologiska Principper för Kroppens Näring," Stockholm, 1887, p. 155.

‡ Hammarsten, "Lehrbuch der physiologischen Chemie," Wiesbaden, 1904, p. 643.

§ For this and following, see Voit in Hermann's "Handbuch," Vol. 6, pp. 519 *et seq.*, where literary references will also be found.

Further on he quotes the following figures, as the results of various experiments (in grams) :—

	Protein.	Fat.	Carbo-hyd.	Authority.
Normal allowance for an adult .	130	—	—	Payen.
,, ,, ,,	119	51	530	Playfair.
Man doing moderate work .	130	40	550	Moleschott.
,, ,, ,, .	120	35	540	Wolff.
Soldier on ordinary duty .	117	35	447	Hildesheim.
Soldier during field-exercise .	146	44	504	,,
Dutch soldier . . .	100	—	—	Mulder.

From the above Voit goes on to say that he has arrived at the following standard for a moderate " worker "—that is, a workman who performs moderately severe labour—*as the mean average of a very great number of observations* :—

118 grs. Protein ; 56 grs. Fats ; and 500 grs. Carbo-hydrates.

And here we have the celebrated Voit standard, which for the past twenty-five years and more has maintained its sway over science !

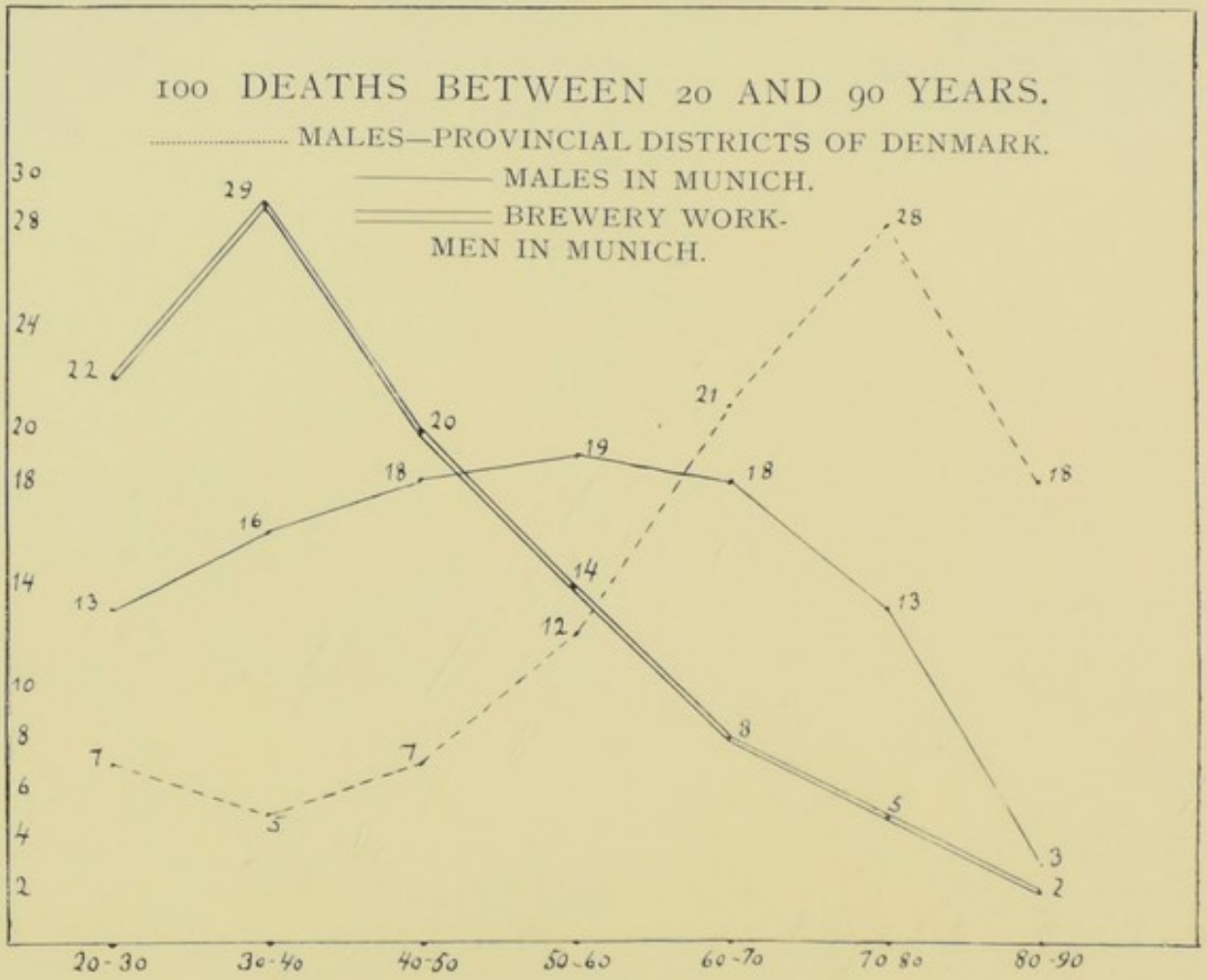
Voit then proceeds to give further support to this standard by citing various references. He states that, according to Liebig, the intake of a *brewer's man in Munich* is (in grams) :

	Protein.	Fats.	Carbo-hyd.
In Bread . .	42	—	224
In Meat . .	148	73	—
In Beer . .	—	—	375
Total	190	73	599

If we reckon the protein contained in bread to be 8 per cent., in meat to be 20 per cent., and the carbo-hydrates in beer to be 5 per cent., our brewer's man nourishes himself on :—

525 grs. Bread ; 740 grs. Meat ; and 7½ litres (13·12 pts.) Beer.

In comparison with which Voit's diet-standard is a rather modest one.



2.—Mortality of Brewers, etc.

It is interesting, in this connection, to compare the mortality statistics for :—

A. Total males of from twenty to ninety years of age in Munich.*

B. Men employed in breweries in Munich.

C. Total adult male agricultural population in Denmark.†

The calculations are made in this manner, that the number of deaths between twenty and ninety years are set as 100. Then is calculated how many per cent. of these are found between thirty and forty, how many between forty and fifty, etc.

Observe the great contrast between brewers in Munich and the male agricultural population in Denmark. The mortality among young men of the latter is very low (the rate rising high between the ages of from seventy to eighty). Yet, of the brewers, the majority die in youth, and the rate is very low after the sixtieth year of age, because few live so long. The curve for all male adults in Munich shows a very even mortality. But does it not appear to the reader that the Danish mortality curve is the more natural ? Surely, it is not in accordance with nature that the greater number of men should die between the thirtieth and fortieth year of life !

It is absurd that Liebig and Voit should set up this meat and beer diet as a standard ; it should only be advanced as evidence that the standard should be quite otherwise.

Later on, Voit draws attention to Playfair, from whom he takes the following figures (grams) :—

	Protein.	Fats.	Carbo-hyd.
Farm-labourer in India . .	57 (?)		560
,, ,, Dorsetshire .	83 (?)		293
,, ,, Gloucestershire .	108		432
English Marine	142	73	408
Railwayman in the Crimea . .	162	94	375
Smith	176	71	666
English Prize-fighter . . .	288	88	93

* Sendtner, " Ueber Lebensdauer und Todesursachen bei den Biergewerben," Munich, 1891.

† Danmarks Statistik, 5 Räkke, A. 6, p. 25.

Voit then states that Playfair, as the result of these inquiries of his, sets up the following diet-standard (in grams) :—

	Protein.	Fats.	Carbo-hyd.
Minimum (for maintenance) .	57 (?)	14	340
At rest	71 (?)	28	340
During regular exercise . .	119	51	530
Doing hard work . . .	156	71	567
Doing exhausting work . .	184	71	567

And here ends the second half of Voit's argument. Is it not peculiar in the extreme ? I beg to draw attention to the notes of interrogation in brackets attached to the 57, 71 and 83 grs. of protein.* These queries are Voit's very own. They mean as much as, " That would appear to be impossible." It is only when Playfair approaches the fortuitous equilibrium found by Voit that the latter begins to give credence to Playfair's figures. Thus, the procedure is as follows :—

1. A certain man is selected, one who is accustomed to a good half-pound of meat, one egg, a half-litre of milk, etc. It is found that he is in equilibrium on about 118 grs. of protein. This quantity is then set down, provisionally, as the standard.

2. It is then ascertained how much protein is eaten by individuals belonging to certain classes and in different positions in life on a diet of their own choosing. The result is a whole row of figures, utterly at variance the one from the other, and apparently contradictory. Now all those which deviate

* These low figures are by no means unique. From Professor Tigerstedt†, I will cite a few more of the same kind (experiments by Meinert, Hildesheim, Playfair, Boehm and Scheuber) :—

	Protein.	Fats.	Carbo-hyd.
Smith in Bavaria	94	27	369
Workman in Silesia	80	16	552
Navvy in Saxony	80	37	504
Pharmaceutist in Leipzic . . .	71	69	351
Cigarette-maker (female) in Leipzic .	62	53	304
Straw-plaiter (female) in Leipzic . .	72	56	440
Seamstress in Leipzic	56	51	229
Painter in Leipzic	87	69	366
Joiner in Leipzic	77	57	466
Poor workman	86	12	610
Seamstress in London . . .	64	29	292
Workman in Luckau	83	16	573
Student in Japan	74	6	476

Later on I will give even lower figures.

† Tigerstedt, " Fysiologiska Principper för Kroppens Näring," p. 158.

widely from the standard—and especially those below it—are thrown overboard ; and then, of course, figures are obtained which agree more or less with the standard. And thus the standard is proved.*

It is the general rule, not only in Denmark and Germany, but all over the civilised world, that the working classes in agricultural districts live frugally, on the plainest food, in which little meat is included ; while workpeople in the towns are accustomed to more varied diet with a relatively generous supply of meat. I presume that the difference between country folk and town people is the same in England. From Tatham's " Supplement to Report, 65, 1908," we are able to compare the difference in mortality among these two classes in England. Taking 100 as our standard, we have the following :—

	Working Men. Country.	Working Men. Towns.
Total mortality . . .	100	471
From phthisis . . .	100	1031

It must be conceded that this great disparity cannot be due solely to difference in diet. Country life is, in many ways, more healthy than town life ; but we can say with confidence that there is nothing here to show that a rich meat diet imparts vitality or helps to prolong life. The reverse is in all probability the case. Would it not be more sensible to acknowledge, once and for all, that, if we are going to standardise a diet, chosen according to individual taste, it would be better to seek for the required standard among those classes the members of which live the healthiest and longest lives than to take as our pattern the habits of those the majority of whose members die in what ought to be the flower of their age ?

Before leaving Voit we will reproduce a few extracts from his concluding remarks. He writes† :—

" It has been suggested that my findings by experiment [that protein

* The above looks as if it were mere violent, ironical exaggeration. But I would ask anyone who doubts to examine it for himself. He will be obliged to concede that it is the simple truth. I am not, by any means, accusing Voit of deceit : it is but the old story : Voit became enamoured of a theory ; and practice, though he himself was quite unconscious of it, had to bow before that theory.

† Hermann's " Handbuch," Vol. 6, I., pp. 522 *et seq.*

is not used up by work.—Editor] do not agree with Playfair's statistical revelations, mentioned just now [that according to the work done from 57 up to 288 grs. protein are decomposed.—Editor]. But this contradiction is only apparent.

"Every man, according to his supply of muscle, is able to perform a certain amount of work, and requires for his maintenance a certain quantity of protein in his food, irrespective of whether he is at work or not. The heavy work of a smith, or of a brewer's drayman, or of an English docker, would only be undertaken by the man who by virtue of his muscles would be able to perform it; he would, therefore, require more protein for the maintenance of his strongly developed work-organs than would a weakly tailor. Were the latter to absorb and consume ever so great a quantity of protein, he would never be able to do the work of a smith. The highest possible amount of work which a man is able to perform depends on the state of development of his muscles, and the worker requires protein in his food in proportion. Thus one finds that a strong worker takes more protein than a weak one, and the consumption of protein in different individuals usually runs parallel to the amount of work done. But one and the same individual katabolises, in otherwise precisely similar conditions, an equal quantity of protein when at work and when resting. If work increased protein katabolism, a worker would be satisfied with less protein on Sundays and holidays than on work-days; but seek to ascertain for once the diet of a robust workman on these days, and it would be found that the quantity of protein would be the same in both instances; *for a reduction in the supply of protein on a day of rest would mean loss of muscle to the workman, and on his return to work, he would no longer be able to perform his usual task.*"

I have italicised the two final clauses because they bring Voit's method of reasoning into such sharp relief. But I should imagine that the majority will rebel against such a statement that a workman would lose in muscle-bulk on Monday because he did not get enough beef to satisfy him on Sunday. Such a suggestion strikes me at first sight as improbable in the extreme, and yet Voit is content to let his assertion go without advancing any proof in support of it. It seems to me, moreover, that in this case he is directly contradicting himself, seeing that elsewhere* he insists that the circulating protein is decomposed before the muscle protein. Later on, Voit continues in this manner (p. 522) :—

"The above given figures (the 118 grs.) apply only to a worker capable of moderate exertion, and not to one intensively active, who,

* Ebda, p. 300.

because of his greater bulk of muscle, requires yet more protein, up to 150 grs. and more, and a larger supply of non-nitrogenous foodstuffs."

Further on he writes (p. 523) :—

" Recent experience has led to more value being placed on a constant and generous supply of non-nitrogenous foodstuffs for a strong worker. Chamois hunters, desirous of making their loads as light as possible, take with them on their arduous expeditions no richly albuminous but mostly fat foodstuffs, which during excessive strain are lost from the body, and which, apart from that, are more sorely missed by people, whose bodies are none too well supplied with fat, than the more restricted loss of protein, which may afterwards be replaced by a few ample meals."

Here Voit would appear to be near the truth, but does not seem to be able to peer through the mist of theory enveloping him. As regards the chamois hunter, I should be much surprised to see one, on a holiday, eating beefsteak after beefsteak in order to replace the muscle he had lost. We might venture to say that the man has lost nothing in this way, but, to the contrary, has increased his muscularity by vigorous training. Further on, Voit replies to certain protests which had been raised against his standard as early as the years 1878 and 1879—those of Beneke and Flügge, for example. He writes (p. 525) :—

" It is objected * that the quantity of foodstuffs prescribed for a moderate worker (118 grs. Protein, 56 grs. Fats, and 500 grs. Carbohydrates) is set at too high a figure for a general average ; that the worker could be satisfied with less, as many people consume less, particularly protein. It cannot be doubted that less vigorous and degenerate people are to be satisfied with a smaller quantity of protein than 118 grs. (of which 105 are absorbable). Thus Flügge (' Beiträge zur Hygiene,' Leipzic, 1879, p. 93) in the Hygienic Institute in Leipzic, tested a serving-man weighing 59·7 kg. and who was of weak constitution and of limited physical strength, and who, he found, on his usual, principally vegetable, diet, secreted only 9—10 grs. of nitrogen (equal to 52—65 grs. protein) per the urine ; also from other individuals in Leipzic and from two workmen in Berlin he obtained results of from 8—11 grs. of nitrogen in the urine. I have shown similar results from prisoners ; but a man of weak constitution and of indifferent powers of exertion is not a moderate worker. *The standard quantity required for a moderate worker would be too high only, if people weighing 67 kgs. were able to accomplish for a protracted period the work of a moderate*

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* Beneke, " Schriften der Ges. zur Beforderung d. ges. Naturwiss, zu Marburg," Vol. II., p. 277 (1878).

worker ; that is to say, if they were able to work from nine to ten hours per day at cabinet-making, bricklaying or soldiering, and which people required, on a mixed, but chiefly vegetable, diet, less protein for the maintenance of their muscular systems. It should be carefully noted that on a diet consisting principally of animal food, because it is easier of absorption in the intestines, only about 108 grs. of protein are necessary. As Bowie ('Zeitschrift für Biologie,' Vol. 15, p. 459; L. 879) has submitted, a powerfully built man is not able to maintain nitrogen equilibrium on less than 118 grs. of protein.

"A soldier in barracks is in the same position as a moderate worker ; but during manœuvres and on active service he must be provided with the diet of a strenuous worker. Provision may thus be made for him :—

	Protein.	Fats.	Carbo-hyd.	Meat.	Bread.
In barracks . .	120	56	500	230	750
On manœuvres. .	135	80	500	258	750
On active service .	145	100	500	281	750

"An individual of the same age but of smaller bulk requires less protein for his maintenance ; but for reasons already given not less in proportion to what he lacks in weight, but quite disproportionately more."

Small people, therefore, require in proportion an especially generous supply of protein. We must remember this later on when speaking of the Japanese. I would also draw the reader's attention to the passages above italicised by me. We shall have opportunity later on to bring overwhelming proof that a moderate worker can maintain his musculature, etc., on far less than 118 grs. of protein. Consequently, this standard—according to Voit himself—must be too high. Voit plainly emphasises that the ideal is the minimum of protein which will maintain all the organs in perfect health and efficiency.

We must consider for a moment Bowie's evidence that a powerful man cannot maintain himself in equilibrium on less than 118 grs. of protein, for Voit recognises this argument as satisfactory evidence. Bowie* was Voit's pupil, in point of fact, and merely echoed his views, and of twenty-six pages of comprehensive apology the majority are devoted solely to repetitions of Voit's arguments. The only thing new is the report of three experiments in equilibrium, each of two days'

* Bowie, "Zeitschrift für Biologie," Vol. 15, p. 458.

duration, on three different men. Nos. 1 and 2 were both supplied with the same fare, which was composed of :

81·1 protein ; 69·5 fats and 230·5 carbo-hydrates.

Of this No. 1 decomposed 82 grs. protein and No. 2 decomposed 108 grs., in reference to which we may remark : firstly, that the total bulk of aliment was too small. Both the subjects complained of "gnawing hunger." In which circumstances it is self-evident that protein from the body itself was consumed. Secondly, No. 1 was accustomed otherwise to take 92 grs., and No. 2, 121 grs., of protein in their food. Thus, when the quantity supplied suffered a reduction, it is also obvious that in the first two days a minus balance showed itself (see above).

Subject No. 3 received

86·3 protein ; 108·9 fats and 331·4 carbo-hydrates,

and decomposed 96 grs. of protein. (The fæces were not examined ; but the quantity, as in the foregoing experiments, was set down at a guess as 2·3 grs. N. = 14·4 grs. protein.) But the experiment lasted only two days, and no information is vouchsafed concerning the man's previous consumption.

These experiments are, therefore, valueless. It is a matter for surprise that Voit and his pupils should care to make such experiments public. After which it is very refreshing to listen to Bowie's conclusion in the following grave words addressed to carping critics :—

"The domain of Science is free, and everybody must be allowed to express his opinion. But there are certain eventualities wherein one takes upon oneself an enhanced responsibility for one's utterances, and such a one presents itself when these are concerned with the application of the doctrine of Nutrition—in its present stage, at least. Upon the conclusion of several years' tedious experiments, Prof. Voit has succeeded, by the application of obtained results, in opening a path to the Science of Nutrition of men and animals. There is no doubt that we are here concerned with the most important questions in National Economy ; yet all our perseverance and energy is required in order to attract the attention of directors of prisons and hospitals, and of the military authorities to these revelations. Stubborn opposition will have to be encountered again and again, etc." . . . "Thus, it is very desirable that the present estimates of the food supply

necessary to human beings be shaken only by comprehensive argument based on extended experiment, and on definite statements as to the physical constitution, the work done, and other circumstances, etc."

These admonitory words appear to me to be quite applicable ; but they should have been aimed at Voit and not at his opponents. Inasmuch as Voit and his pupils did not carry out a single experiment with a moderate worker on less than 118 grs. of protein, which experiment was extended for any acceptable period of time, he could not have had the slightest notion to what extent such a high standard is necessary, and had in consequence, and in accordance with Bowie's exhortation, no manner of right to force his standard on the authorities.

In the same volume of the " Zeitschrift für Biologie " in which Bowie's apology appears there is included a treatise by Rubner,* in which he also defends the Voit standard. The effusion contains the following pearls :—

" Dr. Wernichs, in his geographical-medical studies on the Japanese, who live chiefly on rice, gives the following account : ' The Japanese have not the robust constitutions of the Chinese ; rather do they evince a physical debility which shows itself in their stunted growth, limited chest-circumference, and the meagre development of their musculature. For food they eat rice soaked in water, with a little fish now and then, and vegetables preserved in brine. The allowance of rice at any one of the three daily meals amounts to 470 grs. They suffer in consequence from chronic stomachic distension, and frequentiy from digestive disorders."

It certainly sounds strange at the present day to hear anyone speak of the " physical debility " of the Japanese.

I hope that the reader has clearly understood that, when confronted with the question : " What ought to be the daily allowance of protein if a human being is to continue to live in perfect health and vigour ? " no attention must be paid to Voit ; and I will, therefore, proceed to various other investigations which I have come across in studying this question.

* Rubner, " Ueber die Ausnützung einiger Nahrungsmittel im Darmkanale des Menschen " in " Zeitschrift für Biologie," Vol. 15, p. 197.

CHAPTER V

HIRSCHFELD'S EXPERIMENTS *

Dr. Hirschfeld experimented upon himself. He was 24 years of age, and weighed 73 kgs. (nearly 161 lbs.), had but lately served in the army, and was possessed of a powerfully developed musculature. He must, therefore, be regarded as somewhat exceeding the mean average.

His customary diet contained from 100 to 130 grs. of protein. He arranged two series of experiments; the first lasting 15, the second 20 days. The dietary consisted chiefly of rice, milk, butter, potatoes, pork, beer and sugar, with an insignificant portion of meat upon occasions. By way of example I give the bill of fare on two non-consecutive days. I have chosen from the first series the sixth day, when the quantity of protein food was highest, and the eighth day, when it was lowest :—

Sixth Day.

	Contents in Grs.			
Food.	Protein.	Fats.	Carbo-hyd.	Alcohol.
500 grs. Potatoes .	11·0	—	100	—
100 grs. Butter .	0·9	92	—	—
150 grs. Rice .	10·5	—	117	—
2½ litres Beer .	13·0	—	132	76
100 grs. Bacon .	3·0	75	—	—
20 grs. Meat .	4·0	—	—	—
100 grs. Milk .	4·0	4	4	—
20 grs. Coffee .	0·6	—	—	—
50 grs. Sugar .	—	—	50	—
Total .	47·0	171	403	76

On the same day 5·32 grs. nitrogen (33·25 grs. protein) were secreted per the urine.

* Hirschfeld, in Pflüger's "Archiv für die gesamte Physiologie," Vol. 41.

Eighth Day.

Food.	Contents in Grs. Protein.	Fats.	Carbo-hyd.	Alcohol.
500 grs. Potatoes	11	—	100	—
120 grs. Butter .	1·1	110	—	—
½ litre Beer .	2·5	—	30	15
⅗ litre Burgundy	—	—	6	48
130 grs. Rice .	9·1	—	101	—
20 grs. Coffee .	0·6	—	—	—
50 grs. Milk .	2·2	2	2	—
40 grs. Sugar .	—	—	40	—
Total .	26·5	112	279	63

On the same day 4·9 grs. nitrogen (30·6 grs. protein) were secreted per the urine.

Thus, on this eighth day there was, doubtless, a minus balance—which must have been increased if we take the fæces into account. But the comparatively large amount decomposed was because on the preceding day, the seventh, 39·4 grs. of protein were ingested. On the following day, the ninth, the amount decomposed declined to 24·5 (as a natural consequence of the small quantity in the food on the eighth day) although on the same day the intake was 34·75 grs. In this case, therefore, there was a considerable surplus. Here, then, is satisfactory evidence that one ought not to judge by the equilibrium on an individual day or on one or two individual days when the food quantities are not kept constant. The following figures show the total quantities of nitrogen in the food and in the urine for both periods:—

First Series.

	Nitrogen. In the Food.	In the Urine.
1st day . .	6·72	9·607
2nd ,, . .	7·15	7·469
3rd ,, . .	7·25	6·756
4th ,, . .	6·64	5·52
5th ,, . .	6·18	5·71
6th ,, . .	7·52	5·32
7th ,, . .	6·3	5·387

FIRST SERIES—*continued.*

	Nitrogen.	
	In the Food.	In the Urine.
8th day . .	4·4	4·9
9th ,, . .	5·56	3·92
10th ,, . .	5·44	4·41
11th ,, . .	6·2	6·048
12th ,, . .	5·3	4·984
13th ,, . .	6·5	5·723
14th ,, . .	6·0	5·18
15th ,, . .	5·93	4·636
Average 4th to 15th day .	6·0	5·14

Average daily contents of food over the whole period of 15 days: 38·31 grs. protein; 172·6 fats; 358·3 carbo-hydrates; and 74·2 alcohol = 3,750 large cal.

Average daily output per the urine for the last 12 days: 5·14 grs. nitrogen (32·12 grs. protein).

Total large cal. = 3,750.

SECOND SERIES.

	Nitrogen.	
	In the Food.	In the Urine.
1st day . .	6·3	—
2nd ,, . .	6·0	7·921
3rd ,, . .	6·1	6·804
4th ,, . .	6·9	5·569
5th ,, . .	5·9	4·704
6th ,, . .	5·3	3·763
7th ,, . .	5·0	4·704
8th ,, . .	6·8	5·497
9th ,, . .	6·8	5·594
10th ,, . .	6·2	5·286
Average from 4th to 10th day.	6·11	5·01

Average daily contents of food over whole period of 10 days: 38·3 protein; 173·9 fats; 398·5 carbo-hydrates and 72·5 alcohol

Average daily output per the urine for the last seven days: 5·01 grs. nitrogen (31·31 protein).

Total large cal. = 3,916.

Thus it is seen that the organism, after the second and third days, is probably brought into equilibrium, which is thereafter maintained. Upon a reduction of nitrogen in the food—as, for instance, on the eighth day of the first series—the nitrogen in the urine follows suit, especially on the succeeding day. Furthermore, if we take into consideration that about a third of the nitrogen in potatoes proceeds from amides (to say nothing of the nitrogen in caffeine), we arrive at the result that Hirschfeld, in all probability, katabolised not more than about 25 grs. of actual protein. And who can say but that that is the minimum ?

And did Hirschfeld keep physically fit while the experiments were proceeding ? It ought really to have made no difference, seeing that decomposition " regulates itself in accordance with muscular bulk and not with the amount of work performed." Yet Hirschfeld was not idle during that time. In the first period he practised weight-lifting regularly, with weights of 12 kgs. (26·46 lbs.) on the whole, for one hour daily. Furthermore, he took quick walking exercise of from two to three hours' duration ; he engaged also in mountaineering, climbing from 600 to 900 feet. Besides which, he devoted some six to seven hours per day in his laboratory. During the second series he undertook walking excursions among the mountains from 3 a.m. until 11 a.m. There was not the slightest decline in physical strength during these periods. Indeed, he noticed that he had gained in strength, especially in the arms. During the first period his weight decreased by about one pound ; but during the second there was no such loss.

The only fault which opponents could find with these experiments was that they were not definite enough. Several of the food-stuffs were not directly analysed, but were calculated by means of König's average figures. Neither was there any analysis of the fæces. But one year afterwards Hirschfeld repeated the experiments,* when definite analytical data were obtained in every detail. He arranged two distinct series, each of eight days' duration. From the four final days in each period we get the following :

* Virchow's "Archiv," Vol. 114, p. 310.

	Nitrogen in Food.	Nitrogen in Fæces.	Digested.	Nitrogen in Urine.	Balance.	Calories.
1st Series .	4·64	1·27	3·37	5·13	—1·76	2,739
2nd Series .	7·44	1·66	5·78	5·87	—0·09	3,628

In the latter instance nitrogen equilibrium is, practically, established on a protein intake of 46·5 grs. total and 36·7 grs. digested.

One cannot dispute that Hirschfeld has demonstrated *that protein decomposition per the urine can show a far lower return than had ever been suspected, and that a powerful man can maintain himself, in undiminished vigour, for a period of* 14 *days, at least, on a dietary consisting chiefly of potatoes, cereals and fats.*

It is strange, indeed, that Hirschfeld's investigations have been allowed by science to drift almost to oblivion. He was quite a young man who could make little impression against the weight of Voit's authority, and, moreover, it was objected that his experiments were of too short duration.

CHAPTER VI

THE JAPANESE

Experiments by Japanese Physicians

It is not to be denied that the Japanese, for a very long time past—some thousand years or so—have been experimenting with vegetable and cereal foods. And can they establish nitrogen equilibrium? And to what degree of muscularity do they attain?

We will examine first of all some self-experiments undertaken by two Japanese physicians on Japanese diet while they were on a visit at certain German laboratories.

Mori,* under Prof. *Kellner's* guidance, conducted experiments on himself, partly on mixed Japanese diet, and partly on purely vegetable Japanese diet. On the mixed diet, which contained about 109 grs. of protein, he was able to establish equilibrium; but on purely vegetable diet (two parts barley, and one part rice), which contained about 71 grs. of protein, he failed, losing about 8 grs. daily. Moreover, he could not manage to ingest more than 524 grs. of dry substance, while, as he writes, the Japanese are able to consume some 750 grs. Mori and Kellner reckoned that an adult Japanese must necessarily require 100 grs. of protein, and for this purpose must consume 900 grs. of dry substance; but Mori adds: "Such an amount of food is not consumed at the present day by the people of the lower classes." Hence Mori and Kellner came to the logical conclusion:—

> "The vegetable dietary, upon which the bulk of the Japanese people subsist, is insufficient for the maintenance of an effective organism."

Munco Kumagawa† also experimented on himself with Japanese diet. He began with two series on mixed diet,

* Kellner and Mori in "Zeitschrift für Biologie," Vol. 25.
† Munco Kumagawa, in Virchow's "Archiv," Vol. 116.

whereby he, as in Mori's case, was able to establish equilibrium. Then he tried the following dietary :—

450	grs.	Rice . .	circa	28	grs. Protein.
80	,,	Miso * . .	,,	9	,, ,,
250	,,	Rape-cole . .	,,	1·6	,, ,,
10	,,	Soy† . . .	,,	0·9	,, ,,
1,000	,,	Tea . . .	,,	4	,, ,,
		Total	,,	44·2	,, ,,

containing 7·08 grs. nitrogen.

On this diet 7·05 + 1·66 = 8·71 grs. of nitrogen were excreted per the urine and fæces, which represents a loss of 1·63 grs. of nitrogen. As this diet, meanwhile, contained only 2,010 large cal., Kumagawa tried it again for a period of nine days, but in the following increased quantities :—

600	grs.	Rice
100	,,	Miso
300	,,	Rape-cole
27·7	,,	Sugar
10	,,	Soy
594	,,	Beer
583·3	,,	Tea.

This dietary contained 54·7 grs. protein, which equals 8·76 grs. nitrogen; 6·06 + 2·03 = 8·09 grs. nitrogen were excreted per the urine and fæces. There was consequently a gain of 0·67 grs. nitrogen. The food had a fuel value of 2,587 large cals. Whereupon, Kumagawa writes :—

" I thus arrived at the unexpected result that, from an intake of 54·7 grs. protein, with a sufficiency of calories, I showed a plus balance, although only 42 grs. were actually absorbed."

* Kumagawa writes : " Miso is a thick dark-brown substance obtained, by slow fermentation, from the soy-bean (*soja hispida*), wheatmeal, rice, common salt and water."

† Soy is the well-known sauce made by mixing bruised soy-beans with roughly ground wheat, barley or rice, covered for twenty-four hours and allowed to ferment, salted, watered, stirred daily for two months, and then drawn off and filtered. Kumagawa says : " Both these preparations are to be found in every Japanese kitchen. Rice is never served plain. When it is properly prepared with miso and soy we find it very palatable."

His health was excellent, and the food, thanks to the miso and soy, appealed to his taste better than any other. Kumagawa severely criticises Kellner's and Mori's experiments. He writes that two parts barley and one part rice make a very wretched Japanese dietary, which could not be enjoyed without miso and soy. For which reason Mori ate no more than

53·63 Protein, 8·77 Fats, and 387·04 Carbo-hydrates,

which hardly gives a fuel value of 1,900 cal.; and thus it is quite natural that he should have lost protein. He reproaches Kellner and Mori that, on the strength of such experiments, they should proclaim, in the name of science, that the Japanese are insufficiently nourished. He protests that the facts contradict such a deduction. He says that: "*The people of the lower classes in Japan* * *are altogether of more powerful build than those of the upper classes, who eat meat.*"

As a supplement to the above, we may include the following remarks of Prof. Baeltz,† a keen observer, and one of the best authorities on the Japanese country and people ‡:—

"I had two jinrikisha-men; two powerful young fellows, one twenty-two, the other twenty-five, years of age. They had followed the same calling for years. I provided their food, which was exactly measured, what they ate, and what they drank; and the chemical composition of the food was ascertained by recognised means. These men received definite instructions:—Every day for three weeks they had to drag me, a man weighing 80 kgs. (176·4 lbs.), a distance of 40 kms. (24·84 miles), running all the time. That appears to be a fairly arduous task—but not more so than that which these men would have willingly undertaken. But for my purpose it was quite enough; for we considered a walking expedition of 40 kms. as something quite respectable; but for a man to run 40 kms. every day throughout a sunny August is rather more than one would usually expect of us.

"Now the men, during the experiment, kept to their usual diet,

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* Mori and Kumagawa, moreover, are not in agreement concerning some of the habits of the Japanese. Mori declares that the great bulk of the Japanese living in the interior eat no meat or fish at all. Kumagawa says that they eat fish either once or twice a week, or once or twice a month. On one point, however, they do not differ, and that is that fish plays a very unimportant part in Japanese diet.

† Baeltz was, for some years, body-physician to the late Mikado.

‡ Quoted by Dr. Albu in "Die vegetarische Diät." It should be observed that Dr. Albu writes against vegetarianism, but concedes that one may subsist on vegetarian diet, which is proved among other things by Baeltz's observations.

which contained fats amounting to less than half that proposed by Voit, while the contained protein fluctuated from between 60 to 80 per cent. of his postulate. Carbo-hydrates, on the other hand, were provided in exceedingly large quantities, in the form of rice and potatoes, barley, chestnuts, lily-roots and other foodstuffs peculiar to the country. After fourteen days I weighed the two men. One had not made any change, while the other had added half a pound to his weight. After the fourteenth day I told the men I wished to give them meat. They were delighted, for meat is a luxury to them. I therefore substituted for a part of the carbo-hydrates a proportionate quantity of protein—not quite so much as Voit demanded, but a considerable amount. The men ate it with avidity; *but after three days they came and asked me to discontinue the meat, and to give it them only upon the conclusion of their probation, because they felt so fatigued, and could not run so well as before.* (Italicised by myself, M. H.) Then, until the close of the experiment, I provided them with the original dietary, and the result was as before. The one retained his weight with perhaps a difference of 100 grs.; of the other an increase of about half a pound is to be recorded.

"I will tell you of even greater feats of endurance on similar diet. I am only relating that which I myself witnessed. On the road from Tokio to Nikko—the latter place lying amid mountains at a distance of 110 kms. (68·31 miles)—it took me, driving in a carriage with six changes of horses—making the journey by night, because, being in summer, it was so fearfully hot—from six o'clock in the evening until eight o'clock the following morning, which is fourteen hours in all. Just as we were driving out of Tokio, I saw a Japanese sitting in a jinrikisha, and asked him whither he was going. Nikko was, likewise, his destination. He was being pulled along by a man, and he arrived one half-hour after us. We had changed our horses six times, and yet this Japanese had dragged his compatriot, an adult, averaging about 54 kgs. in weight, over a distance of 110 kms. at a running pace in about fourteen and a half hours—and on vegetable diet only."

One might feel inclined to take an oath that the above could not be true; but the narrator must be a thoroughly trustworthy man, and one need but read a little more about the Japanese to be frequently confronted with similar incidents, until, finally, one feels obliged to give credence to these statements. Besides which, have we not, of late years, received such startling evidence of the almost incredible physical powers of the Japanese, that the "scientific critic" of their inadequate diet can now only be described by such a term as "comical"—or, better still, "tragi-comical"? It is doubtful whether in all Europe there is a man capable of performing tasks which an

ordinary Japanese jinrikisha man would regard as everyday affairs.*

From an issue of the *British Medical Journal*, 1904, p. 622, I reproduce the following :—

" As is well known, the Japanese are, physically, a small people, yet they are capable of remarkable feats of strength and endurance ; and, as recent events have once more shown, are full of courage and daring. The Japanese themselves attribute their high average of physical strength to a plain and frugal diet, and to a system of gymnastics called ju-jitsu, which includes a knowledge of anatomy and of the internal and external use of water. It is claimed that the average standard of health in Japan is much higher than that in China, though the Japanese are a much smaller race. In 1899 a commission was appointed to consider whether by a meat diet, or by other means, the stature of the race could be raised ; but the conclusion arrived at was that, seeing that their feats of strength and powers of endurance were superior to races much taller than themselves, the lowness of their stature did not matter. . . . By the copious ingestion of water, the action of the bowels and kidneys is stimulated, and it is worthy of note that rheumatism is almost unknown in Japan. It is probable that the absence of meat from the diet, combined with the use of plenty of water, accounts for this immunity. . . . In the matter of diet, they are frugal to a degree, rice being the staple food in every Japanese house and appearing at every meal. Japanese troops have often made record marches on diet consisting solely of a little rice. *Vegetables and fruit are grown in abundance, and their value as a regular part of diet is realised far more than in this country.* Indeed, a labourer is content to work a whole day on a dinner of tomatoes, cucumbers and salad. Salad is eaten cooked, as a cure for sleeplessness. Milk is scarce, because it does not pay to keep cattle to produce milk alone, and the meat is not eaten. Tea, poured out almost immediately after it is made, is taken without milk. Beer is drunk to some extent, but not in large quantities ; and though

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* There has been some disagreement concerning the way in which these jinrikisha men live. Oshima (U.S. Departm. of Agr. Office of Exp. Stat., Bull. No. 159, p. 75) tells of one who ate plentifully of animal food, content of digestible substances being : 137·1 grs. of protein, 21·8 grs. fat, 1,010·1 grs. carbo-hydrates, in all 5,050 cal.

But this man did not perform such heavy work as the men above mentioned. In four days he ran 30 + 10 + 5 + 15 miles, averaging fifteen miles a day, while Baeltz's two men ran about twenty-five miles daily for twenty-one consecutive days, and the third man mentioned by Baeltz ran sixty-eight miles in fourteen and a half hours. There would certainly be cause for reconsideration of the question if the first-mentioned meat-eating man had been capable of equal performance. Oshima's man was possibly degenerating under the influence of European habits. Oshima also tells us of a jinrikisha man who metabolised only about 70 grs. of digestible protein daily.

But the main question is not whether we can work on such great quantities of protein. The point is, can we work, and possibly work better, on small quantities of protein ?

spirits are imported, they are little cared for. Cigarettes are smoked in great moderation, pipes being preferred ; but their bowls are small and contain only a few pinches of tobacco, as Mr. Tree has been demonstrating recently to the British public."

As it no longer pays to quote the " physical debility " of the Japanese as an argument against vegetable food, its opponents have executed a complete *volte-face*, and now inform us that the Japanese eat quite as much meat as do the Europeans. But this is directly opposed to facts. If one is not satisfied with the above-given statements by Prof. Baeltz, Drs. Mori and Kumagawa, reference may be made to official Japanese returns. I have lying before me at the present moment the very latest annual statistics for Denmark and Japan—" Statistisk Aarbog, udgivet af Statens statistiske Bureau, Copenhagen, 1906 " ; and " Résumé statistique de l'empire du Japon, Tokio, 1905." Reference to these shows that according to the latest enumeration there were in Denmark and Japan the following numbers of :—

	Denmark, 1903.	Japan, 1902.
Cattle . . .	1,840,466	1,531,197
Pigs . . .	1,456,699	992,596
Sheep and Goats .	915,814	169,490

There are, thus, far more domestic animals in Denmark than in Japan. And when we take into consideration that there are only 2½ million inhabitants as against Japan's 46 millions we shall find that for every 1,000 inhabitants there are :—

	In Denmark.	In Japan.
Cattle	736	33
Pigs	538	22
Sheep and Goats . . .	367	3½

In the Japanese pavilion in the exhibition in Dresden there were some statistics concerning cattle for slaughtering in Japan. As yearly average from 1884—1908, 148,510 oxen were slaughtered in Japan.

If we suppose that each animal on an average yielded 400 lbs. of dressed meat, we have a total of sixty million lbs. of meat.

In Japan there are forty-six millions of people, which gives us 1⅓ lbs. of meat per individual per annum.

This computation corresponds very nearly with what Oshima says. He writes as follows (*ibid.*, p. 133) :—

" During the year 1900, the ascertained quantities of animal food per head of the population were as follows :—

Dressed meat	1·3 lbs.
Fresh fish	26·9 ,,
Dried fish	2·5 ,,
Imported meat and fish . . .	0·3 lb.

" With the fish is included a certain proportion of inedible material, *i.e.*, bones, etc., for which allowance would have to be made in estimating the actual amount of food material available. The figures will serve to indicate, however, what is perhaps the probable maximum consumption per head of the population, including children under fifteen years of age, and adults over sixty years of age. These figures are in striking contrast to those of other countries.

" Most, if not all, of the meat used in Japan is consumed by the well-to-do people in large cities. The greater part of the fish, also, is consumed by people in comfortable circumstances, especially in the coast regions. Methods of preserving fish are not yet highly developed ; moreover, among the rural population, the high price of fish prohibits its use.

" The rural population of the interior depends very largely, or almost entirely, upon vegetable diet. Fish is eaten, perhaps, once or twice a month, and meat once or twice a year, if at all. The poorer working classes in the cities, also, use very little animal food. But the poorer working classes in the cities and the peasantry of the rural districts comprise nearly 75 per cent. of the total population, and it is therefore safe to assume that this proportion lives chiefly or wholly upon vegetable diet. And this, it may be observed, literally means vegetarianism. The so-called lacto-vegetarianism is unknown in Japan. Cows are scarce, and milk and other dairy products are expensive, and such as are available are consumed almost entirely by the wealthier people in the cities."

And p. 129 :—

" It is sometimes remarked, that the *peasants in the rural districts of Japan, living largely on vegetable food, are really healthier and stronger* than people of the better classes, who live on a mixed diet, and the better physical condition of the former is commonly believed to be due to their diet. The comparison, however, is hardly a fair one, because the general conditions of living, other than diet, vary greatly among these classes."

We are not much disturbed by Oshima's argument, for it is

apparent that he is reluctant to criticise the European standard, in which he seems to believe. This is, if anything, an advantage, for all suspicion of inclination to overvalue vegetarian principles is removed. Oshima concludes as follows (p. 130) :—

" The vital question, however, is not whether persons can keep well and strong upon a vegetable diet, for such is abundantly proven by practice and by experiment ; but whether they cannot be equally as well, or perhaps much better, and more advantageously nourished on a mixed diet."

The sum of the matter is evident : the Japanese are practically vegetarians in the full sense of the term, and in spite of this " under-nutrition," going without meat and milk, they are quite able to hold their own with any of the " richly nourished " nations. The chief reason why the Japanese adopted a meat diet was because of the disease " beri-beri." The history of this movement is very interesting and instructive.

About 1880 beri-beri appeared as a veritable scourge in the Japanese navy, as will be seen from the following figures given at the exhibition in Dresden :—

1878–83, of 29,321 marines, 9,516, or 32·5 %, had beri-beri.

1884, 1885, 1886, 1887–89 of 48,275 marines, 718, 41, 3, 3 or 1·6 %, had beri-beri.

In 1884, it is evident, matters were improving; and what was the reason ? On January 1st, 1884, the regimental authorities began to provide the food for the soldiers, instead of giving each of them 15 sen (3*s*. 7*d*.) and later 18 sen (4*s*. 4*d*.) per day ; with this money the soldiers had to buy their food, the consequence being that most of them had been eating rice, which is the cheapest and easiest to prepare. Now when the regimental authorities provided the food, the bill of fare was quite luxurious with a content of 197 grs. of protein, 43 grs. of fat, and 775 grs. carbo-hydrates.

Three hundred grs. of meat and 50 grs. of fish a day ! When we come to think of the size of the Japanese, this is excessive hyper-nutrition. The desire was, evidently, to go one better than the European. Probably the soldiers could not eat such great quantities of food.

Later on, the bill of fare was changed, containing 140 grs. of protein, 24 grs. of fat, and 607 grs. of carbo-hydrates.

On this diet the daily rations per individual were, grs.: 375 rice, 131 barley, groats, 38 sugar, 11 beans, 8 wheat-flour, 74 soy, 4 tallow, 244 bread, 225 meat, 150 fish, and 450 vegetables.

Evidently, a most extravagant diet, rich in meat and vegetables.

BILL OF FARE.*

Breakfast.	Miso-soup with onions.
	Salted cabbage.
	Rice-barley-porridge.
Dinner.	244 grs. bread.
	22 ,, sugar.
	225 ,, meat.
	225 ,, potatoes.
Supper.	150 ,, fish with soy.
	225 ,, white turnips boiled with soy.
	Rice-barley-porridge.

The miraculous effect of the diet on beri-beri seems to show with almost mathematical certainty the wonderful effect of meat in combating the disease. The Japanese had no doubt at all about it.

But we must be very cautious in drawing conclusions, when there are many different factors to be taken into account.

The change in the diet was not restricted solely to the addition of meat to it. The quantity of rice was reduced by one-half or more, and barley-groats and bread substituted. Furthermore, besides cabbage, about one pound of potatoes and turnips were supplied. All these factors may have contributed to the ultimate result; but which of these was the most potent it is impossible to say.

The above rations were those provided while the men were in harbour or on shore. When at sea the diet was similar, with the exception that preserved provisions took the place of

* Exhibition in Dresden, 1911.

fresh meat and vegetables. Instead of salted cabbage at breakfast, turnips salted down with rice-bran were served.

It is very interesting to compare the experience of the Japanese with that of the Norwegians, which was the very reverse of that of the former. On Norwegian boats the disease was quite unknown on long voyages until 1894, but since that year it was frequently recurring. Curiously enough, it was in 1894 that the Norwegians "improved" the diet of their seamen as follows * :—

	Before 1894.	After 1894.
Bread . . .	Of bolted rye-flour.	White bread.
Peas and salted meat† .	Every day.	Once or twice a week.
Preserved meat and fish		Three or four times a week.
Dry fish . . .		Once a week.

Thus the Japanese add meat and fish to their diet and beri-beri disappears ; the Norwegians do the same and beri-beri appears. The only conclusion at which we can arrive is that *meat cannot have been the operating*, or the sole operating, factor in the checking of beri-beri in Japan.

The riddle is easy of explanation now that we know that the substances which hinder the development of beri-beri are found in the bran of cereals, in peas, beans, fresh meat, etc. ; that it is not protein which is the resisting agent is evident from the fact that these foods are ineffective against the disease if they are heated to 120° ; thus preserved meat has been found to be useless. The beneficial substances are soluble in water, in fact. Animals suffering from beri-beri while fed with pearled rice can be cured if they be given rice-bran, or a water extract of bran.

Thus it is not difficult to understand the contradictory state of affairs experienced by the Norwegians and the Japanese. In Norway they restricted the use of peas, and, instead of bread of bolted rye-flour containing a rather large amount of bran, they provided white bread. In Japan they restricted the use of

* Axel Holst, Paper read before the Society of Tropical Medicine and Hygiene, London, November 17th, 1911.

† Probably fat pork with only a little lean.

rice and gave bread. I am not sure as to what kind of bread it was, but it was probably not our fine white bread. Besides which, the food supplied while the men were on shore or in port—fresh meat, potatoes, turnips and cabbage—must certainly have been beneficial. Perhaps the soy had the best effect, being a water extract from beans and bruised grain. While at sea the preserved meat could perhaps have had no effect ; but the other factors were still partly operative, and a fresh factor was the salted bran, which must have been very effective.

It is curious to think that the Japanese would have been spared all these afflictions if they had never learned to pearl their rice, or if they had given their soldiers soup made with rice-bran.

With which I will close my discussion of the Japanese. They have been the means of furnishing us with abundant proof that *a race of people can maintain themselves for over a thousand years in truly wonderful physical and mental condition on very little protein, derived almost exclusively from vegetables.*

But here in Europe we have our " Japanese." A staggering blow has been dealt at the belief in the strength that can be derived from meat by the brilliant victories achieved by vegetarians in the more strenuous sporting contests.*

On June 26th, 1898, a Berlin Sports Club arranged a walking contest of 113 km. (over seventy miles). There were twenty-three contestants, of whom eight were vegetarians and fifteen meat-eaters. *The first six to arrive at the goal were vegetarians.* They came in almost on one another's heels, and were in splendid condition. Of the fifteen meat-eaters only one got home, and he was half an hour behind the winner. All the other meat-eaters had retired from the race. No. 1 was *Karl Mann,* an old vegetarian ; he covered the seventy odd miles in fourteen hours eleven minutes. He lived entirely on fruit, salad, milk and bread.

On June 18th, 1902, there was another walking match, and

* " Archiv für physikalisch-diätetische Therapie," 1902, p. 101 ; and Dr. Caspari, " Physiologische Studien über den Vegetarianismus," Bonn, 1905, p. 97.

this time between Dresden and Berlin. The course was 202 km. (125½ miles), and no time was allowed for a rest. There were thirty-two starters. Karl Mann was again the victor, in twenty-six hours fifty-eight minutes. No. 2 came in two hours later. *The first five to arrive were vegetarians.*

The last-mentioned race was strictly supervised, in every particular, by medical men, of whom *Dr. Caspari* was one. Dr. Caspari had two of the men under close observation during their training and also during the race. These two men were Karl Mann and another competitor who, I think, was of about the same age. The latter was a flesh-eater, and had to give up halfway through the race. It is interesting to observe how Dr. Caspari, who is not a vegetarian, tries to explain that the whole affair was a pure matter of luck!

CHAPTER VII

VARIOUS OTHER EXPERIMENTS AND INVESTIGATIONS

In order not to tire the reader too much, I will take these in condensed form. The results agree in every respect with those dealt with in foregoing chapters.

Klemperer * undertook experiments in metabolism with two vigorous young men as subjects, who for eight days received the following diet :—

33 grs. protein ; 264 grs. fats ; 470 grs. carbo-hydrates ; and 172 grs. alcohol—with a consequent fuel value of 5,200 cal.

Nitrogen equilibrium was established, and there was even a plus balance, although 19½ per cent. of the protein was non-digestible, so that equilibrium was obtained in reality on 26½ grs. of digestible protein, representing 4·24 grs. nitrogen.

I do not consider that this experiment ought to be advanced as proof, because of the large amount of alcohol used—172 grs. of alcohol represent about half a litre of spirits, calculated on a basis of 34 per cent. of pure alcohol. The subjects must have been partly intoxicated, and we do not know accurately what effect this had upon the normal metabolism.

Caspari † and *Glaessner* arranged experiments in metabolism, the subjects being a vegetarian married couple, of whom one had lived for eleven years, the other for three years, on vegetable food. The dietary during the experiment consisted of bread (cakes), potatoes, carrots, hazel-nuts, dates, sugar, linseed oil, and barley water. The quantities contained were :—

	Wife.	Husband.
Total protein . .	33·31 grs.	48·94 grs.
Digestible protein .	25·25 ,,	36·12 ,,
Calories . .	2,715	4,559

Both subjects established a decided equilibrium, therefore, at least, there was a balance on 25 to 36 grs. of protein.

* Klemperer, " Zeitschrift für klin. Medizin," Vol. 16.
† Caspari and Glaessner, " Biochem. Centralblatt," Vol. 2.

Landergren * made experiments with a diet in which there was a minimal quantity of protein. As all ordinary bread contained too much protein for his purpose, he baked special bread and cakes composed as follows :—

Bread : 100 parts wheat-meal ; 200 parts maize (0·05 per cent. nitrogen) ; 53 parts melted butter ; 15 parts yeast, and a little kümmel.

Containing 2·9—3·4 per cent. protein.

Cakes : 100 parts wheat-meal ; 300 parts maize ; 75 parts cane sugar ; 75 parts milk-sugar ; 150 parts melted butter, and a little yeast.

Containing 1·9—2·1 per cent. protein.

The subject was supplied with only these two kinds of bread, potatoes, coffee, beer, together with a cream prepared from raspberry juice, potato-meal and sugar. As he did not come down under 28 grs. protein on this diet, he lived for the last three days principally on the above-described cream and a little bread, whereby he was brought down to 5—6 grs. protein. I append the most important figures :—

	In the Food.			In Urine.	
	Nitrogen	= Protein.	Carbo-hydrates.	Nitrogen	= Protein.
1st day . .	5·63	35·2	507	12·16	76·4
2nd ,, . .	4·59	28·7	787	8·37	52·2
3rd ,, . .	4·61	28·8	841	5·02	31·4
4th ,, . .	4·53	28·3	839	4·50	28·1
5th ,, . .	0·86	5·4	898	4·01	25·1
6th ,, . .	0·96	6·0	931	3·36	21·0
7th ,, . .	0·90	5·6	908	3·34	20·9

It will be seen that, although the subject is not in equilibrium, the output of nitrogen in the fæces not being stated, it indicates that equilibrium might be established on about 21 grs. of digestible protein.

* Landergren, " Skand. Archiv für Physiologie," Vol. 14.

We pass on to Dr. Sivén's * experiments on himself during thirty-two consecutive days on the following five standard diets (the figures represent grams) :—

	I. 9 days.	II. 6 days.	III. 6 days.	IV. 4 days.	V. 7 days.
Bread . .	140	140	140	—	—
Butter . .	85	100	115	120	60
Potatoes .	150	200	300	600	200
Sugar . .	40	60	100	105	300
Milk . .	800	400	—	—	—
Cream . .	30	30	45	45	—
Rice . .	200	200	—	—	—
Apples . .	—	—	200	300	700
Tea . .	400	600	800	400	—
Coffee . .	200	200	300	500	—
Beer . .	330	330	330	330	—
Wine . .	—	—	—	—	400
Protein . .	66·69	54·44	39·12	28·25	15·19
Fats . .	117·1	115·8	113·1	116·0	5·12
Carbo-hydrates	256·3	267·7	284·1	290·3	398·8
Calories . .	2,505	2,486	2,477	2,444	2,441
Nitrogen balance	+6·56	+7·50	+2·80	+0·25	−5·44

As the quantity of protein continually decreases, one cannot reckon with the balance for the first days of each period. It is, therefore, calculated with the average for the last three days, with the exception of Period IV., where only the last day is taken into account. It is scarcely a matter for surprise that equilibrium could not be established on such a senseless diet as that of Period V., from which cereals (bread, groats) were entirely excluded, and the man received besides only one-fifth kg. of potatoes, and had to live on butter, sugar, apples and wine. The only thing remarkable is that the minus balance is so small.

Period IV. offers various points of interest. Here, bread and milk have been omitted, in order to reach a low protein level. The diet, apart from the almost innutritive beverages,

* Sivén, " Skand. Archiv für Physiologie," Vol. 10.

consisted only of butter (cream), potatoes, sugar and apples, which is such an abnormal combination that no man would adopt it in practice. But despite this artificial modicum of protein, no deficiency is discoverable. Equilibrium was established on the 28 grs. of protein. If the output 9·89 grs. be deducted, there remain but 18·56 grs. of "digestible" protein. If we take into consideration that the entire quantity of nitrogen in coffee and tea, two-thirds of it in beer, and about two-thirds in potatoes and apples, is not forthcoming in protein compounds, we arrive, according to Sivén's analysis, at the surprising result that of the 28·25 grs. there were only 14·37 of actual protein. And with these 14 grs. we would appear to be down somewhere about the minimum!

I would ask the reader to cast a glance at Period II., where it appears that a diet, consisting principally of such simple fare as bread, butter, potatoes, milk and rice-porridge, contains nearly double the necessary protein (in comparison with Period IV.).

Dr. Sivén remarks that he continued quite capable of exertion during this experiment, and did not perceive the slightest disturbance to his physical health. But on the monotonous diet of Periods IV. and V. he became more and more sensible of disgust. But such a diet, which entirely lacked our principal means of nourishment, bread, lies altogether beyond the domain of practice. It is interesting to note how nature seeks in this way to save herself while yet on the right side, and before things have been pushed to extremes.

That such a simple diet, as in Period III., consisting, in fact, of butter, bread and potatoes only, should have occasioned no inconvenience, either with regard to the health, the nitrogen equilibrium, or on the score of monotony, is worthy of the most careful consideration.

I will also mention that *Peschel** likewise experimented on himself, and showed that he was able to establish equilibrium on an output of 5·07 grs. of nitrogen in the urine.

Neither must the experiment of *Dr. Neumann*† be omitted.

* Peschel, "Untersuchungen über den Eiweissbedarf des gesunden Menschen," Berlin, 1891.

† "Archiv für Hygiene," Vol. 45, p. 1.

His daily allowance contained, on the average, 74·2 grs. protein; 117 grs. fats; 213 grs. carbo-hydrates; representing 2,367 calories; which amount of protein, in proportion to the foregoing experiments, is not very small, but it is 37 per cent. less than the old standard. These experiments acquire their importance from the fact that they were extended over long periods (two years).

Voit,* also, in his later years, undertook experiments with small quantities of protein. One subject, a vegetarian, showed that he could establish equilibrium on about 54 grs. of protein. In this case, one would think, Voit proved himself to be in the wrong; but actually concede so much he would not. He put his laboratory janitor upon the same vegetarian diet, which the man ate very unwillingly. The result was that the subject showed a minus balance—as was only natural, seeing that the experiment lasted only three days. Voit then contended that the vegetarian had eaten too much starch food and had thereby injured his digestive canal. The man ate :—

22 grs. fats and 557 grs. starches;

but as he weighed only 57 kg., Voit reckoned that the above quantities would work out for a man weighing 70 kg. at

27 grs. fats and 684 grs. starches.

Although something must be deducted from this, because of the limited quantity of protein, yet Voit maintained that such a large amount of starch food is injurious. He professed to have "firmly established" that a man cannot assimilate more than 500 grs. of starch.

It is really quite interesting and instructive to note what the old disputant has to say at this time—twenty to thirty years after his first investigations in the subject. To begin with, he makes a concession :—

"I am, however, willing to grant that, at the present day, a great deal more meat is consumed than is necessary, and that, as a result of earlier views, too high a value is placed on it. Vegetables ought to form the foundation of diet for healthy people, and only so much meat,

* Voit, "Zeitschrift für Biologie," Vol. 25.

supplying protein and fat, should be added to supplement the proper quantity of carbo-hydrates with the correctly proportionate amount of fats and protein."

This appears to be very promising ; but the fact is that Voit is palpably writing on the understanding that the correct quantity of protein is still 118 grs. He proceeds with a whole host of arguments against a plentiful provision of carbo-hydrates ; as, for instance, when he quotes a smith, who says " that he does not work so well on many potatoes," with more in like vein. He writes in conclusion :—

" Of yet more importance is the experience gained from such cases where—as, formerly, in Prussian prisons—limited quantities of protein, together with plenty of starch-meal, in a diet almost exclusively vegetarian (black bread, potatoes, legumes, cabbage and turnips) in the form of gruel, are supplied for an indefinite period. The majority of prisoners on long sentences fall ill in consequence, contracting catarrh of the stomach and intestines with dyspepsia, and dying of starvation, if not given other food. . . .

" I have frequently explained the importance of meat, and have pointed out that the addition of meat to a preponderatingly vegetable diet, does not chiefly concern itself with the increase of the protein supply, which could be accomplished by means of the legumes (beans, lentils, etc.), but to avoid the ill effects of a diet consisting for the greater part of poorly nourishing vegetables : thus, the full benefit is to be obtained from meat only when it conduces to less consumption of bulky and innutritious vegetables."

We shall have opportunity later on to show how fallacious are these arguments.

Rubner * also found that he could establish equilibrium on a potato diet with a very limited quantity of protein (about 52 grs. digestible crude protein—N × 6·25—or 35 grs. pure protein), but he did not venture to test the consequences in practice, although in his works much is said against the use of protein in large quantities.† But it would take up too much of our time to enter further into Rubner's elaborate experiments.

We will leave laboratory experiments for a while, and try to find out to what level of protein consumption, so far as has been observed, people have been able to descend on freely chosen

* E. von Leyden, " Handbuch der Ernährungstherapie," 1897, Vol. 1, p. 129.

† Rubner, " Die Gesetze des Energieverbrauchs," Leipzic, 1902, pp. 34 *et seq.*

diet. We have already given, in a note on p. 24, a column of figures which we will now supplement with a few other examples.

I would like to draw attention to some very interesting and valuable experiments which the "U.S.A. Department of Agriculture" has prosecuted for several years in order to determine clearly on what diet the various classes of the population in all the States live. The experiments were carried out in this way: assistants were sent to visit various casually selected families, the assistant remaining with the family for a fortnight as a daily guest. The food-stuffs were weighed by him, and he took samples for subsequent chemical analysis, etc. The families, meanwhile, were requested to continue to live during the fourteen days in the manner customary with them. No account was taken of the quantity consumed by each individual member of the family. The total consumption alone was noted, and the whole adjusted in proportion to the adult male according to the following scale:—

Male, adult	10
,, 14—17 years old	8
Female, adult	8
,, 14—17 years old	7
Child, 10—13 ,, ,,	6
,, 6—9 ,, ,,	5
,, 2—5 ,, ,,	4
,, under 2 years	3

In other words, two children of from six to nine years were reckoned as equal to one adult male, or five adult females as equal to four adult males, and so on.

From a whole series of these experiments I select only a few individual ones which have an especial interest for me. These are:—

Atwater's and *Wood's* inquiries concerning negroes in Alabama.* Twenty families were subjected to experiment, nearly all of them being tenants of rural plots. The character of the diet varied very much; the nearer the family to a town, the more

* Atwater and Wood, "Dietary Studies with reference to the Food of the Negroes in Alabama," U.S. Department of Agriculture, Bull. No. 38, Washington, 1896.

protein they consumed. From seven of the families, living farthest from any town, the following figures (in grams) for the adult male were obtained :—

	Protein.	Fats.	Carbo-hydrates.	Cal.	Nutritio ratio.
No. 1 .	31	27	304	1,625	1 : 11·8
,, 2 .	26	83	225	1,800	1 : 15·9
,, 3 .	33	99	214	1,935	1 : 13·3
,, 4 .	44	57	372	2,240	1 : 11·4
,, 5 .	35	60	389	2,295	1 : 15
,, 6 .	49	138	255	2,535	1 : 11·7
,, 7 .	49	119	362	2,790	1 : 12·9

Thus it will be seen that here, in the instances of those families on the lowest protein supply, we have probably descended as low as 20—25 grs. of digestible protein. We must also note how small is the total food quantity ; three of the families show less than 2,000 large calories. Note, furthermore, the astonishingly wide range of the nutritio-ratio.

One of the investigators, the well-known Prof. Atwater, now deceased, who superintended all these experiments, laid down, as a result of the mass of material collected, the following " Normal Standard for America " :—

	Protein.	Cal.	Nutritio ratio.
Woman, doing little muscular work .	90	2,400	1 : 6·5
,, ,, moderate ,, .	100	2,700	1 : 6·6
Man, not working	100	2,700	1 : 6·6
,, doing light muscular work .	112	3,000	1 : 6·5
,, ,, moderate ,, ,, .	125	3,500	1 : 6·8
,, ,, hard ,, ,, .	150	4,500	1 : 7·3

Atwater then compares the diet of the negroes with his standard, and naturally finds that they are " under-nourished." I find it interesting to note how little this " under-fed " condition of theirs—by about one-quarter in protein and one-half in calories—seems to affect them. They work in the season, man, woman and child, from dawn to sunset, taking only a short rest at midday. " They swing their great mattocks to the rhythm of some song or other." They appear to be

generally satisfied with their simple circumstances. Only in the neighbourhood of towns are the conditions changed; they are more pretentious, and their diet, as well as the proportion of contained protein, approach the normal. (Is this the influence of science?) The daily dietary of those negroes who live at a distance from the towns is thus described:—

"The daily fare is prepared in very simple ways. Corn meal is mixed with water, and baked on the flat surface of a hoe or griddle. The salt pork is sliced thin, and fried until very brown, and much of the fat fried out. Molasses from cane or sorghum is added to the fat, making what is known as 'sap,' which is eaten with the corn bread. Hot water, sweetened with molasses, is used as a beverage. This is the bill of fare of most of the cabins on the plantations of the 'black belt,' three times a day throughout the year."

The most remarkable point—so far as I am concerned, at least—is that the negroes are able to persist on this uniform diet. But the explanation may well be that the simpler the diet and the more it consists of carbo-hydrates, the longer is it before the monotony of it begins to pall. Beef steak with fried eggs would soon become insupportable if set before one three times a day, even if potatoes and bread were eaten as well.

*Jaffa's** investigations were undertaken in connection with fruitarians in California. We will here occupy ourselves with the case of a family of two adult women and three children of thirteen, nine and six years. With the exception of the children in babyhood, the family had lived for seven years on fruit alone, and had therefore acquired very little protein. We may remark that this case has the additional interest that it deals with children; and one would say that for the latter a generous supply of protein was of the utmost importance for the promotion of their physical growth.†

In these experiments, contrary to those just cited, individuals were taken separately. The members of this family ate twice daily. The first meal was at 10 o'clock in the morning; the second at five in the afternoon. The first consisted always of nuts and fruit; at the second, as a rule, no nuts were eaten with the fruit; but honey and olive oil instead. Variety was

* Jaffa, U.S. Department of Agriculture, Bull. No. 107, Washington, 1901.

† Voit, in Hermann's "Handbuch," Vol. 6, I., p. 532.

obtained by selection between five different kinds of nuts, together with fresh fruit (apples, apricots, bananas, figs, oranges, grapes, olives, peaches, pears, plums) and dried fruits (dates, raisins, etc.). A little celery and tomatoes were also eaten, and very rarely (by the thirteen-year-old girl) a little prepared cereal food.

It is added that the whole family were of short stature ; but this was a congenital defect with all of them, and one with which the fruit diet had nothing to do. The father as well as the mother (who was one of the adult women in question) and grandmother of the children were all of diminutive growth. The investigation produced the following results :—

	Weight.	Protein.	Cal.
1. Woman, 33 years . .	90 lbs.	33 grs.	1,300
2. ,, 30 ,, . .	104 ,,	25 ,,	1,040
3. Girl, 13 ,, . .	75½ ,,	26 ,,	1,235
4. Boy, 9 ,, . .	43 ,,	27 ,,	1,255
5. Girl, 6 ,, . .	30½ ,,	24 ,,	1,190

For comparison we include the American " Standard " for

	Protein.	Cal.
Woman doing light work . .	90 grs.	2,400
Child aged from 10—13 years .	90 ,,	2,450
,, ,, ,, 6—9 ,, .	65 ,,	1,750
,, ,, ,, 2—5 ,, .	50 ,,	1,420

The first glance will show how monstrously the family was " under-nourished ; " at the best, only one-third of the protein and one-half of the calories. Furthermore, although the individuals were undersized, the deficit, especially in protein, is too colossal. It may be recalled that, according to Voit, the difference between the amount of protein required by a small, and that by a big man, is not nearly so great as one would suppose. Nos. 4 and 5 come nearest the " Normal Standard " ; but these two children were comparatively over-fed during the period of experiment. The investigator states expressly that they ate more then than was usual with them, because the food, so long as the experiment lasted, was paid for by the State, and the children were, in consequence, allowed to eat, regardless of the expense, whatever fruit they liked best, which, otherwise,

the family would not have been able to afford. This circumstance showed itself plainly in their weights ; thus :—

No. 4 at commencement of experiment weighed 43 lbs. ; at close, 45 lbs.
„ 5 „ „ „ „ „ 30½ „ „ 33 „

A marked increase on " under-nourishment " in the course of fourteen days.

Several interesting little details were brought to light by these experiments on strict fruitarians—natural apes, we might call them. I will only select two for discussion here.

1. *The Cost.*—As a result of a great number of experiments promoted by the U.S. Government, it has been found that it costs an adult man, on an average, to live—that is, to eat—in America, 25 cents (1*s.* 0½*d.*) per day. But the cost of the fruit diet during the period of experiment, calculated for an adult man, worked out at 35 cents (1*s.* 5¾*d.*) per day. But, as already remarked, the expenses during the period of experiment were somewhat heavier than under normal conditions, although, on the other hand, the experiment took place at a time—in autumn—when fruit is cheap as a rule. Taking everything into account, the investigator came to the result that *it costs more to live on fruit alone* than on ordinary fare. And such was the case *even in that land of fruit, California.* Thus we may easily make up our minds that if we are ever to start playing at being apes in this country, we must be prepared to act as do real apes—that is, we must steal the fruit we require.

2. *Prof. Jaffa's Deductions.*—The investigator, who evidently is a firm adherent to the " Normal Standard," is obviously in a dilemma what to make of the results obtained. It is extremely diverting to examine the views expressed by him, for which purpose I will reproduce a sample of them. He writes * :—

" It is a difficult matter to draw any general conclusions from the foregoing dietaries without being unjust to the subjects. It would appear, upon examining the recorded data and comparing the results with commonly accepted standards, that all the subjects were decidedly under-nourished, even making allowances for their light weight. But

* U.S.A. Department of Agriculture, Bull. No. 107, p. 19.

when we consider that the two adults have lived upon this diet for seven years, and think they are in better health and capable of more work than they ever were before, we hesitate to pronounce judgment. The three children, though below the average in height and weight, had the appearance of health and strength. They ran and jumped, and played all day like ordinary healthy children, and were said to be unusually free from colds and other complaints common to childhood."

He concludes as follows :—

"The subject gained nitrogen, although on a diet containing much less nitrogen than the tentative standard demands. No extended comments can be made on these results, because, as before stated, there are few, if any, similar experiments at hand for comparison. Further investigation along this line is needed."

Prof. Jaffa's astonishment makes itself felt. How much nearer the point it would have been had he concluded : "The commonly accepted standard is altogether at fault." But to make such a confession would have been to throw down the gauntlet in the face of the combined scientific forces of England and America ; and Prof. Jaffa has neither the courage nor conviction to do that—and the same may be said of some of the other men above mentioned.

Thus far had I come by August, 1905, when I obtained possession of Prof. Chittenden's work (of that year) on experiments which he had conducted on twenty-six men. Those who read what is written above will understand that the intensely interesting results obtained by him did not surprise me ; yet I venture to say that they must have caused a great deal of astonishment on the part of scientific men.

CHAPTER VIII

PROFESSOR CHITTENDEN'S EXPERIMENTS

BEFORE we deal with these experiments we must spare a few words concerning the man to whom the credit is due that they were taken in hand. This gentleman was Mr. Horace Fletcher, the well-known American. But we will let him speak for himself * :—

" About ten years ago, at the critical age of forty-four, the writer was fast becoming a physical wreck in the midst of a business, club, and social tempest. Although he was trained as an athlete in his youth, and had lived an active and most agreeable life, he had contracted a degree of physical disorder that made him ineligible as an insurance risk. This unexpected disability, with such unmistakable warning, was so much a shock to his hopes of a long life, that it led to his making a strong personal effort to save himself. The study was taken up in systematic manner, account of which is too long to relate here ; but the eager auto-reformer soon learned that his troubles came from *too much* of many things, among them, too much food and too much needless worry ; and realising the danger ahead, he sought a way to cure himself of his disabilities by the help of an economic food supply, as did Luigi Cornaro ;† but what is even more important, he found a way to enjoy the smaller quantity of food much more than any plethoric luxury can give, and arrived at the method by a route that showed a means of conserving a healthy economy and an increased pleasure of eating, at the same time, in quite a simple and scientific manner, that anyone may learn and practise without any ascetic deprivation whatever. Cornaro buried the real clue to his economic and pleasurable success with his body, owing to his vague generality of description of his method. The writer is determined not to make the same mistake, and thereby bury *his* key to a happy and easy life."

As we cannot here reproduce the 400 odd pages that go to make up Mr. Fletcher's interesting book, we must content ourselves with explaining that the key in question is, briefly : *Eat sparingly, and chew well,* by extremely careful mastication, each bit of food being swallowed only when it is so

* Horace Fletcher, " The A.B.-Z. of our own Nutrition," London, Ewart, Seymour & Co., Burleigh St., Strand.

† An Italian philosopher, who lived over 300 years ago.

finely divided and so thoroughly mixed with the saliva that it slips down, so to speak, by itself. The taste veers round more and more until only simple and principally vegetable food is preferred.

Mr. Fletcher paid a visit to Prof. Chittenden of Yale University, at the latter's home in New Haven, U.S.A., when it was arranged that Prof. Chittenden should experiment with Mr. Fletcher as subject. Prof. Chittenden gives the following account of these experiments * :—

"In the autumn of 1902 and in the early part of 1903, Mr. Fletcher spent several months with the writer, thereby giving an opportunity for studying his habits of life. For a period of thirteen days in January he was under constant observation in the writer's laboratory, when it was found that the average daily amount of protein metabolised was 41·25 grs., his body-weight (75 kgs.) remaining practically constant. Later, a more thorough series of observations was made, involving a careful analysis of the daily diet, together with the analysis of the excreta. For a period of six days the daily diet averaged 44·9 grs. of protein, 38·0 grs. fat, 253 grs. of carbo-hydrate, the total fuel value amounting to only 1,606 large calories per day. The daily intake of nitrogen averaged 7·19 grs., while the daily output through the urine was 6·30 grs., and in the fæces 0·6 gr. ; *i.e.*, a daily intake of 7·19 grs. nitrogen, with a total output of 6·90 grs., showing a daily gain to the body of 0·29 gr. nitrogen, and this on a diet containing less than half the proteid required by the Voit standard, and having only half the fuel value of the Voit diet. Further, it was found by careful and thorough tests made at the Yale gymnasium, that Mr. Fletcher, in spite of this comparatively low ration, was in prime physical condition. In the words of Dr. Anderson, the director of the gymnasium : 'The case is unusual, and I am surprised that Mr. Fletcher can do the work of trained athletes and not give marked evidences of over-exertion. . . . Mr. Fletcher performs this work with greater ease and with fewer noticeable bad results than any man of his age and condition I have ever worked with.' It is not our purpose here to discuss how far these results are due to insalivation, or the more thorough mastication of food. The main point for us is that we have here a striking illustration of the establishment of nitrogen equilibrium on a low protein diet, and great physiological economy as shown by the low fuel value of the food consumed, coupled with remarkable physical strength and endurance."

In November, 1902, Prof. Chittenden began to experiment upon himself. At that time he weighed 65 kgs., was nearly 47 years of age, and, as he writes,†

* *The Popular Science Monthly*, New York, 1903, p. 128.
† Chittenden, "Physiological Economy in Nutrition," New York, 1905.

" Accustomed to eating daily an amount of food approximately equal to the so-called dietary standards. Recognising that the habits of a lifetime should not be too suddenly changed, a gradual reduction was made in the amount of protein or albuminous food taken each day. In the writer's case, this resulted in the course of a month or two in the complete abolition of breakfast, except for a small cup of coffee. A light lunch was taken at 1.30 p.m., followed by a heavier dinner at 6.30 p.m. Occasionally, however, the heartier meal was taken at noontime, as the appetite suggested. It should be added that the total intake of food was gradually diminished, as well as the protein constituents. There was no change, however, to a vegetable diet, but a simple introduction of physiological economy. Still, there was, and is now, a distinct tendency towards the exclusion of meat in some measure, the appetite not calling for this form of food in the same degree as formerly. At first, this change to a smaller amount of food daily was attended with some discomfort, but this soon passed away, and the writer's interest in the subject was augmented by the discovery that he was unquestionably in improved physical condition. A rheumatic trouble in the knee-joint, which had persisted for a year and a half, and which only partially responded to treatment, entirely disappeared (and has never since recurred). Minor troubles, such as ' sick-headaches ' and bilious attacks, no longer appeared periodically as before. There was greater appreciation of such food as was eaten ; a keener appetite and a more acute taste seemed to be developed, with a more thorough liking for simple foods. By June, 1903, the body-weight had fallen to 58 kilos.

" During the summer the same simple diet was persisted in—a small cup of coffee for breakfast, a fairly substantial dinner at mid-day, and a light supper at night. Two months were spent in Maine at an inland fishing resort, and during a part of this time a guide was dispensed with and the boat rowed by the writer frequently six to ten miles in the forenoon, sometimes against head winds (without breakfast), and with much greater freedom from fatigue and muscular soreness than in previous years on a fuller dietary."

On Prof. Chittenden's return home his weight was 57½ kgs. From July 1st it had remained constant at this point, at which it would seem that the body had itself found equilibrium. In order to determine the nitrogen equilibrium he collected each day's output of urine from October 13th, 1903, to June 28th, 1904—eight and a half months in all. The urine was analysed every day and the contained amounts of nitrogen, uric acid, phosphoric acid, etc., determined. A table, which occupies seven pages of Mr. Chittenden's book, gives the result for each day. The daily average was as follows (the figures represent grs.) :—

	Volume Urine.	Nitro-gen.	Uric Acid.	Phosph Acid.
From 13/10, 1903, to 12/3, 1904 .	468	5·69	0·392	0·904
From 13/4, 1904, to 27/6, 1904 .		5·40		

Attention is directed to the small volume of urine, which was fairly constant for the whole period. Prof. Chittenden offers the explanation that the probable cause is that on a low intake of protein there is less thirst and less desire to drink. Prof. Chittenden proceeds :—

"Further, in view of the small nitrogenous waste there is no need on the part of the body for any large amount of fluid to flush out the kidneys. The writer has not had a turbid urine during the nine months period. With heavier eating of nitrogenous foods, an abundant water supply is a necessity to prevent the kidneys from becoming clogged, thereby explaining the frequent beneficial results of the copious libations of mineral waters, spring waters, etc., frequently called for after, or with, heavy eating. Obviously, a small volume of urine each day means so much less wear and tear of the delicate mechanism of the kidneys."

Very remarkable is the low nitrogen output, 5·69 grs. = 35·56 grs. protein decomposed ; in the last two and a half months it is as low as 5·40 grs. nitrogen = 33·75 grs. protein. This is less than one-third of the Voit standard. But was the body in nitrogen equilibrium ? Prof. Chittenden affirms that there could be little doubt that it was, as the body-weight (57½ kgs.) was constant during the whole period. As for myself, I should lay as much stress on the fact that all the time the health was in excellent condition.

But to make sure on this point, two carefully conducted experiments were arranged ; the first lasting from March 20th to the 25th (six days), the second from June 23rd to the 27th (five days). To give the reader some idea of Prof. Chittenden's dietary I will give the bill of fare for each day of the second period.

THURSDAY, JUNE 23RD, 1904.

Breakfast :—Coffee, 123 grs. ; cream, 50 grs. ; sugar, 11 grs.
Lunch :—Omelette, 50 grs. ; French fried potatoes, 70 grs. ; bacon, 10 grs. ; wheat gems, 43 grs. ; butter, 9 grs. ; strawberries, 125 grs. ; sugar, 20 grs. ; cream cake, 59 grs.
Dinner :—Beefsteak, 34 grs. ; peas, 60 grs. ; creamed potato, 97 grs. ; bread, 26 grs. ; butter, 17 grs. ; lettuce-orange salad, 153 grs. ;

crackers, 43 grs. ; cream cheese, 15 grs. ; coffee, 53 grs. ; sugar, 12 grs.

Total nitrogen in food .. .. .. 6,622 grs.
Total nitrogen in urine .. .. .. 5,260 ,,
1,863 cal.

FRIDAY, JUNE 24TH.

Breakfast :—Coffee, 96 grs. ; sugar, 8 grs. ; milk, 32 grs.
Lunch :—Creamed codfish, 89 grs. ; baked potato, 95 grs. ; butter, 10 grs. ; hominy gems, 58 grs. ; strawberries, 86 grs. ; sugar, 26 grs. ; ginger snaps, 47 grs.
Dinner :—Cold tongue, 14 grs. ; fried potato, 48 grs. ; peas, 60 grs. ; wheat gems, 30 grs. ; butter, 11 grs. ; lettuce-orange salad with mayonnaise, 155 grs. ; crackers, 22 grs. ; cream cheese, 14 grs. ; ginger snaps, 22 grs. ; coffee, 58 grs. ; sugar, 10 grs.

Total nitrogen in food .. .. .. 6,331 grs.
Total nitrogen in urine .. .. .. 5,300 ,,
1,506 cal.

SATURDAY, JUNE 25TH.

Breakfast :—Coffee, 101 grs. ; milk, 36 grs. ; sugar, 13 grs.
Lunch :—Omelette, 50 grs. ; bacon, 9 grs. ; French fried potato, 23 grs. ; biscuit, 29 grs. ; butter, 8 grs. ; cream cheese, 17 grs. ; iced tea, 150 grs. ; sugar, 15 grs. ; ginger snaps, 42 grs.
Dinner :—Wheat popovers, 57 grs. ; butter, 10 grs. ; lettuce-orange salad with mayonnaise dressing, 147 grs. ; cream cheese, 21 grs. ; crackers, 22 grs. ; cottage pudding, 82 grs. ; coffee, 48 grs. ; sugar, 11 grs.

Total nitrogen in food . . . 4·491 grs.
Total nitrogen in urine . . . 4·430 ,,
1,392 cal.

SUNDAY, JUNE 26TH.

Breakfast :—Coffee, 122 grs. ; cream, 31 grs. ; sugar, 8 grs.
Dinner :—Roast lamb, 50 grs. ; baked potatoes, 52 grs. ; peas, 64 grs. ; biscuit, 32 grs. ; butter, 12 grs. ; lettuce salad, 43 grs. ; cream cheese, 21 grs. ; toasted crackers, 23 grs. ; blancmange, 164 grs.
Supper :—Iced tea, 225 grs. ; sugar, 29 grs. ; lettuce sandwich, 51 grs. ; strawberries, 130 grs. ; sugar, 22 grs. ; cream, 40 grs. ; sponge cake, 31 grs.

Total nitrogen in food . . . 5·922 grs.
Total nitrogen in urine . . . 4·660 ,,
1,533 cal.

MONDAY, JUNE 27TH.

Breakfast.—Coffee, 112 grs.; cream, 22 grs.; sugar, 10 grs.

Lunch.—Roast lamb, 9 grs.; baked potato, 90 grs.; wheat gems, 47 grs.; butter, 12 grs.; sugar, 25 grs.; iced tea, 250 grs.; vanilla éclair, 47 grs.

Dinner.—Lamb chop, 32 grs.; asparagus, 49 grs.; butter, 17 grs.; creamed potato, 107 grs.; bread, 35 grs.; lettuce-orange salad with mayonnaise, 150 grs.; cream cheese, 12 grs.; crackers, 21 grs.; coffee, 63 grs.; sugar, 9 grs.

Total nitrogen in food . . .	5·486 grs.
Total nitrogen in urine . . .	4·980 ,,

1,454 cal.

I will draw up Prof. Chittenden's nitrogen balance for both periods. (The dietary for the first is not reproduced, as it was very similar to that above given.)

	Nitrogen in Food.	Nitrogen in Urine.	Nitrogen in Fæces.	Balance.
Period I. 1,613 cal. .	6·40	5·77	0·79	+0·17
Period II. 1,549 ,, .	5·68	4·93	1·06	−0·07

6·40 grs. nitrogen corresponds to 40 grs. protein.

Thus, we have equilibrium on one-third protein and one-half the calories, as demanded by the Voit standard. I will subjoin a few of Prof. Chittenden's observations concerning this balance.

"Health, strength, mental and physical vigour, have been maintained unimpaired, and there is a growing conviction that in many ways there is a distinct improvement in both the physical and mental condition. Greater freedom from fatigue, greater aptitude for work, greater freedom from minor ailments, have gradually become associated in the writer's mind with this lowered protein metabolism and general condition of physiological economy. The writer, however, is fully alive to the necessity of caution in the acceptance of one's feelings as a measure of physical or mental condition, but he has been keenly watchful for any and every sign or symptom during the course of these experiments, and is now strongly of the opinion that there is much good to be gained in the adoption of dietetic habits that accord more closely with the true physiological needs of the body. If a man of 57 kgs. body weight can maintain a condition of equilibrium with continuance of health, strength, and vigour (to say nothing of possible improvement), with a daily consumption of, say, 40 grs. of protein food, and sufficient non-nitrogenous food to yield 2,000 calories, why should he load up his system each day with three times this amount of protein food, with enough fats and carbo-hydrates to yield 3,000 plus calories?

" Finally, the writer, in summing up his own experience, is inclined to say, that while he entered upon this experiment simply with a view to studying this question from a purely scientific and physiological standpoint, he has become so deeply impressed with the great gain to the body by this practice of physiological economy, and his system has become so accustomed to the new level of nutrition, that there is no desire to return to the more liberal dietetic habits of former years."

I find it extremely gratifying that Prof. Chittenden should say exactly what I myself have been preaching for many years to my colleagues and all others who would listen to me. I also have experienced that same feeling of buoyancy and eager interest in work of which Mr. Chittenden writes. As regards the calories, I have never shown so low a record as Mr. Chittenden; but I will deal with this point in a later chapter.

It is far more convincing, especially as Prof. Chittenden was formerly a believer in high protein, and, particularly, in meat. At the Pratt Institute in Brooklyn he lectured before the students on " The value of meat as food "; from which lecture I quote the following: *

" Understanding now that the main function of proteid foods is to supply the nitrogen needed by the body, we may ask: What advantages do meats possess as a source of this nitrogen ? In answer, we may reply, that they represent a concentrated form of proteid food, their nitrogen is readily available, they are easily digestible, they have an agreeable flavour, they add variety to our diet, they contain extractives which have an exhilarating and stimulating effect, they satisfy the pangs of hunger more completely and for a longer period than the vegetable proteids.

" The suprarenal is one of those glands that until recently have been considered as devoid of any very marked physiological action, but as we now know, there is formed in the medulla of that gland something which has a striking physiological effect upon the muscular system generally, and especially upon that of the heart and arteries. Its action is to increase the tone of all muscular tissue, and this result is produced mainly, if not entirely, by direct action. This action can be demonstrated in a negative way, by simply removing the suprarenal capsules from an animal, when there is produced extreme weakness of the heart and of the muscular system generally, and great want of tone in the vascular system. Hence, it would appear that at least one of the functions of the suprarenal capsules is to produce a material which is added in some way to blood, and the effect of which is to assist, by its direct action upon the various kinds of muscular tissue,

* From a manuscript given to me by Mr. Horace Fletcher.

in maintaining that amount of tonic contraction which appears to be essential to the physiological activity of the tissue. It must also be remembered that there are other so-called ductless glands in the animal body, such as the thyroid, which undoubtedly also manufacture certain products which find their way ultimately into the blood, and traces of these may likewise be present probably in the muscular tissue, and hence become components of the 'meat.'

"These statements may be taken as an illustration of a principle which I believe worthy of some consideration, viz., that in satisfying the needs of the body for proteid foods with meats, we derive certain advantages other than those associated simply with the proteid matter itself. Various extractives, active principles, etc., all endowed with more or less physiological properties, are likewise ingested as a part of the meat, and add their effects perhaps to aid in keeping up the tone and utility of the organism. . . .

"The hard-working labourer is the man who above all others needs the full complement of proteid food, and he is adding to his own strength and prosperity, as well as of his children's, when he is able to provide his family with a reasonable amount of animal proteid. . . .

"In conclusion, allow me to say that, in my judgment, meats occupy a somewhat peculiar place in our category of dietetic articles. A close examination of the dietetic custom of civilized people shows that two distinct objects are ever kept clearly in view, viz., the satisfying of the grosser needs of the body, the needs of general nutrition, and satisfying the needs of the higher functions of the central nervous system. Now meats plainly share with vegetables, fruits, dairy products, etc., the ability to minister to the former wants of the body, but in addition they have certain stimulating properties which distinguish them from the grosser vegetable foods. In this respect they might almost be classed, perhaps, with such articles as tea, coffee, etc., in their power of ministering to the wants of the brain and nerves. As Sir William Roberts well says: 'The struggles for existence, or rather, for a higher and better existence among civilised men, is almost exclusively a brain-struggle, and these brain-foods, as they have been not inappropriately termed, must be regarded as a very important part of the equipment for that struggle. . . . If we compare as best we may, with our limited information, the general characteristics of the high-fed and the low-fed classes and races, there is, I think, to be perceived, a broad distinction between them. In regard to bodily strength and longevity, the difference is inconsiderable, but, in regard to mental qualities, the distinction is marked. The high-fed classes and races display on the whole a richer vitality, more momentum and individuality of character, and a greater brain power, than their low-fed brethren, and they constitute the soil or breeding ground out of which eminent men chiefly arise.'"

Prof. Chittenden mentioned further that a horse-breeder knows by experience that race-horses require plenty of oats,

while the dray-horses need only corn and hay. He concluded as follows :—

"So with mankind the nature and quality of the nutriment, aside from its containing the one proportion of the several requisite elements, exert a specific influence upon the character of the mind and body, and meats may be fairly placed in the front rank of foods as giving important aid toward that higher physical and mental development which belongs to the civilization of the nineteenth century."

I suppose that there is scarcely any meat believer at the present time who could speak more ably and more persuasively concerning "The value of meat as food." Reading these arguments, it is difficult to refute them. But fortunately, there is no need to do it; for Prof. Chittenden has done that himself, and in the best possible manner. To say so is to utter no reproach against the learned Professor. To the contrary, Prof. Chittenden is great enough to recognise and admit his mistake. Small men do not act in such wise.

But this should be a lesson to all who stand for authority and teach nutrition rules to try both sides of the question personally before uttering their authority. I have never known a researcher to try living on a low protein diet in a proper manner who has not confirmed my own conclusions.

Besides the above experiments, Prof. Chittenden enlisted the help of others in the university, some of whom volunteered to undergo similar tests. These men were Prof. Lafayette Mendel, Dr. Frank Underhill, Dr. Arthur Dean, and Mr. George Beers, Clerk. Prof. Chittenden gives the following average results for the five men :—

	Age.	Weight (Kg.) Begn.	At End.	Date.	Av. Nitrogen in Urine.
Chittenden	48	57·5	57·4	13 Oct. to 27 June	5·69
Mendel .	32	76·2	70·0	10 Nov. to 23 June	6·53
Underhill .	26	67·6	65·2	26 Oct. to 23 June	7·43
Dean .	25	63·2	65·0	28 Oct. to 3 April	8·99
Beers .	38	61·1	61·5	8 Oct. to 15 June	8·58

For shorter periods of from four to seven days carefully calculated nitrogen-balance tests were made. The following figures show the daily averages :—

	Nitrogen in Food.	Urine	Fæces.	Balance.	Cal
Chittenden I. . .	6·40	5·44	0·79	+ 0·17	1,513
,, II. . .	5·68	4·93	1·00	— 0·07	1,549
Mendel I. . .	7·79	7·50	1·47	— 1·18	1,975
,, II. . .	8·19	6·31	1·50	+ 0·38	2,448
Underhill I. . .	8·84	7·56	1·12	+ 0·16	2,068
,, II. . .	6·76	6·46	0·74	— 0·44	1,785
Dean . . .	8·83	8·77	1·42	— 1·36	2,529
Beers . . .	8·85	8·51	1·29	— 0·95	2,168

Furthermore, Prof. Chittenden made experiments with eleven soldiers for five months. They had previously lived, as do other soldiers, on meat and other rations containing a high content of protein ; but during the experiments they were allowed only about so much nitrogenous food as that received by the professional men. Herewith the averages for all the eleven men together, from November 1st to April 1st :—

Average age of men, twenty-six ; weight, at beginning, 62·2, at close 61·3 kgs. ; average nitrogen in urine, 7·80 grs.

The balance tests show :—

	Nitrogen in Food.	Urine.	Fæces	Balance	Cal.
Period I. . .	8·13	7·70	1·41	— 0·97	2,078
,, II. . .	9·52	7·20	1·62	+ 0·70	2,500
,, III. . .	8·64	7·01	1·92	— 0·29	2,840

The soldiers were given gymnastic work for an hour daily under Dr. Anderson, of Yale Gymnasium, and another hour of physical exercise. Strength tests were taken at the beginning and at the end of the experiments, and it was shown that the average strength increase was 83 per cent., but, of course, the training had something to do with this improvement.

Similar experiments were tried on eight students, six of them continuing for the whole period of five months, from January 15th to June 15th, 1904. They were selected from those gymnasts and athletes who were at the time among the most prominent men in their particular spheres.

The following table gives the age, the weight at commencement and end of the experiment, the nitrogen output per the urine for the first day, and the average output per day

from February 1st to April 12th, and from April 13th to June 15th.

	Age.	Weight. At beginning.	Weight. At end.	Nitrogen in Urine May 1.	Nitrogen in Urine Feb. 1 to April 12.	Nitrogen in Urine April 13 to June 15.
G. W. Anderson .	27	75·0	70·9	18·02	9·94	8·81
W. L. Anderson .	22	63·1	60·0	16·44	10·78	10·05
Donahue . . .	25	64·5	62·2	17·46	7·55	7·39
Jakobus . . .	22	57·3	57·0	10·70	7·44	7·43
Schenker . . .	22	73·5	71·9	16·21	10·37	9·82
Stapleton . . .	24	77·2	73·4	16·20	13·12	9·00
Average . .	24	68·4	66·1	15·84	9·92	8·75

The balance tests show (May 18th—May 24th) :—

	Food.	Nitrogen in Urine.	Fæces.	Balance.	Cal.
G. W. Anderson .	11·55	8·22	1·62	+ 1·71	3,091
W. L. Anderson .	8·78	8·48	1·55	− 1·25	2,494
Donahue . .	8·84	7·58	1·17	+ 0·62	2·450
Jakobus . . .	9·66	7·02	1·36	+ 1·28	2·542
Schenker . .	10·95	9·64	1·80	− 0·48	2,486
Stapleton . .	11·47	9·15	1·99	+ 0·34	2,809
Average .	10·21	8·35	1·58	+ 0·28	2,648

Strength tests showed that the average improvement of these men, although in the "pink of condition" and in active training, at the beginning of the experiment, was more than 31 per cent. at the end of the five months.

CHAPTER IX

CRITICAL REMARKS ON THE FOREGOING EXPERIMENTS

If we wish to determine the necessary amount of protein and calories we must, first of all, decide the age and weight of our standard adult man. For our purpose we propose that his age be between the twenties and thirties, and his weight 70 kg., or roughly, 154 lbs. = 11 stone.

Now, in pursuance of our quest, if we turn to the Chittenden reports we may take those concerning the soldiers and students, all of which men, with one single exception, are within the age selected.

We will select only those periods which show a plus balance, and, striking the average, we get the following :—

Soldiers	(Average weight, 61·3 kg.)	Nitrogen, 7·20 grs.	Cal. 2,500
Students	(,, 66·1 kg.)	,, 8·35 grs.	Cal. 2,448

which, if we bring the same into proportion to our man of 70 kg., gives us :—

Soldiers, 70 kg.	Nitrogen, 8·22 grs.	Calories, 2,804
Students, 70 kg.	,, 8·84 grs.	,, 2,804

The difference between the figures being very slight, we may see that it is possible to get nitrogen equilibrium on 8 to 9 grs. output of nitrogen in the urine, representing 50 to 55 grs. of digestible protein in the food ; and there is no doubt that it can be done, although I am not so sure about the 2,800 calories.

The question now arises as to how much work those soldiers and students performed during the experiments.

Firstly, as Prof. Chittenden himself has stated, and as I have been informed by *Mr. Horace Fletcher*, the soldiers were not regular soldiers of the line. They were volunteers from the Hospital Corps of the United States Army, and were by no means well chosen. Some of the nineteen men who formed the original squad deserted at the first opportunity, and it

was suspected that they volunteered for the test only in the hope that it afforded them a better chance to desert. Those who remained chafed under the irksome, but necessary, restraint, and evinced much discontent at times; but the effect of the dietary and the discipline was in the direction of less and less dissatisfaction, until finally, some time afterwards, the entire thirteen who had completed the experiment, volunteered unanimously to serve in yet another.

Beyond daily exercise—one hour in the gymnasium and one hour in the open air—it does not appear that they were particularly active, expending less energy than does a man engaged in some ordinary occupation. The students were very capable athletes, no doubt, but nothing is stated as to the amount of exercise they underwent at the time.

Although Prof. Chittenden's reports are exceptional and of very great value, they lack certain details which, if present, would have made the results much more convincing. The most important of these is that the intake of food during the whole period is not stated; but only the intake during the shorter periods of from five to seven days.

To judge from my own experience in conducting similar experiments, I should think that it would have caused little inconvenience to have kept accurate account of the total amount of the food provided and to have deducted the quantity left unconsumed. Considering the labour which the whole business must have entailed, surely a little additional trouble could have been spared to obtain figures which could only enhance the practical value of the results.

Having given us details only of some of the shorter periods, Prof. Chittenden has left himself exposed to the attacks of critics, who may urge that there is no possibility of telling whether the test-subjects ate the same quantities of food throughout the experiment as they did during the shorter periods. Psychical influences could, also, quite subconsciously, have asserted themselves. Undoubtedly, the subjects were aware that the aim of the tests was to prove that they did not really require so much food as they were accustomed to take, or as the army regulations allowed them. How easy, then, would it have been for them to have assisted or opposed the

intention of the experiment as their different moods happened to dictate.

Our suspicions increase when we consider the great variation in the quantities of foods consumed from day to day during the balance periods. Taking the students, for example, we have the following :—

	Calorie variation. Actual.	Calorie variation proportioned to 70 kgs. Standard.
G. W. Anderson .	2,826 to 3,429	2,790 to 3,385
W. L. Anderson .	1,748 ,, 3,013	2,007 ,, 3,459
Donahue . .	1,911 ,, 2,781	2,150 ,, 3,129
Jakobus . .	2,041 ,, 2,914	2,506 ,, 3,578
Schenker . .	1,900 ,, 3,100	1,850 ,, 3,018
Stapleton . .	2,072 ,, 3,442	1,976 ,, 3,283
Average .	2,083 ,, 3,113	2,213 ,, 3,309

When it is seen that the students ate 50 per cent. more on the one day than on another, does it not suggest that the conditions were not always quite normal ? One is constrained to think that there were days when they ate very sparingly, in which event the average can serve us as no safe guide to our standard.

There are details in the other experiments which point in the same direction of doubt ; but it is useless to argue further on mere suppositions. I will say only that from Chittenden's experiments we cannot deduce anything definite as to the calorie requirements for optimum efficiency. Furthermore, I am not convinced that the diet can be reduced quite as much as Messrs. Fletcher and Chittenden claim. For which reasons further experiments are necessary, extended tests in which is included exact measurement of the amount of food consumed throughout the whole period occupied by the tests.

CHAPTER X

PROFESSOR IRVING FISHER'S EXPERIMENTS *

VERY nearly related to Chittenden's experiments are those of Prof. Irving Fisher, also of Yale University. Prof. Fisher was assisted by Prof. Mendel and Prof. Underhill (chemical analysis), and by Prof. Rettger (fæcal tests as to colour, odour, quantity, putrefactive and fermentative properties, and bacterial examination). The special objects of the experiments were to test the value of that which has come to be known as "Fletcherising," in relation to its influence on nutrition. In his rules governing the tests, Prof. Fisher describes "Fletcherising" as free choice in selection of food in accordance with the dictates of the appetite. A large variety of food, including meat and dishes commonly prepared in the locality, was supplied, and the subjects were particularly enjoined to masticate thoroughly, and to keep even liquid foods in the mouth until well insalivated, and to swallow only in response to almost compulsory inclination. Attention was not to be concentrated on the number of bites given the food, but on the gustatory pleasure excited by the food. This latter injunction was given in compliance with the belief that digestion is greatly assisted by enjoyment of the food. (Horace Fletcher.)

The test subjects numbered nine, and the experiment lasted for four and a half months. The diet supplied at the beginning contained—

28 grs. protein, and had a fuel value of 2,830 cals.

The time occupied by the experiment was divided into two periods of two and a half and two months respectively. The first period was governed by the above injunctions only; but

* Irving Fisher, "The Effect of Diet on Endurance," New Haven, 1907.

during the latter an additional regulation was made. The subjects were informed as to the protein content of the various foods, and were asked to eat those foods least rich in protein, so long as the appetite evinced no disinclination to them.

Such a method is, if I may be permitted to say so, " Fletcherism " and " Hindhedism," in combination.

Of the exercises introduced as tests of physical endurance, three were as follows :—

1. Rising on the toes as many times as possible ;
2. Deep knee bending as many times as possible ;
3. Raising the legs from the floor to a vertical position as many as possible while lying on the back.

I have calculated the chief averages as follows :—

	Calories.		Protein.		Strength.	Endur-	Weight
	Total.	Per cent.	Grs.	Per cent.	Per cent.	ance.	Kilos.
At the beginning .	2,830	100	98	100	100	100	68·2
After 2½ months .	2,670	94	82	80	104	133	67·3
After 4½ months .	2,220	78	51	52	93	189	65·5
Which is :—							
" Fletcherism " .		− 6		−20		+33	
" Fletcherism " + " Hindhedism "		−22		−48		+89	

If these figures are mathematically reliable, they are of very great interest. It would then be established that " Fletcherism " reduces the calories by 6 per cent., the protein 20 per cent., and increases the endurance 33 per cent. With the conscious reduction of food rich in protein, and especially meat—a practice which I also have been following for the last seventeen years—the endurance is increased by about 90 per cent. ; but I would not venture to accept this evidence without reserve. In such cases it is impossible to exclude the psychical factor. The showing is somewhat opposed to that of Chittenden. In the Chittenden experiments they were looking for increased strength, and found it. In the Fisher experiment it was the endurance of the men which attracted main attention, and they found the endurance increased, while their strength varied very little either way.

Some time after Prof. Fisher arranged some comparative endurance tests between sixteen meat-eaters (students from Yale University), and thirty-two vegetarians connected with the Battle Creek Sanitarium. The latter had been vegetarians

for from four to twenty years.* They not only abstained from meat, but also from coffee, tea and condiments ; and, although it is not so stated in the report, they were all teetotallers and non-smokers. (Horace Fletcher.)

The endurance tests were as follows :—

1. Squatting on the heels and rising thence to upright position, as many times as possible ;

2. Holding out the arms fully extended, for as long a time as possible.

Results :—

	Meat-eaters.	Vege-tarians.	Percentage of diff.
Knee-bendings . . .	383	846	121 %
Holding arms out (minutes) .	10	49	390 %

If we take the standard of the meat-eaters as 100, the endurance of the vegetarians is 221 and 490.

This is almost too good, and it is difficult to believe that the muscular powers were altogether uninfluenced by certain psychical factors. But if we do not venture so far as to make use of these comparisons because of their questionable reliability, we may at least draw the conclusion that strength and endurance have nothing to do with the consumption of generous quantities of protein, as was formerly a matter of faith. Furthermore, it must be admitted that great endurance is possible on simple food of low protein value, in support of which we may also cite the example of the Japanese and Arabs.

I was interested, further, to observe the progressive decrease in the putrefactive properties of the fæces, concerning which Prof. Rettger writes :—

"The odour was very slight in nearly every specimen in the last series; and there was a marked difference between series 1 and 2, particularly in the former.

"The figures indicate considerable difference in the putrefactive and fermentative properties of the three series, and the decrease is progressive."

By way of example, I take some of his figures, as follows :—

* Irving Fisher, "L'influence de l'aliment carné, etc." Traduit par Dr. Nyssens, Bruxelles.

Subject.	Fæcal tests. Putrefactive degree.		
	Jan.	Mar.	June.
E . . .	30%	25%	10%
M . . .	20%	10%	15%
W . . .	30%	10%	5%
Average . .	27%	15%	10%

As to the part played by "Fletcherising," and the part played by the conscious choice of food, poor in protein, there is no possible means of deciding. No one can doubt that it is beneficial thoroughly to chew the food, but that is not to say that "Fletcherising" is to be regarded as the end itself, or only as a means to that end.

According to my opinion and experience, the safest plan would be, firstly, to select food that is, to the best of our knowledge, healthy, plain, and not too rich in protein; secondly, to masticate it thoroughly. A luxurious table served with many richly nitrogenous dishes will always prove too great a temptation to many people to over-eat themselves; and though they may have masticated ever so thoroughly, that will not save them from the evil consequences of over-repletion.

But no matter how much importance may be placed on different means to the same end in the final analysis and settlement, the great merit of Mr. Fletcher's agency in reforming the standards cannot be disputed. It was he, and he alone, a layman, who in defiance of the concensus of opinion of physiological science, raised the question, and by whose action the experiments of Chittenden and Fisher came into being; investigations which have resulted in dealing a mortal blow to the old faith in a maximum protein requirement.

Readers will, perhaps, have noticed that nearly all the test-subjects dealt with in this chapter lost in weight: Chittenden (from November, 1902) by 7·6 kgs.; Underhill by 2·4; Mendel by 6·2; Soldiers by 0·9; Chittenden's students by 2·3; and Fisher's by 2·7. But whether that be a good or a bad sign has yet to be decided. Improvement in physical condition is not an evil sign.

CHAPTER XI

THE EXPERIMENTS OF PROFESSOR McKAY* IN INDIA

ALTHOUGH it seems to me that these experiments were rather faulty, we must consider them because they have been used as arguments against Chittenden.

McKay began his experiments with different persons who were connected with the Medical College in Calcutta.

1. Students and assistants, belonging to the higher castes, who were able to choose what food they liked.

2. *Functionnaires.*

A. Durwans, who belonged to the higher castes.
B. Bearers, from lower castes.
C. Domes, from the lowest castes.

In all there were forty-four persons. The nitrogen excretion of each individual was examined during every four or five days.

	No. of Persons.	No. of Analyses.	N in the urine. Min.	Max.	Aver.
Assistants .	28	124	3·40	9·04	6·05
Durwans .	7	36	2·61	9·30	5·94
Bearers . .	2	8	3·22	3·47	3·35
Domes . .	7	32	3·44	14·02	6·85
In all .	44	200		Average	5·98

As the average weight was 52 kgs., for 70 kgs. it would be : 8·05 grs. of nitrogen ; that is, about 50 grs. of digestible protein.

Examination of the blood of 156 people, mostly students, gave the following results :

* McKay ; " Scientific Memoirs by the Officers of the Medical and Sanitary Departments of the Government of India," No. 34. Calcutta, 1908.
Do. do. No. 37. Calcutta, 1910.
Do. do. No. 48. Calcutta, 1911.
Do. " The Protein Element in Nutrition," p. 210. London, 1912.
In subsequent quotations these three publications will be found referred to as No. 37, No. 48, and Prot. El. respectively.

No. of Observations.	Aver. % of Hæmoglobin.	Aver. of Red Blood Cells.	Aver. of White Blood Cells.
9	92	5,520,000	10,400
30	87	5,500,000	9,800
60	81	5,300,000	9,700
27	76	5,200,000	8,700
20	71	4,810,000	8,000
10	67	4,800,000	7,650

The percentage of hæmoglobin was determined by Gower's hæmoglobinometer. It is lower than the normal; the number of red blood corpuscles being, on the contrary, higher than the normal.

Nitrogen-balance experiments were secured from two assistants. The results were as follows:

	Weight kg.	N in Food.	N in Fæces.	N Digested.	N in Urine.	N Balance.
No. 1 .	61·5	8·64	1·71	6·93	6·73	+ 0·20
No. 2 .	50·5	10·56	2·01	8·55	8·42	+ 0·13

For 70 kgs. weight the nitrogen excretion would be respectively: 7·66 grs. and 11·57 grs. of nitrogen.

The assistant, No. 1, with the low metabolism was "well nourished and muscular."

If the above balance is regarded as the usual metabolism of the subject, there is nothing to show that a strong organism in India is not able to develop on a low protein ration.

No. 2 was "thin and poor in muscular development."

McKay gives some very interesting figures relative to the feeding of prisoners in India:

A. Prisons in Bengal.

The bills of fare of a big prison in Bengal were as follows:

			Protein.	Fat.	Carboh.
Rice .	26·65 ozs.	= 755·80 grs.	51·63	6·80	589·55
Dhall. .	6·15 ,,	= 174·41 ,,	39·32	4·76	94·72
Vegetables .	6·15 ,,	= 174·41 ,,	2·36	1·58	9·06
Oil . .	0·64 ,,	= 18·14 ,,	—	17·35	—
In all .			93·31	30·49	693·33 = 3,511 Cal.

As the prisoners weighed 50 kgs. on an average, the amount of calories for 70 kgs. would be 4,914.

As will be seen, this is nourishment greatly in excess of need. It is about double the proportion of both protein and calories

found necessary by the Chittenden experiments. What was the result of this hypernutrition? We must infer that there was poor digestion due to fermentation, disturbance of the intestines and symptoms of poisoning. This is just what happened. McKay comments on the results of his experiments with these food standards in No. 34, p. 46, as follows:

"No less than 25·52 per cent. of the protein of the food passed out unchanged. This result is in marked contrast to what Chittenden obtained in different experiments on students, scientific men and soldiers; in all his records the fæcal nitrogen was exceedingly small in amount. To this he attaches the greatest importance, and, in fact, makes it one of the principal arguments in favour of strict moderation of protein intake, contending that with a small nitrogenous residue the opportunity afforded for intestinal putrefaction and fæcal intoxication is kept at a minimum. If this view is sound and worthy of credence—and we believe it to be so—what can be said about the diets presented and discussed above? They are one and all bad in every respect, and particularly bad, in that the large waste in the alimentary canal allows excessive micro-organismal development and formation of toxic compounds. As we already have had occasion to point out, this must assuredly be a factor in the prevalence of intestinal disorders and in the causation of certain diseases. So much is this the case that an experienced jail officer states that it is one of the rarest of novelties to discover a prisoner who passes a solid stool.

"From an economical standpoint alone the large waste in food material is worthy of consideration and investigation. What part of the diet is principally to blame? We have made some investigations and collected evidence that would appear to inculpate the dhall; they are not sufficient, however, to base a definite opinion on. It is well known that, even among those accustomed to dhall, and of course much more so with Europeans, if a small amount of dhall more than usual be partaken of, diarrhœa and intestinal troubles are apt to ensue. Further, in connection with the fluid condition of the stool characteristic of the dhall-eating Bengali, we can state from personal experience that its fluidity is not due to rice—the Chinese and Japanese are great rice-eating people, yet their stools are not watery, but well formed. Dysentery may be said to be comparatively rare in the provinces of India where the diet of the population does not mainly consist of rice and dhall, whereas in Bengal, both in the jails and elsewhere, dysentery is very prevalent."

McKay made a series of experiments in Bengal prisons which strengthen the opinion that the prisoners in India get too much to eat. He shows how, with mere reduction of the quantity of food, the protein digestion is increased. This is seen from the following figures (No. 37, p. 61).

(Beans and vegetables are constant ; but rice varies.)

No.	Rice. Ounces.	Grams.	Calories in Food.	N in Food.	N Digested in all.	N Digested in %.
1	26	737	3,511	14·63	7·85	53·66
2	24	680	3,310	14·42	8·00	55·39
3	23	652	3,210	13·56	8·09	59·69
4	20	567	2,908	13·12	8·40	64·03
5	19	539	2,808	12·74	8·47	68·33

Note the increase in the percentage of the digestibility. It is also striking that the total quantity digested is increased. With a decrease of 2 grams of nitrogen in the food, the quantity digested is increased 0·62 grs.

The same occurs when a less quantity of beans is used, while the other foods remain constant.

That some of the digested dhalls may have a poisoning effect, as McKay thinks, is not only probable, but almost certain. One kind, *Lathyrus sativius*, which is often used, is certainly poisonous. There have been times when 5 per cent. of the population of Bengal were suffering from "Lathyrismus" (No. 34, p. 40). But according to Professor Fröhner * *Cicer arietinum*, or gram dhall, which, after McKay, seems to be very commonly used, seems to be not less poisonous. That some of the other kinds are the same is very probable.

These disturbances, from too much food and poisoning, are easily accounted for, as McKay states, that prisoners, as well as the common population in Bengal, are thin and scraggy, in spite of the excessive food given them.

When McKay essays to show that a change from rice to wheat might increase the digestive power, it seems to me that his figures and conclusions are not convincing. He does not keep the quantity of food (calories) constant. He only gives wheat for rice to balance the quantity of protein content, but as wheat is about double as rich in protein as rice (12·24 per cent. against 6·95 per cent., No. 37, p. 27), the number of calories is reduced so much that this alone can account for the difference.

For example, we will take the experiment No. 1 (No. 37, p. 76).

* Fröhner, "Lehrbuch der Toxikologi," p. 187. Berlin, 1901.

In this diet there would be (calculated from Tables in No. 37, p. 37; and in No. 34, p. 35) 361 grs. rice; 193 grs. dhall; 193 grs. wheat; and 146 grs. vegetables; in all 2,642 cal.

We have: 14·69 grs. nitrogen in food; and 10·63 digested nitrogen: that is, 72·24 per cent.

It is seen that the percentage of the digestion is a little higher than in the above experiment, No. 5 (see Table, p. 81), with 539 grs. of rice without wheat; but this difference is so small, that it is inside the mistake limit, and besides that, the quantity of food is smaller: 2,642 cal. as against 2,808 cal.

Finally, I will refer to three experiments in which meat and fish take the place of wheat (No. 37, p. 91).

Constants.			
Burma Rice . .	18 ozs. = 510 grs.	I.	Wheat 4 ozs. = 113 grs.
Dhalls . . .	4 ozs. = 113 grs.	II.	,, 2·7 ozs. = 68 ,, + flesh 2 ozs. = 57 grs.
Vegetables . .	5 ozs. = 142 grs.	III.	,, 2·7 ozs. = 68 ,, + fish 3 ozs. = 85 grs.

With results as follows:

I.	2,678 Cal.	12·82 N in food	8·64 N digested = 67·41 per cent.
II.	2,589 ,,	13·12 ,, ,,	9·57 ,, ,, = 72·99 ,, ,,
III.	2,626 ,,	13·44 ,, ,,	9·88 ,, ,, = 73·54 ,, ,,

If we compare No. 1 with the before-mentioned experiment on 19 ozs. of rice without wheat, it will be seen that the digestibility is about the same. It is easily understood that a little more nitrogen (protein) is digested when meat and fish are given, which are rich in protein content, and which are not, as in wheat, enclosed in cellulose envelopes. But the question involved in this inquiry was whether the larger quantity of protein was beneficial, harmful, or indifferent.

That meat, or wheat, facilitates the digestion of rice is not shown.

B. Prisons in the United Provinces.

Wheat Food.

The diet which is the most usual at this prison is at follows:

	Ozs.	Grs.	Protein.	Fat.	Carboh.	Calor.
Wheat . .	23	652	66·31	9·85	472·57	2,296
Gram dhall .	5	142	26·01	7·01	71·78	466
Arhar dhall .	2	57	12·41	1·05	30·70	187
Vegetables .	6	170	3·48	0·58	9·06	57
Oil . .	$\frac{8}{25}$	9·1	—	9·10	—	84
In all . .	—	—	108·11	27·59	584·11	3,090

3,090 cals. Weight 55 kgs.

3,933 ,, ,, 70 ,,

When the prisoners are on light tasks, such is, undoubtedly, over-feeding. The average of digestion experiments with forty-six prisoners in five periods, each of ten days duration, showed the following :—

N in food 17·09 grs. Digested 11·65 = 68·116 %

This diet was in use for nine months. During three months, the diet employed contained 10·19 grs. digestible nitrogen. McKay computes the daily average for the whole year to have been :—

N in food	16·73 grs.	Digested	11·29	= 67·4 %
Protein	,, 104·56 ,,	,,	70·56	= 67·4 %

If we compare the wheat diet with the above-mentioned rice diet in Bengal, we must, for reasons already given, use the same quantity of food in proportion to body weight.

The diet in which there were 19 ozs. of rice had the following composition :—

	Weight. kgs.	Rice. grs.	Dhalls. grs.	Vegetables. grs.	Oil. grs.	Cal.
	50	539	174	174	17	2,808
Per	55	593	191	191	19	3,089

and the wheat diet :—

		Wheat.				
	55	652	199	170	9	3,090

We see that the two kinds of diet are about the same, both being purely vegetarian. Only in the last case rice takes the place of wheat.

The rice-digestion experiment gave the following results :—

Per 50 kgs., 2,808 cal.	N in food	12·74 grs.	Digested	8·47 = 68·33 per cent.
	Protein ,,	79·6 grs.	,,	52·9 = 68·33 ,, ,,
Per 55 kgs., 3,089 cal.	N ,,	14·01 grs.	,,	9·32 = 68·33 ,, ,,
	Protein ,,	87·6 grs.	,,	58·2 = 68·33 ,, ,,
Wheat diet :				
Per 55 kgs., 3,090 cal.	N ,,	17·09 grs.	,,	11·65 = 68·16 ,, ,,
	Protein ,,	106·8 grs.	,,	72·8 = 68·16 ,, ,,

It will be seen that in the wheat diet there are 14·6 grs. more digestible protein than in the rice diet. According to the old standard of minimum protein requirement, this would be an advantage ; yet I think that it is of no importance.

If I had to criticise a diet as monotonous as this (in Europe it would correspond to a diet of bread with scarcely any

butter), I should say that there was danger of scurvy. That this disease is common in India, we can read between the lines of McKay's writings : " Anti-scorbutica has always to be given with such food " (No. 48, p. 14). Yet I think this danger could be safely evaded if less rice and wheat and more potatoes were given. That, by this means, the protein would be reduced, I regard as of no importance. Scurvy could also be prevented by the provision of a little meat or milk ; though that would be more expensive.

Digestive disorders are not at all so frequent in the United Provinces as in Bengal. I cannot account for the reason. I agree with McKay that it cannot be on account of the rice. I surmise that the reason is that different kinds of dhall are used in the two places. If this be not so, then we must look for the explanation to other things besides the food.

C. Prison in Behari.

The diet in this experiment was intermediary between those of the two experiments commented on. A mixture of rice and wheat was used. The result of this experiment was also somewhere between those obtained from the others. I will, a little later on, return to this matter.

D. The Sikhs.

The Sikhs are known to be the most able-bodied of the Hindoos. McKay cannot say too much in their favour. For example, he writes (Prot. El., p. 203, Quotations from Bonarjee) :—

" Taken as a whole, the Sikh is one of the finest types of men to be found in Asia. Is independent without being insolent, resolute and firm in character, remarkably free from petty bias and prejudices like other natives of India. He respects himself, and as a result, commands the respect of others; he is a soldier by instinct and tradition, regards cowardice as worse than a crime, and, with his splendid physique and well-bred ways, is one of the finest of Oriental races."

McKay describes the diet provided for trained Sikhs as under (No. 48, p. 197) :—

" The ordinary trained Sikh takes two meals daily—morning and evening. The ordinary articles of diet, with their approximate quantities are as follows :

Milk	16 ozs. daily.
Flour (wheat)	24 ,,
Ghi (butter)	2 ,,
Dhall	4 ,,
Vegetables : Potatoes . . .	4—6 ,,

"*Rice*.—Six to 8 ozs. is taken occasionally as a change, when this is done less wheat flour—about 16 ozs.—is used.

Meat . .	16 ozs. taken two or three times a month
Rum . .	3½ ,, per man daily."

By taking the daily average of the food computed from the analyses given by McKay (No. 48, p. 28, and No. 34, p. 35) we get the following :—

	Ozs.	Grs.	N.	Cal.
Milk . . .	16	454	1·54	214
Wheat . .	24	680	11·06	2,394
Butter . .	2	57	—	451
Dhalls . .	4	113	3·62	370
Potatoes . .	5	142	0·41	130
Meat . . .	1·33	38	1·46	43
Rum . . .	3·5	100	—	301
			18·09	3,903

If we reckon with the following digestibility (Rubner, McKay, No. 48, p. 109) : milk 91·2 ; wheat, 67·1 ; beans, 70·8 (as the average) ; vegetables, 76·2 ; meat, 97·7 ; we get 13·12 grs. of digestible nitrogen. Or if we compute on a basis of 3,000 cal. we get 10·26 grs. digestible nitrogen ; that is, about 64 grs. digestible protein.

The old standard (105 digestible protein) was 67 per cent. higher, but then we must not forget that the protein in the food of the Sikhs is nearly all vegetable, being mostly wheat protein.

I suppose an English soldier would not be content with meat only twice a month.

I cannot find any exact account of what the Sikhs really ate. The quantity stated is evidently from the bills of fare, but whether the soldiers ate the entire ration or not is not stated.

When a food consists of wheat, the protein content cannot be very low (700 grs. of wheat corresponding to about 1 kg. of

bread). With bread as the chief item, especially wheat bread, we are undoubtedly far on the safe side of the protein minimum.

We cannot deny that these Sikhs are very interesting. This vegetable food, with very little admixture of animal product, corresponds very nearly to the food which has been used many years in the author's home, and which has been found to be ample for our needs. Of course, we have a much greater variety, eating less quantities of cereals and more vegetables (potatoes). We also use a great deal more fat, but such variety can only be of advantage. Stomach disorders are unknown to us, and we are acquainted with scurvy only by the name.

McKay's Conclusions.

These facts are much more valuable and interesting because they are given by one who believes stoutly in the importance of protein. McKay does not at all see that his own experiments disprove his theories, therefore his conclusions are contradictory and illogical. I will illustrate this by giving some quotations from No. 48, p. 124 :—

"The facts as we have found them are :

"1. Students and the fairly well-to-do classes in Bengal exist on a metabolism of less than 40 grs. protein daily.

"2. Bengali prisoners on Lower Bengal jail diets exist on a metabolism of 47·18 grs. protein daily.

"3. Behari prisoners on Upper Bengal jail diets exist on a metabolism of 59·37 grs. protein daily.

"4. United Provinces prisoners exist on a metabolism of 70·53 grs. protein daily.

"There is no doubt, therefore, but that the jail dietaries of the United Provinces are very much superior to those in use in Bengal, and seeing that the prisoners, both in Bengal and in the United Provinces, put on weight and improve physically while in jail, there can be no question of the actual sufficiency of the Bengal or United Provinces prison fare.

"Leaving aside for the present the much discussed problem of the quantity of available protein a diet should furnish, we know from practical experience that the jail dietaries of the United Provinces are sufficient for all the physiological requirements of labouring prisoners, *i.e.*, we know that dietaries furnishing 11·286 grs. of available nitrogen daily throughout the year are amply sufficient to maintain the prisoners in as good, and better, physical condition, than they show either before incarceration or after release."

McKay would, therefore, take 11·26 grs. of digestible nitrogen as a standard for the future, but discusses the difficulty of maintaining this standard on vegetables while avoiding too much bulk and food. If we cannot reach the standard on rice, we must make use of wheat or fish. But why should we take 11·26 grs. as a standard when 7·55 grs. is found to be enough in Bengal ?

McKay writes, concerning this point, in another place (No. 37, p. 99) :—

" Granting that we are correct in assuming that the prisoner, on the average, lives on 7·55 grs. of nitrogen per day, and that he remains healthy, and even puts on flesh on this amount, there is no urgent necessity to increase his nitrogenous metabolism."

Here McKay is right ! But why, then, should we try to reach a standard of 11·26 grs. ? McKay reasons thus (No. 48, p. 127) :—

" While acknowledging the force of the different arguments for the reduction of the level of protein metabolism, we have had sufficient evidence in our work in India to confirm us in the opinion that a liberal supply of absorbable protein is the all-important element of a diet, without which, no matter how plentiful the other constituents may be, physical fitness, capacity for work, and power of resisting disease, cannot be expected."

It all reads as if it were penned last century. At that time all were of this opinion. Strong prejudice alone must have prevented McKay from seeing clearly.. In my opinion, in the light of my experience and evidence, he is the very reverse of right.

If McKay were not steeped in the old beliefs he would see that all the time he is proving himself in the wrong.

He emphasises very strongly that the Behar forms a direct contrast to the Bengali (Prot. El., p. 181). He says that the former is a stronger, healthier and more capable individual in every respect—shows a much superior physical development, greater capability of muscular exertion, and distinctly greater degree of vivacity, tenacity, energy, etc. Better developed, stronger, more healthy, more able to do bodily work than the Bengali.

But what, then, is the reason for this great difference ? * We might take the climate in consideration ; but McKay writes as follows (p. 182) :—

" The differences in climate, however, are only marked between the extremes of Bengal and Behari, whereas whenever we find a change from a diet of rice and dhall to one containing wheat in addition, the superiority of the Behars at once becomes evident."

McKay points to his own experiments (No. 37, p. 106). From this we see that the food of the Behars consists of :—

Rice	13·34 ozs.	= 378 grs.
Wheat	10·00 ,,	= 284 ,,
Dhall	6·00 ,,	= 170 ,,
Vegetables . . .	6·00 ,,	= 170 ,,

A test of this diet gave the following result :—

N in food 16·75 grs., digested 8·76 grs. = 52·36 %
Pr. ,, 105 ,, ,, 54 ,, = 52·36 %

That the Behars are so very well nourished on such a monotonous pure vegetable diet, which only contains 54 grs. of digestible protein, is surely not the way to convince Chittenden and myself that our food is not sufficient.

McKay seems to be equally wrong regarding the *Sikhs*, who, as we have said, seem to be his highest ideal of manhood. One would almost think that he has not noticed how little meat is given to the trained soldiers (*vide* No. 48, p. 197). In his book published one year later (Prot. El., pp. 90—91), he has forgotten to mention the food of the trained Sikhs when he speaks of Sikh diet. He writes only of the food supplied

* What is the cause of the difference between Bengali and Behars ? Of course, I cannot say ; but, according to McKay, the Bengali are not at all normal, they suffer continually from digestive troubles. And what is the cause of this ? As McKay states, from experience of the Chinese and Japanese, it cannot be the rice. He could also have said, on the same grounds, that it could not be the low protein diet. The Japanese, at least, live on low protein diet ; and the same is proved by the long low protein experience of my own family, which experience has now lasted for more than seventeen years, and none of us have ever known any digestive disturbance.

The Indians, it seems, eat poisonous dhalls. Now, the question is, do the Bengalis eat more, or less, poisonous kinds of this food than do the Behars ? For myself, I cannot say.

Apart from which, that McKay should make use of these disorders, which have no connection with low protein diet, as proof against Chittenden seems to me to be quite absurd.

to recruits. But if we compare the statements given in the two cases relative to milk and meat, we shall find the following strange difference :—

	No. 48, p. 197.	Prot. el., p. 91.
Milk	. 10·2 ozs. daily.	16 ozs. daily.
Meat	. 3 or 4 ozs. twice a week.	3 ,, ,,

In the last instance there is one and a half times as much milk and three times as much meat as in the first instance.

The unreliability of McKay's statements is further evidenced by his remarks on the Japanese and concerning Oshima's report (Prot. El., pp. 72—76).

I would ask the reader to read these passages in McKay's book and then compare them with my remarks on Oshima's report (pp. 42—43). Who would understand from McKay's account of Oshima's experiments that the latter declares that three-fourths of the Japanese are practically vegetarian, and live upon 60 grs. of protein daily, and that this vegetarian part of the population is the best developed, physically. "They are stronger and healthier than people of the better classes" (Oshima, *l.c.*, p. 129. Compare also the statements of Dr. Kumagawa, p. 38). McKay should not forget that this incontestible evidence shows convincingly that a protein-poor vegetable diet is no hindrance to good bodily development.

McKay does not forget to quote Oshima's jinrikisha man (mentioned by me, p. 40), but his remarks are not fair. He writes as follows (Prot. El., p. 75) :—

"His work was very laborious, and consisted in drawing his rikisha with one man in it anything from fifteen to thirty miles daily. The rikisha men often run long distances with heavy passengers. A not uncommon run is from Tokyo to Nikko, a distance of sixty-eight miles which they cover in fifteen hours.

"This is an example of these classes who are held up by vegetarians as demonstrating the wonderful results that can be obtained by a simple vegetable diet, as the usual impression conveyed is that these feats of strength and endurance have been performed on a few handfuls of boiled rice."

May I ask if this manner of writing is worthy of a scientific man seeking the truth? To begin with, the first man (the meat eater) did not run from fifteen to thirty miles, but from five to thirty miles (the average was fifteen miles), while Baeltz's man

(non-meat eater) ran on an average twenty-four miles on pure vegetarian diet. According to McKay, we might think that they were meat-eating jinrikisha men who ran from Tokyo to Nikko; but, surely, he can know nothing about that. Now, if these men were living upon vegetables alone—which is very probable—what manner of proof have we here, and why all this ridicule poured by McKay on vegetarians? I am surprised that a scientific man should insist that these men live on "a few handfuls of boiled rice." Baeltz says no such thing; he declares that his men ate "rice and potatoes in exceedingly large quantities."

McKay writes, further, concerning the miraculous effect of meat-diet on beri-beri in the Japanese Navy. In this connection he does not mention the fact that we know that beri-beri is caused by pearled rice. This omission cannot be because he was not aware of this fact, as in another place in his book (p. 210) he brings it forward as argument for a liberal supply of food, "in order that the system may be afforded the opportunity of picking out those particular combinations which are so essential to its nutrition."

Is it his opinion that we should, quite without reason, surfeit ourselves? Certainly not; for McKay has clearly shown the harmful results of this. Or is it his opinion that we should richly provide ourselves with protein? That, also, cannot be the case, for "those particular combinations" have nothing to do with protein.

We should think that the only rational thing to do would be to use the foods containing the substances mentioned. The method recommended by McKay is very much like that followed by physicians of some centuries ago, when, if they did not know what medicine to give, mixed twenty different kinds together in the hope that, if one kind did not perform a cure, another would.

Perhaps this method might be effective if the poor patient could withstand the whole twenty medicines.

There are not many pages in McKay's book that do not contain statements open to contradiction, but space does not permit me to specify all the errors and contradictions. Besides, it is unsatisfactory to criticise a work that is based

upon uncertain grounds. But as regards those of McKay's statements which we can test for ourselves, we find that they do not give good evidence of trustworthiness ; how, then, can we trust those others which we cannot check, or have no means of investigating ?

I think that McKay's works are likely to do harm. The first impression which they give when we read them hastily is removed when we read very carefully ; but how many readers are there who have the time and inclination to take so much pains. The reader will come to the conclusion that Chittenden says one thing and McKay another ; and not being certain as to which of them is right, the result will be—*Confusion !*

CHAPTER XII

ARE VEGETABLE FOODS DIFFICULT TO DIGEST?

"WE ought to include in our diet both animal and vegetable food-stuffs in due proportion. The vegetable foods are indeed cheaper, but they are so difficult to digest, that, to obtain enough for our needs, we should be obliged heavily to overload our stomachs, etc., etc."

The above is a fair sample of the lectures, founded on Voit, which have been dinned into our ears so many hundreds of times that most of us ought to know it as well as our ABC. And in this respect, it is the potato which is always and everlastingly being held up as an awful example, somewhat after this style :—

The potato is particularly indigestible, and this applies more especially to potato protein, of which a third is passed undigested. Thus, if we put the protein content of potato at 2 per cent., it is easy to calculate that a pound of potatoes contains only 6 grs. of digestible protein, and that, as an adult man requires 105 grs., he must, if living on potatoes alone and is anxious not to lose too much muscle substance, eat at least 17 lbs. of potato a day.* And by way of practical example, reference is then made to the misery of the Irish on a potato

* As a matter of course, science had to go further. For the sake of consistence, it had to be reckoned (and such, in fact, is actually the case) (Rubner, in E. von Leyden's "Handbuch," 1897, Vol. 1, p. 129) that about a third of the so-called protein in potatoes consists of amides, and as these are regarded as perfectly digestible (Kellner, "Untersuchungen über Asparagin," in "Zeitschrift f. Biol.," Vol. 39); (Kellner, "Die Ernährung der landwirtschaftlichen Nutztiere," Berlin, 1900, p. 84)—that is, absorbable—that which is indigestible must come from the protein alone. It follows, therefore, that in a pound of potatoes there must be 9 grs. of calculated protein, about 6 grs. of absolute protein, of which 3 grs. are indigestible and only 3 grs. digestible. But as it is evident that Voit's opinion is that the 105 grs. should consist essentially of absolute protein (in meat there are, so far as I know, no amides, and in corn very little), we must come, consequently, to the impressive conclusion that to live on potatoes alone (the Amides, be it understood, being valueless—which I do not believe them to be), a man must eat at least 30 lbs. of potato a day—which would be rather a tall order, even for an Irishman.

diet. (Until quite recently we were also asked to consider the wretched condition of the Japanese on their rice diet.)

The above, I think, affords us sufficient excuse to examine this dogma concerning the indigestibility of vegetable foodstuffs a little closer. For the sake of brevity, I will deal only with the principal representatives of either camp, namely: meat, milk, rice and potatoes. I will rely on investigations conducted in Voit's own laboratory in Munich by his pupils, Rubner and Constantinidi, and described in Voit's "Zeitschrift für Biologie."

Experiment with Meat.*

For three days the test subject ate a daily average of 1,435 grs. of meat without bone and fat. More he could not manage; and on the third day, having an attack of nausea, he could swallow this amount only with much difficulty. The meat was in the form of beef-steak—fried with butter, pepper, onions and salt. The record of intake and output in grs. stands thus:—

	Meat.	Protein.	Fat.	Cal.
Intake . . .	1,435	305	20·9	1,445

	Urine. Protein.†	Fæces. Dry Substance.	Protein.	Fat.	Cal.
Output .	264·4 317·5 303·1	17·2	7·5	4·4	72

Protein equilibrium (calculated on the last day's urine):—

$$305 - (303{\cdot}1 + 7{\cdot}5) = -5{\cdot}6$$

Loss per fæces ("indigestible"): 2·5 % protein; 21·1 % fat.

I esteem it of interest to note that a man, despite the "easy digestibility" of meat, cannot secure the requisite fuel value (calories) from meat (plus a little fat) alone. Ranke, in three tests, was not able to eat more than 1,832, 2,009 and 1,281 grs. of meat, of which 5·2, 12·4 and 11·5 per cent. respectively, of "protein" was lost per the fæces. Ranke was not able to continue his researches for more than a day at a time because

* Rubner, "Zeitschrift für Biologie," Vol. 15, p. 121.

† "Protein" stands for N × 6·25. In the food and fæces only the average for the three days is given—which also applies to the following experiments.

he experienced a feeling of aversion to meat, and suffered from stomach distension, nausea, etc.

It is, further, worthy of note that Rubner's test subject suffered from considerable lassitude, particularly in his legs; which also happened in the course of another experiment. Ranke,* too, records similar results, and suggests that the cause must be ascribed to some decomposition and excretion product of the meat.

Meat, by itself, is therefore, a "strengthless" diet, which moreover, would appear to give rise to symptoms of poisoning. It is worthy of remark that this possibility occurred even to the Voit school. Of such symptoms nothing is heard in the subsequent experiments with maize, rice, bread, potatoes, milk or eggs.

Experiment with Milk.†

We append but a single typical example:

	Milk.	Protein.	Fat.	Carbo-hyd.	Cal.
Intake . .	3,075	121·3	119·9	129·1	2,142

	In Urine. Protein.	In Fæces. Dry Substance.	Protein.	Fat.	Carbo-hyd.‡	Cal.
Output . .	103·7	40·6	9·4	6·7	—	101

Nitrogen equilibrium (as the test lasted only one day, it is of no significance):

$$121{\cdot}3 - (103{\cdot}7 \times 9{\cdot}4) = +\,8{\cdot}2$$

"Indigestible": 7·7 % protein; 5·6 % fat.

Experiment with Rice.§

The rice was prepared in this way: 125 grs. beef marrow, and 500 grs. water, boiled to a kind of porridge.

	Rice.	Protein.	Fat.	Carbo-hyd.	Cal.
Intake	638	65	74·1	493	2,977

	Urine. Protein.	Fæces. Dry Substance.	Protein.	Fat.	Carbo-hyd.	Cal.
Output . .	{83 / 61·6}	27·2	13·3	5·2	4·4	121

* "Archiv für Anat. und Physiol.," Leipsic, 1862, p. 311.
† Rubner, "Zeitschrift für Biologie," Vol. 15, p. 132.
‡ No record is given as to the quantity of carbo-hydrates in the fæces.
§ Rubner, "Zeitschrift für Biologie," Vol. 15, p. 144.

Nitrogen equilibrium :—

$$65 - (61{\cdot}6 + 13{\cdot}3) = -9{\cdot}9$$

As the experiment lasted only two days, this deficit indicates nothing. If we take into consideration the decline in the urine output from the first to the second day, we can entertain no doubt that equilibrium would have been established on the next day. One cannot help wondering how these German investigators ever hoped to extract anything from such equilibrium experiments.

" Indigestible " : 20·4 % protein ; 7·1 % fat; 0·9 % carbohydrates.

Experiment with Potatoes.*

The potatoes were boiled and mashed with butter. The result was :—

	Potatoes.	Butter.	Protein.	Fat.	Carbo-hyd.	Cal.
Intake .	1,700	100	44·8	100·5	367	2,623

	In Urine. Protein.	Fæces. Dry Substance.	Protein.	Fat.	Carbo-hyd.	Cal.
Output .	66·2 / 26·9 / 39·7	20·12	8·7	1·19	2·72	58

Nitrogen equilibrium (calculated from last day's urine) :—

$$44{\cdot}8 - (39{\cdot}7 + 8{\cdot}7) = -3{\cdot}6$$

It will be seen that we are near equilibrium on the third day, and that it probably would have been established on the fourth day. In any case, everything points to the probability that we can easily attain nitrogen equilibrium on 3,000 cal. from potatoes and butter ; that is, on 1,944 grs. potato + 144 grs. butter.

"Indigestible":—19·5 % protein; 1·2 % fat ; 0·74 % carbohydrates.

Now, if we calculate in the usual way the digestibility of the four food-stuffs, we get the following co-efficients of indigestibility " :—

* Constantinidi, "Zeitschrift für Biologie," Vol. 23, p. 442.

	Protein.	Fat.	Carbo-hyd.
Meat and fat . . .	2·5	21·1	—
Milk	7·7	5·6	—
Rice and fat . . .	20·4	7·1	0·9
Potatoes and fat . . .	19·5	1·2	0·74

These figures, and many more of equally unimportant value, verily haunt the pages of all our most prominent handbooks,* and upon them is constructed the proverb concerning the relative indigestibility of protein. Is not the whole dogma based on an absolutely gross miscalculation? Now let us try, for a moment, to reckon with the above figures in another way, so that we keep strictly to the absolute figures for the output of dry substance, protein and calories in the fæces. We have then :—

	In the Food.		In the Fæces.		
	Protein.	Cal.	Dry Substance.	Protein.	Cal.
Meat and fat .	305	1,445	17·2	7·5	72
Milk . . .	121·3	2,142	40·6	9·4	101
Rice and fat . .	65	2,977	27·2	13·3	121
Potatoes and fat .	44·8	2,623	20·12	8·7	58

Because of the extra variation in the food quantities in the intake, direct comparison with the quantities excreted in the fæces is impossible.

Assuming that the content of the fæces is in proportion to the content of the food-intake, we will try to calculate how all the figures will stand in relation to 3,000 cal. We have then, in round numbers :—

	In the Food.		In the Fæces.		
	Protein.	Cal.	Dry Substance.	Protein.	Cal.
Meat and fat . .	633	3,000	35½	15½	150
Milk . . .	178	3,000	57	13	142
Rice and fat . .	65·5	3,000	27½	13½	121
Potatoes and fat .	51	3,000	23	10	67

I am of opinion that the above table offers many points of interest. Is it not remarkable, for instance, how the quantity

* E. v. Leyden's "Handbuch," 1897, Vol. 1, p. 115; Von Bunge, "Lehrbuch der Physiologie," Leipsic, 1901, Vol. 2, p. 73.

of protein in the excrement would seem to be independent of that in the food? Whereas the protein contained in the food varies from 51 to 633 grs., that in the fæces fluctuates only between 10 and 15½. And how is this to be explained? Quite simply, if one might regard both these quantities as relatively independent of each other. If we could regard the fæces as a kind of excretion of a relatively constant combination comparatively little influenced by the food ingredients, we should be able to solve the problem. We should have to assume that the above-given quantities of protein in the food are, practically speaking, all digested and absorbed together, while the nitrogen in the fæces is derived in quite preponderating proportion from the digestive secretions. But are we at all justified in assuming so much? Certainly, we are, and more than justified. In support of which I beg leave to quote Prof. Hammarsten,* who writes :—

"Human fæces appears, as a rule, to consist only in limited proportion of food refuse, and for the most part—after a meat and milk diet, almost exclusively—of intestinal secretions. In consequence of which many foodstuffs seem to engender larger quantities of excrement, principally because they excite more copious secretions."

That this statement, which is based upon a whole series of the experiments conducted by the Voit School,† is correct it would be difficult to doubt. But in the face of it the fable of the indigestibility of vegetable protein must fall to the ground. If the 15½ and the 13 grs. of protein obtained in the meat and milk experiments are derived "almost exclusively from digestive secretions," it must be immediately granted that the smaller quantities, 13½ and 10 grs. from the rice and potatoes, must come, yet more exclusively, from the same source. To sum up, therefore, in so far as we are able, this means that the 51 grs. of protein in slightly under 4 lbs. of potatoes is completely digested and absorbed; but, meanwhile, the same amount of nitrogen as contained in 10 grs. of protein is excreted with the intestinal secretions. We are thus set the ludicrous task of multiplying 10 by 100, and dividing the product by 51, whereby

* Hammarsten, "Lehrbuch der physiol. Chemie," 1904, p. 343.
† "Zeitschrift für Biologie," Vols. 35, 39.

we obtain 19½ as a result. Physiologists are welcome to amuse themselves by working out this little mathematical exercise, but they are in no way justified in describing this quotient, 19½, as 19½ per cent. of indigestible protein, and then proclaim to the world that our most easily digestible and cheapest food-stuff, the potato, is so very indigestible.

If we have managed at last to shake ourselves sufficiently clear of the old prejudice and miscalculation, we should deliver our verdict, I think, somewhat as follows: Of 3,000 cal. in potatoes and fat, 67 (2 per cent.) go to waste in the fæces; in rice and fat, 121 (4 per cent.) is the loss; in milk, 142 (5 per cent.); and in meat and fat, 150 (5 per cent.). Thus vegetable food-stuffs, and potatoes in particular, are considerably better digested than animal. This is supported by the circumstance that for digestion of the first-named less nitrogenous substances are needed in the intestinal secretions (viz., 10 to 13½ grs.) than for digestion of the last-named (13 to 15½ grs.).

That vegetable protein foods are just as digestible as animal is directly proved by Constantinidi's experiments discussed above. In order to obtain "sufficient protein" on the potato diet he added in one experiment 200 grs. of gluten meal to the 1,700 grs. of potato; but in the fæces there were excreted only 3·9 grs. more of "protein" than in the experiment with potatoes alone. But 3·9 is only 2·5 per cent. of 153; whence Constantinidi concludes:—

"Vegetable protein acts no differently in the intestines from animal protein."

We have seen how, in the meat and fat experiments, 150 cal. went to waste, while of the same quantities of potato and fat in the food the loss was only 67 cal. But this loss ensued only through the intestinal secretions. There is, however, yet another secretion by which calories are lost, and that is in the urine. If we reckon that for every gram of protein in the aliment 1·08* cal. goes to waste in the urine, therefore, with 633 grs. of protein 684 cal. are lost in the urine, and with 51 grs. protein, 55 cal. The total loss, therefore, in the meat and fat experiments may be reckoned thus: 150 + 684 = 834 cal.,

* Kellner, "Stoff und Energie Umsatz des erwachsenen Rindes," Berlin, 1900, p. 431.

while the loss in the potato and fat experiments shows 67 + 55 = 122 cal.*

Consequently, the waste in the former case is about six times as large as in the latter. And yet it is said that potatoes over-tax the intestines! But who will say that all these unused calories in the urea could possibly interfere with metabolism in the organs?

The idea that potatoes, by reason of their large bulk, distend the stomach and intestines, creating pot-bellies, is likewise the sheerest nonsense. Rice, it is true, is smaller in bulk when dry; but rice is never eaten in a dry condition, and when cooked in water it swells to fourfold size, so that rice and potatoes in quantities yielding an equal amount of calories, would be about equal in bulk. Milk is claimed to require even more space accommodation.†

It is also said that potatoes overtax the intestines, because of the large amount of refuse they yield. But we have already shown this assumption to be erroneous. None of the food-stuffs investigated yield so little refuse as potatoes and fat. Three thousand calories of these yield only 23 grs. of dry substance, while rice and fat yield 27½ grs., milk 57 grs., and meat and fat 35½ grs.

I would like to know what now remains, from a strictly scientific standpoint, of the fable concerning the indigestibility of the potato, which fable, as we have seen, has its origin in gross miscalculation. Certainly, it derives some support from yet another experiment, in which was found the following amounts of indigestible substances:

32·2 % protein.
7·6 % carbo-hydrates.

We will examine this experiment somewhat closely.

* It must be understood that I do not mean to say that of the 3,000 cal. 824 and 122, respectively, go to waste. The figure 3,000 (arrived at by calculation with the factors 4·1, 9·3 and 4·1) represents, as a matter of fact, the nett value after deduction of the waste. Thus, originally, it would have stood 3,834 and 3,122 cal.

† This matter of the excessive volume (wateriness) of certain food-stuffs is a much debated point in cattle feeding. For some time it was the chief objection which country people had to turnips (which, by the way, contain only half the proportion of dry substance that potatoes do). Docent Fjord‡ dispelled the notion when he demonstrated by experiment that cows

‡ Fjord, ' 20 Beretning fra Kgl. danske Forsögslaboratorium," Copenhagen, 1890, p. 28.

Potato Experiment II.*

The test subject ate (or, more correctly, devoured!) for three days a daily amount of 6 lbs. of potatoes, and 144 grs. of fat. The potatoes were served, sometimes cooked in their jackets and eaten with butter, sometimes with vinegar and oil as a salad, and sometimes baked. The record appears thus (in grs.) :—

	Potatoes.	Protein.	Fat.	Carbo-hyd.	Cal.
Intake : .	3,078	71·6	144	718	4,574

	In Urine.		In Fæces.			
	Protein.	Dry Substance.	Protein.	Fat.	Carbo-hyd.	Cal.
Output : .	80 47·5 37·5	93·8	23	5·36	54·6	3·57

Protein equilibrium (calculated from last day's urine) :—

$$71{\cdot}6 - (37{\cdot}5 + 23) = + 11{\cdot}1.$$

"Indigestible" : 32·2% protein ; 3·7% fat ; 7·6% carbo-hydrates.

We will compare some of the most important absolute figures from both experiments with potatoes (in grs.) :—

		In the Food.		In the Fæces.				
		Potatoes.	Cal.	Dry Substance.	Protein.	Fat.	Carbo-hyd.	Cal.
Experiment	I.	1,700	2,623	20·12	8·7	1·19	2·72	58
,,	II.	3,078	4,574	93·8	23	2·36	54·6	357

As will be seen, there exists no sort of agreement between these two experiments. The quantity of potatoes eaten in No. II. is one and four-fifths as large again as in No. I., yet in the fæces there appears about three times as much protein, five times as much dry substance and fat, and twenty times as much carbo-hydrates. And how are we to explain it? Very simply! The subject in No. II., who was a soldier, was evidently commanded to eat as much potato as he possibly

who ate no turnips drank more water than cows fed on turnips, so that the stomachs of the former were as distended by the water as were those of the latter by the turnips.

* Rubner, "Zeitschrift für Biologie," Vol. 15, p. 146.

could, and as there are limits to the powers of the stomach and intestines to deal with more than a certain amount of potato, these two organs gave notice of their inability to fulfil all that was demanded of them, by allowing a part of the potatoes to pass unchanged (exactly as fat will pass through unchanged if too much is ingested); and undigested pieces of potato were actually found in the fæces. That would also suggest that the man had not properly chewed the potatoes; but the supreme indication is that his poor stomach had been grievously overloaded. Four thousand five hundred and seventy four calories are indeed a large amount of nourishment to take. It appeared also, that he had absorbed too much protein, seeing that he showed a *plus* balance of 11·1 grs.

To sum up *Because a German soldier over-fed himself, for once in a way, with potatoes, therefore, potatoes are very indigestible!**

When foods rich in cellulose are eaten there is a heavy loss per the fæces; for example, in the case of wholemeal bread, about 13 per cent. of the calories are lost; and similarly with other food-stuffs. But I really do not know why it should be thought so terrible that the large intestine should be given a little extra work to do. When it is otherwise, the intestinal muscles deteriorate. For instance: if rabbits and mice are supplied with food which contains no indigestible substance (cellulose), they will simply die. Of course, I will freely admit that, so far as human beings are concerned, they can keep themselves alive with the help of castor oil, senna tea, turkey rhubarb, etc.

I venture to reproduce a few observations made by the well known Prof. von Bunge, of Basle, in connection with this particular subject.† He writes:—

"Although the life of a human being would not be directly endangered if deprived of cellulose, there is reason to believe that the normal activity of the intestines could well be adversely affected. The intestinal muscles will atrophy as well as any other muscle, if given no work to perform. When dealing with human nutrition, therefore, we

* Curiously enough, it is the result of this last experiment of Rubner's (and not the first experiment of Constantinidi's) which has been adopted in most of the standard works on nutrition.

† Von Bunge, "Lehrbuch der Physiologie," Leipzic, 1901, Vol. 2, p. 77.

must take care that the food is not too poorly supplied with vegetable fibrine. The exaggerated anxiety, prevalent among the well-to-do classes, to avoid 'indigestible dishes,' may lead to general debility of their intestinal muscles. Habitual constipation would, perhaps, not be such a common malady if we had been accustomed from tender years to food rich in vegetable fibrine. In recent times wholemeal bread, rich in cellulose, has frequently been utilised as a remedy against chronic constipation."

Prof. Bunge goes on to explain that there are certain cases in which it might be inadvisable to employ wholemeal bread as a remedy, as increased peristaltic movements of the intestines would, by acceleration of the passage of the food-stuffs, prevent the body from obtaining the full benefit from them ; but he says in conclusion :—

" It seems to me, however, *that the advantages of a food rich in cellulose must outweigh its disadvantages.*"

I can fully endorse Prof. Bunge's statements, and can neither understand this terrible horror of indigestible food-stuffs nor the vast amount of discussion that goes on about it.

It would, then, be not amiss if I conclude these remarks on " digestibility " with the statement that much of the argument concerning the indigestibility of vegetable foodstuffs is *the direct outcome of gross miscalculation. In other cases, there may be something in it ; but in the present one this indigestibility is perhaps more beneficial than injurious.*

I may mention that the above chapter was written eight years ago, since when I have conducted experiments* in digestion on an extended scale hitherto never attempted. I find it extremely gratifying to be able to state that, notwithstanding the considerable interval of time, I have not had occasion to alter one word of what I wrote eight years ago.

* " Skandinavischen Archiv. für Physiologie," 1912, Vol. 27, p. 277 ; " Zeitschrift für physik. und diät. Therapie.," 1912, Part 11, und 1913, Part 2.

CHAPTER XIII

MY OWN EXPERIMENTS

(A) Experiments in Cheap Nutrition.

Up to this point we have been going over the field of our subject entirely from a physiological standpoint; but in this chapter we shall devote ourselves especially to the pocket, in order to find out how cheaply we may live, taking sufficient nourishment to maintain ourselves in perfectly able-bodied condition. And yet we regard the whole matter as extremely simple. There will be no need for us to cudgel our brains over questions concerning "sufficient protein," "sufficient animal food," for we flatter ourselves we have been able to prove how easily we can obtain practically all the protein we require, and that vegetable food is, at least, quite as good as animal food. Upon which grounds we are able to avail ourselves of a very different standard from that which we have hitherto employed for the valuation of food-stuffs. The old standard of König may be appropriately termed the "Protein standard." According to this the method of reckoning was: protein, fats, starches = 5 : 3 : 1; which means that protein was estimated as having five times the value of starch (and sugar), and nearly twice the value of fat. Now, this standard has nothing whatsoever to do with physiology. It does not refer in any way to the relative alimentary value of the three forms of food. It is purely a commercial, or money standard. Thus, if a merchant buys a tin of lobster for 1*s.* 3*d.*, and 2 lbs. of flour for 3*d.*, it does not follow that a tin of lobster has five times the alimentary value of 2 lbs. of flour. This view would probably never have occurred to him. Yet there is just as little common sense in saying that 2 lbs. of protein has five times the food value of 2 lbs. of starch food. The proportion 5 : 1, in fact, means nothing further than this: if a starch or protein

food-stuff is purchased from the grocer or the butcher, five times more must be paid on an average for the protein than for the starch food. Formerly, when the necessity of protein was an article of faith, it was only natural that people should be glad to pay fivefold for it ; but we, who have lost the old faith, and have an affection for our pockets, are striving with all our might against having to submit to this shameless extortion. We reason thus : We have no use for much protein. The little bit which we need ought to be obtainable as a mere makeweight to the starch and fat foods that we buy. Therefore, we will not pay more for protein than it is worth, and all practical experience goes to show that the practical value of 1 lb. of protein is about equal to that of 1 lb. of starch food. We reckon thus not in accordance with the formula 5 : 3 : 1, but according to this : 1 : 2·3 : 1, which means that we reckon according to the fuel value :—

1 gr. Protein	= 4·1 cal.
1 gr. Fat	= 9·3 ,,
1 gr. Carbo-hydrates	= 4·1 ,,

Which Rubner laid down as the average practical value of protein, fats and carbo-hydrates for human nutrition, when calculated on ordinary mixed diet.

It will easily be recognised that if we really can use this new Calorie standard as a foundation for our nutrition, there will ensue a complete revolution in our economical relations. We shall be able to live more cheaply than the most learned man has ever dreamed.

The table opposite sets forth the composition* and approximate price of some chief food-stuffs.

Column 1 gives the cost in farthings. Cols. 2—5 show the chemical composition of the food-stuffs ; col. 6 shows by calculation how many calories may be had per farthing. This table gives a most convenient survey of the comparative cost of our simpler food-stuffs. In cols. 7—9 we give prices obtaining in Denmark for comparison. The Danish prices

* The figures for the chemical composition are taken from "The Chemical Composition of American Food Material," U.S. Department of Agriculture, Bull. 28, Washington, 1906.

	Price per lb. in farth.	Contains per cent.			Calor. in 1 lb.	Calor. 1 farth.	Danish price.		Calor. 1 farth.
		Prot.	Fat.	Carboh.			Ore per Kilo.	Farth. per lb.	
Pearl Barley	7	8·5	1·1	77·8	1,650	236	20	4·8	344
Buckwheat	5	6·4	1·2	77·9	1,620	324	28	6·7	242
Oatmeal	8	16·1	7·2	67·5	1,860	233	36	8·7	268
Rice	6	8·0	0·3	79·0	1,630	272	36	8·7	313
Wheat flour	5·6	10·8	1·1	74·8	1,640	292	20	4·8	342
Sugar	8	—	—	100	1,860	233	40	9·6	190
Bread	4·9	9·3	1·2	52·7	1,205	246	20	4·8	251
Peas	8	27·6	1·0	62·0	1,655	207	26	6·3	263
Beans	8	18·1	1·5	65·9	1,625	203	35	8·7	193
Potatoes	1·88	1·8	0·1	17·7	310	165	6	1·45	214
Margarine	24	1·0	85·0	—	3,605	150	100	24·0	150
Palmin	32	—	100·0	—	4,218	132	100	24·0	176
Lard	32	—	99·0	—	4,176	130	120	29·0	144
Butter	56	1·0	85·0	—	3,605	64	200	48	75
Cheese, cheddar	28	27·7	36·8	—	2,145	77	120	29	74
Milk	6·5	3·3	4·0	5·0	325	50	14	3·4	96
Eggs	40	11·9	9·3	—	635	16	100	24	26
Bacon	36	9·1	62·2	—	2,795	78	120	29	96
Pork—									
lean	32	24·8	14·2	—	1,060	33	—	—	—
medium	—	13·5	25·9	—	1,345	42	110	26·5	51
fat	—	10·7	43·5	—	2,035	64	—	—	—
Beef—									
lean	36	18·8	3·0	—	475	13	—	—	—
medium	—	16·5	16·1	—	985	27	120	29	34
fat	—	16·0	29·1	—	1,525	42	—	—	—
Mutton—									
lean	36	16·5	10·3	—	740	20	—	—	—
medium	—	18·5	18·0	—	1,105	31	100	24	46
fat	—	15·2	23·8	—	1,290	36	—	—	—

are those which we used for our calculations in 1906. To obtain English prices obtaining at about the same period, I have had recourse to a report issued by the Board of Trade in 1908.* According to this report the mean prices obtaining in London in 1905 were : Sugar, 2*d*. per lb. ; butter, 14*d*. ; Cheese (cheddar), 7·1*d*. ; bacon, 8·9*d*. ; milk, 4*d*. per quart ; bread, 4·9*d*. per 4 lbs. ; potatoes, 3·29*d*. per 7 lbs. ; flour, 9·7*d*. per 7 lbs. The prices for other foods I have had from a resident of London ; but they are for 1912, and, therefore, perhaps a little too high for comparison.

For better comprehension we may take the average cost of different groups of food-stuffs, and we get the following :—

* "Cost of Living of the Working Classes." Report of an enquiry by the Board of Trade. Presented to both Houses of Parliament, London, 1908.

	Prices farth. per lb.		Calor. per farthing.		Prot. Cal. per cent.
	England.	Denmark.	England.	Denmark.	
A. Cereals and Sugar (1–7).	6·4	6·9	262	253	9·6
B. Pulses (8–9). . .	8	7·4	205	228	24·3
C. Potatoes . . .	1·88	1·45	165	214	8·4
D. Fats (11–14) . .	31	26·5	122	142	1·3
E. Butter . . .	56	48	64	75	0·5
F. Milk	6·5	3·4	50	96	18·9
(,, in Copenhagen) .		(3·9)		(83)	
G. Eggs	40	24	16	26	34·9
H. Meats (19-21) medium .	35	26·5	33	44	26·3
,, beef lean . .	36		13		73·8

Average " A + B + C " gives 211 cal. per farthing ; while average " F + G + H " gives 33 cal. per farthing. It will thus be seen that it is seven times more expensive to live upon milk, eggs and meat than upon corn, pulses and potatoes.

Why will people pay seven times more for their food ? Partly because of the demands of taste, but also by reason of some pseudo-scientific misunderstanding, according to which the last-mentioned foods are believed to impart health and strength (muscles). And why so ? Because these foods are so rich in protein. In the final column of the above table is stated how much per cent. of the whole amount of calories is derived from the protein. In the cereals the amount is below 10 per cent. ; while in milk, eggs and meat it is from 20—35 ; indeed, in lean meat it is as much as 70 per cent. If we disregard the pulses—which, if taken in large quantities, are not good for the digestion—we shall find that, to conform with the old standard (120 grs. protein and 3,000 cal., of which 16 per cent. of the calories should be protein), we should have to live on " mixed diet," that is to say, eat expensive animal food with the cheap vegetables.

All of which makes it obvious that we have to decide a most important economical consideration if the old protein standard is right. If we need only the half, or perhaps even less than half the amount of the old standard, then it is not at all difficult to live cheaply.

Suppose that a fully grown man needs 3,000 cal. per day,

then try to calculate how much the daily cost of his food would be were he to live on cereals alone, on potatoes alone, etc. According to prices now obtaining approximately in London, we have :—

	Cal. per farthing.	3,000 Cal. cost in farthings	in *s.*	*d.*
Cereals	262	11·4	0	3
Leguminosa . . .	205	14·4	0	3½
Potatoes . . .	165	18·2	0	4½
Fats	122	24·6	0	6
Butter	64	46·9	1	0
Milk	50	60·0	1	3
Meat	33	90·9	1	10½
Eggs	16	187·5	3	11
Lean Beef . . .	13	230·7	4	10

Thus it will be seen that it costs about twenty times as much to live on meat as to live on cereals. I admit that it is possible to buy meat in some of the poorer quarters at very cheap prices, but such meat is often of poor quality, and in nutrient content can be more expensive than good meat, besides the danger that cheap meat may be from diseased animals. We are on safer ground when we come to the cereals ; the cheaper kinds being by no means always the inferior. Sometimes the cheaper are even better than the more expensive, for example, I pay only 1½*d.* per pound (Danish) for flour ; while in some of the wealthier quarters as much as 3*d.* per pound is demanded for flour of no better quality. Perhaps it may be little more white, but that is no advantage at all ; if anything, it is a disadvantage. It would be very interesting to discover how many millions of money are wasted by housekeepers in certain countries, simply because they do not understand how and what to buy, thinking that the most expensive must be necessarily the best. The dearest may be the best in some cases, but more often than not it is otherwise. The shopkeeper trades largely on the fallibility of the public.

A young girl should not get married before she has passed an examination in the choice, purchase and preparation of food. Is not such knowledge quite as important as that of the names of all the rivers and mountains in China and South

America? But it must not be forgotten that false knowledge is very often worse than none at all.

Above I have mentioned only a few kinds of food-stuffs; space does not allow me to deal with the hundred and more varieties which are on the market. There are many vegetables which are more expensive than meat and eggs. For example, 1 lb. of melon contains only 90 cal. To obtain 3,000 cal. in a melon diet we should have to eat 33 lbs., which, at a cost of 4*d*. per lb., would be 11*s*. One pound of asparagus contains 85 cal.; 35 lbs., therefore, would have to be eaten to obtain the requisite number of cal., which, at a price of, say, 10*d*. per lb., would work out at 29*s*. People easily fall into the misconception that it is cheaper to live on vegetarian food than on a mixed diet. Moreover, there is a risk of getting too little nutriment when living upon vegetables alone. It is very easy to live healthy, well, and cheaply on vegetarian food, but you must know how to buy and use such food properly.

Very few people restrict their diet to a single kind of food, or even to a single group of foods. The customary diet is composed of various kinds of foods. As an example of the price of a mixed diet, I append the following rough calculations:—

A. Supposing that we, to obtain our 3,000 cal., take $\frac{3}{4}$ (2,250) from cereals, $\frac{1}{8}$ (375) from potatoes, and $\frac{1}{8}$ (375) from fat, the cost would be: 8·6 + 2·3 + 3·1 = 14 farthings: $3\frac{1}{2}d$.

B. Taking $\frac{1}{2}$ cereals, $\frac{1}{4}$ potatoes and $\frac{1}{4}$ fat, the cost would be 5·7 + 4·6 + 6·1 = 16·4 farthings: 4*d*.

C. Taking $\frac{1}{4}$ butter, $\frac{1}{4}$ milk, $\frac{1}{4}$ meat and $\frac{1}{4}$ eggs, the cost would be: 11·7 + 15·0 + 22·7 + 46·9 = 96·3 farthings, or 2*s*.

These standards are, as before stated, only imaginary. Few, or nobody, would follow them in practice; but a combination of B. and C. would, I think, correspond to the diet usual with many. The cost would then be:—

D. $\frac{1}{2}$ B. = 2*d*. + $\frac{1}{2}$ C. = 1*s*., in all 1*s*. 2*d*.

Surely a resident in London spending no more than that on his food would be regarded as living economically; though he could live just as well—or even better perhaps—upon half the money or less.

To give his theories a practical test, the author tried an eight

weeks' experiment, from June 25th to August 17th, 1905, to see how cheaply he could live without restricting himself to a limited number of varieties of food.

When I showed that I could live upon from 4*d.* to 6*d.* a day there was quite a sensation here in Denmark (I was driven to write a cookery-book to show how we prepared our dishes). People could not believe that it was possible, which is strange, considering that more than half the population of this world live on less.

We will, by way of example, take the fare provided in the prisons in Behari (p. 88), which food, as McCay tells us, is better than the food ordinarily used by the Behars (see p. 87).

The cost of the food (calculated according to London prices) :—

Rice	13·34	ozs.	at 6	farthings	per lb.	5·00	farthings.
Wheat	10·00	,,	,, 5·6	,,	,,	3·50	,,
Dhalls	6·00	,,	,, 8	,,	,,	3·00	,,
Potatoes	6·00	,,	,, 1·88	,,	,,	0·71	,,
Oil	$\frac{5}{16}$	,,	,, 32	,,	,,	0·63	,,
						12·84	

If we allow one farthing for spice, then the total cost would be fourteen farthings or 3½*d.* This diet, upon which the Behars wax strong and healthy, according to prices, obtaining from India, would cost only 1½*d.* (McCay, No. 48, p. 160).

The ordinary diet of the Sikhs, a notoriously vigorous people, would cost in London :—

Milk . .	16	ozs.	6·5	farthings	per lb.	6·5 farthings.
Wheat .	24	,,	5·6	,,	,,	8·4 ,,
Butter .	2	,,	56	,,	,,	7 ,,
Dhalls .	4	,,	8	,,	,,	2 ,,
Potatoes .	5	,,	1·88	,,	,,	0·6 ,,
Mutton .	1·33	,,	36	,,	,,	3·0 ,,
						27·5 ,,
						= 7*d.*

I have not included the rum in the above list, as I do not

know the price of it in England; but I am sure that the Sikhs would not suffer any harm without it. I do not suppose that we can compare the Indian butter with good Danish (English) butter. Judging by the price of it I should say that in quality it must be akin to margarine. If we compute the price of the butter as that of margarine—24 farthings—it would cost three instead of seven; and the total cost would be 23·5 farthings, or about 6*d*. As this diet provides the Sikh with more than 3,000 cal., 3,000 cal. would cost even less than 6*d*. And there can be no doubt that such a diet, which keeps the Sikh in such good condition, is ample for all requirements.

That it is possible to live on about 25 öre a day I have myself proved by means of a practical test lasting eight weeks, from June 25th to August 17th, 1905. As I cannot give the details* here, the reader must be content with the average figures for each day:—

	Protein grams.	Calories.	Cost in Ore.	Farthings.
1st week .	55	2,228	26·2	14·6
2nd ,, .	56	2,292	27·9	15·6
3rd ,, .	48	1,956	25·5	14·2
4th ,, .	53	2,203	24·8	13·8
5th ,, .	64	2,406	26·5	14·8
6th ,, .	61	2,323	25·9	14·5
7th ,, .	61	2,396	26·9	15·6
8th ,, .	59	2,281	25·2	14·6
Average:	57	2,236	26·1	14·6 = 3·7*d*.
Per		3,000		5*d*.

In those eight weeks I lost 2 lbs. in weight. And how did I feel during that time? Well, although I have lived very plainly for many years, I had never (except for a few limited periods) gone quite so far in frugality before, and *never did I feel better*. I was conscious of a decided increase in strength. I have been a cyclist for years; and the neighbourhood of Skanderborg is very hilly; in fact, in the whole

* Details are given in: M. Hindhede, "Ernæringsforsög," Copenhagen, 1907 (Nordisk Forlag).

country (and I am acquainted with many of our country roads), I know of no worse climbs than there are about here. There are inclines which for many years I hesitated to attempt, but that summer I managed them with greater ease than ever before. Although without being in training, I tried once a somewhat longer cycling tour. In one instance, on Sunday, July 29th, I left Skanderborg at 6.45 a.m. At first we had no intention of putting our powers to the proof ; it was to be merely a family excursion. I was accompanied by my wife, and one of my test subjects. We chose the route Skanderborg-Horsens—Brädstrup—Bryrup—Silkeborg—Skanderborg, in all, 105 km. (sixty-six miles). That was a fairly good performance for people of about forty-five years of age, of very little training, on one of the hottest days in summer. We allowed ourselves plenty of time, made a long halt in the middle of the day, and only arrived at Silkeborg (71 km. = forty-four miles) at 4 o'clock in the afternoon. When in Silkeborg, I had a feeling that there was no pleasure to be had in winding up the day by peddling that handspring of a distance into Skanderborg. I determined thereupon to ride to Lem, near Ringköbing, my birthplace. I left Silkeborg at 4.15 and arrived in Lem at 8.30—71 km. (forty-four miles) in four and a quarter hours. In order to show that I was not overstrained, I got up at three o'clock the next morning and rode back to Skanderborg, which I reached at 10.45 in the forenoon. The whole trip, 248 km. (155 miles), was supervised by witnesses ; these were, besides my companions during the first part of the excursion, Farmer Sören Lambäk in Lem, Dr. Harzen in Herning, Dr. Bjerregaard in Silkeborg, and others. I will here reproduce a declaration by the last named :—

" Dr. Hindhede passed through Silkeborg on Monday morning, the 30th July, at 7.30 in the morning. His pulse was then 73, vigorous and regular ; the heart was normal ; Respiration 16. (16 to the minute).

" P. C. BJERREGAARD."

Although I had thus ridden about 75 km. (forty-seven miles) at a speed of 17 km. (10·6 miles) per hour, I had not over exerted myself in the least. It could scarcely be said that I was in training, and before I arrived in Skanderborg—with the wind and sun in my face ; temperature 53° F. in the shade—

my legs felt somewhat tired, but my heart and lungs were quite unaffected. I may add that it has been a continually recurrent experience of mine that my heart holds out longer than my voluntary muscles. I do not easily get out of breath. That, I consider, has something to do with my nearly " poison-free " mode of life.

In the meantime my family and I continued our frugal way of living. Our household numbered in all ten (for a limited period there were twelve of us). The following table gives our food consumption for one month :—

TABLE II.

Food quantities in Kgs.	Cost in Pence.	Contents in Grs.		Fuel value Calories.
		Protein.	Fats.	
73·36 cereals . . .	224	6,160	720	236,834
33·44 sugar . . .	176	—	—	129,131
42·50 bread . . .	88	3,290	605	102,660
24·10 oleaginous foods .	385	75	21,855	204,476
149·25 milk . . .	191	5,515	2,990	76,410
4·40 cheese . . .	29	1,540	440	10,762
2·16 dried fruits . .	22	60	—	6,438
4 fresh fruit . .	30	40	—	1,312
158·50 green stuffs . .	175	2,600	30	114,681
6 eggs . . .	63	780	660	9,456
2·40 meat . . .	45	380	415	5,409
15 white beer . .	21	—	—	4,920
0·71 coffee and tea .	32	—	—	—
0·54 additional . .	5	—	—	—
yeast . . .	20	—	—	—
condiments . .	30	—	—	—
Total 306 days . .	1,536	20,440	27,715	922,796
,, per day . .	5	67·2	91	3,012
Reckoned for 270 days, per day	5·8	75·7	103	3,418

All individuals can be reckoned as adults, with the exception of two little girls of eleven and thirteen years of age, who, however, were away most of the time. Half the company consisted of ladies.

It will be noticed that in the last line of Table II., I have worked out the cost and content for 270 days. I have, in fact,

reckoned the ten to twelve men and ladies as equal to nine adult men. Nine men in thirty days gives 270 men in one day, by which we arrive at a cost of 5·8*d.* for an adult man, who, however, receives a very fat (containing 103 grs. fat), and a very rich diet (3,418 cal.). This method of calculation was adopted in order to compare the cost of our diet with that of other well-to-do families. Dalhoff and Mackeprang * give a table setting forth the disbursements of twenty-seven better class families for various victuals and proportioned to a year's provision for one adult man. In Table II. I have compiled a similar list. The figures for an adult man are obtained by multiplication of the prices given in Table II. (for 270 days) by one and one-third. Thus we obtain the cost for an adult man in twelve to thirty days.

TABLE III.

	My House.	The 27 Families.
	d.	*d.*
Cereals and bread	415	638
Sugar	236	197
Oleaginous foods	513	733
Eggs	85	178
Milk	255	373
Fruit	70	190
Vegetables (garden produce)	234	199
Meat	59	1,239
Delicacies	—	194
Condiments, etc.	67	190
Coffee, tea, cocoa	48	244
Beer, wine	28	280
Cheese	39	91
Miscellaneous	—	373
Total for one man per annum	2,049 = 170*s.* 9*d.*	5,119 = 426*s.* 7*d.*
,, per day per man	5·8	14*d.*
,, six men in one year	1,024*s.* 6*d.*	2,259*s.* 6*d.*

It will be of interest if we compare details. Cereals (corn, groats, etc.), and bread are classed together, because otherwise the comparison would not have been fair, as the twenty-seven families bought all their bread, while we bake our white bread ourselves. This is, of course, the reason why we get

* Dalhoff og Mackeprang, "De Bedrestille de Familiers Udgifter," Copenhagen, 1906.

our bread so cheaply. It will be seen that we have very sweet teeth in our family ; for we have eaten more sugar than all the twenty-seven families together. That the twenty-seven families have had to pay more for their oleaginous foods is, perhaps, because they ate butter, while we were content with a substitute. The disbursements for eggs and milk are much heavier on the side of the twenty-seven families, which is, indeed, a sign of faith in these " nourishing " foods. The twenty-seven ate more fruit, while we consumed somewhat more vegetables. The apparent reason for this is that in summer time we eat rhubarb in place of fruit, and the rhubarb is entered among the vegetables (garden produce). But where we have the pull over the twenty-seven is under the items meat and delicacies (snacks)). They also appear to have consumed an imposing quantity of spices and condiments, and the difference in coffee, tea, beer and wine, is tremendous. As to what is included in " miscellaneous " is not evident, so we must leave it undecided. Taking all in all, the above table tells us plainly that *that which makes living so expensive among the well-to-do are meat, coffee, tea, and spirituous liquors.*

But what return do these four dear, good friends make for the money they cost ? The answer is : Diseased kidneys, liver and heart ; gout and, above all, bad temper !

The figures in the last line—the 1,025*s.* and 2,260*s.*—give a fair yearly average for a family of from seven to nine members (equal to six adult men), according to the new and the old methods.

To tell the truth, I must confess that we do not always live quite so cheaply. There are times when we eat a little more meat, for I am no vegetarian, and it is impossible to prove that a little meat, now and then, is harmful. But rarely does it cost us more than 7*d.* per day to live ; yet we do not stint ourselves, as our daily bill of fare will prove.

It is only to be expected that readers feel some curiosity as to what we eat. But that cannot be described in a moment. To give a list of our dishes would convey nothing ; it is necessary that I give some idea of their various ingredients and the method of preparation.

Our principle is to select as much as we like of the cheaper

food-stuffs, and only a modicum of the more expensive—just so much, in fact, as to give them a fair test. Intelligence, discrimination, and culinary ability are, of course, among the essentials ; *but the key to the whole problem is that we never need trouble our heads about protein.*

Frederik Madsen.

I will now bring to the notice of my readers the case of a young man named *Frederik Madsen.* It was in the year 1906 ; Madsen was twenty-one years of age, and had been a vegetarian for the preceding five years. In all that time, so he avows, he had tasted neither meat, coffee, tea, alcoholic liquors, nor tobacco. During the first years he had to undergo many annoyances, because of his exceptional way of life, at the hands of his employer and his own family ; but it will be enough if we follow him from May, 1905, onwards, when he began his seventeen months' period of military service as engineer. After a great deal of trouble he managed to gain permission to forego partaking of the usual regimental rations, and to secure a food allowance in money upon giving an undertaking to cater for himself. For the first month and a half he was obliged to take his place at mess with his comrades ; but he ate nothing of the food by himself tabooed. During the ensuing fifteen and a half months he received for his food allowance somewhere about the following sums :—

160 days at 65 öre	=	8*s.*	6*d.*	.	104	crowns	= 114*s.*	6*d.*
152 ,, 70 ,,	=	9*s.*	2*d.*	.	106·40	,,	= 117*s.*	2*d.*
188 ,, 82 ,,	=	10*s.*	8*d.*	.	154·16	,,	= 169*s.*	8*d.*
				Total .	364·56	,,	= 401*s.*	4*d.*

Besides this, he managed now and then, in his leisure time, to earn a little by private work. Of these additional sums he kept no account, any more than he did of his expenditure. But he was able to recall the following amounts :—

Surplus from military service, in cash . 312 crowns.

One bicycle . . .	115	,,
One field-glass . .	18	,,
Stolen	25	,,
Mislaid	10	,,

New clothes when leaving army . .	70	crowns
New boots . . .	11	,,
Total . .	561	,, = 617*s.* 7*d.*

Danish soldiers do not save money as a rule; more often than not they have to rely on money sent them from home.

That was the financial side of the business. And he mentions many other advantages besides, such as his greater independence and liberty. When his comrades, for example, returned from exercise at 11 o'clock, they had to remain in barracks for two hours, waiting for dinner, while he was free to go out at once. Furthermore, he states that his comrades, while in barracks, were so tired of their uniform fare that they could scarcely eat it,* an experience which Madsen escaped entirely.

And what was the condition of this young man all this time? Was he able to fulfil his duties? To settle the matter, I applied to Surgeon-Major Dr. Bondesen, of the corps of Engineers. Dr. Bondesen was so kind as to send me the following communication and information, with permission to publish the same :—

"DEAR COLLEAGUE,—

"It gives me great pleasure to answer your inquiries concerning Pioneer Madsen, 456, 1905, as I remember him quite well, and while he was with us he excited my most lively interest—as well as that of the whole company. His diet was almost incredibly simple—consisting of bread, water and 'palmin,' with potatoes upon occasion, and, rarely, a little milk. He was a particularly useful man, an arduous worker, and possessed of greater powers of endurance than most people. He thrived amazingly; during the whole eighteen months he was never on the sick list, and never sought medical assistance. His weight during the first five months was :—

May 18th	69½ kgs.
June 16th	72 ,,
July 17th	72½ ,,
August 15th	76½ ,,
September 15th	74½ ,,

"He was not weighed during the winter, but he seemed to me to increase considerably in bulk in the course of that season, which I also

* To be obliged to eat the same meat diet for days together will soon disgust any man. As a matter of fact, it is extremely difficult to get a change of food in barracks.

mentioned in my medical inspection report. He acted as company cook's assistant; and helped himself to bread and boiled potatoes only—never anything else. He must, however, have consumed great quantities of these things.

"Of other particulars connected with him, his colour-sergeant made the following notes; they are absolutely authentic.

"Yours sincerely,

"J. BONDESEN.

"No. 456-1905. F. MADSEN.

"His daily fare consisted almost entirely of dry black bread and potatoes.

"He partook of the regimental probationary rations until he was relieved therefrom on July 5th, 1905; and during that period (May 16th to July 14th) appeared at the regulation meal-times.

"At dinner he chose only the porridge dishes, sweets, stewed rhubarb and the like. Of solid food he ate only bread and cheese, with margarine only on some rare occasion.

"After July 5th he catered for himself; his diet consisting principally of black bread, which he procured partly from the probationary kitchen, such pieces as were left over being given him.

"He used 'palmin' (coca butter) with his black bread. Sometimes, however, he had margarine; but only, as he said, when he could afford it.

"In the late summer he began to take bread-and-milk regularly; but evidently regarded it as a luxury (in an economical respect he appeared to make steady and continual progress all the time).

"As to his physical condition, he compared favourably—despite his peculiar nutrition—with any of his comrades in the company; indeed, he passed as one of the strongest and also—which, in the circumstances, is the more remarkable—as one of the most hardy. It was quite a common experience in the company to see how the men tried to get into the same working squad as No. 456.

"One of the company's junior officers, who frequently commanded a detachment set to work on the Lyngby-Vedbäk Railway (work in which No. 456 participated as a rule), stated in reply to inquiry that he often had occasion to observe the industriousness of No. 456, as it was known to this junior officer that 456 rarely ate lunch, notwithstanding that he tasted nothing in the morning before leaving camp. (But he did usually take something in the morning. It was only for a couple of months that he restricted himself to two meals a day—dinner and supper. Hindhede.) At lunch-time he contented himself with a short nap, after which he resumed work as indefatigably as ever. Upon his return from these expeditions he, so it is reported, consumed very large quantities of dry black bread. As a matter of fact, he made, relatively, a very hearty meal when once he had made up his mind to eat.

" He declared the best time he had to be that spent in cantonments, as it was then comparatively easy for him to procure fruit, tomatoes and the like; besides which the company took care that a dish of vegetables was set aside for No. 456.

" During the final camp manœuvres he asked permission one day to be allowed the water in which the potatoes had been boiled, and which was usually thrown away, a broth which he sipped to his black bread with keen appetite.*

" No. 456 was very robust, and, moreover, was never on the sick list. He hardly ever wore stockings, either in summer or in winter. It used to be a fixed rule with him, in winter and summer alike, as soon as he got up, to go naked down to the lavatory and let himself be thoroughly sluiced with cold water.

" 456 was a very thrifty man, and very methodical in money matters; he sought, from day to day, to increase his income; but he was never reluctant to lend to his comrades whenever any of the latter were in difficulties.

" He earned a good deal extra at his trade of gardening, especially in the last spring, when he laid out and kept in order gardens in Hellerup and the neighbourhood. He was so industrious that he set up as 'contractor,' and found jobs for about a dozen of his comrades at different places in the vicinity.

" The money he earned he paid regularly into the savings bank, and only once in a while did he spend anything on himself; thus, he bought a bicycle, and on his discharge was able to purchase himself a new suit for sixty-five crowns.

" 456 appeared to be very interested in literature, and in his leisure hours read pamphlets, newspapers and books, which he obtained from the library in the capital; he was also a frequent visitor to the library at the soldiers' home.

" His chief pleasure was to go to the theatre, but he always preferred the great dramatic masterpieces to purely popular pieces.

" He never smoked tobacco in any form. When in the company of his comrades and disposed to take refreshment, he always confined himself to soda-water or lemon and seltzer.

" L. E. Sörensen, Sergeant,
" 5th Comp., Eng. Regt.

" 20-12-1906."

Letters.

I might fill a large volume with the hundreds of letters I have received from my disciples; but I will give only one or two of them here.

Law Student C., writing on February 3rd, 1907 :—

* The potatoes were peeled before boiling. Potato soup is very nice (The Author).

"DEAR DR. HINDHEDE,—

"I was a disciple of your reform-diet even before the appearance of your book. During a journey through Finland in the summer of 1904, I began to consider, or rather, to ponder, for the first time, over the question of the 'grace of meat.' The tide of my fortune was at a very low ebb, and I had, perforce, to be careful in every particular, and, above all, with regard to meals (of which there are all too many in 'overfed' Finland); I had to reduce them to a minimum both in daily number and in cost. Thus it came to pass that for days together I took nothing else but the 'Smörgaas' (bread and butter dishes), which, in most parts of the country, consists of black rye-bread, Scandinavian hard bread, butter and cheese, as well as a black 'piroge' made of groats upon occasion. Therewith I drank fresh milk or coffee, the latter prepared in a way somewhat akin to that which is probably known to you as 'West-jutlandish.' I soon began to notice that every time my ascetic diet was interrupted by a 'meat-festival' (whenever, for instance, I was entertained by some family visited by me on my way through the country) I was overtaken by a remarkable feeling of fatigue which did not harmonise—I make this confession very reluctantly—with the sense of well-being which was the result of my spartan way of life, as I used to call it. But since my return, and particularly, of course, after your book appeared, I have been able to establish by experiment that my experience in the subject of nutrition coincides almost exactly with your own as set forth by you in your writings.

"I need scarcely add that this determination of mine has brought me as much joy and contentment as it has caused grief and consternation to my mother and to the other members of my family.

"Strange to say, I note that the ladies are the most bitter opponents of us 'Hindhede fanatics.' And, sad to relate, the more elderly housewives—at least, those with whom I am acquainted—are the most obdurate—nay, almost reactionary. If I would characterise my dear mother's dieteticai-physiological view of the matter, I could do so only in these words: She eats in accordance with the ideas instilled in her by her education, because she regards all reform as emanating from evil, and considers all the various kinds of gout and similar miseries with which she has been plagued for years as something good. All that is necessary is to adhere closely to old custom, and then there is no need to worry about new truths.

"But you must know plenty of similar instances.

"I will add that I, now twenty-seven years of age, have practised Müller's System since first it appeared, and have discarded woollen underclothing (in which, naturally, I have been swaddled since birth) for the past two years, never wearing socks, either in winter or summer.

"I owe deep gratitude to you and to J. P. Müller for a healthy, vigorous and energetic body, and you, in particular, have shown me how to live in a way as healthy as it is economical—which latter consideration is, as a rule, of the utmost importance to a student.

"Yours gratefully and sincerely,

"X. (Law-student)."

Richard L., Copenhagen, writes April 20th, 1907 :—

To Dr. Hindhede, Skanderborg.

" I must beg you to pardon me that I trouble you with yet another letter to the many which must be addressed to you as a consequence of your books ; but I thought it might interest you to have news of a man who has been following in your footsteps already eight months before he saw your book, and who, so far as he is aware, has obtained the most exceptionally beneficial practical results therefrom. As I say, I have now been living for about nine months here in Copenhagen very nearly on the same lines as laid down by you ; and in no single month have I spent so much as 10 crowns (11*s.*) on my upkeep in food—indeed, for one month, it cost me as little as 7½ crowns. The experiment was made partly for economical reasons, partly because I have suffered a good deal with gout and kidney disease (my last attack was in 1905, when I was confined to bed for five months with gout-fever and inflammation of the kidneys, and was for nine months unable to do any work). In the course of twelve years I have had gout-fever five times and other severe gout attacks, as well as six attacks of kidney-stone ; and it was in the hope of preventing stone and chalk formations, and to get rid of those already present, that I began to live principally on vegetable food. So far as I can tell, it has partially succeeded : for, whereas in the autumn I was so badly attacked by gout that I had to lay up for days together until the stiffness passed, during this winter I seem to have been free of a great deal of the stiffness, while I have also a distinct feeling that I now possess some resistance to the disease. Furthermore, my strength has markedly increased as a result of my simple and ascetic way of life, although one would think that the whole course of my life had changed to the detriment of my health ; for whereas I used, formerly, to get up between four and six o'clock in the morning, going to bed, as a rule, between nine and ten in the evening, I have been engaged in work during the last nine months which never permits me to go to bed before midnight, and keeps me up every other day, as a rule, until about three in the morning.

" Nevertheless, my strength has increased (I have, besides, lost in weight, the same decreasing from 195 to about 160 lbs.), so that I, who for seven years (I am fifty-two) could cycle scarcely for one half hour at any time without becoming bathed in perspiration, can now pedal away for from three to four hours without any particular exertion, and without getting too hot.

" Yours truly,
" L."

In 1906 certain young students started a boarding house after my principles. Three meals a day are provided at 17·25 crowns (19*s.*) a month. There is another similar establishment where the charge is a little more—22 crowns (25*s.*) per month.

3.—Six Young Men.

There are twenty to twenty-five men in the former house and forty-five to fifty in the latter. The accompanying photograph shows six of the men who boarded for about four years in the cheaper of the two establishments. These houses are called "Hindhede Boarding Houses;" but it is not exactly correct to designate them as such, as no meat at all is provided in either of them. I do not proscribe meat altogether; yet, of course, I recognise that it would be impossible to serve meat at such low prices as are charged in these houses. Even if it were ruled that only a little of it should be eaten, it is certain that some of the boarders would rebel at the restriction; therefore, if it is to be served at all, the price of board will have to be raised to avoid a deficit.

Real Hindhede diet can only be managed in a home where the parents have direct control over their children.

There may be some curiosity as to how the boarders in the above-mentioned houses fare on the simple diet. Some of them, after a time, experience a desire for meat in some form or other; but I have never heard that any of them have ever complained of any loss of strength, or of being less able to do strenuous work, as the result of subsisting on such plain food.

The photograph facing this page is of six young men who have been living, for the past three to four years, in the cheapest of the boarding houses mentioned, at a cost of 19s. a month.

I take leave to quote the case of Esper Andersen as a further example:—

Esper Andersen.

The following is from the *Mariager Newspaper*, August 3rd, 1912:—

"Twenty Years Ago.

"It is now twenty years since the Jysk Cykleunion (Jutland Bicycle Union) organised the Jyllandslob (Jutland Run).

"It began August 7th, 1892, at Magdalemöllen, at Aarhus. The run was 77½ Danish miles, or, about 363 English miles, from Aarhus southward to the frontier, across the heather-lands to the North Sea; then to the border of the Limfjorden; and back again to Aarhus.

"There were nineteen starters, of whom three fell out because of the breaking of their bicycles at the beginning, and six others gave up on the way.

"There were only ten who completed the course; and a dairy-manager, Esper Andersen, by name, from Jebjerg, in Salling, was the winner, arriving some hours before the second man.

"Of the participants from Copenhagen, who were the champion cyclers of the time, only one, Mr. Obel, finished. The racers did not count on the Jutland roads or the Jutland strength and endurance.

"It will be seen, by the following list that the three best riders were Jutlanders, and that of those who completed the run six were from Jutland.

1. Esper Andersen, Jebjerg (36 hours, 10 minutes).
2. Korndrup, Randers (39 hours, 27 minutes).
3. Randrup, Jebjerg (42 hours, 15 minutes).
4. L. Andersen, Holbk (42 hours, 48 minutes).
5. H. Obel, Copenhagen (42 hours, 53 minutes).
6. Lind, Ebletoft (44 hours, 28 minutes).
7. Anderschon, Odense (44 hours, 38 minutes).
8. Nielsen, Odense (46 hours, 25 minutes).
9. Hvid, Hammel (47 hours, 30 minutes).
10. C. Hansen, Randers (47 hours, 31 minutes).

"Esper Andersen was the Jutland champion, and, since the run has not been repeated, he is still champion.

"At that time the newspapers printed much about this contest. In the *Politiken* we read about the reception at Vennelyst, at Aarhus, as follows:—

"RECEPTION OF THE VICTOR.

"At 6.25 o'clock in the afternoon, Esper Andersen passed the judge's stand, after making 77 miles (363 English miles) in thirty-six hours and ten minutes, and was covered with flowers by the ladies.

"He would not listen to the suggestion of having a bath and a rub-down or even resting. He did not seem tired in the least. He took the train at 6.45 p.m. because he felt that he must go home to do his evening's work at the dairy; but on the morrow he promised to run over to Aarhus on his bicycle for the festival in his honour.

"After a five-minute speech he mounted his bicycle again, the crowd running after him and shouting 'Hurrah!'"

The following is from the *Skive* newspaper:—

"At ten o'clock in the evening, there were many more people at Skive Station than ever before, fully one thousand, and the management of the bicycle club had engaged a band of music to play at the station so that the first man of the club could be received with all the honour which can be done in a hurry, and which the hero of the day had so well earned.

"A little before the arrival of the train the music began to play, and as soon as Esper Andersen was visible the multitude shouted hurrahs,

and this was repeated wherever he appeared. He thanked them and they cheered again and again. Greater ovation has not been tendered to a bicycle champion anywhere. Esper Andersen must be reckoned as the best endurance rider of Denmark, and even of the entire North."

Esper Andersen was at that time thirty-four years of age. Since then twenty years have passed. Andersen was serving as the manager of a dairy in a Jutland village, and he was living in the same manner as a rather prosperous Jutland farmer lives at the present time; that is, on a mixed diet, with meat; though not so much meat as is usually eaten in the towns. He is very strongly built, weighing from 75 to 80 kgs., but at the age of fifty he went up to 100 kgs., and at the same time he lost his usual excellent state of health which he had enjoyed during his youth when he was in vigorous exercise.

He realised that he was eating too much—especially too much meat—and, therefore, he cut down the quantity of his food, reducing his meat, in particular, to the minimum. On this diet his weight went down, and he regained his former health. He felt quite young again, cycling with greater ease than before, and conceived the idea of making a test of endurance under conditions similar to those governing his triumph of twenty years before.

He began training, during which time he took a very hardy diet without flesh food. It consisted principally of bread, butter, vegetables and fruit.

On August 1st, 1912, at 9.15 A.M., Esper Andersen started on his second round of the former course, just twenty years later, accompanied by a motor bicycle as pacer, and with two "controls" (judges) in an automobile.

It soon began to rain, and he had to make his way on softened roads, which in that part of the country are often very bad, being very sandy. A threefold misfortune was the sequel of this bad condition. It was between Vejle and Herning. The motor went on before to order lunch; the automobile punctured a tyre. Esper Andersen had to ride alone, besides which he punctured his tyre and had no means of repairing the damage.

There was a delay of from thirty minutes to one hour. Later

he lost more time, though not so long as before, through taking a wrong road.

In spite of these misfortunes he made the course of 363 English miles in thirty-seven hours, or only fifty minutes more than twenty years before, which, as will be seen, were fully accounted for by the extraordinary delays interfering with this later test.

Esper Andersen gave me particulars concerning his diet previous to the time he went into training. The average for one day taken from the consumption of one week, was, besides his principal food, bread, butter and barley porridge—500 grs. (1 lb. 2 ozs.) cabbage ; 64 grs. (2·3 ozs.) sugar ; 29 grs. (1 oz.) cheese ; 9 grs. (5 drs.) fish ; 43 grs. (1·5 oz.) beets ; 29 grs. (1 oz.) carrots.

As will be seen, this is a very simple diet, even more so than mine. And yet on such fare Esper Andersen has recovered all his old capacity for enjoying life besides gaining renewed strength.

Of course, it does not at all surprise me. I say, " of course," so far as I am concerned ; but I shall be surprised if it does not astonish the world in general and athletes in particular. Such a result does not agree at all with the old ideas about " Invigorating " foods.

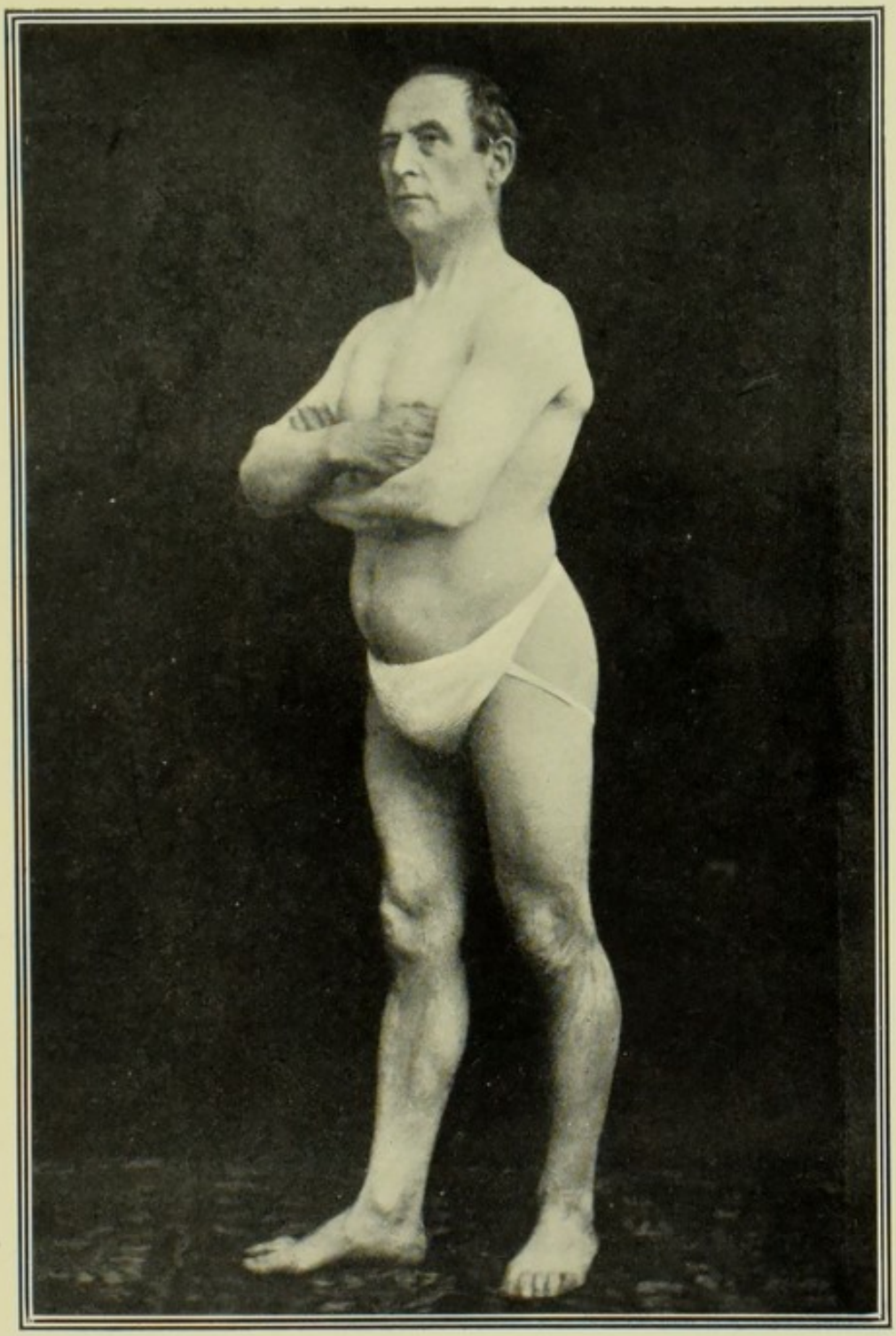
The photograph facing this page shows Esper Andersen as he was in December, 1912.

(B) Experiments to Decide the Nitrogen Minimum.

Since January 1st, 1911, I have had under my control a research laboratory, furnished by the Danish Government. My principal test subject has been Mr. Frederik Madsen, of whom an account has just been given, and he has also acted as one of my assistants in the work of the laboratory.

I have now the command of means wherewith to determine accurately the intake and output, and have already made many experiments upon the digestibility of various food-stuffs with Mr. Madsen and others.

Space does not permit me to go far into the subject, but I will give very briefly the principal results of a protein minimum experiment which lasted from January 8th to July 3rd, 1912.



4.—Esper Andersen.

When seeking to discover the protein minimum, it is necessary that the fuel value (calories) be taken into account at the same time. It is not in reason to suppose that an elderly and sedentary individual, whose requirement is only 1,500 cal. daily, needs the same quantity of protein as would a young and very active man, whose requirement may be from 3,000 to 4,000 cal. daily.

Instead of giving in definite figures the minimum requirement of protein for individuals of different weight, age and activity, it will be more instructive if we state the proportion in relation to the whole nutriment—protein calories in proportion to total calories. The old standard of Voit prescribed about 3,000 cal. for the average man of 70 kgs. in weight, of which 500 should be protein calories. The proportion of protein calories to total calories in this case was, therefore, one to six. If we are considering a question involving 105 grs. of digestible protein corresponding to 17 grs. of nitrogen and 430 cal., we must put it thus :

$$\frac{\text{Digestible protein calories}}{\text{Total calories}} = \frac{430}{3{,}000}^{*} \text{ or 1 to 7.}$$

In the above it would have been more correct if we could have stated the amount of *digestible* calories in the lower factor as we have done in the upper factor ; but as the digestible calories are not given in all the tests later used for comparison I have been unable to give them myself.

If we avoid using richly nitrogenous animal food we can on the same number of total calories reduce the digestible protein calories by about one half. Thus instead of $\frac{1}{7}$ we have $\frac{1}{14}$, or 52·5 grs. of digestible protein, corresponding to 8·5 grs. of nitrogen ; though it would be very difficult to get any lower. As a matter of fact, Prof. Chittenden has not gone so low, as a rule ; which will be seen if the subjoined examples are examined.

I have not taken all the subjects, but have selected only three professional men and six of the students as types.

* Hereafter, I intend to signify this proportion with the letter P.

	N Digest.*	Prot. cal. Digest.	Total cal.	P.	Calculated to 3,000 cal.	
					N.	Protein.
Professors—						
Chittenden . . . . (age, 48, wt., 57·4 kgs.)	5·61	144	1,613	1 : 11·2	10·43	65·19
Mendel . . . . . (age, 32, wt., 70·1 kgs.)	6·69	172	2,448	1 : 14·2	8·20	51·25
Underhill . . . . (age, 26, wt., 65·2 kgs.)	7·72	198	2,068	1 : 10·4	11·20	70·00
Students—						
G. W. Anderson . . . (age, 27, wt., 70·9 kgs.)	9·93	255	3,091	1 : 12·1	9·64	60·25
W. L. Anderson . . . (age, 22, wt., 61·0 kgs.)	7·22	185	2,494	1 : 13·5	8·68	54·25
Donahue. . . . . (age, 25, wt., 62·2 kgs.)	7·67	197	2,450	1 : 12·4	9·39	58·69
Jakobus . . . . . (age, 22, wt., 57·0 kgs.)	8·30	213	2,542	1 : 11·9	9·80	61·25
Schenker . . . . (age, 22, wt., 71·9 kgs.)	9·16	235	2,486	1 : 10·6	11·05	69·06
Stapleton . . . . (age, 24, wt., 73·4 kgs.)	9·49	243	2,809	1 : 11·6	10·14	63·28
Average . . .	—	—	—	1 : 12·0	9·84	61·47

From the above report of Chittenden's, it would seem as though we may safely conclude, that although a man, who needs 3,000 cal., gets scarcely 10 grs. of digestible nitrogen (61—62 grs. of digestible protein) he is yet able to establish nitrogen-equilibrium. Yet this is only about 59 per cent. of the old Voit standard—105 grs. of digestible protein.

Prof. Chittenden himself did not go so low as would appear at first glance ; for we must take the small number of calories into account.

There is no doubt but that an adult man, whose daily requirement is 3,000 cal., can maintain nitrogen-equilibrium when only one-twelfth of these—viz., 250 cal.—is furnished by digestible protein ; but it is of far more interest to me to discover whether this is the minimum or whether we can go even lower than this.

* The figures in this column are obtained by deducting the N in fæces from the N in food (see table on p. 69).

There have been very few investigators who have experimented with foods wherein the proportion of protein was less than one-fourteenth. Most of the names of these have already been given in another part of this work, but I will repeat them here together with the dates of their experiments :—Hirschfeld, 1887—1888 ; Kumagawa, 1889 ; Klemperer, 1889 ; Peschel, 1890 ; Sivén, 1900 ; Landergren, 1902 ; Folin, 1905.

The following table gives a survey of results obtained :— *

	N Digest.	N in Urine.	Bal.	Cal. in Prot.	Total cal.	P.
Hirschfeld . . . . (age, 24, wt., 73 kgs.)	5·78	5·87	— 0·09	150	3,628	1 : 24
Kumagawa . . . . (age, 27, wt., 49 kgs.)	6·72	6·06	+ 0·06	172	2,584	1 : 15
Peschel . . . . . (age, 23, wt., 80 kgs.)	5·47	6·04	— 0·57	140	2,669	1 : 19
Sivén . . . . . (age, 30, wt., 58 kgs.)	5·70	5·64	+ 0·06	146	2,481	1 : 17
,,	4·54	4·14	+ 0·40	116	2,477	1 : 21
,,	2·97	3·40	— 0·43	76	2,444	1 : 32
,,	1·12	2·29	— 1·17	29	2,441	1 : 84
,,	1·10	1·97	— 0·87	28	2,441	1 : 87
Landergren II. . . . (age, 22, wt., 70 kgs.)	0·26	5·33	— 5·27	6·7	3,246	1 : 484
Landergren IV. . . (age, 20, wt., 62 kgs.)	1·05	4·85	— 3·80	27	2,808	1 : 104

On the above table it will be seen that Kumagawa established equilibrium at N.R. $\frac{1}{15}$; Sivén at $\frac{1}{17}$ $\frac{1}{23}$; and Hirschfeld approximate equilibrium at $\frac{1}{24}$; but in those cases where P is lower, none established equilibrium.

All these experiments have the same failing : they were of too short duration, lasting from four to nine days only. Sivén's was somewhat longer, lasting nineteen days in all, following a period of twenty days on the usual diet. But we can see that the nitrogen excretion in the urine can be brought much lower than was thought possible, and still nitrogen equilibrium be maintained ; but we also receive the firm impression that the organism cannot subsist for any length of time on these low

* Klemperer we have omitted for reasons already given (too much spirits). Neither could we include Folin, because he did not take into account the digestible protein, which was, probably near to vanishing point, as with subject No. II. of Landergren's.

standards. Nature protests and revolts at once. Klemperer gave his subjects a liberal supply of alcohol and chalk to prevent eructations, cramp, colic and diarrhœa, from which otherwise they would have suffered.

Peschel writes :—

"Whether I could continue with the same food for longer periods, maintaining nitrogen equilibrium, I cannot say. In this respect, I have just as little evidence of having reached the limit as have other investigators. In any case I could not have continued with the food any longer in the form prescribed. Even if the body-cells could have withstood it, the palate and stomach would have rebelled. I must also add that while I, personally, felt no definite physical antipathy when serving as a test-subject, I must admit that I did not 'feel so well and strong as usual.'"

Landergren writes :—

"At the same time, all my subjects, including those who got more than enough of energy foods, felt peculiarly languid when starved of nitrogen, although they enjoyed the food."

Sivén writes :—

"During periods V. and VI., when solid food was not taken, the writer felt great disgust at the monotony of the plain fare, and only by great persistence and determination was he able to continue the experiment to the end."

And later on, he writes thus :—

"If the experiments had been continued for a few days longer, I might, perhaps, have established nitrogen equilibrium ; but owing to the great aversion of the appetite to the food which I had been taking during the last eight days, and for other extraneous reasons, I was compelled to abandon the experiment."

I have already described the composition of these intolerable diet prescriptions ; but, for the sake of convenient reference, I will again give a few examples :—

Klemperer :—300 grs. bread ; 300 grs. butter ; 250 grs. sugar ; 800 grs. beer ; 280 c.c. (about 10 ozs.) cognac ; half litre (·88 pint) coffee, and 2·5 grs. meat extract.

Peschel :—145 grs. butter ; 150 grs. sugar ; 150 grs. bread ; 75 grs. rice ; 482 grs. potatoes ; 50 grs. cakes ; 50 grs. honey ; 750 c.c. cognac ; 10 grs. tea ; 2 grs. meat extract ; 8·6 grs. salt.

Sivén :—120 grs. butter ; 600 grs. potatoes ; 105 grs. sugar ; 45 grs. cream ; 300 grs. apples ; 400 c.c. tea ; 500 c.c. coffee ; 330 c.c. beer.

Landergren :—Sago ; sago-powder ; raspberry syrup ; potato flour ; and sugar. All this was stewed to a cream, which was eaten with bread made of 100 parts of wheaten flour, 200 parts Messina flour, 55 parts butter, with yeast and caraway seeds.

Folin :—400 grs. starch and 300 c.c. cream, boiled together.

If the readers can imagine what such bills of fare signify, I am sure they will be as badly affected as I was, for I began to feel squeamish at the mere thought of having to subsist for several days on such diet and on nothing else. Such combinations are too sweet, too fat, and too insipid. It was no wonder that the organism protested !

Without taking the protein into consideration, these dietaries undoubtedly lack certain substances necessary for the nourishment of the organism. Although I can subsist for months together on bread made from wholemeal flour, I get tired and weak on bread made from sifted flour. And how should I fare if I had to eat bread made of starch alone, with a starch and sugar porridge therewith ?

I do not think that these investigators understood how to arrange a combination of food-stuffs poor in protein so as to avoid the unfavourable influence of other factors. The best way in which I can illustrate how I accomplished this is to give a few examples. Below is the record of an experiment of eleven days' duration. The average of the eleven days is given as the daily standard :—

PERIOD 2. JANUARY 14TH—24TH.

	N.	Cal.
2,191 grs. of potatoes . . .	7·06	2,368
153 ,, margarine . . .	0·12	1,254
In food	7·18	3,622
In fæces 17 grs. of dry substance .	1·14	93
Digested	6·04	3,529
Lost per cent.	15·9	2·6

Calories in digested protein, 155 ; total cal. 3,622 ; P 1 : 23·4 (1 : 22·8).*

In urine, 5·83 ; N balance, 6·04 − 5·83 = + 0·21.

On such a simple food as potatoes alone (and fat) we are about able to reach a nutritio-ratio † corresponding to that which was formerly the lowest (Hirschfeld, 1 : 24) at which nitrogen equilibrium was maintained.

But we can go even lower.

The protein-content of various kinds of potatoes differs very much ; thus, König, in 210 analyses, found that it varied from 0·69 to 3·67 per cent. of protein ; Atwater in 136 analyses found the protein-content to vary from 1·1 to 3·0 per cent.

The potatoes used in above experiment contained 0·322 per cent. of nitrogen ; that is, 2·0111 per cent. of protein (1·081 cal.). Later, we discovered a variety of potato which contained 0·1925 per cent. of nitrogen, or 1·201 per cent. of protein (1,031 cal.).

An experiment with this latter variety, continued for nineteen days, showed the following daily average :—

PERIOD 15. APRIL 17TH—MAY 5TH.

		N.	Cal.
	2,337 grs. of potatoes .	4·50	2,409
	165 ,, margarine .	0·13	1,352
	216 ,, onions . .	0·26	157
In food	. . . . .	4·89	3,918
In fæces	21 grs. of dry substances	1·27	108
	Digested	3·62	3,810
	Lost per cent. . . .	26·0	2·8

Calories in digested protein, 93 ; total cal. 3,918 ; P 1 : 42 (1 : 41·7).

In urine, 3·41 ; N balance, 3·62 − 3·41 = + 0·21.

Here is a balance with a P much lower than any before recorded. If we wish to go still lower, we must use rhubarb,

* The figures in parentheses show P calculated to digested calories.

† It is not quite correct to use this expression for P. The exact N.R. would here (calculated in digestible matter) be 1 : (22·8 − 1) = 1 : 21·8.

or strawberries, combined with starch and sugar as a porridge, in which combination there is no fear of nausea.

The eight-day experiments gave the following daily average :—

PERIOD 19. MAY 29TH—JUNE 5TH.

		N.	Cal.
	700 grs. of potatoes .	1·63	750
	65 ,, margarine .	0·05	533
	89 ,, onions . .	0·11	65
	1,912 ,, rhubarb . .	1·21	344
	207 ,, starch . .	0·29	704
	400 ,, sugar . .		1,658
In food	. . . . .	3·29	4,054
In fæces	77 grs. of dry substance .	2·83	321
	Digested	0·46	3,733
	Lost per cent. . . .	86	7·9

Calories in digested protein, 11·8 ; total cal. 4,054 P = 1 : 344 (1 : 316).

Another eight days' experiment with strawberries :—

PERIOD 22. JUNE 26TH—JULY 3RD.

		N.	Cal.
	700 grs. of potatoes .	1·63	750
	75 ,, margarine .	0·06	615
	2,519 ,, strawberries .	3·27	919
	162 ,, starch . .	0·23	551
	375 ,, sugar . .		1,554
In food	. . . . .	5·19	4,389
In fæces	128 grs. of dry substance .	5·16	624
	Digested	0·03	3,767
	Lost per cent. . . .	99·4	14·2

Calories in digested protein, 0·77 ; total cal. 4,389 ; P = 1 : 5,700 (1 : 4,892).

These four periods are only given as examples. The first part of this experiment in search of minimum protein possibilities continued from January 28th to July 3rd. The

following table gives some main average figures for the nitrogen balance :— *

Periods.	Days.	Food.	Digestible N in Food, per day. grs.	N-Balance. whole per. grs.
1st	6	+ Potatoes . .	5·60	− 15·69
2nd	11	+ Potatoes . .	6·04	+ 2·24
3rd	10	+ Potatoes . .	6·64	− 9·50
4th	9	+ Potatoes . .	7·14	+ 5·62
5th	4	+ Potatoes, prunes .	2·33	− 8·52
6th	8	+ Potatoes . .	6·70	+ 14·97
7th	8	Black bread, prunes .	4·07	− 0·29
8th	4	− Potatoes . .	3·65	− 6·55
9th	4	+ Potatoes . .	6·85	+ 2·28
10th	10	− Potatoes . .	3·89	− 8·05
11th	3	− Potatoes . .	3·77	− 0·62
12th	5	+ Potatoes . .	7·31	+ 7·90
13th	12	− Potatoes . .	3·78	− 15·82
14th	6	− Potatoes . .	3·71	− 3·84
15th	19	− Potatoes . .	3·62	+ 4·15
16th	7	− Potatoes . .	2·45	− 16·69
17th	8	− Potatoes . .	4·15	+ 6·28
18th	8	− Potatoes . .	2·84	− 11·15
19th	8	− Potatoes, rhubarb	0·46	− 29·00
20th	11	+ Potatoes . .	7·36	+ 25·26
21st	9	− Potatoes . .	4·29	+ 2·86
22nd	8	− Potatoes, straw-berries	0·03	− 21·10
22 per.	178 days			− 75·25 grs. of N.
5 per.	34 days (1, 5, 7, 19 and 22)			− 77·60 grs. of N.
17 per.	144 days			− 0·65 grs. of N.

Thus it will be seen that the total loss is 75·25 grs. of nitrogen which represents 470 grs. of protein. This loss is small, and did not seem to affect Mr. Madsen in any way. But if we take the fruit periods away, where we (except in period 7) tried to get far below the limits of balance-possibilities, and also take the first period away, which, on account of reasons already stated, cannot be used, we have seventeen periods, or 144 days, on pure potatoes diet, left ; or fifty-eight days on normal potatoes and eighty-six days on potatoes with quite abnormal protein content. During these days there was an exact balance (− 0·65 is inside the limit of errors).

I must add that health conditions throughout the whole experiment, with the exception of an attack of tonsillitis for

* I cannot here give details, which can be found in a separate report, which will be published later, in the "Skand. Archiv. für Physiologi," I think.

about four days, were excellent. On January 8th the weight was 73·3 kgs., and on July 3rd 69·3 kgs.—a comparatively small loss when we take into consideration that the experiment was pushed to extremes for the purpose of finding the minimum requirement of protein.

But there is no certainty, even now, that we have discovered the limit. In the 15th period, our test-subject, a very active man, using about 3,900 cal., maintains nitrogen equilibrium on 3·62 grs. of digestible nitrogen, that is, 22·6 grs. of protein, of which about one-third was not protein, but low nitrogen compounds. We have:—

	3,918 cal.	N digested 3,629	= 22·69 of protein.
calculated for	3,000 ,,	,, 2·77	= 17·3 ,,

We may remember (p. 126) that the diet used for Prof. Chittenden's experiment, of a fuel value of 3,000 cal., contained on an average 9·84 grs. of digestible nitrogen, which is 61·5 grs. of protein; therefore it will be seen that we ourselves used a diet from three to four times lower in protein content than that used by Chittenden. But, as before remarked, we are not quite sure that we have ascertained the minimum.

At first I thought that these experiments on potatoes so poor in protein must be at too low a level, and that unpleasant results would ensue; but both Mr. Madsen and myself, for I had also been testing the diet for some time, were ready to persist until any unpleasant symptoms should appear. After the eighty-sixth day on this diet Mr. Madsen was compelled to relinquish the experiment, because, the time being then midsummer, we could get no good potatoes. But as, after about three months' trial, there was no hint of the anticipated unpleasant results, we came to the conclusion that it would exhaust our patience to wait for such.

That the nitrogen excreted in the urine can go lower than the 3·41 grs. recorded in the 19th period will be seen from that fact, that in the 22nd period, when we were reducing the digestible nitrogen in the food to a negligible quantity, the nitrogen excreted continued to decrease: 1st day, 4·23; 2nd day, 2·90; 3rd day, 3·16; 4th day, 2·64; 5th day, 2·58; 6th day, 1·80; 7th day, 1·97; 8th day, 2·03.

These figures would suggest that there is a possibility of equilibrium on 2 grs. of nitrogen—that is, on 12·5 grs. of digestible protein, and on even less if we calculate on a basis of 3,000 cal.

These results, which are confirmed by many other experiments of mine on low protein diet, suggest, at least, that an active man of between twenty and thirty years of age, of 70 kgs. in weight, can easily establish equilibrium on 25 grs. of digestible protein, which is only 24 per cent. of the old academic standard of 105 grs.

It may therefore be said that *the whole protein problem over which the world has been worrying itself for the past fifty years has been but one huge mistake; for if we are to judge by the results of these equilibrium experiments, it would seem to be practically impossible to avoid getting protein enough.*

If we take the trouble to study the innumerable equilibrium experiments (Atwater and Langworthy, for example, in the United States Reports of the Bureau of Agriculture, Bulletin No. 45, have collected altogether 2,299 of these tests) the only comment we can make is: *What a waste of time and labour!*

If 4 grs. of nitrogen is enough, it is absurd to think that we should have paid such great attention to insignificant plus and minus balances in records covering only a few days and when the supply has been between 15 to 20 grs.! As a matter of fact, equilibrium experiments lasting only a few days are valueless. For the first fourteen days on poorly nitrogenous food Mr. Madsen failed to establish equilibrium. Had I concluded the experiment then, as has so often been the case with other investigators (I may say that I have found no recorded experiment on potato diet of more than three days' duration) I must have arrived at a totally false conclusion.

As already demonstrated, there seems to be little risk of getting too little protein; but there would seem to be much greater risk of getting too little of other more important, but less well-known food substances, the supply of which is as liberal in poorly nitrogenous as in richly nitrogenous foods.

Apart from the question of protein-minimum, our experiments revealed other interesting data, which the exigencies of present space forbid us to include. Those who wish to study

these are referred to the special reports of the experiments. In this book I must confine myself to a few remarks concerning

Digestibility; Requirement of Calories, etc.

Reference to the tables given on pp. 129 and 130, will show that from 2,200 to 2,300 grs. of potato there were excreted only 20 grs. of dry substance in the fæces, or about 1·2 grs. of nitrogen and about 100 cals. All my potato tests, with different subjects, extending about 1,000 days, showed like results. Now, if we take into consideration the probability that this refuse may have been derived from the intestinal secretions, *we may assert with confidence that potatoes are completely digestible.*

Even if we calculate the nitrogen and fuel value in the digestive secretions as loss, as has hitherto been done, the sum is only 1·2 grs. of nitrogen and 100 cals., or about 2·7 per cent. of the total cals., which is surely but a trifling amount.

Differing entirely in this respect from the potato, the nitrogen in the *strawberry* is wholly indigestible, the nitrogenous substances being present only in the skin and seeds, which pass through the intestines without being absorbed, entailing a loss of 624 cals. in the fæces. As regards the other nutriment taken with the strawberries, there is no doubt that nearly all of it was digested; discounting the strawberries, therefore, there would have been a loss of only 100 cals. in the fæces. Thus the strawberries, which had originally a fuel value of 900 cals., would appear to have been responsible for the loss of 500 cals., which means that over 50 per cent. of the calories of the strawberries was lost.

Two thousand five hundred grams of strawberries, costing about Kr. 1·20 (1*s.* 4*d.*), give only 400 cals., or not more than is yielded by about 400 grs. of potatoes, costing only 3 öre (less than ½*d.*). In other words, *strawberries are forty times as expensive as potatoes in fuel value.*

It is now easy to comprehend what egregious mistakes *Albertoni** and *McKay*† were guilty of when asserting that it is necessary to provide animal food with vegetable foods in order

* Albertoni, "Archiv. für exp. Path. and Tharm.," Vol. 64.

† McKay, "Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India," Nos. 34, 37, and 48.

to increase the digestibility of the latter. The coolies of Bengal suffer much from diarrhœa, and excrete as much as from 400 to 500 grs. of fæces daily with a loss of from 7 to 8 grs. of nitrogen.

But it is not because the coolies' food consists of vegetables. My subjects on potato diet never suffered from diarrhœa, and excreted only from 60 to 90 grs. of wet fæces, with about 1 gr. of nitrogen. McKay, throughout his long work, was able to prove nothing more than that dhall beans make very bad food. That he should bring this forward as evidence against Chittenden's experiments is quite unreasonable. It has been common knowledge for many years on the Continent that beans are difficult to digest, and result in a great loss of nitrogen in the fæces.*

It would seem as if potatoes react beneficially on the intestinal functions. When potatoes are well masticated they agree well with the subject, and there would appear to be much less fermentation in the alimentary canal, and the fæces have very little odour. Only once in the long course of the experiments were Mr. Madsen's evacuations at all moist, and those of another subject were somewhat of the same nature for a few days, owing to his having partaken of too much fat. These observations are in strict accord with those of Sivén.†

In proportion to Prof. Chittenden's test-subjects, I remarked that my subject used a far greater number of calories—in all the potato periods: av. 3,600 cal., 3,500 digested cal.—while Chittenden's students, weighing on an average 70 kg. each, used only a little more than 2,800 cal.

Now, the question is: Does a low nitrogen supply necessitate the use of more calories? But we cannot answer this question so far with any degree of certainty. As already stated, we are not quite certain as to Prof. Chittenden's figures; furthermore, before we can decide by comparison, we must know something about the activity displayed by the subjects. My test subject is an assistant in my laboratory, doing not only the work of a janitor, but has many other duties to perform. He is a very active man, who is in constant movement from

* Prausnitz, "Zeitschrift für Biol.," Vol. 26, p. 228.
† "Skand. Archiv.," Vol. 10, p. 113.

six o'clock in the morning until ten at night. His calorie requirement does not astonish me.

Sivén, who brought the nitrogen katabolised down to as low a level as we did, used only 2,450 cal.

I have, therefore, no grounds for believing that the protein minimum demands a disproportionately large amount of calories. Prof. Chittenden, we may remark, thought that in reducing the protein he would also be able to reduce the number of calories.

I wonder if it will be necessary, when yet further reducing the protein, as we did, to counter-balance the reduction by increasing again the proportion of calories.

Perhaps, readers may doubt—especially if they judge by the results obtained by other experimenters—the possibility of being able to eat potatoes and butter alone for six months. I will cite that which Folin wrote after one day's experience of potato diet in the middle of his—as I conceive it to have been—terrible starch-cream diet :—

"On July 7th each of the two subjects consumed about 2 kilos of potatoes instead of the arrowroot starch food; one of the subjects being tired of the pure starch. This change was tried for one day. . . . It may be here remarked that the consumption of about 400 gm. of starch in the form of potatoes, even for one day, proved a much more difficult task than taking arrowroot; and the following day both Dr. A. and Dr. N. expressed a decided preference for the pure starch."

After reading the above, does it not seem incredible when I state that Mr. Madsen and certain other subjects of mine, on December 20th, 1912, have been subsisting solely on potatoes and margarine for more than 300 days each, while a few others, including myself, have been doing the same for about 100 days ? Yet, it is absolutely true, as I have ample evidence to show. Of course, to succeed, careful attention must be paid to the following details :—

Firstly :—One must know how to buy potatoes.

Secondly :—One must know how to boil potatoes.

Thirdly :—One must know how to eat potatoes.

It is only during the first few days that any difficulty in eating the potatoes will be experienced; but this will be overcome in about a week's time. But *conditio sine qua non* : Never eat a bad potato. It will kill the appetite.

One of my best subjects, Mr. Horace Fletcher, who is epicurean in his tastes, writes me as follows :—

" I enjoyed the potatoes cooked in your laboratory by Mr. Madsen more and more as time went on, until I became quite accustomed to them as a regular diet ; but I cannot always rely on getting good potatoes. Even when I am assured that they have been boiled fresh, expressly for me, I have not always found them uniformly good.

" When travelling in Germany and Italy, I took with me my scales, and had, therefore, no trouble in weighing my potatoes ; but it was not so easy to tell whether the dishes served me were not made up of potatoes which had been standing some hours, or even days, in a warm atmosphere. On restaurant cars I fared better than in hotels. On two or three occasions I was made temporarily ill from eating old potatoes which had been disguised in the cooking.

" I am convinced that when potatoes are good in the first place and are well cooked, it is not only possible but very agreeable to subsist on them continually without experiencing any but pleasant results."

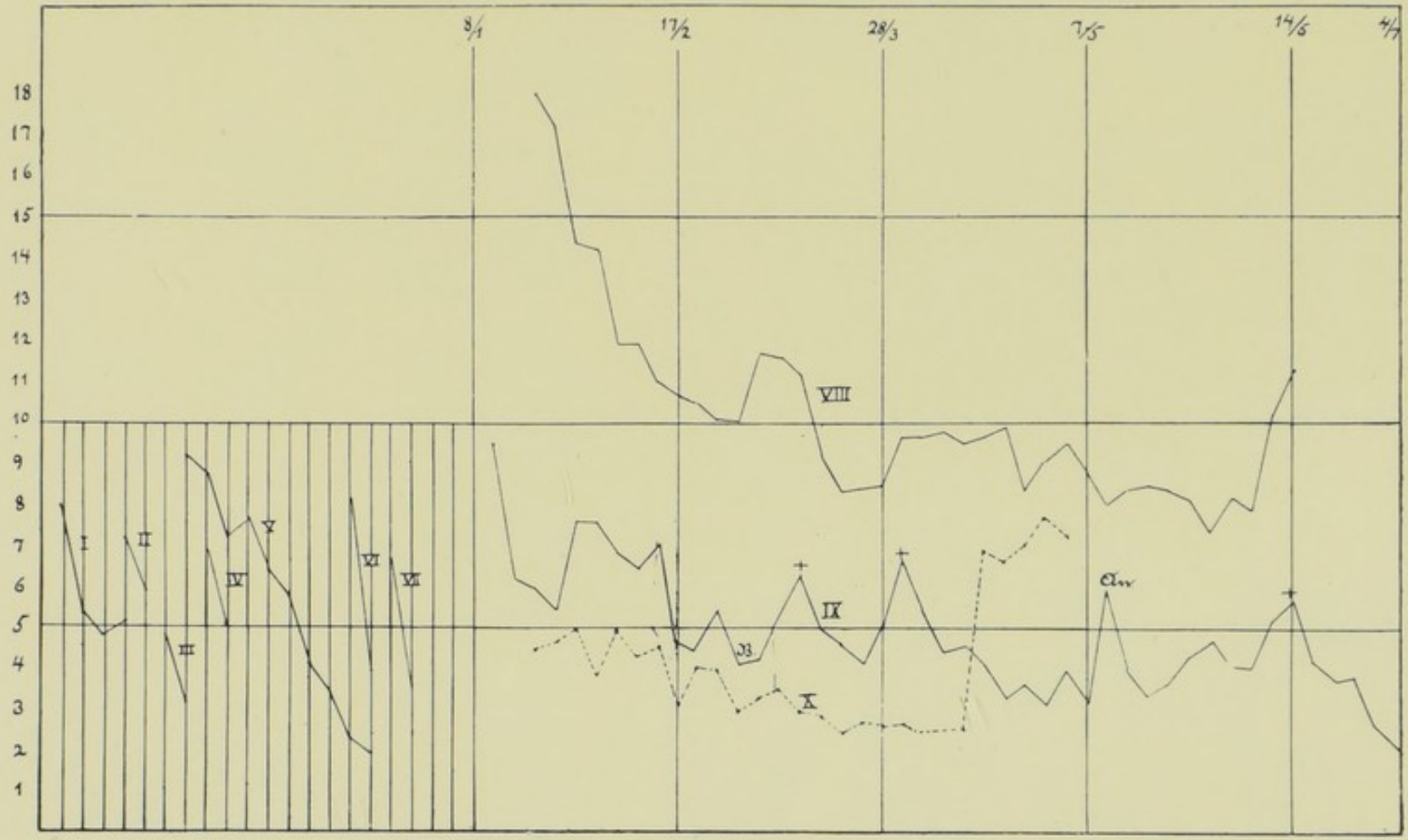
" Sincerely yours,

" HORACE FLETCHER."

In the diagram facing this page will be found a survey of the various minimum experiments which have hitherto been made.

I. Hirschfeld. .	1887	15 days	7·94	5·48	4·81	5·15	—	—
II. Hirschfeld. .	1888	8 ,,	7·27	5·87	—	—	—	—
III. Klemperer .	1889	8 ,,	4·89	3·11	—	—	—	—
IV. Peschel . .	1890	8 ,,	6·98	5·07	—	—	—	—
V. Sivén . .	1900	39 ,,	9·22	8·70	7·22	7·62	6·34	—
			5·64	4·14	3·40	2·29	1·97	—
VI. Landergren .	1902	7 ,,	8·52	3·80	—	—	—	—
VII. Folin . .	1905	7 ,,	7·20	3·40	—	—	—	—
VIII. Chittenden* .	1904	152 ,,	17·78	17·15	14·33	14·19	11·85	11·86
(G. W. Anderson)			10·90	10·38	10·10	10·00	11·70	11·50
			11·11	9·22	7·34	7·39	7·41	9·66
			9·68	9·75	9·49	9·63	9·88	8·76
			9·06	9·42	8·67	7·97	8·31	8·44
			8·33	8·11	7·25	8·15	7·80	10·14
			11·20	—	—	—	—	—
IX. Hindhede . .	1912	178 ,,	9·41	8·17	5·92	5·32	7·58	7·52
(Fr. Madsen)			6·77	6·42	6·89	4·46	4·33	5·32
			4·04	4·16	5·29	6·78	4·92	4·60
			4·15	5·01	6·61	5·41	4·32	4·49
			4·19	3·23	3·54	3·10	3·78	3·12
			5·76	3·82	3·26	3·63	4·22	4·69
			4·04	3·99	5·14	5·63	4·24	3·47
			3·06	2·55	2·00	—	—	—

* Klemperer, Landergren and Folin made several experiments with different individuals, of which I have selected only one, and that the longest, in each case, as a type. From Chittenden's experiments with students I have taken G. W. Anderson. His weight was about 70 kilos, and his nitrogen output per the urine for the last two months of the experiment was 8·81 gm. per day, or the exact average for all the students during the same period.



5.—Nitrogen Minimum.

The figures used in construction of the diagram are given in the table on page 138. The figures with decimals represent four days' averages in grs. of nitrogen excreted per the urine. The number of days standing after the year of experiment indicates the length of period occupied by each test.

It will be observed that there have been very few of these minimum protein experiments. With the exception of those of Sivén (Klemperer's, as already remarked, cannot be used for purposes of accurate comparison) none have been lower in nitrogen than 5 grs. for more than a very few days. The Chittenden experiment was much above this figure.

With regard to our own experiments, it will be seen that for the first forty days—from January 8th to February 17th—while Mr. Madsen was subsisting on ordinary potatoes—those with the usual protein content—he went above 5 grs. of nitrogen. The irregularity of the curve in the diagram, although only four-day averages are reckoned, and the nitrogen content of the food varies but little, showing in a striking manner how useless it is to take any notice of any short time balance.

After February 17th Mr. Madsen went below 5 grs., and frequently under 4 grs. The three summits of the curve, marked +, correspond to short periods when he was again, for the sake of experiment, eating ordinary potatoes, the nitrogen in the urine going up immediately as a result. It suggests that the relatively large amount of nitrogen in ordinary potatoes is of no use to the body which, consequently, tries to get rid of it again at once.

The summit of the curve, marked "An," corresponds to the days when Mr. Madsen was not himself, owing to the slight attack of tonsillitis ("Angina") mentioned above.

B. shows an eight-day period on a diet of bread and prunes. It is interesting to note that here the nitrogen excretions tend to decrease rather than otherwise. In this instance we get equilibrium on 4 grs. of nitrogen—about 25 grs. of protein. This is directly contrary to Rubner, who declares that, while we may reduce nitrogen excretion on potatoes,

we cannot establish nitrogen equilibrium on a bread diet containing less than 90 grs. of protein.*

This contention forms one of the chief arguments with which Rubner still defends the old Voit standard of protein requirement; but even this argument is without avail, as I have other data with which to disprove it.

Madsen's curve, given on the diagram facing p. 138, follows that of Chittenden; but is much lower. This seems to me to afford a good guarantee that in no case is there any risk in accepting Chittenden's figures as a standard in the place of those of Voit and Rubner. For practical purposes the limit of protein economy has there been reached. To go lower becomes a matter of difficulty.

I have not yet mentioned Curve X. in my diagram. This curve is even lower than IX. It belongs to a person (myself), fifty years of age and 68 kgs. in weight, yet who was satisfied on 2,500 cal. But I must again refer to the special report.

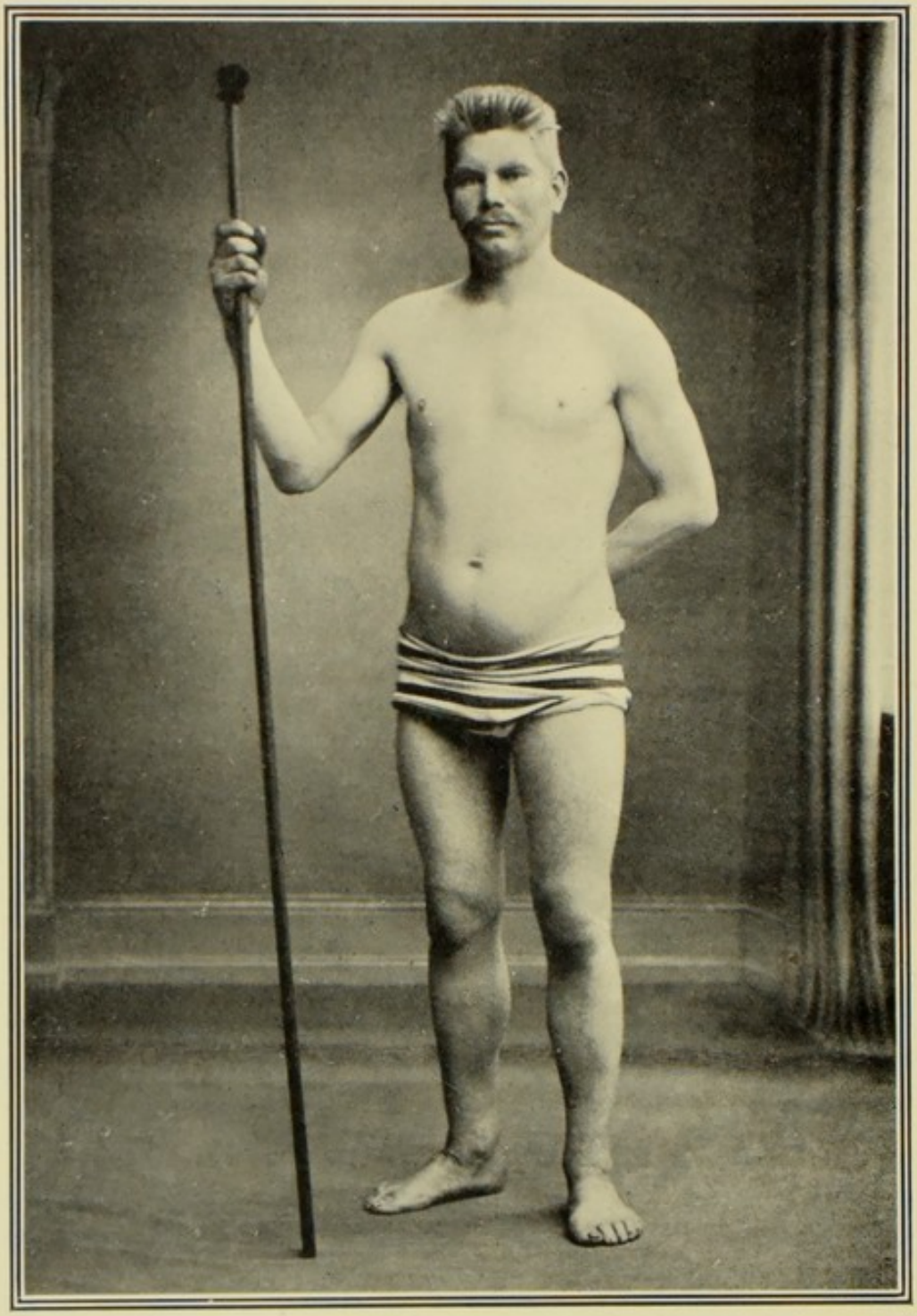
If anyone pretends that such extremely extended and monotonous experiments are of no practical value, because it is hardly likely that anyone will elect to live on potatoes alone as a regular diet, I reply that to live in security it is absolutely necessary to ascertain definitely the boundaries within which we are safe.

It is of the utmost importance to the cottager and the farmer to know that potatoes may be used with safety as the mainstay of diet. Potatoes cost next to nothing to raise, very little labour and land being required for the purpose. No food is so easy to provide and prepare. Corn must be reaped, dried, threshed, ground, kneaded, leavened and baked. Potatoes need only to be dug up, or pulled, from the soil, washed and boiled for about half an hour; and, moreover, it must not be forgotten that potatoes will grow in ground too poor and dry for corn to thrive.

Further Particulars Concerning the Minimum Test.

The above test with Mr. Madsen was not completed on July 3rd. There was an interruption of a month during the

* Rubner, "Volksernährungsfragen," 1908, p. 41.



6.—Frederik Madsen.

summer holidays * (July 4th—August 8th), after which the potato experiment was continued until December 18th, 1912. In order to test whether it was possible to perform heavy work on a strict potato diet, Mr. Madsen took a place as farm labourer during harvest time, and after that as mason's labourer (August 9th—November 11th). He tried to work as hard and as long as possible, but beyond increasing his daily allowance of potatoes (3,500 grs. or about 8 lbs. were eaten daily) he made no other change worthy of remark. His physical condition was excellent. From November 12th to December 18th, 1912, he continued the same diet when back again in the laboratory. The details of calculation are not ready yet for publication, but I would ask the reader to examine the accompanying photograph of Mr. Madsen taken on December 21st, 1912. There is no sign at all of under-nourishment. He is absolutely fit in every respect.

As some people might think that I could not give a wholly unbiassed statement of Mr. Madsen's physical condition, I asked the following experts to be so kind as to test Mr. Madsen themselves. These gentlemen were :—

Dr. Holger Strandgaard, M.D., Director of the Boserup Sanatorium for Tuberculosis.

Dr. Axel Borgbjærg, M.D., Specialist in gastric and intestinal diseases, Copenhagen.

Dr. Joh. Fisher, M.D., Professor at the University of Copenhagen, X-rays Specialist.

Dr. Kjær-Petersen, M.D., Copenhagen. Our most experienced physician in investigating the number of blood corpuscles.

Dr. J. P. Chrom, M.D., Author of " Klinisk Mikroscopi," and for several years " clinical assistant " in our largest hospital here in Copenhagen.

I take this opportunity of recording my indebtedness to

* During this period Mr. Madsen did not live on potatoes alone, because at the time and in the place where he was he could not always get good potatoes. The old ones were indifferent and the new ones had not come in ; he confined himself to his usual purely vegetable and protein-poor diet of bread, butter, porridge, etc.

these gentlemen for their kind assistance. No one will doubt their ability and impartiality.

I will restrict myself to giving the following statements :—

"BOSERUP SANATORIUM,
"*November 25th*, 1912.

"I have to-day examined laboratory assistant Frederik Madsen, twenty-seven years old, paying special attention to the lungs and heart. The thorax is well formed; respiration is normal; no dullness. Lung sounds normal.

"Cardiac dullness from the left sternal margin to 1 c.m. inside the nipple line. Ictus in the fourth intercostal space rather weak. The heart sounds normal. Pulse 64, regular, strong.

"The muscles of thorax and arms unusually well developed. He looks, on the whole, healthy and natural.

"After three minutes of strong gymnastic exercises the heart sounds were quite unchanged. Respiration 24.

"N. J. STRANDGAARD."

"AXEL BORGBJÆRG, M.D.
"Specialist in
Gastric and Intestinal diseases. "*Copenhagen d* 22-12-12.

"Examining Mr. Frederick Madsen in November, 1912, I found no sign of any organic or functional derangement in the organs of digestion. Both the secretory as well as the motory functions of the stomach were normal.

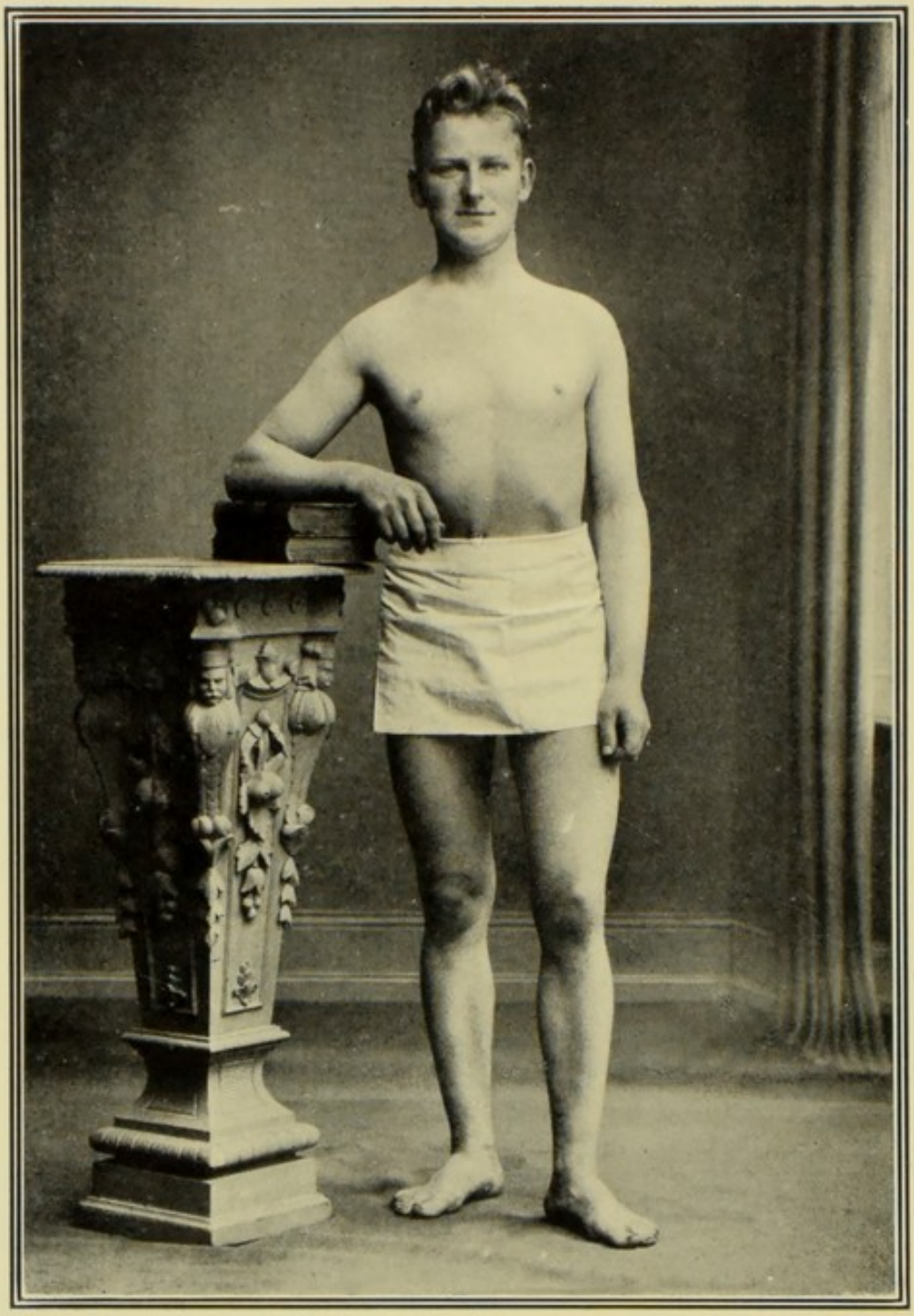
"A Röntgen photograph of the stomach taken by Prof. Joh. Fisher on December 4th showed that the form and position of the organ were normal. There was no sign of dilatation.

"AXEL BORGBJÆRG."

"During December, 1912, the undersigned estimated at different times the number of red blood cells of Mr. Frederik Madsen; the numbers per mm. were calculated as follows:

	4,300,000
	4,480,000
	4,320,000
	4,320,000
	4,488,000
	4,748,000
Average	4,444,000

"ELISABETH LUDVIGSEN.
"KJÆR PETERSEN."



7.—Alfred Jörgensen.

"COPENHAGEN,
"*December 28th*, 1912.

"By blood tests on Mr. Frederik Madsen in the St. Thomas Alle Laboratory, the red blood cells were found in the proportion of 4·5 million per mm.

"The amount of hæmoglobin was determined according to Haldane's method at 101 and 104.

"J. P. CHROM."

The normal number for red cells is not very constant, but it lies between 4 and 5 millions; generally, say, 5 millions, for men and 4·5 millions for women. If the number ascertained in the Madsen test is a little low, on the other hand, the amount of hæmoglobin is large (normal, 90—100). Every blood cell has, therefore, more than the normal amount of hæmoglobin.

The X-ray photograph shows Mr. Madsen's stomach taken by Prof. Joh. Fisher after a meal of bismuth-porridge. It affords visible proof that there is no sign of dilatation, although the subject had been living for so many months on potatoes alone, the daily amount during the last four months being about 8 lbs. per day.

If Mr. Madsen had been the only subject tested, it might be supposed that his was an exceptional case. But as I have already said, I had many others undergoing the test, and results were all very much the same.

MR. ALFRED JÖRGENSEN,

as will be seen by his photograph, is a young man, his age is twenty-one, and he is a student. From January 18th to December 18th, 1912, he lived on potatoes and margarine alone, except for a short period during the summer holidays. In these eleven months there was a decided improvement in his physical condition. On December 20th, 1912, he covered the distance, running and walking, between Haslev and Copenhagen —forty-two miles—in nine hours, notwithstanding that he had been out of training for the preceding five months at least. Such a feat, he assures us, would have been an impossibility with him a year before, when even a short-distance run would bring

on heart palpitation. He started from Haslev at 4.30 a.m., and arrived here in Copenhagen at 1.30 p.m., and was by no means exhausted; on the contrary he appeared quite fresh and fit, as attested by Dr. A. Pers, M.D., Mr. Horace Fletcher and others; and spent most of the afternoon going about the town.

As he does not live in Copenhagen, I cannot personally supervise his diet; but I am sure that he is an absolutely reliable man. He occupies several honorary posts, such as President of the Temperance Association in the large college at Haslev; is one of the leading members of the Danish Students' Temperance Association, and holds a prominent position in the Y.M.C.A. As his experiments in diet caused much sensation and discussion at the college, he was constantly observed by his 200 comrades—which was, perhaps, the best of all possible supervision. Had he purchased any food but potatoes in the little town of Haslev, the news would have immediately been conveyed to, and have become common knowledge at, the college.

During the summer vacation, Mr. Jörgensen undertook a cycling tour of seventeen days through Denmark and Sweden.

During this trip his expenses were :–

	Crowns.	£	s.	d.
Bread	2·70	0	2	11½
Margarine	0·89	0	0	10¾
Sugar	0·34	0	0	4½
Cherries	0·17	0	0	2¼
Rhubarb	0·10	0	0	1½
Food	4·53	0	4	6½
Tickets	9·88	0	10	10½
Other Expenses	5·88	0	6	5½
Total Crowns	19·85	1	1	10½

For three days of the seventeen he enjoyed the hospitality of friends; for the remainder of the time his night's lodging was a haystack. He carried a saucepan and some margarine

in his satchel, and when hungry he would seek out a potato-field, ask permission of the owner to dig up a few potatoes, which he would boil and eat with the margarine. Such a meal, he declares, was delicious.

Whenever he refers to this tour, his face lights up with pleasurable reminiscence.

CHAPTER XIV

OVER-FEEDING

NEARLY all healthy human beings and animals can, by augmenting their food supply, store up fat to a certain degree; but putting on fat and maintenance of a state of corpulence is a costly business. Nature has always a distinct tendency to return to normal conditions if the augmented supply of food is discontinued. This assertion may, perhaps, appear to be contrary to the experience of many stout people. They may, perhaps, yearn to be able to reduce their figures; but such a wish is not often gratified. And wherefore not? Frequently it is because the palate is always being tempted by dainties produced by culinary art, and the individual is consequently induced to eat far more food than his normal condition requires. The body is not able to use up the surplus, and new layers of fat are, therefore, stored up as soon as the old ones disappear. There are many remarkable cures for obesity. The most renowned is the Banting treatment, which requires that the patient live principally on lean meat, taking starches and sugar only in very limited quantities. This cure often achieves its object, but, at the same time, the meat diet results in exhaustion and depression. The best cure for obesity is extraordinarily simple; it is nothing but this: (1) Diminish the intake; (2) increase the output; or, in other words: "Eat less and work more." This as a cure for obesity is ten times better than the Banting system. There is nothing to be gained by becoming slim, if, at the same time, the treatment results in debility. But if, while eating less, the muscles were invigorated by sport and work, one would grow, simultaneously, *slim and strong*.

As a consequence of the doctrine of hyper-nutrition, which has held sway for so long, people have conceived the most singular ideas concerning health and strength. I do not know

what is the English ideal of a "strong man," but the German ideal I conceive to be that of a man of some 80 to 90 kgs. (13 to 14 st.) with fat, rosy cheeks, a fairly round abdomen. and a layer of fat some two to three inches thick evenly distributed over the surface of his body. A very common objection to vegetarianism, as well as to teetotalism, is this: "Yes, but the vegetarian, or the teetotaller, looks so weedy and so miserable." And it is directly due to such conceptions that we are led to admire butchers and brewers' draymen, because they look so strong, and to despise the weedy moorland peasants of Jutland, in Denmark, or the Japanese. But let the butcher try to perform the work of the moorland peasant on a hot summer day; or harness the brewers' drayman to a Japanese jinrikisha, and our views as to what constitutes strength and endurance would alter considerably. A very large number of these so-called strong men are weaklings in reality, whose thick cushion of fat may, perhaps, merely serve to conceal flabby muscles, and a heart and liver suffering more or less from fatty degeneration, and who pants and wheezes with every great exertion, and one who may perhaps, die in early life (as already stated, the average life of a brewers' man in Munich does not exceed forty-two years; but it is possible that the men look "strong" to the last).

Of course, I am far from asserting that every stout man is a weakling. A heavy build indicates strength; and by a heavy build a physician always understands a well-developed muscle system or skeletal framework. But whether a man is "strong in fat," or "strong in muscle," is not to be determined by a mere chance encounter in the street; we require expert examination of him in a naked state to decide that. Of course, there is nothing to prevent the association of corpulence with strength; but, speaking generally, it may be said that corpulence is a very doubtful asset, which, though many strive to obtain it, there are many more who try to be free of it.*

* I take this opportunity of quoting an American doctor of many years' experience, who has had frequent occasion for research among different classes of people. He writes (Edward Curtis, M.D., "Nature and Health," New York, 1906, p. 70):—

"That over-eating tends to shrink the span of life in proportion as it expands

At this juncture one is sure to encounter a rejoinder that has every appearance of weighty importance. It is something like this: "But it must be healthy to live generously; otherwise, how could tuberculosis be overcome by the fat cure?" Many dozen times have they tried to bowl me over with this poser, wherefore I think it would be unwise to evade the ticklish point raised.

First of all: is it certain that the fat cure—hyper-nutrition—can cure tuberculosis? Well, considering how often we hear and read that it does, we ought to believe it. But, all the same, I am not convinced of the correctness of the dogma. I do not deny that patients on a super-diet have been able to recover; but this does not prove that recovery was due to the diet. Some ten years ago it was noticed that patients seemed to get well when ordered plenty of brandy, wine and beer. And now it is maintained that such treatment is harmful, and that, if the patients recovered, it was in spite of the treatment. Suppose history repeats itself in this case, and in another decade we come to the decision that the patients of to-day who recover have done so in spite of the hyper-nutrition treatment! Over-feeding is certainly not the only means of cure. Of most importance, I believe, are open-air treatment, care of the skin, etc. I hold that, in reality, the ideal treatment is that which insists that the consumptive patient live out-of-doors day and night throughout summer and winter alike. The effect of custom and consideration of the possibilities of bad weather or snowstorms may constrain us to let the patient pass the night indoors, when, to make up for it, we leave all the windows open, no matter how many degrees

the liver is demonstrable both directly and indirectly. Let any life assurance agent be asked his experience with heavy-weight risks, in whom the waist measures more than the chest, and the long-drawn face of the business man, at the memory of lost dollars, will make answer without need of words. If careful note be taken, of those happy ones who attain to green old age, and, in nine cases out of ten, these jolly old boys—no disparagement, but all honour, in the phrase, will be found to be modelled after the type of the octogenarian, Bryant, or the nonogenarian, Bancroft—the white-faced, wiry, and spare, as contrasted with the red-faced, the pursey, and the stout. It is true that in old age much of an adventitious obesity is absorbed and disappears; but the Bryant-Bancroft is that of a subject who has never been fat at all. And just such is pre-eminently the type that rides easily past the fourscore mark, reins well in hand, and good for many another lap in the race of life."

of frost there may be. I agree entirely with *Prof. Saugmann** that no harm results from such treatment. Furthermore, experience makes us absolutely certain that people who live with their windows open hardly ever take cold, except when they are in the company of others who, fearful of draughts, mew themselves up in air-tight rooms. I believe that if we were all brought up from childhood on the creed of the open door and window we should be able to dispense altogether with sanatoria. But the most useful result of all would be freedom from the haunting fear of fresh air, from which about 99 per cent. of us suffer.

But while the sanatoria are able to show so many good results by means of the open-air treatment, and are thus of such great assistance to us in combating ancient superstition in this direction, it is extremely vexatious and provocative of harm that they not only encourage the other superstition as to hyper-nutrition and the gospel of meat, but even go so far as to agitate on its behalf.

I have had personal experience in the treatment of tuberculosis,† and I have, moreover, devoted some time to the study of the disease and its statistics. My experience and studies have not strengthened my faith in the doctrine of hyper-nutrition, which, moreover, conceals the danger that, meanwhile, the stomach is being ruined. I have sought elsewhere to demonstrate the unreliability of tuberculosis statistics, and I would add to that which I have already said, but that it would take us too far.

It is difficult to see into the future; nevertheless, I will venture to prophesy that a time will come when all this hyper-nutrition and over-stuffing will be abandoned, and we shall be content to prescribe for our consumptive patients a relatively cheap, carefully-prepared and, to a certain extent, varied diet, one which they could also provide for themselves, even if their means were slender. Meanwhile, I take it for granted that open-air treatment, physical culture, intelligent care of the skin, etc., will continue to progress. In which case it will soon appear that the appetite will begin to assert itself, and, con-

* "Ugeskrift for Läger," Copenhagen, 1904, p. 437.

† For many years there has been a small sanatorium attached to the hospital over which the author presided for eighteen years.

sequently, the majority of patients will put on weight ; though they must be warned against putting on too much.

These opinions of mine are supported by the following remarks made to me by a physician well known for his work in connection with the tuberculosis problem, and who is at the same time chief physician to a large Children's Home. His information ran somewhat as below :—

" The children in the Home live quite simply, eating only very little meat. An important part of their diet consists of rather thick slices of black bread and margarine, etc. It is wonderful how well all the children look. They recover in astonishing time once, they come into the Home, and the various tubercular affections disappear, as a rule, spontaneously."

But even if there were any probability that a fairly generous supply of food and a certain degree of plumpness were of advantage against a wasting disease such as tuberculosis, it does not follow that there is any need for the large quantities of meat so often consumed in sanatoria. Meat is not fattening, by the way. That people have conceived the idea that much meat makes fat is because big meat-eaters consume, as a rule, a lot of fat, and above all, over-eat themselves because the various meat courses appeal to their palates.

I will give an instance of an increase in fat on very plain diet. Quite recently I had under my care in the hospital at Skanderborg a porter of fifty-seven years of age who was suffering from a stomach complaint of long standing. He was put upon the following diet :—

Breakfast : Coarse oatmeal porridge, tea, white bread and butter.

Lunch : Porridge or gruel of various kinds and prepared in different ways.

Afternoon : Oatmeal soup with fruit-juice ; some pastry.

Supper : White bread and cakes, with tea.

On this diet his weight increased as follows :—

28/8/1905 (on admittance) .	58½ kg.
2/9/1905	59½ ,,
9/9/1905	61 ,,
16/9/1905	62½ ,,
23/9/1905	64 ,,
30/9/1905 (on discharge) . .	65

which is an increase of 6½ kg. in thirty-three days on extraordinarily simple diet, and meanwhile his stomach trouble disappeared altogether. I sought to vary the monotony of the diet by the addition of certain usually harmless dishes, such as baked fruit, vegetable butter, a little boiled fish and other similar foods, but they did not agree with this man.

Wherefore, when it is a question of putting on fat in a case of tuberculosis, I propose that fat be made with fat and carbohydrates, and that meat be sparingly employed, which will be as beneficial as it is cheap.

But even if it be correct to fatten tuberculous patients to a certain degree, by no means does it follow that healthy people ought to be also fattened. Among other evidence to the contrary, we may cite that which is an every-day observation in farming, and that is that fat and highly nourished animals cannot last out so long as thin ones.*

The individual who carries about with him a layer of fat some inches thick reminds me of that man who always took with him, wherever he went, a 25-kg. sack of flour slung round his neck so that he should never know the pangs of hunger. Body fat would be of as much service as flour in such a case, but it would be of advantage to carry one's store of provisions somewhere else than on the abdomen or on the shoulders.

I will conclude this chapter with the following statistics †:—

* That I am not alone in my opinions regarding the danger of sanatorium cures is proved by the subjoined extract from an article entitled "Hypernutrition of Tuberculous Patients, and its Dangers," which appeared in the *Journal des Practiciens*, of October 6th, 1906.

"Patients on such a diet are preparing for themselves a source of manifold ills. The immediate consequences may be: digestive disorders, diarrhœa and colitis, congestion of the liver; passing on to diabetes, albuminuria, skin troubles, bronchitis, blood-spitting, nervous disorders, tabes.

"Later consequences to patients subjected for a long time to hypernutrition treatment may be: sclerosis (induration and hardening of the tissues), constriction of the blood vessels, obesity, gout, gall and kidney-stones, etc.

"It is said that a sufferer from tuberculosis can cure himself so long as his digestive powers are normal. One might also add that he is running a risk, at the same time, of acquiring arthritis (gout).

"There is no doubt that a tuberculous patient, in whom there is an increase of katabolic change, requires an augmented allowance of food. But hypernutrition with protein is useless. It creates either digestive disorders, or arthritical complaints arise; stone in the kidney, among others."

† Mosso, "Krankheit und sociale Lage," München, 1912. Refer to statistics of the Insurance Company "Germania" and to Dr. Bouchard, Paris.

	Morbidity (Bouchard). Normal Persons.	Stout Persons.
Bronchitis	100	946
Kidney stones	100	652
Psoriasis	100	460
Hæmorrhoids	100	414
Gall stones	100	400
Eczema	100	383
Gout	100	312
Asthma	100	291
Furuncles	100	240
Bright's disease	100	189
Heart diseases	100	187
Stomach diseases	100	45
Tuberculosis	100	25

	Mortality (Viktoria). Normal Persons.	Stout Persons.
Liver diseases	100	440
Apoplexy	100	161
Nephritis	100	153
Heart diseases	100	144
Tuberculosis	100	32
Age	100	0

It will be seen that both morbidity and mortality are very high among stout people, stomach diseases and tuberculosis being exceptions; although, at the first glance, it would seem surprising that the former disease does not afflict the stout to greater proportion. But the explanation may possibly be that it is particularly those men possessed of vigorous stomachs who are able to eat so much that they grow fat. They are fat because they have healthy stomachs; and do not have healthy stomachs because they are fat. A man with a weak stomach can scarcely become stout. There may be some truth, therefore, in the saying: "It is healthy to have a weak stomach."

Further, a man suffering from tuberculosis is not likely to grow stout.

But even if we admit that fattening is able, to some degree, to prevent tuberculosis, so many other ailments appear in consequence that in the end the result will be adverse.

The statistics of the "Viktoria" Insurance Company show that—

Of stout persons . 90 % die between 30 and 60 years.
Of normal „ . 70 % „ „ 30 „ 60 „

According to these statistics, a stout man cannot expect to die a natural death of old age. It should not be forgotten that many of the so-called "stout people's diseases" are very painful. Death from old age is painless.

POSTSCRIPT, NOVEMBER, 1912.

The foregoing chapter was written in the year 1905, since when, it would appear, physicians of tuberculosis sanatoria have been coming round more and more to my way of thinking.

At the sanatorium at Silkeborg, in Denmark, the chief physician, Prof. S. Bang, and his assistant, Dr. Begtrup Hansen, made experiments with Hindhede diet.*

The diet ordinarily employed at the sanatorium for an individual weighing 75 kg. was one of

4,800 cal. and 190 grs. protein.†

During the period of experiment the patient in question weighed on an average about 66 kg. Under normal conditions, therefore, he would have received a diet of

(about) 4,200 cal. and 166 grs. protein.

Instead of this, he was supplied, while the experiment lasted, eighty-six days in all, with a daily average of

3,500 cal. and 84 grs. protein ;

that is, the fuel value was reduced to about five-sixths, and the protein to about one-half.

As we have seen in a former chapter (p. 110), the author, during his two months' experiment, took a daily average of

2,236 cal. and 57 grs. protein.

If we increase this supply by about 50 per cent. we get

3,354 cal. and 86 grs. protein.

Thus it would appear that the experimental diet in the sanatorium, in so far as it was constituted, was a diet quite *à la* Hindhede, the quantity only being increased. We have now to see how the patient fared on his half-ration of protein.

First, a little information as to his condition at the beginning of the experiment. We will hear what Dr. Hansen himself has to say :—

" The case was one of a patient in Ward III. (a severe case, therefore) suffering from an open tubercle, from albuminuria, with symptoms of incipient laryngeal tuberculosis, together with a slight fever temperature. One cannot pretend that he was a man specially suitable to undergo an experiment. The reason why we continued the experiment with him was that the albumen in his urine gave us definite data on which to arrange the test-diet, and because the continued increase in his weight indicated that the experiment was doing him no harm. Finally, a positive result from such a patient was bound to be of the greatest value."

* Th. Begtrup Hansen : "Bidrag til Belysning of Ernäringsterapien hos Phtisikere" in "Beretning fra den danske Nationalforening til Tuberkuloseus Bekämpelse," Copenhagen, 1907, p. 129.

† There are sanatoria in Germany where the diet is one of 5,000 cals. and 250—260 grs. protein.

Then follows a table giving content of food, nitrogen equilibrium, weight, etc. Equilibrium was always *positive* throughout the experiment; and, if the first three days are deducted, an average of six tests makes it appear that 1·36 grs. of nitrogen, which represents 8·5 grs. protein, were put on. In the eighty-six days the weight increased by 6·9 kg. (from 62·3 kg. to 69·2 kg.); and during the experiment the lungs showed great progress towards improvement. I will again let Dr. Hansen speak for himself. He writes :—

" When the period of experiment began, the patient was still a little feverish. He had begun to leave his bed, and also came for a few days to the ' convalescent ward,' but had to return to his bed, as his temperature again rose. After this his temperature declined slowly and steadily until, at the beginning of September, he was normal. He was by this time back again in the convalescent ward, and, by degrees, was able to take longer and longer walks, until, at the end of the period, he was out walking for five hours daily. Albumen disappeared altogether from his urine.

" Taking all in all, he made as good progress during the period as could possibly be wished. Examination of his chest showed a decided diminution of the lung-affection. Expectoration became insignificant. The tubercle bacilli disappeared. There was no more albumen in the urine. The fever left him, and, what is more remarkable, his weight increased by 6·9 kg.; the affection of the larynx alone remained unchanged, and all on a diet which complied only in limited measure with the usual treatment by hypernutrition with special administration of protein, as the quantity of protein supplied was diminished by more than one-third [Dr. Hansen could well have said, ' by about one-half '] in proportion to the allowance of protein in the diet usual in the sanatorium."

At a subsequent period the patient was put on the ordinary sanatoria diet. He continued to increase in weight; but only to the amount of 5·3 kg. in 107 days, which is at the rate of 50 grs. per day, whereas his daily increase during the period of experiment was 80 grs. Dr. Hansen writes :—

" Thus he made steady progress, though scarcely at the same rate as in the foregoing period, in which he, so to say, took the decisive turn for the better. This, however, affords no reason for assuming that the poorly albuminous diet had a more beneficial influence than the richly albuminous; rather was it that at the end of the period of experiment the patient had advanced as far on the road to recovery as he could come rapidly. Progress must go more slowly after that."

Dr. Hansen concludes with the following expression of opinion, with which I can entirely agree :—

" Of course it is impossible to draw from one single experiment any further conclusions regarding the question of nutrition in the cure of phthisis. The test-subject may have been a good economist in the up-keep of his body (which he certainly was), and it is safe to say that cases to the contrary would not be difficult to find; what the experi-

ment does show is that excessive protein feeding is no absolute and imperative necessity in the cure of phthisis."

The following was written quite recently by Dr. Strandgaard,* Chief Physician to the Boserup Sanatorium for Phthisis, which institution is the property of the city of Copenhagen.

" Exhaustive experiments made by Dr. Hindhede here in Denmark have shown that a man needs for his daily nutrition only 50–60 grs. of protein ; but whether we prescribe 60 grs. or 120 grs. of protein, we must not, as we have done hitherto, regard it as the most important part of the dietary ; for the above figures demonstrate to the contrary. An invigorating diet does not consist of a disproportionately large allowance of meat, eggs and the like ; to the contrary, such a diet can be very harmful, and may even cause meat-poisoning. A mixed diet, in which the carbo-hydrates take the first place and protein a lower position, is the most ' nutritious.' It suffices for healthy people ; and there are also reasons for thinking that sufferers from pulmonary complaints should be fed on a similar mixed diet ; and, as they should eat more of all kinds of food than healthy people need to do, in cases where there is no appetite, the extra quantity of food must be regarded as medicine ; and there need be no fear of ill consequences, as the food which is eaten without appetite is quite as well digested as food eaten in the other condition, although the contrary is generally held to be the case.

" As the proportion of protein ought to be low and that of the carbo-hydrates high, the patient must draw his supply of energy from the latter. A plateful of oatmeal porridge is a good thing on which to begin the day, though two platesful are better than one. Hot dishes possess no special virtue. Bread and butter are very good things, and should not be eaten always in the form of sandwiches with meat and cheese, as is the general custom in Denmark. If meat, in the form of steak or chops, is served at lunch, it should not be allowed to be the most substantial part of the meal. Plenty of bread and butter should be eaten. At dinner, the first dish ought, as a rule, to be the chief one. If it be a case of rice pudding and a joint of meat, and one is under orders to eat well, it is better that two portions of the pudding be taken to one of the meat, rather than the reverse. If the second dish consist of meat, or another richly albuminous food, one should help oneself to plenty of potatoes, macaroni, or any other carbo-hydrates which are on the table. It were better that we spoke of ' potatoes and beef,' rather than of ' beef and potatoes,' as we are in the habit of doing. Bread ought to be eaten with hot dishes, a morsel of bread accompanying every mouthful."

That the chief physician to a great phthisis sanatorium should write in the above manner is extremely gratifying to me. Dr. Strandgaard's advice is practically the same as that which I have been recommending for the past seventeen years.

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* Strandgaard, "Lungetuberkulosres hygieiniske Behandling," Kobenhavn, 1912.

CHAPTER XV

SUMMA SUMMARUM

Rich Protein Diet is not only useless, but, probably, harmful.

I HAVE already said that it would seem to be practically impossible to avoid getting protein enough! Does it not appear to be quite in the order of things that, practically, we must always get enough protein for our needs if we eat as Nature dictates? How, otherwise, could mankind have progressed so well since some hundred thousand years before Christ until A.D. 1866, in which year Voit stepped on the stage with his standard? Nature makes such careful provision in all things that there could be nothing more certain than that a means of nourishment so indispensable to all animal organisms as protein actually is must be present in such generous measure in all our food-stuffs that there is not the slightest necessity to fear that we should be unable to get an adequate supply.

The first point is that much protein is useless; but the second is to discover to what extent and in what way a high intake of protein is harmful. The latter question is more difficult to handle than the first, and we must here content ourselves to consider probabilities as evidence; and probabilities can, in the end, become so very probable that with their help we may almost cross the boundary line into certainty.

It is probable that Muscular Strength declines on a rich Protein (Meat) Diet.

For evidence I will draw on my own experience. I feel weaker after eating much meat, and physiologists tell us the same story of their test subjects when these are supplied with meat alone.

All doctors know how weakening is the effect of a meat diet, such as the diabetic diet and the Banting system. Furthermore, I may recall the information given earlier in this book.

It cannot well be denied that this fact does not attest that much protein (animal) imparts strength. We will proceed to inquire what explanation is forthcoming as to the drowsiness consequent upon over-indulgence in protein. If 30 to 60 grs. be sufficient, is it really a matter for wonder that the powers of the body are severely taxed to cope with 120 to 200 grs.? Protein, which cannot be entirely consumed in the body, leaves behind it a large proportion of incombustible waste which it is the office of the liver and kidneys to excrete, calling for special exertion on the part of these organs. Now, if this large amount of protein be unwanted, unnecessary, it is not a very far step to the assumption that it must be injurious, because such a considerable amount of energy must be devoted to katabolism in the cells and to the excretion of its waste products through the kidneys, energy which might, otherwise, be utilised to assist metabolism in the muscles; and in the consequent fatigue we have our explanation.

It is probable that rich Protein Diet is the cause of various Ailments.

That luxurious habits, especially over-indulgence in meat, can give rise to various stomach, kidney and arthritical complaints is supported by manifold experience. To bring direct proof to bear on it is difficult, for there are so many other factors which may have a contributory effect. Even though it be taken into account that gourmands are the most frequent sufferers from the above disorders, this does not in any way settle the matter. He who "eats well," often "drinks well"; and which of the two is the culprit—the alcohol, or the protein? It is most probable that both these boon companions share the responsibility between them. And on this point nearly all doctors are in agreement. As regards stomachic maladies, over-exertion is chiefly to blame, and the same may possibly be the explanation of kidney and liver complaints. It is, however, probable that in these cases, as well as in gout, the trouble arises from poison by the breaking down products of pro-

tein. Several of these are poisonous, such as ammonium and other nearly related bodies, which form the antecedents of urea. In which connection we will cite the interesting experiments undertaken by the Pawlow school.* The portal vein (the vein bringing blood from the intestines to the liver) of a dog was joined to the hepatic vein, by which means the liver was isolated and the blood flowed directly from the intestines into the general circulation. It was found that, in consequence, less urea and more ammonia was excreted in the urine. When the dog was given ammonium carbamate in its food it was seized with convulsions, and died with all the symptoms of poisoning, although ammonium carbamate, administered under normal conditions, is relatively harmless. Exactly the same toxic symptoms were exhibited in the case of another dog which had been operated on in the same way, and which was fed with a liberal supply of meat; whereas these symptoms did not result when non-nitrogenous food-stuffs were given. In the blood of the second dog there was found a considerable quantity of ammonia in every part of the body, whereas, normally, this substance is found only in the blood in the portal vein. These investigations, therefore, go to show that the office of the liver is to render harmless, by conversion into urea, the ammonium compounds which arise from the decomposition of animal protein in the intestines, and suggest that the organ performs the same service in regard to various other waste products of metabolism. It is easy to conceive that the liver is to a certain degree composed of these poisonous products, but that there are limits to the functional ability of the organ to render these poisons harmless, which may possibly explain some of the maladies from which those who indulge largely in meat suffer.

The Arabs.—I am of opinion that we might learn a great deal from the Arabs with respect to those diseases which result from excessive meat eating. It is well known that the French and Italians have experienced the utmost difficulty in their attempts to subdue this brave and energetic people. They appear to be of very slender build, but their powers of endurance

* Hahn, Massen, Neucki and Pawlow in "Archiv für exper. Pathologie und Pharm.," Vol. 32, p. 161, and Vol. 37, p. 26.

are remarkable, and do not pass with youth. They lead a warlike life from the fifteenth to the seventieth year, while their horsemanship is wonderful.

A French army medical officer* who has recently been studying the Arabs, furnishes us with some valuable information concerning them, of which I give a few extracts below :—

" The Arabs are slim and wiry ; their limbs are lithe and strong. The profile is more curved than straight. Their noses are hooked, skin brown, eyes and hair black. They live in tents made of camel's hair, which are of such a nature that the wind blows right through them. These habitations are terribly insanitary : in the middle of the tent a hole is sunk in the ground in which they burn green wood for both cooking purposes and for warmth. In this smoky enclosure human beings and animals live in a strange confusion, there being nothing to keep them apart. The Arabs—of the poorer class, at least—are clad in rags which swarm with vermin."

Anything more unhealthy, according to European ideas, would be difficult to conceive. One would imagine the poor to be continually afflicted with epidemics of disease, particularly as they subsist on " hunger diet."

Dr. Auzimour continues :—

" The frugality of the Arabs is just as far famed as is that of the camel. Men often go on long journeys into the desert with only a bag of meal, some figs, a skin of water and some dates. With the meal the Arab makes some little cakes, each about the size of an ordinary nut, which he dries in the sun or bakes in his fire. These cakes, with some dates, are his provision for the day. The fare is nearly always vegetable plus a little milk, and, very rarely, a little meat.

" Alcohol—the ' sea of sin,' as the Arabs call it—is strictly forbidden them by their creed ; for the Prophet was well aware of its dangerous influence."

The effects of this apparently " poor " living are described by Dr. Auzimour :—

" The Arabs are very hardy and very resistant to disease. Abdominal wounds, with perforation of the intestines, heal without the use of antiseptics when the injured parts have been put back into place. Wounds, healing in such circumstances and without consequent blood poisoning, are a source of wonder to surgeons acquainted only with Europeans."

Much particular information is given, such as the following :

" The Arabs are almost entirely immune to typhus. There are many French physicians in Tunis who have never encountered a case of this

* Bernard Auzimour, " Résistance des Arabes," Montpellier, 1905.

disease among the people. The following statistics from L'Hôpital de Mustapha are very striking. Dating from 1868, there were 659 cases of typhus among 28,251 European patients; which is 2·3 per cent. Of 9,147 Arab patients there were but thirteen cases of typhus; which is 0·1 per cent."

There were, therefore, twenty-three "well-nourished" Europeans who contracted typhus to one "hunger-fed" Arab, despite the fact that their insanitary habits should make the latter more liable to the disease.

"Diseases of nutrition are almost unknown; ulcers and cancer of the stomach are very seldom met with; and if one comes across a chance case of summer diarrhœa, it is generally because the sufferer has been eating too many melons. Appendicitis is very rare among the Arabs, and is entirely unknown among the vegetarian nomads. Gout and kidney gravel are also quite unknown."

This is no peculiarity of the race, because Dr. Auzimour states that the Arabs, who live in towns and who eat as Europeans do, are no more resistant to these diseases than are Europeans.

For many years I have been convinced that common stomach troubles and intestinal disorders very often arise from fermentation caused by putrefying animal protein, as these complaints disappear, like dew under the morning sun, on a low protein diet. Since my family and myself have adopted a low protein diet, we have never been troubled with these maladies—neither do we ever suffer from summer diarrhœa. But with a return to a rich meat diet, for experimental purposes, I contract colic and diarrhœa with mathematical certainty.

Possibly, from long experience of exclusively vegetable food my intestines have lost the power of producing anti-toxins, which must be present if the toxins of meat-fermentation are to be counteracted.

Is it not possible that the absence from the organism of these toxins is the cause of the feeling of buoyancy and increased endurance of which one is so often sensible on a low protein diet?

But I have not the time to dwell longer on this interesting and complicated point; so I will refer the reader to Prof.

Combe's work on the auto-intoxication of the intestines.* It will help us to better understand this point if we bear in mind the way in which an egg or piece of meat will rot. Flour does not become putrid like this, even though it be left standing, while wet, for some time. When rich meat is eaten similar fermentation goes on in the intestinal tract, if only a small proportion of vegetable food is eaten with the meat ; and the terribly offensive odour of the excreta after a meat diet will give some idea of the nature of the fermentation. The excreta after a bread and potato diet have no such odour if these foods have been thoroughly masticated.

If an egg be infected with fæces, and left for some time, it will produce a most dreadful smell ; and if a little of the product be introduced beneath the skin of a rabbit, the animal will speedily die. But if the same experiment be tried with corn, no poisonous products are forthcoming.† Even if we dissolve the starch from flour so that only the protein (gluten) remains and submit it to the same test, we shall fail to obtain any poison products.

It would seem as if there were some essential difference between animal and vegetable protein.

I find that Prof. Maurel, of Toulouse, is of the same opinion as myself in these matters. He served for thirty years as army surgeon in the French colonies, and while in the tropics made many experiments in nutrition, in consequence of which he has come to the conclusion that most of the so-called tropical diseases are caused through over-eating, and, particularly, through excessive meat-eating. In his work on Nutrition‡ he makes the following deductions :—

" 1. That the majority of digestive disorders (dyspepsia, diarrhœa, dysentery) which are so common in the tropics, are partly to be ascribed to hypernutrition.

" 2. That over-indulgence in animal foods is largely the cause of the liver disorders met with in the tropics.

" 3. That, finally, the increased richness of blood, which is due to the absorption of too large a quantity of food, particularly protein

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* A Combe, " L'auto-intoxication intestinale," Paris, 1909.

† *Wien. klin. Woch.*, 1909, p. 1637 ; and 1910, p. 848.

‡ Maurel, " Traité de l'alimentation et de la nutrition," Vol. 1, p. iii., Paris, 1905.

food—which I have termed hypernutrition—constitutes a contributory cause of the fevers so prevalent in our colonies."

Later, Prof. Maurel, while insisting that his experience and consequent deductions refer directly to the tropics, he goes on to say :—

"My own observation in France, made during intervals between my visits to the colonies, have called forth doubts in my bosom as to our alimentary requirements in countries within the temperate zone. Is not the standard given by medical authors altogether too high a one ?"

To which I have but to add that the doubt in Prof. Maurel's bosom is only too well justified.

Meat and Appendicitis.—There is a great deal of evidence forthcoming that appendicitis is caused by fermentation after excessive meat-eating. I have already mentioned that the Arabs do not suffer from it, and I will now quote from a report by Dr. Owen Williams to the Science Committee of the British Medical Association :—*

"*Firstly.*—Cases of appendicitis are very frequent in England, where there is a large meat consumption.

"*Secondly.*—In the rural districts of Roumania there is only one case of appendicitis to every 22,000 sick patients ; while, on the other hand, among the urban population, there is one case to every 221 patients—that is, one hundred times as many. Very little meat is eaten in the country districts.

"*Thirdly.*—In China appendicitis is very rare. Of 169 physicians, only forty-nine had ever encountered the complaint. In the General hospital in Hong-Kong, among 2,140 patients, there was not one case of appendicitis ; while in the Shanghai hospital, which is used by Europeans, there were twenty-one cases among 1,205 patients, which is one in every sixty."

I will give no more examples. I think I have advanced enough evidence that appendicitis is, probably, a meat-eating disease.

Meat and Uric Acid.—While discussing complaints and their relation to meat eating, we must not overlook uric acid disorders such as gout, urinary calculi, etc.

That meat contains many purin bodies which are excreted in the urine as uric acid is well known ; and as meat urine is very acid, the uric acid is not easily dissolved, but is precipitated

* *British Medical Journal*, December 31st, 1910.

as a red sediment, to the bottom of the receptacle. Or it may be precipitated beforehand in the pelvis of the kidney, or even in the tissues of the body.

Potato urine is almost diametrically different from meat urine; it is very slightly acid, being almost alkaline. Uric acid is never precipitated in potato urine, which, on the contrary, is able to dissolve large quantities of added uric acid.

The astonishing facility with which potato urine will dissolve uric acid was discovered by the author, quite fortuitously, when conducting extended experiments in nutrition on potatoes alone.*

It was discovered, for instance, that potato urine which had been standing for twenty-four hours at body temperature was able to dissolve 3·65 grs. of uric acid, while meat urine, on the other hand, could not dissolve its own uric acid, but, to the contrary, precipitating about 1 gr. every day.

From which it is conceivable that renal gravel could be removed under the dissolving influence of potato urine. Whether a potato diet would be successful in dissolving uric acid which has been precipitated in the tissues of the body I am not yet able to state; but there are indications that it is within the range of probability.

Up to the present, alkaline mineral waters have been resorted to as the best remedy against uric acid disorders; the reason being that the waters neutralise the acid formed while protein katabolism is going on in the body, the presence of which in the urine causes the uric acid to precipitate. But if mineral waters are a reliable remedy against uric acid troubles, such as gout, etc., it is extremely probable that a potato diet will be, at least, equally effective. Besides which, there is always a danger, with mineral waters, that the urine may become too alkaline, which effect is not to be feared from a potato diet. If the urine become too alkaline from the use of mineral waters, instead of a precipitation of uric acid, there will result a deposit of chalky salts, which will only serve to increase the

* Iste Beretning fra M. Hindhede's Kontor for Ernieringsundersog elser "Diat og Urinsyre," Copenhagen, 1912; and "Skandinavisches Archiv für Physiologie," 1912, Vol. 26, p. 384, and Vol. 27, p. 87.

size of the stones. This danger does not appear to attend a potato diet; a whole year's observation has not resulted in the slightest precipitation of chalk deposits in potato urine.

Other vegetables and fruits—especially carrots, tomatoes, bananas, etc.—have a similar effect to that of potatoes; while bread has an effect similar to meat.

This discovery would appear to have settled a long-vexed question concerning diet regulation in cases of kidney stones. Some doctors recommend vegetarian diet, while others take the opposite course, and recommend meat or the usual mixed diet, the latter arguing that certain peoples who are known to subsist on an almost exclusively vegetarian diet, such as the Russian peasants and East Indian coolies, are often subject to this complaint.

But when we learn that Russian peasants live chiefly on bread, and that coolies in the East Indies live mostly on rice, wheat and beans, explanation is simple enough. Among the poorer classes in Germany, potatoes form the staple food, and kidney gravel is almost unknown.

Our observations have shown us that purin-free diet is not a sufficient guarantee against urinary calculus. Bread contains no purin, and does not serve as any protection against uric acid disorders.

Our discovery is so recent that, until we have had ample opportunity of subjecting it to prolonged practical tests in the treatment of uric acid disorders of long standing, we shall by no means feel assured that we have found an infallible cure for those individuals who, for ten to twenty years, have been martyrs to gout, and the synovial membranes of whose joints have been destroyed, or that it will effect speedy dissolution of renal calculi, which perhaps are composed of uric acid together with other bodies, phosphates, oxalates, etc.; but, nevertheless, potatoes etc., are perhaps the best remedy we know, and in this connection the following letter is of interest:—

"DEAR DR. HINDHEDE,—

"According to Dr. Bjerregaard, mine is the real old-fashioned gout. My joints were stiff, enlarged and deformed. The disease came on gradually and slowly some fourteen years ago, first one joint being attacked, and then another. It spread, finally, over the whole body.

Last winter I became so bad that I could do no work, and my sufferings were at times almost intolerable. I took sodium salicylate, but all to no purpose.

" Last April I tried a potato diet—potatoes, butter, milk and apples, as well as potato-water. After a month I felt better ; and now, after four months, I am nearly able to resume work. Last April, when I began with this diet, the fingers of my left hand were so cramped and bent that I could not hold anything. Now they are so lithe and supple that one might think I had been playing the violin all my life.

" I am thirty-one years of age.

" I must admit that some of the credit for my present condition is due to the massage and baths, but I am sure that the most potent factor in my recovery has been the potato diet ; and since I have been taking it I have become sensible of a state of health which I have not enjoyed for many years. My weight has also increased by about six or seven pounds.

" Yours faithfully.

" (Signed) PEDER LEEGAARD."

It must be borne in mind that my discovery is new and not yet known to many doctors. That the latter will regard it with suspicion is only to be expected, and not without reason on their part. If I were in their place, I should do the same. We, of the medical profession, are so continually being confronted with new miraculous remedies, which are nothing else but mere quackeries exploited by clever business men, that it behoves us to be as continually on our guard.

But, fortunately for me, any intelligent layman can himself test the truth of my contention.

Any reader, whose urine habitually, or frequently, contains deposits in the form of a red sediment in the bottom of the receptacle—precipitated uric acid—need only diet himself for two or three days on potatoes, butter and fruit exclusively, and he will then observe that the quantity of sediment will gradually diminish until it appears no more. It is not absolutely necessary to restrict oneself to potatoes and fruit ; a very little meat and a little bread may also be taken if two or three pounds, at least, of potatoes and bananas are eaten every day. The effect of such a diet should speedily become apparent. Later on, an experiment may be tried in order to ascertain what quantity of potatoes is required to effect the desired result in a particular case. Of course, if the trouble be of long standing, so that much uric acid has been precipitated within the body, it will

not be enough to limit the diet of potatoes and fruit to a quantity estimated as sufficient merely to dissolve the daily secretion of uric acid; but one must eat as heartily as possible of the diet so as to effect dissolution of the uric acid already precipitated. The more energetically the course is pursued, the sooner will the desired result be obtained.

Another experiment is even more striking and instructive, but demands a little more trouble, and can be best performed by a doctor or chemist. For some days—say, a week—live on bread and meat alone. On the third day, or later, take three medicine bottles, each of 300 c.c. capacity, and in them pour 50, 100 and 150 c.c. of urine, respectively. Procure some uric acid in powder, put up in 10-cg. packets. Now, to each bottle of urine add one of the packets. Place the bottles in the sun or near a stove, so as to keep them at about body temperature. Shake the bottles every five minutes, and note the appearance of their contents. The uric acid will not dissolve; on the contrary, it will grow. After shaking, the urine will assume a cloudy, milky appearance.

Having made the above experiment and taken due note of results, eat only potatoes and butter for a like period. It should be said that the longer the experiment is extended the clearer and more satisfactory will be the results obtained.

But if you eat too small an amount of potatoes the body will draw on its reserve material—the muscular and fat tissues—and the effect on the urine will be the same as if meat were being eaten. Therefore, if the diet consist of potatoes and butter alone, at least three or more pounds of potatoes must be eaten daily, with enough butter (4 to 6 ozs.) to make them palatable, and to furnish the heat energy (calories) requisite for the needs of the body.

The urine for these experiments must be taken when quite fresh: if it has begun to ferment the experiment will fail. The urine should be taken in the middle of the day, some hours after the principal potato meal.

In this second experiment proceed as in the first: on the third day, or later, put the same quantities of urine in similar sized bottles, and add the same quantities of uric acid as before.

But now, when the bottles are shaken, the urine will look

quite different from what it did in the first experiment. It is very possible that all three specimens will be quite clear; which will mean that in all three bottles the uric acid has all been dissolved. Otherwise, it may be that, while the two larger specimens remain clear, there may be some uric acid crystals in the smallest one which have not dissolved.

If the latter experiment be not successful as described, it will be because of some fault in the diet or in the procedure. If, for example, the urine be not quite clear while at body temperature before you add the acid, the experiment will fail. Also, if the urine after standing for an hour in some warm place, say of 38° C. (100° F.), becomes cloudy, it must be filtered before it is poured into the bottles—or, if carefully decanted, the clear part may be separated from the sediment.

I have tried to give a clear description of the manner of procedure so that it will not be impossible even for an educated and intelligent layman to himself test the condition of his urine, if he cannot, for some reason or other, procure the services of a medical man for the purpose; but, of course, it is better that a properly qualified man should assist, or direct, the experiment. A practitioner who has had some experience in chemical analysis would be able to estimate more exactly the quantitative capacity of the urine to dissolve acid. And in this connection I would direct his attention to the paper containing the scientific exposition of my experiments to which I have made previous reference (p. 163).

I will not weary the reader with further argument. I think I have brought sufficient documentary evidence to prove the accuracy of the ensuing statements:—

GREAT EXCESS, PARTICULARLY OF ANIMAL PROTEIN, IS, IN MANY CASES, HARMFUL IN EFFECT.

I wonder if the practical experience of the English is in confirmation of this assertion. I am not very well acquainted with the habits or customs of the English people, but if the bill of fare which I saw on board the S.S. *Ivernia*, while travelling from Liverpool to Boston, serve as any indication, I should say that intestinal disorders, gout, etc., must afford English doctors a very good harvest.

CHAPTER XVI

MEAT AND "ENERGY"

It is impossible now to deny that strength and health can be maintained on a low-protein diet; but it seems just as impossible for the scientists of the old school to rid themselves of the idea that there must be "something" of special value in meat. It would seem to be rather difficult to express the exact truth of the matter. This "something" of value has nothing to do with health, with working ability, with strength and endurance; it is . . . *energy*. As I am not quite sure that I am able to understand the exact meaning of this word, I will let Hutchison * himself explain:—

"The reply of scientific experiment, therefore, as far as can be applied to the problem under consideration, would be that it is undoubtedly possible to maintain a healthy life upon such a daily amount of proteid as is contained in a moderate quantity of vegetable food, and the accumulated experience of vegetarian races fully bears this out.

"This, however, does not dispose of the question. There is such a thing as *degrees of health*, while one freely admits that health and a large measure of muscular strength may be maintained upon a minimum daily supply of proteid, yet I think that a dispassionate survey of mankind will show that races which adopt such a diet are lacking in what, for want of a better word, one can only describe as energy. Now, *energy* is not to be confused with muscular strength. A grass-fed cart-horse is strong, a corn-fed hunter is energetic. Energy is a property of the nervous system, strength of the muscles. Muscles give us the power to do work; the nervous system gives us the initiative to start it. Muscles do their work upon carbo-hydrates which are the characteristic nutritive constituent of vegetable foods. The brain appears to require nitrogen, which can only be obtained in a concentrated form from animal sources. If proteid food, therefore, be regarded as a nervous food, a diet rich in it will make for intellectual capacity and bodily energy, and it is not without reason that the more energetic races of the world have been meat-eaters."

If I am not mistaken, the meaning is, that low protein-eaters are allowed to be strong and healthy, but they must necessarily be dull and stupid. Not flattering for them, but fortunately

* Hutchison, "Food," p. 174, London, 1911.

it is with them as with other idiots; they have not enough sense to understand that they are dull. Therefore, I am not able to discuss this quite subjective question, but must leave it to others. We will try to take up a more objective question. Dr. Hutchison tells us :—

"*The more energetic races of the world have been meat-eaters.*"

Perhaps. But we will see whether the truth be not that it is those who refrain more from meat who represent the energy and vitality of a nation, rather than those who live largely on meat, who, moreover, represent its degeneration.

Speaking generally, it is in the towns that most meat is eaten, and in rural districts, especially the more remote and less "cultivated" places, where there is more frugality in this respect. There is no necessity to prove this statement. Rubner himself is quite of the same opinion (Volksernährungsfragen, p. 84). He writes, with regard to conditions obtaining in rural districts: "We very seldom see meat on the bill of fare, once a week or once a month at most." Now is it a fact that the meat-eating inhabitants of the towns are stronger than residents in the country? No; the contrary is the case.

Concerning which, I refer to Dr. Georg Hansen.* In his work, which is often cited by authors writing on this question, Dr. Hansen shows that great businesses are generally built up by men from country districts who have migrated to town. The children and grandchildren of these men degenerate, as a rule, barely evincing the energy and aptitude of their forbears. (Of course there are exceptions). He shows how families in the cities are wont to disappear in a few generations. I will also quote from a lecture which the hygienist, Prof. Max Gruber, from München, gave in Berlin, 1908. He said :—

"It is an old experience, that nothing is more dangerous for the vitality of a family than high social position. Such families in the cities, especially, do not flourish for long, becoming extinct in the second generation."

He continued as follows :—

"Very often the last generation, or, may be, the last but one, of a disappearing family, shows signs of degeneration. Youthfulness is

* "Die drei Bevölkerungsstufen, Ein Versuch, die Ursachen für das Blühen, und Altern der Völker nachzuweisen," München, 1889.

suppressed, the members are often physically weak and little capable of resistance, as may be seen from the great mortality among Swedish families which have become extinct. Frequently, physical signs are alone apparent. The individuals lack vitality. The children do not evince the same desire for exercise as do normal children ; there is spiritual languor, and little interest in life. Intellectual powers are often great, but there is lack of will-power, perseverance and working ability. Symptoms in the same direction are present in that there is little power of determination ; there is dislike of the married state ; reluctance to beget children, etc.

" But the importance of this phenomenon is by no means exhausted by what I have already stated. The extinction of families is not confined to the upper classes, it occurs also among the lower classes in the towns, and especially so in this place. It is a fact that it is the rural population which for centuries past has kept the nation alive and replaced the heavy losses inflicted by war and plague—I need but refer to the Black Death, in 1348, and the Thirty Years' War ; and it is just as certain a fact that the towns have been swallowing up the whole surplus of increase of the people for hundreds of years.

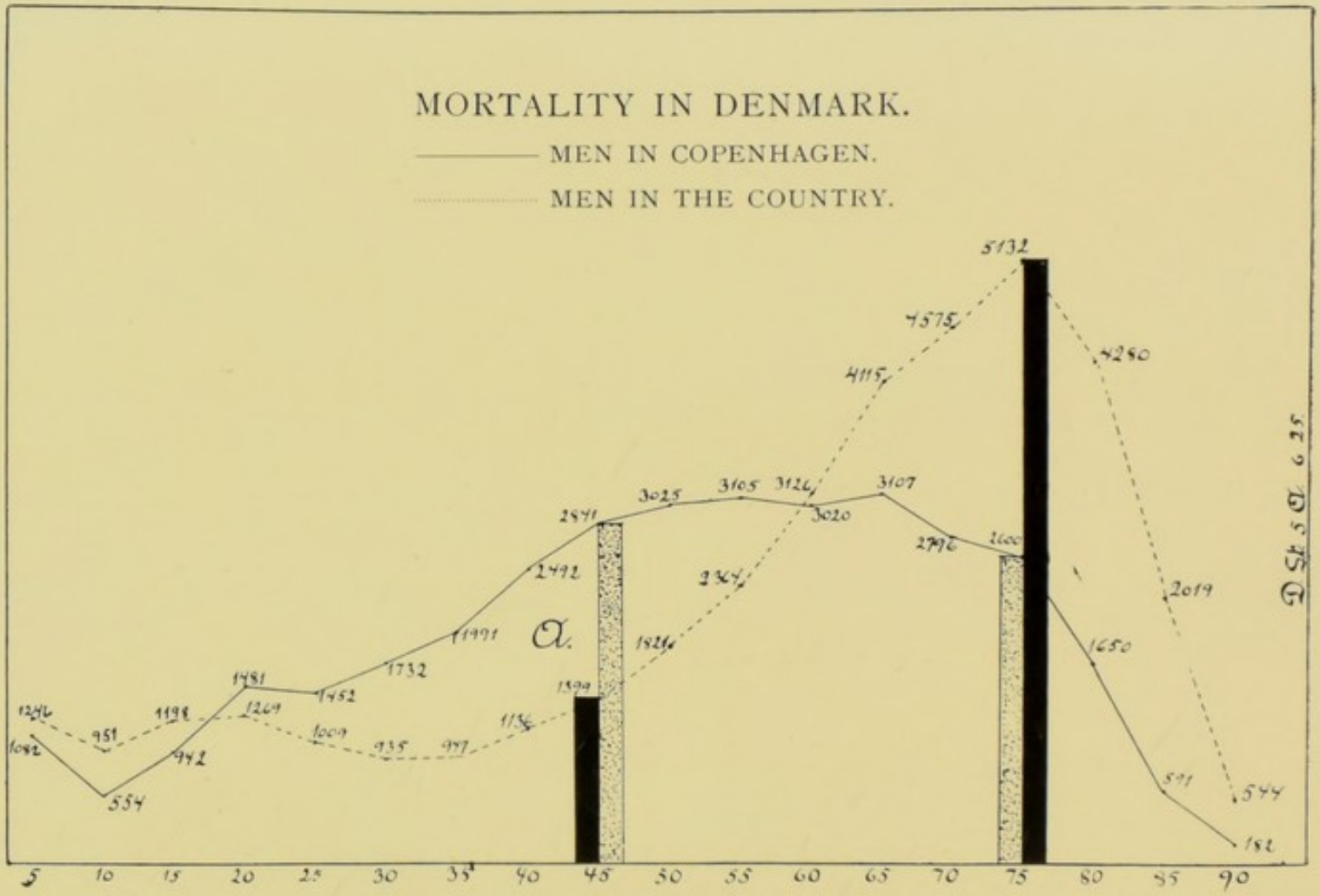
" As soon as we began to draw up systematic statistics the fatal effect of the towns was evident. As long ago as 1761, Süssmilch wrote : ' It is obvious that the secret injury inflicted on the State by the towns is nearly as bad as that effected by pestilence.' "

To what degree the population of the towns consists of people who have migrated from country districts, we cannot always tell. Dr. Hansen gives some figures from Leipzic (dating from the year 1875), from which I have taken the following for men only :—

Age.	Born in Leipzic.	Born outside Leipzic.
0— 5 years . . .	87	13
10—15 ,, . . .	58	42
20—25 ,, . . .	15	85
40—45 ,, . . .	22	78
60—70 ,, . . .	27	73

Naturally, most of the children are native ; but it is almost incredible that of those inhabitants from twenty to thirty years of age, only one-sixth are native, and of older inhabitants only one-fourth.

For Danish towns we have, so far as I know, no statistics of this kind ; but we may arrive at the part played by migration if we compare the increase of population in town and country during the nineteenth century.



8.—Mortality (Copenhagen, Country).

The proportionate increase is illustrated by the following figures* :—

Number of People.	1801.	Towns. 196·378 absolute.	Per Cent.	Country. 732·623 absolute.	Per Cent.
Increase .	1801—1845	89·743	46	338·146	46
,, .	1845—1870	157·806	80	270·045	37
,, .	1870—1890	282·428	144	105·211	14
,, .	1890—1901	232·550	118	44·610	6

It will be seen that while in the first period the increase both in the towns and country was at an equal rate, being 46 per cent. in each case in forty-five years, in the last period given the increase in town population has risen to 118 per cent. of the population in 1801, and that of the country is as low as 6 per cent. If we take into our reckoning that the populations of the smaller country towns growing up round railway stations are included as country population, the diminishing rate of increase in the country becomes even more evident. It is not that the country people are dying off ; it is that they are migrating to the towns in hopes of making their fortunes, though most of them find only misfortune and early death.

How true this is may be seen from the diagram facing this page.†

Deaths among the adult male population in Denmark in the years 1901—1905 were 54,215 in the rural districts, and 20,534 in Copenhagen. As we have the death figures for every five years we will compare the mortality. For easier comprehension, I have multiplied all the figures for Copenhagen by 2·64 (20,534 × 2·64 = 54,210). We can in this way, compare the more easily the death-rate in Copenhagen and in the country. The curve shows the number of deaths in the different age classes.

The death-rate in the country shows that few men die there in the prime of life. Mortality is lowest among those between the ages of thirty to thirty-five ; deaths in five

* Danmarks Statistik, 5 R. A., No. 5.
† Danmarks Statistik, 5 R. A., No. 6.

years amounting to less than 1,000, not 200 a year. The highest mortality is among those of from seventy-five to eighty; 5,000 dying in the five years—or over 1,000 a year. Thus in the country districts few men die in the full vigour of life, while many die in old age; which is quite natural.

But in Copenhagen we have quite another state of affairs. Here the rate of mortality is about the same for those in vigorous manhood and in old age. Twice as many die in Copenhagen between the ages of thirty-five, forty, and fifty as in the country; while the case is the reverse with those between the ages of seventy-five and eighty, twice as many dying in the country as in Copenhagen. While in the country four times as many people die at the age of seventy-five as at forty-five, in Copenhagen more die at forty-five than at seventy-five. The space marked A in the diagram represents 2,700 men dying in Copenhagen between the ages of twenty and sixty, instead of between sixty and ninety (7,139 : 2·64 = 2,704). Imagine the loss represented by these 2,700 deaths, mostly of breadwinners in the full vigour of life. (The population of Copenhagen is roughly 500,000.)

Confusion has arisen, I think, from the fact that in the towns mortality is lowest among the upper classes, and increases as we go downwards in the social scale. Rubner makes use of this as a main argument in support of his views. He writes ("Volksernährungsfragen," p. 102):—

"I have already referred to the great mortality due to insufficient nutrition. *In class division, according to income, of mortality statistics, nutrition is, in reality, to be included as a factor.*"

If, to prove a doubtful assertion, all that is required is to underline the same, then Rubner has proved his point. But if underlining does not carry conviction, it seems to me that it only serves to emphasise the error.

That the rate of mortality is much higher among the lower classes than among the upper classes in the towns, I would be the last to deny. The following figures make this easily apparent:—

* Westergaard, "Die Lehre von der Mortalität und Morbilität," pp. 478, 482, Jena, 1901.

Of every 10,000 deaths per annum, there are,

Years of Age.	In Copenhagen. Labourers.	Rich People.	In the Country. Farm Labourers.
20—25	79	40	60
25—35	96	58	48
35—45	191	92	58
45—55	356	159	96
55—65	642	312	206

It will thus be seen how great is the difference of mortality between labourers and well-to-do people in Copenhagen: of every 10,000 between the ages of thirty-five and forty-five, there are 191 deaths among the former and ninety-two among the latter; while between the ages fifty-five to sixty-five, the figures are, respectively, 642 and 312. That nutrition is to be held accountable for this great difference—the poorer classes eating too little meat—is difficult to prove. It seems to me that the following facts * are very illuminative.

One of the chief arguments of Voit in support of the harmful effect of low protein diet was the miserable condition of the prisoners in German houses of correction.

In one of these institutions—Waldheim in Saxony—the death-rate per 1,000 *from* 1860 *to* 1876 was:—

Age.	In Waldheim.	In Germany.
30	22·7	9·28
40	25·0	13·63
50	40·1	21·45

The mortality was, therefore, twice as high in the prisons as outside.

But, *at the present time*, we have the following figures for one of the largest houses of correction in Germany:—

Death-rate among prisoners—men: 12·2
Total German death-rate—men: 18·2

It is, therefore, at present healthier to live inside these institutions than outside. Yet the diet inside is the same as it was; outside, I suppose, it has been much "improved."

This interesting fact proves how terribly one can be mistaken when taking only one factor into account and ignoring others.

* Hirschfeld, "Krankheit und Sociale Lage," p. 131, Berlin, 1912.

It must surely have been the bad hygienic conditions which were the cause of the former heavy death-rate. Deaths from tuberculosis in the prisons alone have, in the last fourteen years, decreased from 11 to 4·6 per thousand.

It can hardly be doubted that it is the same factors which cause the great difference between the mortality among the rich and poor in our towns.

Firstly, workmen in the towns do by no means eat little of meat, as may be seen by studying Voit's Münich standards. The researches of Drs. Schierbech and Poul Hejberg show that Copenhagen labourers ate, about ten years ago, roughly $\frac{1}{3}$lb. of meat per day—and more, if we regard pork as meat. Secondly, the wealthier classes in Copenhagen show a 50 per cent. higher mortality than the poorer and less meat-eating class of our population—country labourers. To those who would attempt to ridicule my experiments, by which I sought to prove that it is possible to live on $3\frac{1}{2}d.$ per day, I would say : Look at the thousands and thousands—nay, millions even—who are daily proving, and have proved, this possibility over and over again. It is self-evident that the family of a country labourer, earning only 10*s.* to 13*s.* 6*d.* per week, cannot possibly spend more than $3\frac{1}{2}d.$ per day for food *pro persona.*

Yet, how is the mortality among these poor " underfed " people, who, moreover, often live in ill-built cottages which are terribly insanitary ? Incredible as it may appear, it is lower than that among the wealthier classes in the towns. Between thirty-five and forty-five there are only 58 deaths among country labourers, as compared with 92 among well-to-do Copenhageners (see Table, p. 173) ; between fifty-five and sixty-five the respective figures are 206 and 312. Many reasons may be advanced in explanation of this great disparity, but it is evident that among them must certainly not be included that it is their great consumption of meat which gives the country labourer his robust health.

If we compare the country labourer with the well-to-do town dweller, it must be admitted that it is the former who usually appears to be the more " underfed." But, perhaps, that is because our ideals as to what is healthy are all wrong. May it not be that the town dweller is the one who is " overfed."

In a Danish newspaper I came across the following, quite recently :—

"A Farmer in Westjutland."

"He came as a youth to the heather, with £7 10*s*. in his pocket which he had saved from a very small wage. He had two emaciated cows and a horse which every morning he had to help on to its legs, the animal being half-starved.

"With his money he bought 100 acres of very poor heather-land, and a very small house with a slanting roof, and the walls almost tumbling down with age. At one end of the house was the stable and the thrashing floor ; at the other end was a little room with stamped loam-floor, an alcove, and a little kitchen.

"For fifty years he laboured on the land, working strenuously at the ground, and, at last, on those places where the heather used to grow stood beautiful cornfields.

"His back grew crooked, and his fists were all gnarled. He chalked the marl himself. From sunrise to sundown he was on the fields. His face became quite tanned by the wind. But the glance from his blue eyes was sometimes as mild as a child's. When his task was finished, that heather land had been converted into beautiful fields and a farm. He had twenty-eight cows and eight horses ; the whole being valued at £4,500.

"Ten children were born to him, six being boys who became students. He was eighty-three years old when he died."

I did not know the man of whom the above report speaks, but I know many similar cases. I myself, as I have already related, was born and bred amid the like of him ; and it was the vigour and endurance of such men which first made me lose faith in the strength-giving virtue of meat. Nobody could be more energetic than were those farmers ; and it is common knowledge here that, when their sons were sent to the towns for educational or commercial purposes, their mental energy was such that they soon caught up with and passed their town-bred rivals.

But with the passing of one or two generations—thanks to the mental energy derived from meat eating—this superiority no longer shows itself.

Not being sufficiently acquainted with conditions in England I cannot assert that the same state of affairs exists there, but statistics seem to imply that the case is much the same as in Denmark.

From "Tatham (65 annual report, 1900—1902)" I have

constructed the following table, showing the mortality in six trades and professions from five different diseases. I have put the mortality of farm labourers at 100,* and calculated the mortality rate of the others in proportion. The trades and professions are :—

1. Farm labourers, who are not able to afford much meat as a rule.

2. Workmen in towns, representing the urban lower class.

3. Tradesmen (building trade) representing the urban middle class.

4—5. Commercial travellers and butchers, representing the heavy-living (meat-eating) classes.

6. Physicians, representing the well-to-do intelligent classes.

MORTALITY IN DIFFERENT OCCUPATIONS IN ENGLAND.

(Tatham's 65th Annual Report, 1900—1902.)

——	Phthisis.	Bright's Disease.	Diseases of Liver.	Diseases of Digestive System.	Diabetes.	Gout.
Farm Labourers . =	1·00	1·00	1·00	1·00	1·00	0·00
Industrial do. . =	6·30	4·79	5·25	2·09	1·67	1·00
Building Trades . =	2·11	2·79	2·62	1·20	1·17	3·00
Commercial Traveller =	1·87	2·92	7·50	1·40	2·50	4·00
Butcher . . . =	2·02	3·23	7·50	1·45	3·33	5·00
Doctor . . . =	0·72	3·14	6·75	2·30	4·00	3·00

There are many interesting things to be learned from this diagram. But one lesson it does not teach. It is not able to persuade us to believe that much meat imparts health and energy! Diseased stomachs, livers and kidneys are not calculated to increase mental power.

As a doctor, I am glad to see how my professional brothers are able to avoid tuberculosis; but it grieves me to see my English colleagues dying of diseases of nutrition at a higher rate, as a rule, than men of other occupations. They appear to have been martyrs of the mistakes of science.

That meat eating does not prevent tuberculosis is proven

* Except under gout, which seems to be almost unknown among farm labourers, in which case I have calculated the mortality rate from that of industrial labourers, which I have put at 100.

by the fact that the death-rate from tuberculosis is very high, among butchers and commercial travellers.

That deaths from tuberculosis are higher in towns than in the country is easily understood; but it is, according to old views, difficult to understand why the mortality from Bright's disease, and from liver and digestion diseases, should be so high in the cities, where people eat "easily digestible" foods, in contrast to the coarse foods used in the country.

It is very curious to note how farm labourers who, probably, know the least about diet, seem to possess the healthiest organs of digestion.

I have heard many authorities speak about meat as an energy-food; but I have never yet encountered any proof of it.

I will not again refer to the Japanese and their energy; but *à propos*, does the reader not think that the peasants of Servia and Bulgaria are energetic? And notwithstanding that they hardly ever eat meat—as a native Bulgarian once told me, and as we may also read any day in our newspapers. (See that which has been said about the peasants of Roumania, p. 162.)

I will not deny that after eating a large beefsteak there may be a feeling of bodily warmth. Meat is able to increase combustion (Rubner), but this feeling is not energy. After such a beef-steak there is more inclination for sleep than for hard work.

Meat is a fierce-burning fuel; but it seems to burn out the oven itself in the long run.

Thus, it will be seen that it is very misleading to write:—"The more energetic races of the world have been meat-eaters." The truth is that the energetic races eat but little meat; but with increasing wealth and culture, meat-eating also increases, while the national energy decreases. Once the reserve of healthy, plain livers is exhausted (rural populations are at present decreasing), there is nothing to prevent the invasion of some energetic barbarian race, which may conquer and rule for a time until the conquerors also degenerate—spoilt by contact with the two greatest dangers that exist for human beings—Wealth and Modern Culture.

Every student of history must know *that wealth, gluttony and drunkenness are the three great destroyers of energy.*

CHAPTER XVII

LOW PROTEIN DIET AND CHILDREN

"WHATEVER may prove to be good for an ordinary adult, there can be no question that in the case of children, adolescents and pregnant women, it is far safer to adopt a high proteid standard than a low one."

"An abundant supply of proteid seems to be necessary if the blood and muscles are to be kept in good condition, and by promoting oxidation, it increases vigour and diminishes the tendency to require a plentiful supply of proteid, if those mysterious influences which emanate from the brain and spinal marrow are to be maintained with sufficient potency to enable the tissues to ward off the inroads of disease.

"To growing children a deficiency of proteid in the diet is specially disastrous, for the lack of building material which it entails may result in impaired growth and development, the consequences of which may last throughout life." (Hutchinson: "Food," 3rd ed., pp. 25, 175. London, 1911.)

The above quotation is not only an up-to-date statement of a widely read and accepted authority, but it is the general opinion of the medical profession as I myself know. That it is not founded on sound evidence my researches and observations prove.

It has been my experience (continued during thirty years in different parts of Denmark) of children fed on low protein diet, and their unusually healthy appearance, which, together with personal tests, has made me lose my faith in the value of high-protein feeding for children, and which seventeen years ago induced me to try low-protein feeding on my own children, and I have never had occasion to regret the change.

I think it will be difficult to find an urban family where the children are altogether so healthy, well-developed, and free from diseases as in my household.

Their teachers will testify to their normality of brain and intelligence. Recently my daughters have passed our Girls'

High School official examinations. Their graduation certificates show the following results* :—

	Anna, Marks.	Karen, Marks.
Danish	5 + 5 + 6	6 + 5 + 5
English	5 + 6 + 4	5 + 6 + 6
German	5 + 5 + 6	6 + 6 + 6
French	6	6
History	6 + 5	6 + 6
Geography	6 + 6	6 + 6
Natural history	6	6
Physics	6 + 6	6 + 6
Mathematics	6 + 6	5 + 5 + 5
Drawing	6 + 6	6 + 6
Gymnastics	6	6
Order	6	6
Singing	6	6

6 is the highest mark given and 1 the lowest.

It is not easy to get a good measure of intelligence, but it

* It is with some embarrassment that I venture to relate anything of the accomplishments and physical prowess of my own children, but their evidence is so significant that justice to my subject compels me to do so, and in further justification I am impelled to print a communication from a well-known student of health and efficiency, the American dietetist, Mr. Horace Fletcher.

"COPENHAGEN,
"*Christmas*, 1912.

"DEAR DR. HINDHEDE,—By all means give the evidence of your own family in connection with your report on the Optimum Protein-Need in Human Nutrition.

"I think it would be unscientifically neglectful not to mention them. One is more careful in experimenting with his own flesh and blood than with rats, or even dogs, and the results are more practically significant for use as models. To me your family and home atmosphere were the strongest recommendation of your scientific sanity before I was able to read your publications or get the gist of them verbally from you.

"One of the mottoes of my studies of human efficiency for the past twenty-one years has been the Bible injunction: 'By their fruits ye shall know them.' I visited Copenhagen for the first time in 1910, expecting to remain not more than a week, but after meeting the Hindhede family, and others of your assistants and disciples, I became one myself.

"During the two and a half years that have passed in contact with your work, my respect for your scientific conscientiousness and thoroughness has progressively increased, as has also my belief in your nutrition ideals. My study of your family fruit, in the meantime, has been more and more convincing. It is your sacred scientific duty to give to the world their evidence for the good it is sure to do.

"In my own experience, some athletic performances and endurance tests that have been published have done more to strengthen the contentions of 'Fletcherism' than all the laboratory examinations combined; hence, to leave out your best exhibit would be criminal.

"Faithfully yours,
"HORACE FLETCHER, M.A.,
"Fellow A.A.A.S."

will be agreed that ability to easily understand natural sciences, physics, mathematics, etc., is a very fair test.

Generally, it is assumed that girls have difficulties in these directions, but this is not the case with my daughters.

As proof of their physical fitness, a common saying of their comrades is: "No one can keep up with the Hindhede girls on their bicycles." Mounting their machines at half-past six in the morning, and doing seventy miles in six hours with only a quarter of an hour's rest for a wayside breakfast of bread and butter, is an easy task for them.

It is also a tradition in my children's social set that it is next to impossible to tire my daughters in dancing. For instance: Three young men agreed to put Anna to a test by engaging her for waltzing in immediate succession, each keeping her going as long as he could hold out, and then resigning in favour of another of the conspirators. The result was that three of the four became tired, but it was not Anna who was one of the three.

As regards my two sons (Jens, 23 years, and Kristian, 21 years), both are Civil Engineers, and passed their examinations with first-class honours. Of forty Civil Engineers who underwent this examination at the same time as Kristian, at our Royal Technical College, he was the youngest.

This test of my four children, whom I have had under close and constant observation for all these years, and whose optimum health has been my greatest concern, is, for myself, the best evidence I could have of the needlessness of feeding children on a diet high in protein.

A test for a few months may have some value, but not so much as one of seventeen years during growth and the advent of maturity.

This matter seems to me to be of such hygienic and economic importance that I do not want anyone to accept my unsubstantiated statements concerning it. In England and America I cannot refer to visible proof, but it is a matter of record that I have been reporting my observations and have been submitting my conclusions tentatively by lectures and publications in Danish and German for some years; I have

been visited by medical men and economists from various countries, and my colleagues here in Copenhagen have been freely invited to examine my store of accumulating evidence, including my test-subjects in my own family; these, as well as Mr. Madsen, Mr. Jörgensen, Mr. Esper Andersen, and all the others are living witnesses who may be interviewed by anyone.

What misleads the doctors more than anything is their experience of poor children in the slums of our great cities. They have not properly weighed the effect of other influences which cause ill-health.

I should be the last to deny that children are undernourished, but that is often because their parents spend the money on expensive meat, and are therefore unable to procure nourishment enough on the whole. Another fault is that poor people often live mostly on white bread (cakes) and coffee, which is very bad food, especially for children. When these undernourished children get ill and go into hospital, among good conditions and where they get sufficient food, they become hale and hearty, and as they may be getting plenty of meat, eggs, etc., the doctors suppose that the meat is the cause of their recovery, without trying to find out whether the children could not thrive just as well on cereals, potatoes, vegetables, a little milk, and a very small quantity of meat—or no meat at all.

To collect evidence from another walk or condition of life: how frequently we see the children of rich parents looking ill, weakly, and suffering from different ailments! It is not impossible that the cause of their ill-health is the decomposition of excessive protein in their food. We try, perhaps, to strengthen these poor weaklings by giving them still more meat and eggs, but it is only more protein, and more poison.

I beg my colleagues to excuse me, if I have spoken so earnestly concerning this subject. It is a serious matter for children. Hundreds of Danish parents have told me how happy I have made them by relieving them of all cause of worry about their children not getting sufficient meat, eggs, etc. They have been happy to record how the demand for meat has decreased and the desire for potatoes increased, with better health for their precious ones as the result.

But I am no longer without support. As a proof that the truth concerning the proper nutrition of our children cannot be suppressed much longer, I will quote what Prof. Hirschfeld, of Berlin, has written quite recently regarding children fed on low protein :

"THE NUTRITION OF COUNTRY LABOURERS.*

"For the sake of comparison, I will make some remarks concerning the food of country labourers. These people live very frugally, yet their appearance, working ability and health are splendid. My observations were made during the summer of 1902 on an estate at Bromberg, and in 1906 I supplemented these with similar observations on an East Prussian estate near Osterode. The results obtained seem to be of great value, because they correspond very well with certain figures, which Meinert obtained in 1878, after experiments with a family of country labourers in Saxony, and which Hultgren and Landergren obtained in the year 1891, from experiment with a vigorous Swedish country labourer.

"The figures resulting from the use of the most important food-stuffs were as follows :—

	Posen, 1902.	Saxony, 1878.	Sweden, 1891.
Bread	650	700	698
Potatoes . . .	800	600	698
Meat and fish . .	about 70†	about 20	74
Milk	about 500	70	634
Total protein . . .	92	88	114
Digested protein . .	70	69	77

"It will be seen that in all the above places there is much the same use of bread. Neither is there any great difference in the use of potatoes.

"That the figures from Posen are so high is explained by the statement that the subjects were very strong people.

"Almost the only difference is found in the use of meat and milk. In Saxony less was used than in Posen and Sweden. In spite of this Meinert did not find any anomalies with regard to physical conditions. Furthermore, the fact that they were engaged in very arduous work is much in favour of a vigorous working ability.

"As further evidence that meat and milk do not contribute very greatly towards ensuring good quality and nutritive value in the food, I have the results of my own experiments. I have been experimenting with three families with few children, because I find it easier in such circumstances to calculate the food consumption.

"A more precise experiment confirms this. At some schools where

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* Hirschfeld : "Krankheit und sociale Lage," p. 128. Munchen, 1912.

† Nearly all pork, therefore being mostly fat (Author).

there were many children I observed that they were very strongly built and well developed muscularly. There was no sign of anæmia or rickets. As the children were without stockings and boots, observation was easy. Among them was a family of many children who were looking particularly healthy ; and after careful inquiry, I found that they consumed very little milk and meat. Potatoes, bread and fat, however, were eaten in great quantities."

CHAPTER XVIII

ENJOYMENT OF LIFE*

THE greatest pleasure in life is to feel so healthy in body and mind that we have no need for artificial enjoyments.

I hope that the reader will concede that I have furnished many and good reasons in the foregoing chapters to show that our mode of life, approved as it is, to our misfortune, by Science, is unsuited to us, because it enjoins over-indulgence in food generally and in protein in particular, which is not only useless, but directly harmful, apart from the consideration that it is altogether too expensive. If we are agreed upon this, how are we going to divert the ever-spreading movement from the old evil paths? I am perfectly aware of the extreme difficulty presented by such a task. So long as the watchword of Science was beef, and so long as the popular palate responded to the cry, people were ever ready, so far as their means permitted, to follow in the wake of Science. But now that Science is beginning to discuss potatoes and rice—while the popular taste still hankers after beef-steak and poached eggs, a conflict has arisen between two powerful forces, of which the latter, I fear, is the stronger.

It is common knowledge that a certain number of people live to eat, and do not eat to live. It would be hopeless to attempt the reform of such people, even though we try to frighten them with terrifying visions of future gout, catarrh

* I have doubted whether I should include this chapter in the English edition. In each edition since the original appeared in 1906, this book has become ever more scientific, and, therefore, less popular, in form. If I omit this chapter in the present edition, nothing but the exclusively scientific will be left. Although this would probably meet with approval from scientists, there is another consideration—the disastrous effect of over-eating—which first induced me to test the possible advantages of an abstemious life, and which I feel may inspire others to undertake similar tests. *Real conviction can only come through personal experiment.*

of the stomach or kidney colic. The motto of such people is :—

"Let sorrow abide the morrow,"

but when both the morrow and the sorrow are here, habit has taken too strong a hold, resolution is enfeebled, and the time to reform is past beyond recall. If anything is to be effected, we must take time by the forelock ; we must grapple with the evil before it has developed into fixed habit, before the stomach has been elevated to the position of supreme deity, while yet enthusiasm for ideals may be evoked, and while sufficient will-power exists to force the ideal forward to victory in defiance of established convention. But where shall we look to find suitable material for the good work ? Our reply is : Among our young people !

My own experience has taught me what enthusiasm will do for youth. "Where the young are alert, the country will flourish !" Whatever inspires enthusiasm and confidence in the young, that will they bear to victory in the face of all the wiseacres in the world.

Would it not be well worth our while to instil enthusiasm in the minds of the young for the phrase "a healthy mind in a healthy body ?" This would act as a force from within which would encourage our young students, and especially our future doctors, to struggle to the empyrean. But I know not why it is ; so little enthusiasm is apparent in these spheres of life. Medical students learn much concerning "sick minds in sick bodies" ; and are taught how to patch up the latter in various ways ; but the healthy mind must resign itself to wait until it chances to fall ill before medical attention is directed to it. The doctors go their rounds armed with stomach pump, test glass, microscope and medicine bottle, as if these were the weapons with which knighthoods are to be won ; but who ever takes the trouble to teach us to avail ourselves of the means afforded by fresh air, sunlight, clean water, gymnastics, sport, diet, etc., to keep sound minds in health ? Does it not amount to a scandal that knowledge of gymnastics, sports and other branches of personal health culture is not demanded by medical examiners, the more so when we consider that these

subjects are obligatory, so far as I know, in most of our (Danish) agricultural and high schools ?

We will suppose for once that a thousand worthy people have read the foregoing chapters of this book, and have given as much thought to the subject as may be evoked by the perusal of a book in a leisure hour. What comments would such people be likely to make ? I venture to think that a very large proportion of them, 900 perhaps, would argue somewhat in this fashion : " It is possible that if I were to follow the author's advice, I might add a few years to my life, and might also rid myself of gout, stomachic complaints and other disorders. But what attractions has such a life to offer otherwise—a life on potatoes and porridge, butter and bread ; a life almost innocent of beer, tobacco, coffee, meat and other similar comforts ? Life would at once lose all its interest for me ; I would rather enjoy a shorter life with a little self-indulgence, than drag out a long existence of self-denial."

Now, we have here a very serious objection with which to deal, and such an objection is very real to our 900 men ; and we must, therefore—though we smile up our sleeve—meet it with equal seriousness, and set ourselves to determine, first of all, what enjoyment really means and what appertains thereto.

It is not an easy matter to be explained in a few words. We will endeavour to draw two pictures by way of illustration :

Picture No. 1 presents a little child of three, healthy and active in every respect. He is playing on a grass plot ; and the time is about eight on a fine morning in spring. The air is fresh and balmy ; the sun is shining and imparts a genial warmth ; larks are carolling and our little friend is trying to drown their song with all the force of his lungs. From the anxious mother, hovering near, we hear an intermittent, admonitory chorus : " Oh, do be quiet for one moment, Peter ! " " Don't shout so loud ! " " Take care, Peter, or you will tumble ! "—and so forth. But it is impossible for Peter to keep still—nothing on earth could tempt him to do that. Peter is fired with the idea to turn a somersault—if he be prevented, life will not be worth the living. But he cannot manage that somersault. Try as he may, he fails, tumbling now to the right, and now to the left, never succeeding in going

right over. But despite frustrated effort, Peter halloes louder and yet louder. There is such an infectious humour about every one of the little fellow's antics that even his grave and watchful mother is compelled at last to surrender at discretion. Peter's final attempt ends so comically that she bursts out laughing in the middle of a severe protest. The link between the will and the centre of laughter in the brain was not strong enough. Peter is, without question, the victor. His faith is in himself, his fortune and his mother. Though she grumble ever so severely, Peter knows well that, did the neighbour's big dog dare to show its face, mother would hasten at once to the rescue.

Picture No. 2 presents the wealthy merchant B. seated at dinner in select company. The hostess is an artist in the arrangement of a dinner, both as regards the ordering of it and its preparation. The soup is excellent ; the sauce to the halibut is even better, and only surpassed by that to the venison ; while the chicken, being machine-crammed, positively melts in the mouth. The sweets and dessert are in keeping with the rest of the meal. In consequence of which and in response to the hostess' exhortation : " Now, just a little more, if only to please me ! " our merchant manages by degrees to dispose of an incredible amount of food. The stomach, after half an hour's patient endurance, tries to protest, but only to have sherry and hock poured into it by way of answer ; a further protest after yet another thirty minutes or so is laid with a glass of superior 1880 Léoville. A third and final protest is drowned with champagne to the chicken and with madeira to the dessert, until, at last, coffee, together with a glass of Three-Star Hennessy and an extra-fine Havana unlock the gates to the seventh heaven.

The summit of enjoyment is reached. Our merchant is intoxicated with pleasure—if not with something else also. He is sensible of the most sincere and most just compassion for his neighbour, the abstainer, who has strayed into the company, and who, quite unsuccessfully, despite the intolerable, non-narcotised pressure round his midriff, seeks to demonstrate the advantages of a non-alcoholic way of life.

The following day our merchant is not visible. He yearns

for salted herring and bitters. There are yet three days to his next dinner engagement; and he spends the interim in a state of anything but "unmixed joy." He is conscious all the while that something is wrong somewhere. He cannot taste his food; he must go to the doctor for "something for his appetite." The doctor is of a very obliging disposition, and one who would not risk offending our wealthy merchant by any chance. The real trouble is overlooked as if by mutual agreement, and some bitter mixture prescribed. Besides which, our merchant has other remedies to his hand, such as cigars to counteract melancholy (nicotine-poisoning), or an extra-strong cup of coffee for various other complaints. In such fashion, for what it is worth, the intervals can be occupied until the end of the season is reached, and our merchant is at liberty to pay a visit to Carlsbad, or some other Bad, where he may recoup his strength for the next campaign.

But, of course, such a state of things cannot last. Our old friend's heart begins to give him trouble; he has symptoms of stomach distension and liver disorders; perhaps, his kidneys develop serious conditions; gout comes home to him to stay, until, at last, passive dropsy or a sudden heart stroke ends the short but "enjoyable" life of our merchant.

These pictures were designed to exhibit the two extremes* between which all of us oscillate. Here are two ideals, either of which we may emulate. The first is to be attained only with difficulty; the other, to the contrary, is very easy of imitation if we keep to the "broad" pathway through life. If we were to ask the merchant to give us his idea of enjoyment, we should not have long to wait for an answer. He is a connoisseur of wine, of cigars, and of viands to his finger-tips. From him we

* I find Christmas to be the most difficult time in my life. Everybody about me lives "better" then than at any other time; consequently, it is the time when I feel least comfortable. Sitting at a table spread with so many various delicious dishes, it is almost impossible not to eat more than is good for one. There is, therefore, a decrease of well-being. I suppose that, during the Christmas festivities, I feel much the same as other well-to-do people ordinarily feel. Few of such people can know how pleasant it is never to know the discomfort of repletion. It is absolutely impossible to feel perfectly well after a rich dinner, hence the temptation to produce narcotism by means of alcohol. Eating only one or two dishes of very plain food, there is no temptation in this direction. The reader must not forget that it is not only meat which tempts to over-eating: cereal foods with fats and sugar can be quite as bad—plum puddings, for instance!

could obtain ten times the information concerning the rarest table-delicacies that we could find in any encyclopædia. But if we, on the other hand, were to request little three-year-old Peter to tell us how he would define enjoyment, he would, very probably, turn a somersault in sheer amazement. If we attempt to solve the riddle by ourselves, we shall, no doubt, find his love of life to be quite unreasonable. We learn that for breakfast he had bread and milk; that his dinner will consist of potatoes and gravy; that for supper he will have thick slices of bread and margarine. He goes bareheaded and barefoot—indeed, he is all but naked, for his clothes are merely rags and tatters. In short, we find no sense in it all, and involuntarily take to thinking of the "lucky man without a shirt," which we had always held to be the merest fable.

But if we examine our two pictures more narrowly, and through scientific spectacles, we shall see, on the one hand, enjoyment as it comes to us direct from Nature's hand, and preserved by sensible nutrition and a generous use of sun, air, and exercise; on the other hand, we have a sense of enjoyment well nigh extinguished by lazy habits, confinement within four walls, gluttony and all manner of poison, which sense can only be temporarily awakened to fresh life by the self-same poisons which were the agents of its destruction.

All of us have, at one time or other, experienced a feeling of spontaneous exuberance which expresses itself in an indescribable sense of well-being, and one feels so glad and so happy, yet has no idea why it is one rejoices. This sense of well-being is the effect of an extremely delicately-adjusted co-operation of nerves, muscles and organs. The slightest ill or hitch destroys the harmony, just as one broken cog on a toothed wheel will throw the most perfect machine out of gear. How vitally important it is to us that we watch over the precious machinery of our organism with the utmost care, guarding it from useless wear and tear, from rust and decay, and, above all, from dirt and poisons.

And do we exercise such extreme care? What is our treatment of those little machines—our children? Do we allow them free access to fresh air and sunlight? Do we not restrict the natural freedom of their limbs with excessive and

useless wrappings? Do we not coddle them up, keeping them in Arctic costume close to a hot fire in a room with hermetically closed windows? When, later, they strive to resist being over-fed, for the very good reason that they are not hungry, do we not force them to swallow "just a little bit more?" If they like potatoes, bread, butter, fruits, and refuse heavy dishes, do not we compel them to eat meat and eggs, so that they may "grow strong?" How long is it before we begin to offer them poison No. 1: coffee, to which they are, as a rule, naturally averse? Do we not, while they are still comparatively young, give them stronger and stronger coffee, because we ourselves derive "strength" therefrom? And do we not in this way bring it to pass that many a young girl approaching puberty suffers from heart palpitations and "nerves?" And how long is it before we, by bad example, introduce our children to poison No. 2: nicotine, which blunts our mental capabilities and, moreover, has a debilitating effect on the heart and nervous system? And then, possibly, we may teach them how to enjoy that last and worst poison of all: alcohol, as being a polite accomplishment. And in addition we pack them from morning till evening into dirty sweltering school, or living-rooms, until it is really a matter for astonishment when we meet—in our towns, at least—a human being of twenty years who is still normal, healthy and vivacious in every respect.

I suggest, therefore, that a reform is necessary. But as long as the old views regarding nutrition rule the world, a complete reform will be almost impossible.

To discover, theoretically and practically, whether these views are correct or not, has become the problem of my life.

One might insist that I am considering only the physical side of the question—and that, too, only in part. The purely moral side is quite as important, but to deal with it would be beyond the scope of this work. I will only mention that it is a great asset to be capable of a sound and healthy view of life, which admits of a serene mind and a belief in the principle of good in some form or other—as in the child's trust in its mother. But a clear appreciation of the meaning of existence and bodily health are more closely associated

than many people imagine. It is a known fact that pessimism is often the outcome of a debilitated stomach !

I will endeavour to draw up a profit and loss account which will show how observance of the above table of rules will affect enjoyment. I will not be answerable for the mathematical exactitude of the reckoning : I have calculated every detail as justly as I am able, and more than that cannot be demanded of me.

On the "loss" side of the balance sheet must be placed all the unpleasantnesses which have to be faced when one withdraws oneself from the social throng. The abstainer is regarded as an "extraordinary crank," as a "bumptious person," "a hypocrite," and so forth. He is in some degree cut off from social life as it is at present constituted. The palate must be deprived of many delicacies. The ears must forego the pleasure of listening to the round of small talk and general conversation, as well as various piquant smoke-room and post-prandial stories. In short, one is shut out from social enjoyment, which, in certain respects, has its advantages to offer.

On the profit side we have to enter :—

I. *A natural sense of health, well-being and joy in life,* the value of which is priceless and not to be surpassed even by the ecstasy of the gourmand seated before a table spread with the choicest and most exquisite viands, no matter how much in the humour to relish them he may be.

II. *An appetite so perfect* that a piece of black bread and butter with a thin slice of plain Dutch cheese tastes far better than the very finest delicacy known to the epicure. After several years' experience I have now no doubt that "the pleasures of the table," are much enhanced when one eats little and seldom. It needs but one glance at the face of the gourmand when he is trying to make up his mind as to which dainty he shall eat, to convince anybody of this. It is astonishing and incredible to many, that people do not tire of plain diet, whereas luxurious diet soon palls—as may be observed in our sanatoria.

III. *A feeling of impulsive activity and pleasure in work* with its accompanying feeling that work is easy. As regards

physical labour, I have not had sufficient experience of it, but must refer readers to what has been said above. But as to mental labour, I have not the slightest doubt that a simple life renders the brain more capable. I have a heavy suspicion that when people in the forties start complaining that they cannot think and calculate with such ease, are not so capable in fact, of headwork, as they were when twenty years younger, this is only a consequence of degeneration of the brain-cells brought about by indulgence.

IV. *A feeling of economical independence.* As the mode of life described is in every way very inexpensive, a considerable balance should show itself on the right side of the household exchequer. When the income is not too small, and reasonable thrift is exercised in all departments, silly and useless luxuries being done without, many economical worries which harass so many families (particularly those belonging to the so-called upper classes—people with comfortable incomes who feel it their duty to make the most of them) would be much reduced. The housekeeping money saved by this means could be devoted to other and better purposes—to the bringing up and education of the children, for instance, so that they have the opportunity of mounting the social ladder by a degree or so, or of shaping for themselves a career relatively free from care.

V. *Surpassing contentment is further to be derived from the conscientious feeling of having done the best for one's children.* It is easy to see that, apart from mere health considerations, it must be a veritable blessing for children to be accustomed to plain living from their early years. Who knows but that later they may find themselves compelled to live plainly ? In which case the life will not prove so great a hardship. How pitiful it is to see a youngster of fifteen or sixteen beginning life, pampered and fastidious in every respect—such a poor creature is wholly unfit to engage in the struggle for existence. He is only fit to live on the charity of his parents—and there can be no more wretched existence than that.

To sum up.—If we examine our balance sheet, we cannot help observing what an enormous surplus in enjoyment a simple, poison-free life has to offer us. It shows us how we may lead an existence comparatively free from care, affliction,

and boredom—akin to that of the little three-year-old playing on the grass plot—which, again, would serve to guard us from temptation. Leading such a life, we should have no need for alcohol " to soothe life's sorrows," no need for tobacco " to kill time " ; no need for coffee to allay thirst and other less pleasant consequences of a heavy meat dinner. We should not sigh for music-halls or other trashy amusements to while away the evening. We should enjoy, in fact, an almost unlimited freedom, regarding the vast majority of supposedly free people merely as slaves to their own evil habits.

We must, furthermore, take into consideration that that entry on the " loss " side, Isolation, is, happily, but transitory. Strong in our conviction, we are, very naturally, striving our utmost to advance our cause. And in that day when we are in a majority, or even in a not too large minority, the last vestige of inconvenience will be removed. We will then do away with society-life as at present constituted, with all its follies, which demand that a crowd of more or less indifferently acquainted people shall be gathered together, often having not one single interest or sympathy in common, to be placed side by side while they eat ; to be offered alcohol, presumably to counteract their general apathy, or even ill-will, maybe, towards each other. But when we come together it will be because we are attracted to each other by mutual interest ; and we shall not be ashamed to offer our guests the same simple fare which we enjoy every day. We shall thus relieve our wives of much anxiety ; our friends will know that they are welcome to come whenever they like, as we shall always be ready for their reception ; and they will leave us feeling as well and as comfortable as if they had been spending a quiet day at home, and with no fear of seediness on the morrow.

In which manner we shall always be provided with the means to enjoy " society-life " ; and lack of means must compel many a family at the present day to isolate themselves more than they could wish.

Let us imagine that we are an army which has grown into being from that which has been said above concerning the follies of the existing mode of life, and which is agreed to engage in the fight for reform.

Our first step, therefore, is to discover the main positions of the enemy so that we may hurl ourselves upon them at once, without wasting too much powder on less important points. The first and strongest fort with which we have to deal is called *Custom and Convention*. This great stronghold, together with its outwork, *Vanity*, controls far more than half the human race, both with respect to clothing as well as with respect to eating.

If Mrs. A. treats her guests to five courses and to three kinds of wine, Mrs. B. feels compelled to offer her guests the same, or even to go one better with six courses and four wines. "That which everybody does, everybody must do!" Though a man be head over ears in debt, he must not appear to be mean, that is, thrifty. For which reason the guest is urged to overshoot the mark with the never-ending exhortations: "Another helping, just to please me!" "Oh, I can see that you don't like it!" etc.

I cannot understand why hostesses do not employ forcing machines used to cram geese; but perhaps it is because the method is so little known at present. And as it is in company, so is it in ordinary life. When Mrs. A. visits Mrs. B. who lives across the road, the latter lady finds that the journey has been so exhausting for the former that Mrs. A. is in dire need of a "heart-stimulant." Tea is at once prepared, and Mrs. B. would deem it quite a misfortune if she could not induce Mrs. A. to swallow two or three cups of tea together with some pastries. Her intentions are, of course, of the best; for, most probably, Mrs. B. has never given it a thought whether her treatment of her dearest friend's stomach can be at all beneficial to that organ. But the business is not likely to end here. It is quite possible that Mrs. C. will also be honoured with a short visit, and she must not be "offended." Mrs. A. sacrifices herself once more for the sake of etiquette. Indeed, one may spend hour after hour in visiting, and at every house meals, tea and other refreshments will be offered in such abundance that one is thankful to escape with a whole skin. It is certain that our hospitable hostesses do us, unconsciously, more harm than would be conceived. Shall we not try to roast such people on the gridiron of science and irony, until there are none left but

those who are content to feed the hungry, and who will leave the satisfactorily lined stomachs of their friends in peace and quiet ?

Let us suppose that Fort No. 1 has fallen, and we are now advancing to the attack of Fort No. 2, called " Falsehood." We have considered the aspect of this Fort from so many sides in our earlier chapters, that we will refrain from further description of it. But we may supplement that which we have said with the following striking passages from a review of " My System," * written by a Danish physician, Dr. L. :—

" Very few of us are in a position to lead a thoroughly healthy existence. Our work, our daily life and our pleasures act disturbingly in many directions ; and we may say what we like about the last, yet conviviality at meals, with wine, coffee and tobacco, mental expansion and eloquence belong to the hours when we ought, strictly speaking, to be in bed, as well as to recreation, upon which the great majority, with justice, lay such value." J. P. Muller's System is thus recommended to " counteract these more or less inevitable, exciting and depressing influences."

We do not know at which to be the more astonished : at the frank way in which Dr. L. recognises these health-besetting sins as " Pleasures," or the boldness with which he—although a doctor—asserts that to offend against the laws of health is " the right of the great majority." As we know that Dr. L. is certainly no reveller, but a highly respected man whose words carry weight, and who evidently regards himself as interpreting the views of many of his fellow professionals in these matters, we find ourselves more than a little depressed. We say to ourselves that we are acting foolishly in thus striving against the stream which is so eagerly followed by the public. We perceive how far we have progressed on the road to degeneration, decline and destruction. We understand the victory of the Japanese over the Russians. We foresee the " yellow danger." But we may exhort ourselves at the same time to remember that this man and those of the same mind with him, as they themselves admit, are sick. They have been accus-

* " My System," Lieut. J. P. Muller. London. Ewart, Seymour & Co., Ltd.

tomed from childhood to unnatural conditions ; they know nothing of the sublime feeling of satisfaction which is Nature's reward to those who obey her commandments. Cut off from Nature by poisonous influences, they know only of unnatural enjoyments ; and no one can speak of that with which they are unacquainted. It is, unfortunately, of urgent necessity that our young be made to understand these important points, so that when they encounter this monster " Falsehood," whether it proceed from the lips of doctor, pastor, or lord, they may greet it with the cry, with the converted American on their one hand, and our little friend of the grass plot on the other, while their voices echo through the land :—

" Thou liest in thy throat, thou monster. ' It is easy to live, and life may be made constantly happy by beginning in the right way.' "

And uttering these words, I hope to see our three to eighty-year-old youths turn somersaults on the grass to the amazement of our forty to fifty-year-old " dotards." May the latter soon perceive the presence of " the yellow danger," not in the shape of a Japanese invasion, but in the form of a young people glowing with vigour, health and happiness, and living a homely spartan life, breathing fresh air, and drinking sunshine and water.

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