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REPORT
OF
THE NEW GUINEA NUTRITION
SURVEY EXPEDITION
1947

DEPARTMENT OF EXTERNAL TERRITORIES
CANBERRA

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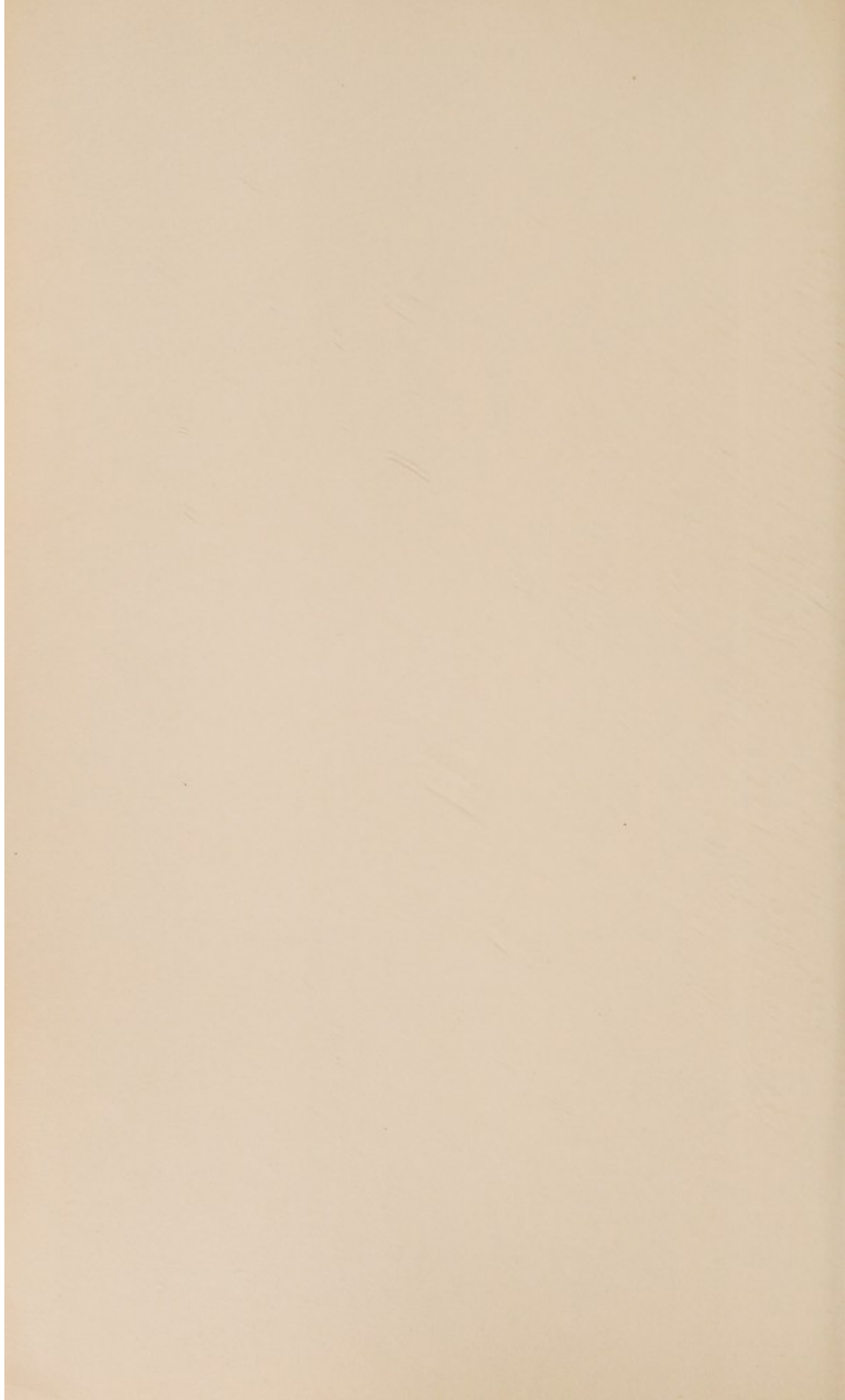
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REPORT

OF THE

NEW GUINEA NUTRITION SURVEY EXPEDITION

1947

CARRIED OUT BY OFFICERS OF:—

Commonwealth Department of Health (Australian Institute of Anatomy, Canberra; School of Public Health and Tropical Medicine, Sydney).

Provisional Administration of the Territories of Papua and New Guinea (Department of Education; Department of Agriculture Stock and Fisheries).

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INTRODUCTION.

The 1947 New Guinea Nutrition Survey was undertaken at the request of the Administrator of the Territory of Papua and New Guinea, and the Department of External Territories. For some time past the Australian Institute of Anatomy has been advising the Department of External Territories on ration scales for labourers in New Guinea. The absence of any specific data relating to the food consumption patterns of the village native made it difficult to devise ration scales based principally on native foods. As the Administration was anxious to use as much native grown food as possible it was considered desirable to collect information relative to the food patterns of native groups living exclusively on indigenous foods, and at the same time ascertain the nutritional status and health of these same groups.

It is known that from time to time in certain localised areas in New Guinea food shortages, amount almost to famine, occur. So that abnormal conditions would not give a distorted picture, it was thought advisable to collect quantitative data on food production and food consumption in areas where conditions were known to be normal. These data could then be used as standards in any future investigation of food shortages.

A third purpose, of perhaps lesser importance, was to ascertain whether it would be possible and desirable to recommend a policy of native agriculture which could combine the production of "cash" and native food crops without detriment to the latter.

ORGANISATION OF THE EXPEDITION.

The field party included the following: a Medical Officer, a Parasitologist, a Nutritionist, two Biochemists, an Agriculturalist, a Sociologist, a Dental Officer and a Photographer. The latter two officers were employed for part of the survey only. In addition, two biochemists were employed at the Institute of Anatomy to analyse dried samples of food and urine samples of vitamin load tests despatched from the field.

The Administration made available in each area a patrol officer who had some knowledge of the local conditions.

The officers and the necessary technical equipment were provided from the staffs of the Institute of Anatomy, Canberra; the School of Public Health and Tropical Medicine, Sydney University; the New Guinea Administration; the Dental Research Institute, Sydney; and the Department of Information, Canberra.

THE AREA SURVEYED.

In this study five villages were chosen for intensive investigation. The food pattern of each village was based upon a different staple food. It was necessary for the villages selected to be reasonably easy of access to an expedition with heavy laboratory and camp equipment. Furthermore, it was advisable for economy in transport and administration to operate from as few main bases as possible.

Other considerations were that the village should possess a more or less stable economy, and that the people would be co-operative. The map shows the locations of the villages. (See Plate 29, page 296.)

The following are brief descriptions of the villages selected:—

Busama is a coastal village a few miles from Lae. The village is spread out along a narrow fringe of sand about 50 yards wide, from which hills rise suddenly and steeply to 500 feet or more. The native men cut and burn patches of scrub on the steep hillsides and ridges, and in these roughly cleared areas the women plant taro (see Plate 31). When this is harvested, corn, pit pit, sugar cane, bananas, and pawpaw are planted in what appears to be a haphazard manner. There are many species of edible green leaves and fruits in the scrub around the village. Numerous coconuts are readily available, and from adjacent swamps an appreciable quantity of sago is obtained. From the sea and small creeks relatively small quantities of fish and shellfish are obtained, but in the season larger amounts of tuna are caught.

The most important food is taro, and both the tuber and the green leaves are eaten almost every day.

Kaiapit is one of a large group of villages situated in the flat, alluvial grass-covered country of the Upper Markham Valley. The elevation is about 1,000 feet above sea level. Communication to Lae 60 miles away is by air along the wide flat Markham Valley.

From the flat floor of the valley, which at this point is about 8 miles wide, grass covered foothills rise steeply to heavily scrub-covered mountains.

The diet pattern is very diverse. The gardens on the flat country (which is often flooded) produce mainly bananas, but sugar cane and pawpaw in addition, whilst in and around each village are planted numerous coconut palms, breadfruits and other food trees. From the gardens of the grassy foothills come sweet potato, maniok (native tapioca), pit pit, corn, sugar cane, whilst taro is grown on the steeper scrub-covered mountains in much the same way as it is grown at Busama.

There are pigs, both wild and domestic, which are sometimes killed and eaten.

Patep Number 2 is typical of many New Guinea villages in the inland mountainous country. It is situated 50 miles from Lae and is perched on top of a mountain overlooking the Wampit River gorge 1,000 feet below and along which winds the Wau-Labu road. From the road a narrow foot track zig-zags up the mountain side and enters the village through which wet clouds are constantly drifting. At this altitude of 3,550 feet, the days and nights are often cold. There are innumerable flies, but mosquitoes are rare—if present at all.

Sweet potato and taro are the staple foodstuffs. These crops are planted in areas on the mountain sides where the scrub has been cut and burned. Other garden produce is pit pit, corn, sugar cane, pawpaw, banana, cucumber, beans and pumpkin. There are many varieties of bush fruits, nuts and edible leaves. Coconuts do not grow satisfactorily at this altitude. One variety of pandanus palm has a highly prized fruit which yielded a reddish emulsion resembling tomato sauce in appearance.

Numerous domestic pigs are kept in well-built pig houses. These are killed and eaten on festive occasions. Hunting with spears and dogs occasionally adds a wild pig to the food supply. Indulged in more or less as a profitable pastime, hunting with bow and arrow adds occasional birds and small animals.

Kavitaria is a coastal village on the island of Kiriwina in the Trobriand Island Group. Kiriwina is a flat coral island of approximately 15 miles by 10 miles, and on one side there is a lagoon where fish and oysters are abundantly available to the coastal people. These sea-foods are exchanged inland for yams in a well developed trade (see Plate 40). The island is fairly densely populated with people who are well-known for their excellent physical appearance.

With the exception of swampy areas the whole island is covered with yam gardens or with the secondary scrub. This latter takes its part in an agricultural rotation with the gardens appropriately known as "Bush Fallowing Rotation." In and around each village is an ample supply of coconut palms, which in addition to supplying food, utensils, building materials, etc., allow appreciable quantities for village copra manufacture and export.

The staple food is yam which is grown seasonally and stored for about five months (see Plate 34). Sweet potato and taro are also grown in appreciable amounts, whilst there are lesser quantities of sugar cane, banana, corn, maniok, pineapple and pawpaw. Village pigs are occasionally killed for feasting.

Koravagi is a village located on one of the numerous tidal waterways which make up the network of the Purari Delta. At full tide the "dry" land is only a few feet above water level, whilst at low tide oozing mud banks line the waterways (see Plate 33). The only method of transport outside the village is by dugout canoe. The cultivated gardens are very small and relatively unimportant, swamp taro and sugar cane being the main crops grown.

Sago, which is made by washing the starch granules from the pithy trunk of the sago palm, is the staple foodstuff. Many coconuts, breadfruit nuts, bush fruits and leaves are collected from food trees. Fish and prawns are trapped, and shellfish are collected from the waterways. An occasional crocodile caught in a fish trap is eaten.

Sago grubs are included in the diet. These provide an interesting example of a biological method of increasing the nutritive value of food. A sago palm is felled, but instead of extracting the sago the trunk is allowed to rot. Several months later, on splitting it open, it is found to be teeming with sago grubs which are collected and eaten.

SUMMARY OF RECOMMENDATIONS.

Improvement in Nutrition.

It is recommended that:—

1. The health and nutritional status of the native children can be improved by incorporating more protein-rich foods in their diets.

2. Increased consumption of animal products is desirable in almost every part of New Guinea. Not only cattle but also tethered milch goats, poultry, buffaloes, sheep and pigs may be valuable sources of animal protein.

3. It should be regarded as most important that the supplies of fish in and around New Guinea should be developed to the maximum possible extent.

4. Consideration should be given to the development of native gardens of supplementary foods in and around plantations and of the more widespread use of these foodstuffs by native labourers.

5. Combined with agricultural development there must be a programme of education of the native in the importance and use of protein-rich foods, especially in the diet of children.

6. Consideration should be given to the wider cultivation of crops such as rice and peanuts which can be easily stored and transported and which would help to eliminate seasonal and regional shortages.

7. The efficiency of existing methods of agriculture deserves attention, and any change must be made with extreme care and must be gradual.

8. A good working rule for the improvement of dietaries would be to endeavour to increase the variety of foods growing.

9. Because of the hot, humid climate which prevails in New Guinea, food preservation and storage presents special problems, especially in the handling of foods of animal origin. The problem is likely to become increasingly important in the future and requires special consideration.

10. There may well be need for Government assistance such as the establishment of marketing centres and the provision of storage and transport facilities in areas where trade in foodstuffs become important, especially if they be of animal origin.

11. While resources of the administration are limited, it would appear to be wise to concentrate efforts to improve the nutrition of the native peoples to those groups which would be most susceptible to new ideas.

12. Before industrial or other projects requiring labour are established in areas, a broad survey should be undertaken to ensure that native food production will not be jeopardised by diverting labour.

Prevention of Disease.

13. The desirability and possibility of preventing endemic goitre in the area where it occurs by increasing the intake of iodine, should receive further investigation.

14. Consideration should be given to finding ways and means of preventing and controlling malaria in native villages.

15. As a measure aimed to prevent the spread of tuberculosis, every effort should be made to prevent overcrowding in villages, not only within the huts themselves, but also in the spacing of these dwellings.

16. It is probable that the high incidence of periodontitis (inflammation of the gums) can be reduced if ways and means of keeping the teeth free of calculus (scale) can be found.

17. In order to more effectively control framboesia (yaws) the scope and frequency of medical patrols should be extended.

Further Research.

18. Consideration should be given to a long-term study of physiological and pathological characteristics, particularly relating to food requirements for optimal nutrition of Melanesian and Polynesian peoples. This must be done in the areas and on people living under as near as possible natural conditions.

19. There is need for more research into the biological value of vegetable proteins in the nutrition of New Guinea natives.

20. Consideration should be given to carrying out an investigation to determine whether in New Guinea hookworm disease is a significant cause of anaemia. Probably this investigation would need to be carried out in the highland country where malaria would not complicate the results.

PART I.

SUMMARY AND CONCLUSIONS.

The most important observations and conclusions from the studies contributed by various authors are collated.

- A. General Considerations.
- B. Sociological Considerations.
- C. The Agricultural Pattern.
- D. The Diet Pattern—Food storage, Food preparation and Cooking, Meal Habit, Food Taboos.
- E. The Nutritional Status.
- F. Relationship of Food Consumption and Nutritional Status—Calories, Protein, Calcium, Thiamin (Vitamin B1), Ascorbic and (Vitamin C).
- G. Possibilities of Improvement of Nutrition through Changes in Native Agriculture.
- H. The Disease Pattern—Malaria, Hookworm, Tuberculosis, Framboesia (Yaws), General Medical Considerations.
- I. Observations on Dental Conditions amongst Native Peoples in Papua—New Guinea—Periodontal Disease (Disease of the Gums), Dental Caries.

A. General Considerations.

The life of the New Guinea native in his village is centred around the procurement of food and the provision of shelter. The amount of time that has to be devoted to these two pursuits varies considerably from village to village, being influenced by soil, climate and the topography of the country. In some ways these also determine the nature and quantity of food won from the unyielding landscape or sea. The idea that food abounds in the tropics and is to be had merely for the garnering does not apply to large parts of New Guinea.

The survey has shown that while the village native is able under normal conditions to obtain enough food to sustain life and health, the diet is often badly balanced according to modern standards. It is probably adequate in calories but too many of these are provided by carbohydrate and not enough by fat and protein. The diet is markedly inadequate in protein. This deficiency exerts a more detrimental effect upon children than adults not only because of the overall low intake but because customs dictate that most of the animal protein available is reserved for the adult males. The intake of minerals and vitamins is probably adequate.

The clinical manifestations of this peculiar food pattern are difficult to detect. Oedema and low serum protein which have on a number of occasions been reported by overseas workers to be associated with low protein intakes were not detected in the New Guinea natives studied. It is known that diets inadequate in protein do interfere with the normal growth processes, causing stunting. The New Guinea native is of smaller stature than the Australian of Caucasian origin. It is not known whether this is mainly due to genetic inheritance of smaller build, but we must recognise that it could be due to inadequate intake of protein in the growing period.

The survey showed there is room for improvement in the health and nutritional status of the children. More abundant supplies of such protein rich foods as can be incorporated in their diets are required. The absence of sources of milk, *i.e.*, cows, goats or sheep, is a real difficulty and it seems that improvements in the near future must come from the introduction of foods that can be grown with the minimum of disorganisation of existing practice and that can be easily incorporated in the diets. Legumes such as peas, beans, and peanuts, perhaps offer the best possibilities. Combined with agricultural development there must be a programme of education of the native in the importance and use of these foods, especially in the diet of children.

Although this study did not include natives working on plantations, the results of the survey have thrown light upon a number of important aspects of the rations of these natives. Ration scales at present in use have been developed around imported staples such as rice, flour and meat augmented where possible with native foods or other imported foods to bring the nutritive value of rations up to accepted standards. The weakness of ration scales of this kind is that unless the importance of the supplementary items is appreciated by overseers, the ration tends to degenerate into a weekly issue of the staple foods.

The survey has highlighted the importance of supplementary foods in the diet of the village native. An easy satisfactory method of maintaining the nutritive value of the rations of the labourer would be the development of native gardens in close proximity to the compound. The gardens should grow those plants which the various native groups are accustomed to eat in their home villages. The provision of these gardens would reduce appreciably the cost of the rations and help to maintain a balanced diet and a healthy, more efficient labour force.

A general and substantial improvement in nutrition in New Guinea must depend upon the steady and concerted efforts over a period of years of many government departments and non-government enterprise. The primary responsibility rests with the Department of Health, but it is through the efforts of the Department of Agriculture, Stock and Fisheries, that changes and adjustments in the production of foodstuffs must be made. Naturally the nutritional factor cannot alone determine agricultural policy. Much can be done also by the Department of Education in contributing to an improvement in nutritional conditions.

B. Sociological Considerations.

The life of the native people is centred around the activity of food procurement, and the greater part of their time is devoted directly to this end. In most of the areas surveyed there was (at the time of the survey)

a fair degree of social and economic stability. The destruction of property and the disorganisation of the community caused by war is now new to the native society, and with the exception of villages of the Purari Delta rehabilitation was almost complete when the survey party visited the villages.

It appears that there is considerable variation in the amount of time which the various villagers expend in food production. The main factors are the distance of the village from gardening, fishing or hunting grounds, the terrain, and the type of foodstuffs grown. **Before industrial or other projects requiring labour are established in areas, a broad survey should be undertaken to ensure that native food production will not be jeopardised by diverting labour.**

In general, villages and regions are self-supporting. The difficulties of transport and the perishable nature of most of the foodstuffs impose limitations on trade. Nevertheless, where a surplus of non-perishable items is available and communications are reasonable, inter-village trading is a normal occurrence.

In certain localised areas trade may be important and here there may well be need for Government assistance such as the establishment of marketing centres and the provision of storage and transport facilities.

Some villages in the Purari Delta furnish an example of a community which is ripe for guidance and perhaps material help in the development of suitable trade avenues. Before the extensive urbanisation of natives in the Port Moresby area an important coastwise trade existed whereby the Moresby natives took cooking pots and trade goods to the Delta area and exchanged them for sago. Nowadays this trade has disappeared because the Moresby native is employed for a wage and can buy imported foodstuffs in the stores. The Delta people keenly felt the loss of this profitable avenue for the disposal of excess sago, and have attempted to resume the trade, but as their canoes are not seagoing they lack transport and their efforts have not been rewarded with success.

While the resources of the Administration for the improvement of native peoples are limited, it would appear to be wise to confine the introduction of new methods and nutritionally desirable crops to the natives who would be most susceptible to new ideas. The natives of the Purari Delta represent such a group.

C. The Agricultural Pattern.

With the exception of some small and strictly limited groups, the native population of the Territory is dependent for subsistence on the production or collection of various vegetable foods. Livestock do not play an important part in the land use methods of the people. Pigs and fowls are the only types kept, and the methods of husbandry are primitive. Where the people have access to the sea or waterways, fish, shellfish, crabs and shrimps, etc., make a useful contribution to sustenance.

Of prime importance in the native system is the production of the staple foodstuff, invariably a starchy vegetable. Sweet potato (*Ipomoea batatas*) taro (*Colocasia antiquorum*), yams (*Dioscorea* sp.), sago (*Metroxylon rumphii*), and bananas (*Musa* sp.) are the main crops of this type, and, varying with the environment, one or other of them is usually dominant to a marked degree in the agriculture of a particular community. Cassava

(*Manihot utilissima*) is an important accessory starch food crop, while any one of several of those mentioned above may also be grown as accessories.

Both wild and planted stands of sago palm are widely distributed in the extensive low-lying swampy areas associated with the larger river systems. All the remaining staples are treated as annuals, which are cultivated in a garden clearing out from forest or grassland. These gardens are usually abandoned after a single cropping, and are allowed to lie fallow for as long as the local population pressure will permit. This period of fallow is often long enough for high secondary jungle to develop before the plot is recultivated; the system has accordingly earned the name of "Bush Following Rotation."

A number of perennials providing fruit, nuts or edible green leaves are also commonly grown for food. The practice is to locate them in irregular groves in or around the village.

The implements used in agriculture are simple axes and knives for cleaning, and the digging stick for cultivation. Crude irrigation systems are occasionally found, while fertilizers and manures are virtually unknown.

POLITICAL, ECONOMIC AND CULTURAL FACTORS INFLUENCING THE AGRICULTURAL PATTERN.

Amongst New Guinea communities prestige and influence in village affairs are attained largely by the ability to make gifts of food and other goods. Food production is carried on by individuals and family units. Communal farming is rare, and when practised is usually limited to the clearing and the fencing of the area in which each individual's garden is located.

The principal economic factors affecting native agriculture are (i) the generally low population density; (ii) the low degree of technological development associated with food production; and (iii) the limited scope for trade and export provided by local political and geographical conditions.

As with most peasant people, women play an important role in agricultural production. The heavier work such as felling and clearing jungle falls to the men, while the lighter but more tedious jobs such as planting, weeding and harvesting are the women's responsibility.

D. The Diet Pattern.

The diets of the natives studied were found to be composed of the following general classes of foodstuffs:—

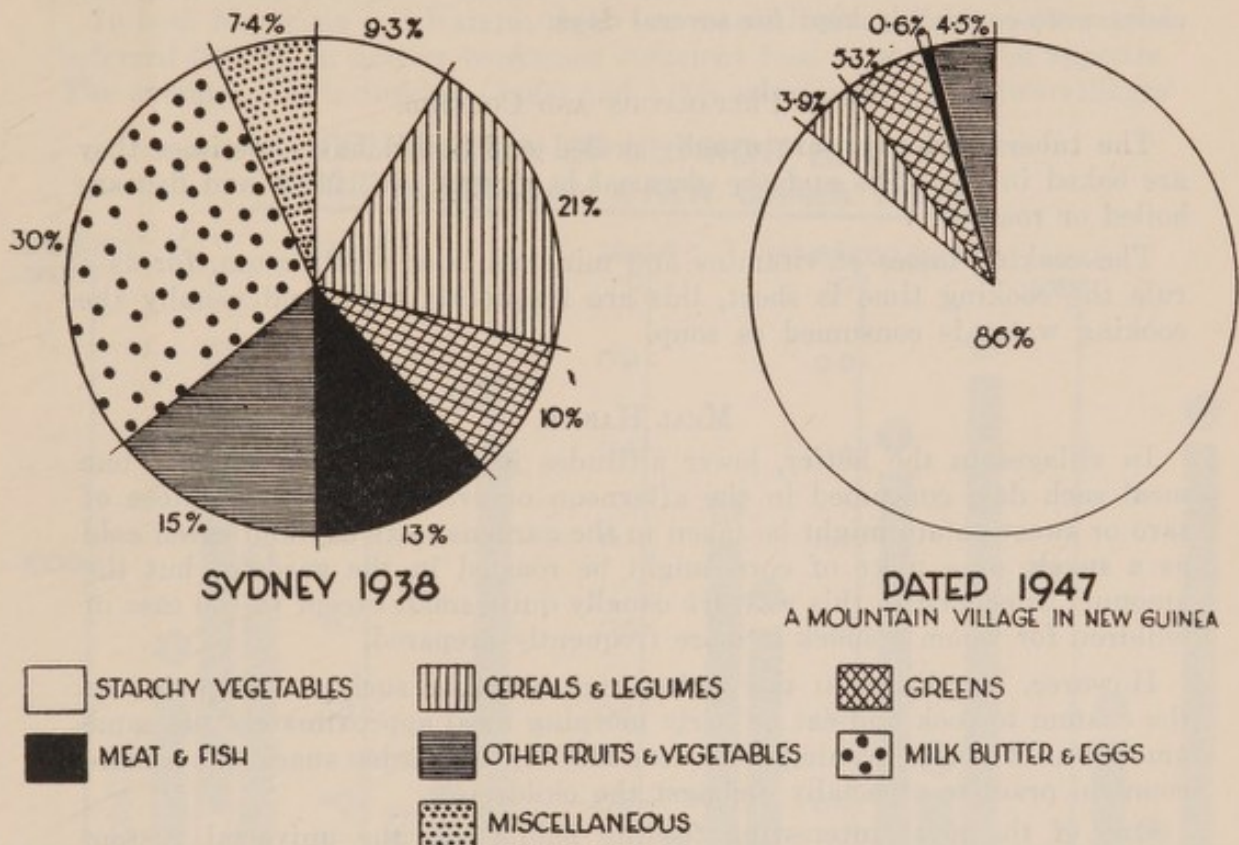
- (a) A staple consisting of a starchy vegetable such as taro, sweet potato, banana, yam or sago.
- (b) Cereals and legumes such as corn, beans, rice.
- (c) Green leafy vegetables.
- (d) Nuts.
- (e) Meat and fish.
- (f) Other fruits and vegetables.

The staple foodstuff is by far the greatest bulk of the food consumed, but although the average consumption of green leaves and other supplements is small it is nutritionally important.

The natives of New Guinea have a food consumption pattern which is different from the Australian and European food pattern, both qualitatively and quantitatively. It is largely a vegetarian diet and lacks any dairy products. The quantity of meat and fish consumed is usually small. (See Diagram I). When the intake of foodstuffs is expressed as nutrients it is seen that the calorie intake is slightly lower, and the protein intake much lower than amounts recommended as desirable to ensure adequate nutrition amongst people of Caucasian origin. However, the intake of vitamins appears to be adequate.

DIAGRAM I.

COMPARISON OF THE PERCENTAGE CONTRIBUTION BY WEIGHT OF VARIOUS TYPES OF FOODSTUFFS IN THE AUSTRALIAN & NEW GUINEA DIETS.



Although the calcium intake of the normal adult is probably well up to computed requirements it is certain that the calcium intake of children is below that usually considered desirable.

In the coastal areas an ample supply of salt is available from sea water. Further inland the procurement of adequate salt presents a real difficulty and considerable labour is often expended in extracting the salt from plant ashes.

It is probable that the intake of minerals other than those mentioned is adequate. In localised areas, however, the intake of iodine is deficient.

FOOD STORAGE.

The hot moist climate which prevails in most parts of New Guinea is inimical to the storage of food crops in a manner comparable with methods practised in colder dryer climates.

With the exception of yams, which may be stored in special yam houses for periods up to five months (see Plate 34), and sago which may be stored in bundles for a few months, there is little storage of harvested crops. The usual practice is to harvest the crop as needed and keep it only for a day or two.

This does not mean, however, that food is not stored against an emergency. It is stored—but as a living plant in the ground. Thus maniok (cassava) and Samoan taro (*Alocasia* sp.) is allowed to remain in the ground as a reserve to overcome seasonal shortages of more desirable crops.

Amongst the animal foods there are a few examples of storage. At Patep partly cooked and smoked Kapul (*Phalanger maculatus*) was kept suspended over the fireplace in the huts for several months. (See Plate 35.) In the Trobriands smoked fish was kept for several days. The pig on the hoof is always a reserve of food. Crabs rendered immobile by binding the claws were commonly kept for several days.

FOOD PREPARATION AND COOKING.

The tubers and roots are usually peeled and boiled but sometimes they are baked in the skins and the charcoal is scraped off. Meat and fish are boiled or roasted.

The cooking losses of vitamins and minerals is at a minimum, for as a rule the cooking time is short, lids are frequently used, and usually the cooking water is consumed as soup.

MEAL HABITS.

In villages in the hotter, lower altitudes it is the custom to have one meal each day, consumed in the afternoon or evening. A small piece of taro or sweet potato might be taken to the gardens next day and eaten cold as a snack, or a piece of corn might be roasted in the gardens, but the amounts consumed in this way are usually quite small except in the case of children for whom a snack is more frequently prepared.

However, in villages at the cooler, high altitudes such as Patep, it was the custom to cook and eat an early morning meal approximately the same amount as the main evening meal. In addition, the garden snack was a more common practice especially amongst the children.

One of the most interesting feeding habits was the universal custom of supplementing the breast milk of infants with premasticated foods from the early age of one to three months. The mother chewed the foodstuff, taro, sweet potato, yam or banana, to a pulpy consistency and fed small portions on her finger to the infant who appeared to relish the mixture. No evidence of harm resulting from the procedure could be detected.

FOOD TABOOS.

In some cases adolescents and other young people are forbidden to eat certain foods under penalty of dire consequences. These are often thinly disguised methods of ensuring that the older people, who perhaps have fewer opportunities of procuring the prized food, have first choice.

E. The Nutritional Status.

The general level of calorie intake as judged by clinical evidence of weight-for-height relationship was probably satisfactory except in the case of the pre-adolescent children whose mean weight was 1-3 lbs. less than Australian children of the same height.

The classical signs of gross inadequacy of protein, namely, oedema and low serum protein, were not detected.

No signs suggestive of deficiency of vitamin A, the B-group vitamins or ascorbic acid (vitamin C) were seen.

A few cases of subclinical rickets were detected by radiological examination. These have been discussed more fully in the next section. It is thought they may have been due to a vitamin D deficiency due to inadequate exposure to sunlight.

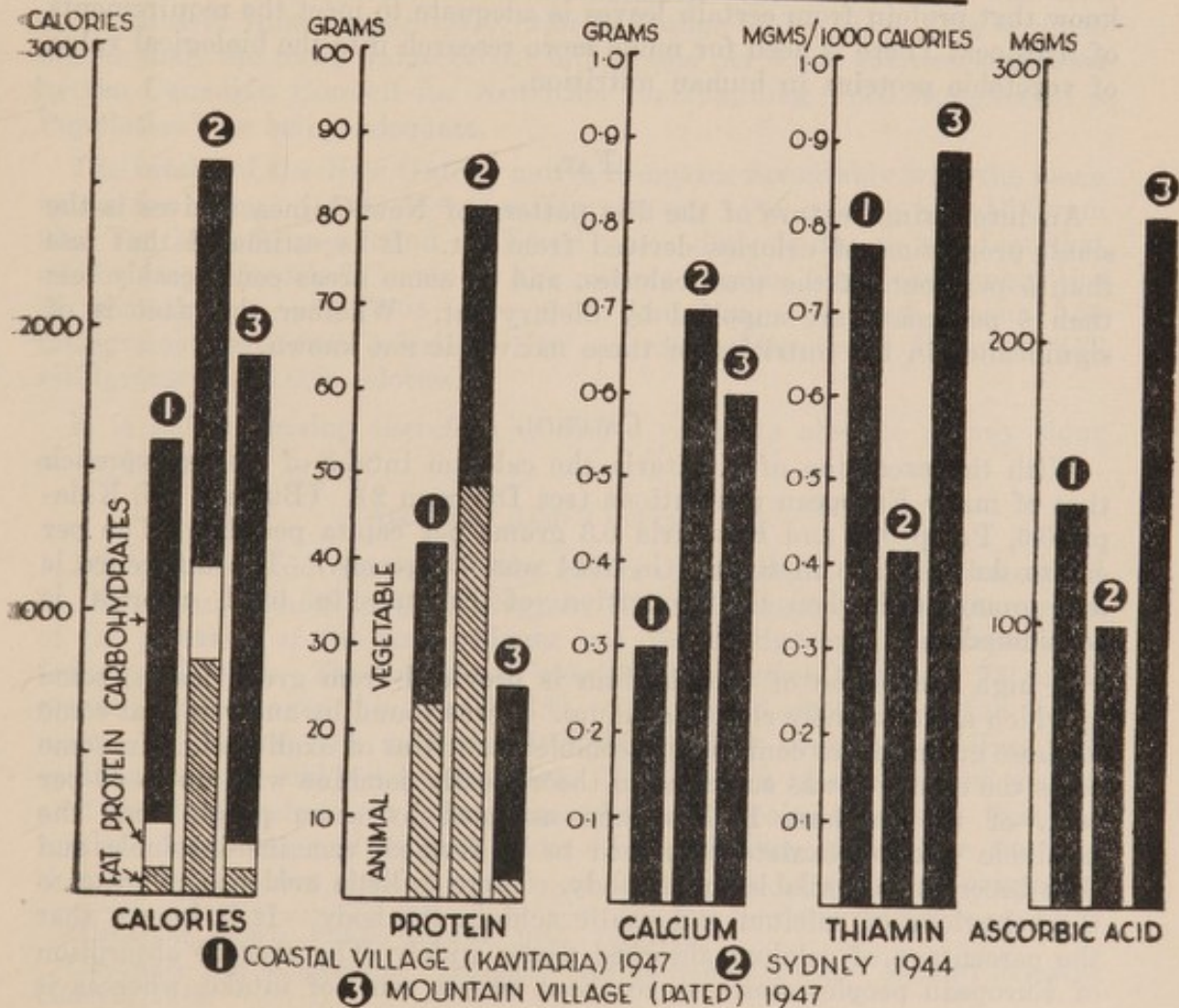
The existence of areas of endemic goitre in New Guinea was noted.

F. Relationship of Food Consumption and Nutritional Status.

CALORIES.

In both Kavitaria and Kaiapit there was ample food available, so it can be inferred that these natives consumed sufficient food to satisfy the appetite. The average calorie intakes (1,600 and 1,609 calories) in these two villages

COMPARISON OF NUTRIENT LEVELS IN THE AUSTRALIAN & NEW GUINEA DIETS.



were almost identical. These figures are considerably less than a comparable figure of 2,570 calories which was the daily per capita intake found in a survey in Sydney in 1944 (see Diagram 2). Even when allowance is made for the smaller body build of the native, the observed calorie intakes were approximately 80 per cent. of the computed requirements. In general, the evidence suggests that in these two villages mentioned, not only were the calorie requirements met, but that previous estimates of the calorie requirements of these native people may have been set at too high a level.

PROTEIN.

With the exception of one village, almost the whole of the protein is of vegetable origin and the per capita daily dietary intake of 19.41 grams is well below the computed requirements. This is in marked contrast to a mean per capita figure of 93 grams found for Sydney households in 1944 (see Diagram 2). In the case of young children the unfavourable contrast is probably even more marked than is shown by these figures, because custom often dictates that meat when available is the prerogative of the adult males. Signs of protein inadequacy were not detected by the techniques of the present survey: it is possible, however, that investigations over a long period involving growth characteristics may have revealed detrimental effects of a protein inadequate diet.

Little is known of the biological value of protein from green leaves and root vegetables. Most of the work on the biological value of vegetable protein has been concentrated on cereals. From animal husbandry we know that protein from certain leaves is adequate to meet the requirements of livestock. There is need for much more research into the biological value of vegetable proteins in human nutrition.

FAT.

An interesting feature of the diet pattern of New Guinea natives is the small proportion of calories derived from fat. It is estimated that less than 5 per cent. of the total calories, and in some areas considerably less than 5 per cent., are supplied by dietary fat. Whether this fact is of significance in the nutrition of these natives is not known.

CALCIUM.

With the exception of Kavitaria the calcium intake of adults approach that of many European populations (see Diagram 2). (Busama 0.5, Kaia-pit 0.6, Patep 0.6, and Kavitaria 0.3 grams per capita per day. The per capita daily intake in Sydney in 1944 was 0.8 grams.) The difference is less pronounced when the proportion of calcium to total calories is considered.

A high proportion of this calcium is provided from green leaves, some of which are extremely rich in calcium. It was found by analysis that some of these green leaves contain appreciable quantities of oxalic acid. In some cases the quantity was sufficient to theoretically combine with up to 50 per cent. of the calcium. It has been assumed by some people that the insoluble calcium oxalate presumed to be formed, remains insoluble and thus becomes unavailable to the body. There is little evidence relating to the behaviour of calcium and oxalic acid in the body. It is known that the percentage of calcium absorbed varies widely. The average absorption of European peoples seems to be about 50 per cent. of intake, whereas it

has been claimed for Singhalese that calcium absorption is in the vicinity of 90 per cent. of intake. In the complete absence of data for Melanesian peoples it was decided to accept the N.R.C. Recommended Dietary Allowances, with the reservation, however, that the figures are probably well in advance of the actual calcium requirements of the natives.

The comparative rarity of rickets in infants is interpreted as indicating that in this age group at least the calcium is adequate, provided the vitamin D supply, which is necessary for the efficient absorption of calcium, is adequate. Vitamin D is a fat soluble vitamin of which the best dietary sources are egg yolk, whole milk, butterfat, fish liver oils. Considerable quantities are also manufactured in the body itself by the action of sunlight on chemical compounds in the skin. The breast-fed infant obtains its supplies of vitamin D partly from the mother's milk and partly from its own sources of manufacture in its skin. Children after weaning and all adult natives obtain their vitamin D requirements from the action of sunlight on the skin.

It is of interest that most of the cases of rickets seen during the survey were at Patep where, owing to climatic conditions, the mothers and babies were less exposed to sunlight than elsewhere. With the present diet pattern prevailing, it is to be anticipated that should the habit of wearing more clothing become common, rickets will increase in incidence.

THIAMIN (VITAMIN B₁).

The mean value of the thiamin intake of the four villages was 0.71 milligrams of thiamin per 1,000 calories (range 0.57-0.89). This is much higher than the mean value of 0.3 milligrams per 1,000 calories suggested by the Canadian Council for Nutrition for Planning Food Supplies of a Population* as being adequate.

The intake of the New Guinea native compares favourably with the mean values for Sydney (1944) of 0.41 milligrams per 1,000 calories (see Diagram 2). The high figures found in New Guinea diets is due to the fact that all the staple foodstuffs eaten by the natives contain significant quantities of thiamin, *e.g.*, yam, 0.94; taro, 0.69; kau kau, 0.86; and banana 0.35 milligrams per 1,000 calories. By contrast white bread contains 0.39 milligrams per 1,000 calories.†

It is not surprising therefore to find a complete absence of any signs of beri beri.

ASCORBIC ACID (VITAMIN C).

The ascorbic acid contents of the native diets were high when measured by European standards (see Diagram 2). The mean per capita values of the dietaries of the four villages was 185 milligrams of ascorbic acid (range 137-244). The levels are considerably higher than the 75 milligrams recommended by the N.R.C., 1945, as desirable for the adult male. In general, the methods of cooking follow conservative lines and cooking losses would not be excessive. The absence of any sign of scurvy, and the high values for plasma ascorbic acid leave no doubt that the intake of ascorbic acid was adequate. These findings are due to the fact that the village diet consists largely of fresh foods of vegetable origin.

*Canadian Journ. Public Health, 1945, 36, 272.

†McCance and Widdowson, "Chemical Composition of Foods," Medical Research Council, 1940.

Although the dietary problems of native labourers who work either on plantations, or in urban occupations, were not within the scope of the survey, yet the fact that such people are usually dependent upon a staple food such as flour, meat and rice, none of which are sources of vitamin C, emphasises the need for a plentiful supply of supplementary fresh foods for labourers. Consideration should be given to the development of native gardens of supplementary foods in and around plantations and urban areas, and of the more widespread use of these foodstuffs.

G. Possibilities of Improvement of Nutrition Through Changes in Native Agriculture.

As indicated when the food intake and nutritional status were discussed, the main improvement in dietary patterns would be by the incorporation of greater amounts of protein rich foods (including those of animal origin). It is probable also that the wider cultivation of crops such as rice and peanuts, which can easily be stored and transported, would help to eliminate regional and seasonal shortages.

Improvements in native agriculture aimed at increasing its efficiency and permitting the production of greater quantities of nutritionally desirable crops are undoubtedly warranted. The efficiency of existing methods deserves attention and changes must be made with extreme care and must be gradual.

Much criticism has been levelled at native agricultural practice in Papua-New Guinea in that it is wasteful of land and that it only supports a low population density. It is to be remembered, however, that the methods used function in a predominantly rugged mountainous country of high rainfall. Under these conditions food production of any sort can be regarded as an accomplishment.

A valuable increase in foodstuffs may be obtained by improving the yield per acre from crops both by the use of better seed and of better methods of husbandry, combined perhaps with organic manures and composts.

A good working rule for the improvement of dietaries would be to endeavour to increase the variety of foods grown. The complementary effects of different foodstuffs in the diet in combination with one another is an important consideration. With the object of improving the nutritional status, a combination of cereals and legumes is recommended. Amongst cereals, rice, millet and sorghum, and amongst legumes, peas, beans and the peanut, may be mentioned as being worthy of special consideration. Supplementary green leafy vegetables as a source of calcium have a special importance to New Guinea nutrition. They are, however, highly perishable.

Wherever practicable, great nutritional value may be derived from increasing the consumption of animal products. In many places, however, it may be easier to provide good class proteins from vegetable rather than animal sources, but, increased consumption of animal products is desirable in almost every part of New Guinea. Not only cattle but also tethered milch goats, poultry and sometimes buffaloes, sheep and pigs may be valuable sources of animal protein.

Fish is a most valuable foodstuff, and it is regarded as most important that the supplies of fish in and around New Guinea should be developed to the maximum possible extent.

Because of the hot, humid climate which prevails in New Guinea, food preservation and storage presents special problems, especially in the handling of foods of animal origin. The problem is likely to become increasingly important in the future and requires special consideration.

H. The Disease Pattern.

MALARIA.

With the exception of Patep all the villages show a high rate of malaria transmission and fall into the hyperendemic category. Patep is situated at an altitude of 3,550 feet, and probably owes its lesser incidence of malaria to this fact. Evidence was obtained that malaria was a significant factor in the production of anaemia and appreciably affected the nutritional status. The importance of finding ways and means of preventing and controlling malaria in native villages, is emphasised.

HOOKWORM.

Practically all the natives, with the exception of infants, were found to be infected with hookworm but comparatively few carried heavy worm burdens. No evidence was obtained that hookworm was a serious menace to health as was the case with malaria.

It was not possible in the present survey to determine whether hookworm disease causes a measurable degree of anaemia in New Guinea natives. This was because malaria, which existed in all villages examined, obscured the picture. Consideration should be given to carrying out an investigation to determine how large must be the worm burden before it causes measurable loss of haemoglobin. Probably the Central Highlands, where malaria is less of a complicating factor, would be the best place to conduct such an investigation.

TUBERCULOSIS.

High percentages of Mantoux positive individuals were found in some of the villages. This indicates a high transmission rate of infection with the tubercle bacillus. The relationship of tuberculosis to the nutritional status is obscure. Ancel Keys, in a recent publication, states, "The data from World War II are adding much confirmation to the conclusion that tuberculosis morbidity and mortality are increased by calorie deficiency. In some cases changes in ascertainment distort the figures, but the general picture is convincing. Clinical reports from areas of food shortages emphasise the frequency of a fulminating type of disease. Tuberculosis is certainly a most serious problem under any circumstances when there is a prolonged severe food shortage."

Although undernutrition does appear to play a part in the spread of tuberculosis, there is little doubt that overcrowding is also an important factor. Every effort should be made to prevent overcrowding in villages, not only within the huts themselves but also in the spacing of these dwellings.

FRAMBOESIA (YAWS).

Where frequent medical patrols were combined with appropriate treatment, framboesia was well controlled. Elsewhere framboesia was widespread. The desirability of adequate medical patrols is obvious.

GENERAL MEDICAL CONSIDERATIONS.

Most of the basic scientific data of the physiology and pathology of the human body has been obtained by studies on people of Caucasian origin who are living in temperate zones of the world.

When the disease pattern of the New Guinea native is compared with that of civilised nations, it is seen that a few diseases are represented in both, notably tuberculosis and gonorrhoea; but many which are common in civilised races are conspicuously rare in the native people; dyspepsia, appendicitis, constipation, atherosclerosis, and eclampsia are almost unknown; gall stones, dental caries, urinary calculi and (so far as is known) some cancers, are all of comparatively rare occurrence; some types of psychoneurosis are apparently uncommon.

It would appear that there is much knowledge to be gained about the effects of social environment and habits on the etiology of disease. Consideration should be given to the long-term study of physiological and pathological characteristics, particularly relating to the food requirements, of Melanesian and Polynesian peoples. This must be done in the areas and on people living under as near as possible to natural conditions.

The essential need for accurate and comprehensive village records in any plan of medical research in the field is stressed.

I. Observations on Dental Conditions Among Native Peoples in Papua-New Guinea.

PERIODONTAL DISEASE (DISEASE OF THE GUMS). (SEE PLATE 42.)

The incidence of generalised periodontitis was very high. In middle and old age many of the population show stages of the disease which by modern standards would undoubtedly be considered as detrimental to the health of the body as a whole.

The results of the nutritionist's observation exclude lack of vitamin C as a factor in the etiology of the periodontal disease observed in New Guinea.

It was almost invariably associated with heavy deposits of both sub- and supra-gingival calculus (scale). It is practically certain that the amount of calculus and debris seen around the teeth would have been sufficient to cause irritation of the gingival tissue and would tend to protect bacteria lodged between it and the gingiva.

There is obviously room for improvement in considering ways and means of keeping the teeth free of calculus.

DENTAL CARIES.

Dental caries exists in each of the three groups of New Guinea natives which were studied. Its incidence is, however, much lower than that usually observed among most "civilised" peoples.

Differences in the characteristics (*e.g.*, age distribution, clinical features and surface incidence) of lesions classified as caries suggest (*a*) that the disease manifests itself in a number of different forms, and (*b*) that differences in the form of the disease exist not only between native and civilised peoples, but also as between groups of native peoples exposed to dissimilar environments. A more satisfactory classification of types of dental caries is desirable.

PART 2.

ANTHROPOLOGIST'S REPORT.

BY

CHARLES JULIUS, M.A.

Section 1.—Introduction.

Section 2.—Methods.

Section 3.—Summary.

Section 4.—Busama.

- (a) Situation of the village.
- (b) The village.
- (c) The people.
- (d) Economic organisation.
- (e) Work.
- (f) Education.
- (g) Comments on some relevant local customs.
- (h) Political organisation.

Section 5.—Kaiapit.

- (a) Situation of the village.
- (b) The village.
- (c) The people.
- (d) Trade.
- (e) Work.
- (f) Education.
- (g) Comments on some relevant local customs.
- (h) European relations.

Section 6.—Patep.

- (a) Situation of the village.
- (b) The village.
- (c) The people.
- (d) Work.
- (e) Trade.
- (f) Education.
- (g) Comments on some relevant local customs.
- (h) Present European relations.

Section 7.—Kavataria.

- (a) Situation of the village.
- (b) The village.
- (c) The people.
- (d) Economic organisation.
- (e) Work.
- (f) Trade.
- (g) European relations.

Section 8.—Koravagi.

- (a) Situation of the village.
- (b) The village.
- (c) The people.
- (d) Education.
- (e) Work.
- (f) Trade.
- (g) European relations.

Section 1.

INTRODUCTION.

The participation of the anthropologist in the survey party was intended to provide the general background for the more detailed studies of the agronomist, nutritionist and other members of the scientific team.

The life of the native people is centred around the activity of food procurement and the greater part of their time is directly devoted to this end. This is in marked contrast with the practice amongst civilised people where the occupation of relatively few is associated with food production.

The source of their food is in the land and the sea, and it was necessary to know about their political control of these resources; the acquisition of gardening and fishing rights by inheritance, purchase, or by other means. It was necessary to study the trade relationship of each village with its neighbours and with the various units of European contact, such as Administrative centres, the missions, industry and trading posts.

As most of the areas surveyed had been considerably influenced by the events of the Second World War, either by enemy occupation or by close contact with our own troops, it was essential to assess the effects of the war and the success of the natives in rehabilitating themselves. Without these data it would not have been possible to assess the normality of the facts observed by the other members of the research team.

The writer was particularly interested in the educational influences to which the developing natives were subjected. These included the informal indigenous education by the family in the primitive art of living, the influence of the "Boys' House" or village club, the more formal village school sponsored by the Mission, and the effect of a period of work with a European. Consequently, some comments are made of the methods by which the natives acquired the various skills associated with gaining their livelihood.

Finally, because it was possible that many of the customs or beliefs observed by the natives may have influenced food supply or distribution within the community, and hence nutritional status, a study of these had to be included.

Section 2.

METHODS.

The basis of the techniques used to collect these data was observation of the people in their normal activities, together with interrogation of reliable informants amongst the people themselves. Use was made of village records and various patrol reports. Anthropological and historical writings were consulted when these were available.

Section 3.

SUMMARY.

Labour Involved in Food Production.

It appears that there is considerable variation in the amount of time which it is necessary to expend in food production. The main factors are the distance of the village from gardening, fishing or hunting grounds;

the terrain and type of foodstuffs grown. In the mountainous terrain such as Busama and Patep where taro was an important crop, comparatively little time remained for leisure; at Kaiapit where the surrounding country was flat and the banana gardens were close to the village, there was considerably more leisure time. At Kavataria also much time was available for pursuing the arts and crafts and this was reflected in an increased adornment of clothing, houses and utensils. At Koravagi it appeared necessary to spend much time away from the village bivouacing at scattered spots where sago and other bush foods were collected.

Food Trade.

Trade in foodstuffs between villages seems to depend primarily on the ease with which transport communications are established. Thus in the flat island of Kiriwina there was a well developed and important trade between the inland villages which concentrated on yam culture and the coastal natives who spent much time fishing. The mountain village of Patep, on the contrary, was completely self-supporting in food. Another factor influencing trade is the proximity of regions which produce specialised articles. Salt manufactured by the coastal people, traded for piglets bred by the mountain folk, is an example. "The cooking-pot for sago" trade of the southern coast of New Guinea is well known. It was noticed that whereas formerly barter and shell money were an important means of exchange, an appreciation of the use of coinage is rapidly developing—the change being stimulated by the war.

Effects of War.

The non-specialised and largely self-contained organisation of the native economy makes it very adaptable to changing conditions such as are induced by war. In most cases the natives have rehabilitated themselves very rapidly. The factors limiting rehabilitation appeared to be shortages of young taro plants for expanding the gardens and breeding livestock which had been plundered.

Population Trends.

It was difficult to reach conclusions concerning population trends owing to the inadequacy, or destruction during the war, of accurate village records. It was, however, evident that in Busama and Kaiapit the populations were increasing, and in the other villages surveyed they seemed to be at least stationary.

Section 4.

BUSAMA.

Situation of the Village.

Busama is a coastal village situated on the Huon Gulf, and is about 18 miles, by sea, due south of Lae, the headquarters of Morobe District and at present a fairly busy centre. Approximately 4 miles round the coast to the south-east of Busama, is Malalo, a station of the Lutheran Mission, and 4 miles beyond this is Salamaua, the pre-war headquarters of the district. Salamaua, as a town, no longer exists.

The nearest village to Busama is Guado, which is about a mile inland. The people of this village, however, belong to a linguistic group distinct from that of Busama, and have few relations with the people of the latter. The same may be said of Wamasu to the south of Busama. A mile beyond Wamasu, lies Buakap, whose people are of the same linguistic group as the Busama, with whom they are probably on terms of greater intimacy than are those of any other village. Travelling in a northerly direction, round the coast towards Lae, there are no permanent settlements until one comes to the village of Labu'Mele, which would be about 16 miles away.

Busama village occupies a narrow strip of flat land, no more than 300 yards wide, between the hills and the sea, the hills behind the village rising steeply to a height of approximately 500 feet. (See Plate 31). Both to the north and the south, the stretch of flat country broadens slightly, but nowhere to a width of more than half a mile until one travels some miles from Busama.

The coastline of country recognised as Busama land stretches from the mouth of the Buang River, eight miles to the north of Busama, to a point 2 miles south of the village. The depth inland varies, but would average about 3 miles, so far as garden land is concerned, though somewhat vague timber and hunting rights are claimed over more mountainous country further inland still. The Busama people, then, have gardening rights over at least 19,000 acres of land.

The Village.

The houses of the village are built on the beach and extend in a fairly regular line, for about three-quarters of a mile along the shore. A small promontory makes a division of Busama into two parts, a division which reflects the present political organisation of the people.

Though the village is still in progress of rebuilding, following the war, and many people are living in more or less temporary houses, the greater number of houses are of rather fine standard. They are rectangular structures, raised on posts well above the sand. Walls are of hewn timber and floors are of palm-wood, while roofs are thatched with palm leaves. Generally, the houses contain one room only, though a few are divided into two or three rooms. Most of them have verandahs, and, in some cases, small outer rooms are built on these verandahs. In such rooms, will sometimes sleep youths and young unmarried men belonging to a family.

As well as the houses, there are a few tents and one or two houses of a special type placed at intervals along the beach. In these special houses, sleep a number of young unmarried men and youths belonging to groups of families. In the days before the village was devastated by war, such houses would have existed for all single men and youths, and the tents represent a temporary expedient to replace some of them. As has been mentioned, occasional families now provide special rooms under the family roof for such people. This would seem to represent a tendency towards emphasis on individual families, as opposed to the extension into a wider kinship grouping, which received expression in the grouping of occupants in a single men's house.

A few of the houses are, at present, somewhat crowded, but this is only a temporary feature as a good deal of building is under way. There are 83 houses in the village (including those in a small, separate settlement established during the war), and this gives an average of 7.4 people to each house.

So far as ownership of house sites is concerned, one is told that there was order before the war, and that a man built and rebuilt his house on one definite site, such sites being inherited matrilineally. Nowadays, though ownership of sites is still recognised, there is a tendency for people to build their post-war houses on sites which do not belong to them, provided the owner does not object.

In this connection, there are the cases of the two village tultuls, Madu and Nga'gali. Madu's parents belong to the section of the village known as Busama Number 1, but Madu himself has moved to his wife's section, Busama Number 2, of which he has been appointed tultul. With Nga'gali, the opposite movement has taken place: movement from Busama Number 2 to Busama Number 1, his wife's section. He, too, is now tultul of the section into which he has moved.

It is probably no more than coincidence that, in such case, movement has been to the section in which the wife's family lives. Such movements appear, however, to be fairly typical of recent tendencies, and are, perhaps, inspired mainly by political influences, which are, at present, extremely strong in Busama. That the situation is still one of uncertainty and that a tendency to shift may remain for some time is suggested by the fact that Nga'gali, among others, said that he would probably later return to his original section.

The People.

The people of Busama belong to a rather large and widely scattered linguistic group, known as the Kawa (1) which includes not only the people of villages such as Bukaua, Asini and Lutu, in the neighbourhood of Busama, but reappears on the northern shore of the Huon Gulf, where it stretches along practically the whole coast to the east and west of Lae.

Particulars of population, sex and age groups, marriages and living offspring per married woman are given in Tables I, II and III.

TABLE I.—BUSAMA: AGE GROUPS (19th June, 1947). Total Population: 616.

Range.	Males.		Females.	
0—1	...	11	10	...
1—5	...	57	45	...
6—10	...	38	44	...
11—15	...	34	39	...
16—20	...	42	48	...
21—25	...	31	23	...
26—30	...	19	21	...
31—35	...	17	22	...
36—40	...	16	18	...
41—45	...	14	12	...
46—50	...	13	13	...
51—55	...	9	5	...
56—60	...	1	2	...
60 plus	...	7	5	...
		Male children: 140	Female children: 138	
		Male adults: 169	Female adults: 169	
		Male total: 309	Female total: 307	

Children: 278—45.1 per cent. of total.

Adults: 338—54.9 per cent. of total.

TABLE II.—BUSAMA MARRIAGES (19th June, 1947).

Age.	Males.			Females.		
	Married.	Single.	Widower.	Married.	Single.	Widow.
16 ...	...	6	...	...	9	...
17 ...	...	8	...	...	9	...
18 ...	...	9	...	...	5	...
19 ...	1	10	...	14	7	...
20 ...	3	5	...	3	1	...
21—25 ...	24	7	...	21	1	1
26—30 ...	15	4	...	20	...	1
31—35 ...	17	...	...	19	...	3
36—40 ...	14	...	2	13	...	5
41—45 ...	14	...	...	9	...	3
46—50 ...	12	...	1	9	...	4
51—55 ...	8	...	1	1	...	4
56—60 ...	...	...	1	...	...	2
60 plus ...	2	...	5	...	...	5

TABLE III.—BUSAMA—LIVING OFFSPRING PER MARRIED WOMAN (19th June, 1947).

Ages of Women.	Number of Offspring.							
	Nil.	1.	2.	3.	4.	5.	6.	7.
16—20 ...	11	6	...	...	...	...	...	...
21—25 ...	9	10	1	1	4	...	...	...
26—30 ...	2	3	5	6	2	1	1	...
31—35 ...	3	...	1	10	2	2	...	1
36—40 ...	1	...	...	3	2	4	...	3
41—45 ...	...	2	...	2	...	3	1	1
46—50 ...	1	5	1	...	...	...	1	1
50 plus ...	...	...	...	1	...	...	...	...
Widows	6	6	3	6	2	3	1	1

Number
of
women.

Particulars of total population and births and deaths are available only from January, 1946. These are given in Table IV.

TABLE IV.—BIRTHS AND DEATHS.

Date.	Popula- tion.	Births.	Deaths.	Births per thousand per annum.	Deaths per thousand per annum.	Natural increase per thousand per annum.
January, 1946 ...	589	...	...	...	...	...
May, 1947 ...	616	33	8	42.01	10.6	31.41

Particulars of total population and births and deaths are available only from January, 1946. These are given in Table IV.

The actual natural increase in the period of 16 months was 25, which added to the population of January, 1946, would give a total of 614. The difference of 2 may be accounted for by immigration.

It appears that the ancestors of the present inhabitants of the village came from at least eight different places and five different language groups, as follows:—Lutu, Bukaua, Asini (Kawa' language); Kela, Lababia (Gela language); Awasa (Laewamba language); Geiwiku (Kia language); and Labu (Apu' language). These migrations were probably of a group nature, and took place within the last century. Within the period of European knowledge of the village there seems not to have been anything in the nature of group movements in the locality, and, in recent years, there has been extremely little immigration or emigration so far as Busama is concerned.

Originally, the distinction between Busama Number 1 and Busama Number 2 was, to some extent, based on the ancestral places of origin of the inhabitants, Busama Number 1 having, for some time, been officially known as Lutu, while the other portion of the village was known as Awasa, the sections being composed, respectively, of a majority of migrants from those two places. One is, furthermore, told that, many years ago, only the Lutu portion of the village was situated on the beach, Awasa having been built on the heights behind.

Nowadays, however, the distinction based on origins has become extremely blurred. There is still a definite division between Busama Number 1 and Busama Number 2, but one gathers that it is largely a political division, and that individuals in the post-war period tend to join one or other "party" according to their own personal taste.

Though, furthermore, the original migrations to Busama apparently were spaced over a considerable number of years, priority of arrival is not now of any importance. One does not, for instance, find the distinct divisions in relation to length of land tenure that could be seen in the Markham Valley village of Kaiapit. (See page 41.)

Linguistically, there has been a complete fusion of the people in the fact that Kawa', the language of the majority of the immigrants, has displaced the languages of the smaller groups.

A comparatively recent migration, not into Busama itself, but on to Busama land, was that of the people of the small and rapidly declining village of Guado. The people of this village came down from the higher lands of the Hote country well within the period of European contact. Their final movement on to low country, in Busama territory, appears to have taken place in 1915. They have, then, been living as close neighbours of the Busama for more than thirty years, yet, though there is no opposition to their occupation of their village site, they do not by any means appear to be on terms of intimacy with the Busama villagers.

Their movement, as a matter of fact, seem to have been inspired by a desire to be close to the Mission school and other Mission facilities in Busama, and was, in this, different from the earlier, pre-European migrations which peopled Busama.

Economic Organisation.

Original settlement of Busama was probably due to pressure of population in the places of origin of the people and the attractions of the Busama area from an agricultural point of view (²). Certainly, Busama remains to-day an extremely rich community so far as available land is concerned.

It is, at the same time, a place strategically situated for purposes of trade. The principles of Busama economy have been examined by Dr. Hogbin in his "Native Trade Around the Huon Gulf, North-Eastern New Guinea." (³). The whole basis of Busama trade is the large area of garden land which, until the dislocation of activities involved by the war, enabled Busama to produce a great deal of surplus food, particularly taro. To the south of Busama, some fifteen to twenty miles away, is the Lababia-Laukanu area, which is short of suitable garden land and, consequently, of food. The people of this locality manufacture clay pots which they exchange with the Busama, in return for food.

Some of the pots received in this way, the Busama retain for their own use, other they pass on to the people of the north, in exchange for carved woodwork or basket work, or to inland peoples, in exchange for yams or sweet potatoes.

In this way, the Busama are the middle-men of a widespread trade. The particular strength of their position lies not only in their geographic position, but in the fact that their trade is founded not on any manufacture, but on the production of surplus garden foods.

They had, formerly, also a fairly extensive trade in pigs, with the people of the Buang Mountains. Pigs passed from Busama to the Buangs; in return, yams and sweet potatoes were received. This trade was, however, destroyed by the war (⁴). As will be seen in discussing the village of Patep Number 2, this misfortune of the Busama people has been of advantage to inland villagers, some miles beyond the Buang Mountains.

The Busama gardens are mostly devoted to the production of taro, and the greater number of them are on the steep slopes of the hills behind the village, though several men have gardens both there and on the flat land lying along the coast to the north and south of the village. The size of the garden varies, the larger ones belonging to the older and more important men of the community.

One particularly large garden is controlled by the luluai of Busama Number 1. This is in addition to his other gardens, and is in the nature of a community benefit, or insurance, its produce, one is told, being used for the support of persons who may need help. Work is carried out in this garden by all the villagers of Busama Number 1.

Apart from taro, there are very small quantities of other plants, such as corn, in the gardens. A few yam gardens are also made.

With regard to the latter, it is an interesting fact that only a recognised group of nine men plant yams, their culture being apparently considered to be a definite skill, to whose acquisition one must serve an apprenticeship. Any man who so chooses may become a yam gardener. If he wishes to do so, he goes to work for a season with a man who grows yams. Subsequently, he receives a portion of the harvest, for use as seed and becomes, in his own right, a yam planter. An example of empirical knowledge involved in yam gardening is that the time for planting is observed from changes in the leaves of a particular tree, a kind of New Guinea rosewood, called in the Kawa language, Alang.*

* *Pterocarpus indicus*.

Work.

In the initial felling of timber and clearing of a garden site, a man is assisted by relatives—some informants said by fellow members of the men's club house to which he belonged. Working parties did not, however, seem to be confined to such a limited group.

Children do not appear to go to the gardens with any regularity, and when most of the adults are away working (as is usually the case in the mornings), the village will generally be full of children left, more or less, to their own devices. Occasionally, one will see them enthusiastically fishing, close to the beach, and using lines, small nets or spears. Most young children, from six or seven years of age, have a considerable knowledge of various types of fish, of places to dig in the sand for shellfish, and in general, it seems as if they are far more interested in fishing activities than in gardening routines.

From the age of thirteen or fourteen, girls commence to accompany their mothers regularly to the gardens. Youths remain in a more or less irresponsible state for far longer, and young unmarried men usually appear to be rather a troublesome element.

House building is work in which relatives co-operate. Young boys take a good deal of interest in this, and it is one occupation in which young men seem willing to take an active part.

Garden work, on most days, commences at about 6.30 or 7 in the morning, and, for women, continues until 2 or 3 in the afternoon. Men, often, will return to the village much earlier, perhaps about 11 or so in the morning. Also, men are not likely to go to their gardens every day. The pace of work is leisurely, and there are frequent rests.

Fishing is undertaken from the beach, with lines, small nets or spears. There are also two large community fishing nets in the village, and the use of these involves the co-operation of a large number of men. Deep sea fishing is done by parties of up to six men in a canoe. Periodically, large groups of women combine in fishing expeditions, taking their small hand-nets to the mouths of the several small creeks in the neighbourhood.

Education.

One earlier function of the club house, that of an educational centre, has been transferred to another institution, the village school, directed by the Lutheran Mission, which has had a European-directed station at Malolo, four miles from Busama, since the year 1906.

The school is divided into two classes, a junior class, made up of 21 boys and 32 girls between the ages of six and nine; and a senior class of 17 boys and 26 girls between the ages of ten and fourteen. The classes are in the charge of two native teachers, both of whom come from the village of Lababia. As the school building is a small one, the classes assemble at different times, the smaller children attending school from 6.30 to 8.30 in the morning and the seniors from 12.30 to 2.30 in the afternoon. Work is done on four days a week, the school being closed on Fridays.

The language of instruction is Yabem, one of the *lingua franca* of the Lutheran Mission, and the teachers possess what appeared to be carefully drawn up and very detailed work-books, printed in Yabem, and setting out the work for each school day. The actual work of the school seems to be rather limited, a typical day's programme being: roll-call, bible history (the story of Joseph), writing and simple arithmetic. The school does not function, as a group, in any other activity. The teachers, however, are alert and keen, and there does not seem to be any dullness or boredom in the institution.

As is so frequently the case, the example set by the teachers and their wives in the matter of housing and general habits, is probably of at least as much value as the work they do in formal schooling. (Compare Kora-vagi, p. 68.)

Comments on Some Relevant Local Customs.

(1) Inheritance.

Inheritance of garden lands, one is told, is in the matrilineal line, rights to make gardens in certain areas passing from men to their sister's sons. It is also recognised that, very often, sons will garden in areas in which their fathers held rights. To do this, however, they must obtain the permission of the true heirs, who may if they so choose tell them to go back to their own land.

Ownership of trees, such as sago and coconut palms, pass from a man to his own children. In the case of a sago palm, all the children inherit a right to a share in the sago. The right of saying when it shall be cut rests with the eldest son, and should any of the other children desire to organise its "working," they must obtain his permission. Coconut palms are divided among all the children.

(2) Men's Club Houses.

Individuals inherit the right to choose membership of the men's club house (2) of either his own father or his mother's brother. The present tendency appears to be that he should belong to his father's club house.

It is probable that the influence of these club houses, of which there are some fourteen or fifteen named, has declined considerably since the war. As was noted earlier, only two or three temporary structures have been built, and young males who would formerly have slept in a club house, are now sleeping either in tents or in the family home.

The club house, in olden times, provided not only sleeping quarters for young men, but a nucleus around which the social and political life of the community crystallised. Each one had its leader and from these a leader would, through his industry, accumulated wealth and strength of personality, emerge the leader of the village.

The club house, at the present time, finds its chief importance as a place in which men occasionally sit and talk and in which they keep their fishing gear. From an organised point of view, the only activity in which it appears to be utilised, is the activity of the Mission. It is the centre for the morning and evening prayer meetings which the people of Busama so scrupulously attend.

Political Organisation.

This aspect of Busama life has received a great deal of attention, ⁽²⁾ and, at present, seems to occupy a good deal of the thought and energies of the people. Their experiences under a powerful and corrupt Government-appointed native official and their sudden release from a tyranny which had lasted for many years have been described by Hogbin. The people still remember this with some emotion, but their memories probably do not have any great effect in bringing about the present state of preoccupation with village politics. The native official referred to, the former Paramount Luluai Bumbu does not, in fact, appear to retain any notable influence in village affairs. It may rather be that the people were for so long accustomed to having no voice in any matters that they have not yet had time to organise their skill in village control. It is likely, as Dr. Hogbin remarks, that when they "have had a little practice . . . disputes will be settled without reference to outside authority"⁽⁴⁾.

A complicating factor is the particularly sharp antagonism between young men and their elders. This has had the result that mature men will insist over and over again that young men should leave the village and enter European employment until they are ready to marry and settle down. One gathers that this incentive is almost as strong in making parents desire that their children should go away to work as is any wish for European money or goods, while the young men, in their dissatisfaction with village controls, are only too willing to concur. The position might be said to be that a period of European employment has come to be recognised as an essential institution in a young man's progress.

Generally speaking, the view of the Busama people on things European is a sane and satisfactory one. Their situation has enabled them to have a good comprehension of European ways, and, concerning European life, they have, apparently, no illusions and no unreasonable expectations.

Section 5.

KAIAPIT.

Situation of the Village.

The village is situated approximately 60 miles by air, in a north-westerly direction, from the district headquarters at Lae, and slightly more than 40 miles from Nadzab, which is connected with Lae by motor road.

The Markham River, at its nearest point to the village, flows a little less than 6 miles to the west. Between Kaiapit and the Markham flow two of the Markham tributaries, the Maniang and the Yafits, which join the main river some 6 miles to the south of Kaiapit. The whole surrounding area is a network of watercourses, some of them, during the period of the survey (the driest time of the year), were not flowing, but during the rainy season (between November and April) it is said that their waters inundate large tracts of country and cause some devastation to gardens and villages.

The villages closest to Kaiapit are Gantisap and Ofofragen, which are, respectively, half a mile and one mile to the north and Ragadampait (two miles) and Bampingiefan (two and a half miles) to the south. The village of Wampua is, approximately, 4 miles to the south-west.

The Government Station is about half a mile to the south-east of the village, and the recently re-established station of the Lutheran Mission about half a mile to the north-east.

A tract of land surrounding the village in the valley floor and extending into the mountains to the east is recognised as Kaiapit land. This area is, by right of inheritance through the patrilineal line, considered to be, in a primary sense, the property of the descendants of original Kaiapit residents.

The question of land tenure was clearly more important in Kaiapit than in any other village visited by the Nutrition Survey Party. Owing to the periodic flooding of considerable areas, the people appeared to feel that a certain amount of their land was being rendered useless, and were notably "land-conscious." The occupation of land by the Government Station, the Lutheran Mission and a local trade store had obviously made a deep impression on the minds of the villagers.

The people also regard with suspicion certain schemes for European-native co-operative agricultural development in the area, and it seems that it is on the occasion of discussion of such matters as these that men of the original Kaiapit groups are thrust to the fore and that their primary rights in the land are loudly stressed by all the villagers.

The Village.

The village is laid out on a straight-line pattern, with two annexes. It is divided into five sections, each of these being made up of the dwellings of relationship groupings, location in a section being generally on the basis of patrilineal relationship, but occasionally on a matrilineal basis.

The houses of Kaiapit are mostly circular in design, having rough log walls and roofs of grass thatch. There is not any great tendency towards Europeanisation, though a few of the houses are raised from the ground and one or two are walled with finely worked planks.

Usually, in Kaiapit, a house is occupied only by an individual family, of a man, his wife and offspring. Elderly people rarely reside with relatives, preferring to live alone in small dwellings, though their food may be provided at the houses of sons or daughters.

There are sixty-nine occupied houses in the village, and Table V gives the situation.

TABLE V.

<i>No. of Occupants in the House.</i>	<i>Occupied Houses.</i>
1	5
2	12
3	16
4	11
5	11
6	12
7	1
8	1

Average occupants per house : 3.8.

As well as the 263 individuals here accounted for, there are twenty-eight people absent from the village.

The People.

The people of Kaiapit belong to the Atsera group, a linguistic group which Capell originally estimated to include about 5,000 people, although he later concluded that "the area covered by Atsera northward seems to be

even larger than was estimated before. It extends as far up the Ramu as Bumbum⁽⁶⁾. It may be noted that, more than ten years ago, Vial gave the Atsera population as 4,901⁽⁷⁾.

The organization of the Markham Valley people has been described by Read⁽⁸⁾ and with a few modifications, due to the fact that the proximity of the Government and Mission Stations has tended to make Kaiapit something of a metropolis, this description is applicable here.

Villages in the Markham are grouped on the basis of old-time alliances for the purpose of warfare, the Kaiapit group having included the villages of Ofofragen, Gantisap, Ragadampiat, Bampingiefan, Suai, Marangits and Wampua. This remains as a primary group with which the Kaiapit people feel close ties of friendship.

Kaiapit also has relations, through inter-marriage, with more remote Markham Valley villages, and with hill villages all within a radius of 8 or 9 miles of Kaiapit.

Even in pre-European days, it is probable that there was a good deal of movement between villages of the area, and that individuals and families occasionally disregarded the patrilocal principle of residence and the patrilineal inheritance of land rights and transferred to villages in which a wife's or mother's kindred dwelt.

The proximity of the Government and Mission Stations has meant that Kaiapit has now become a centre for visitors from an extremely wide area, so that it is the scene of more frequent large-scale meetings of Markham people than any other village in the locality.

At the present time, therefore, Government and Mission pulls, together with the movement of life in the constant coming and going of visitors, have rendered Kaiapit most desirable, in the eyes of surrounding people, as a place of residence, and there has in recent years been an increasing tendency for people to forsake their own villages and join the Kaiapit group, particularly if they should have kindred there.

The present population of Kaiapit is 291, and particulars of age groups, sex distribution, marriages and living offspring per married woman are given in Tables VI-VIII. It is to be observed that village records note a considerable number of people as, simply, "adult," "middle aged" or "aged." Particulars of census, from June, 1944, are given in Table IX. During the period between April, 1946, and July, 1947, emigration exceeded immigration for apparently the first time for some years.

TABLE VI.—KAIAPIT—AGE GROUPS (14th July, 1947)—Total Population : 291.

Range.	Males.	Females.
0—1 ...	8	6
1—5 ...	16	12
6—10 ...	27	18
11—15 ...	16	15
16—20 ...	19	13
21—25 ...	10	13
Adult ...	10	2
26—30 ...	14	13
31—35 ...	7	7
36—40 ...	2	5
Middle aged ...	16	22
Aged ...	8	12
	Male children : 67	Female children : 51
	Male adults : 86	Female adults : 87
	Male total : 153	Female total : 138

Children : 118—40.5 per cent. of total.

Adults : 173—59.5 per cent. of total

TABLE VII.—Kaiapit : MARRIAGES (14th July, 1947).

Age.	Males.			Females.		
	Married.	Single.	Widower.	Married.	Single.	Widow.
15 ...	...	...	...	2	...	...
16 ...	3	3	...	1	2	...
17 ...	3	1	...	...	1	...
18 ...	2	1	...	3	...	...
19 ...	2	1	...	5	...	...
20 ...	2	1	...	1	...	...
21—25 ...	9	1	...	12	1	...
Adult ...	10	...	...	2	...	...
26—30 ...	9	4	1	11	2	...
31—35 ...	7	...	...	7	...	...
36—40 ...	2	...	...	5	...	...
Middle aged ...	16	...	...	17	...	5
Aged ...	7	...	1	6	...	6

TABLE VIII.—KAIAPIT—LIVING OFFSPRING PER MARRIED WOMAN (14th July, 1947).

Ages of Women.	Number of Offspring.						
	Nil.	1.	2.	3.	4.	5.	6.
15—20 ...	11	1	...	...	...	...	...
21—25 ...	6	6	...	...	...	...	...
Adult ...	1	1	...	...	...	...	...
26—30 ...	2	5	4	...	...	...	...
31—35 ...	2	2	1	1	1	...	...
36—40 ...	...	2	...	3	...	...	...
Middle aged ...	...	2	5	5	4	...	1
Aged ...	1	1	3	...	...	1	...
Widows ...	4	2	1	1	3	...	...

} Number
of
women.

TABLE IX.—PARTICULARS OF CENSUS.

Date.	Popula- tion.	Births.	Deaths.	Births per thousand per annum.	Deaths per thousand per annum.	Natural increase per thousand per annum.
January, 1944 ...	260	...	...	...	...	...
February, 1945 ...	267	4	4	26.35	26.35	nil
September, 1945 ...	274	6	2	38.52	12.84	25.68
April, 1946 ...	281	5	2	31.27	12.49	18.78
July, 1947 ...	291	20	6	56.93	17.08	39.85

Trade.

The trade relations of Kaiapit are given in the following table. European money appears to have come into all these transactions, except those involving native tobacco and armbands, for which European commodities are exchanged. In the case of pigs and fowls, money seems most usual; in the case of vegetable foods, rare.

TABLE X.

	To—	From—
Antiragen (north-west)	Taro	Clay pots.
	Women's skirts ... ..	.....
	Spears (from Yaros) ... ..	.....
Tsumen (north-west) ...	Tobacco pipes	Clay pots.
	Spears (from Yaros) ... ..	.....
Yaros Villages	Clay pots (from Antiragen and	Spears.
(north-east).	Tsumen).	String bags.
		Yams.
	Women's Skirts	Taro.
	Coconuts ... ..	.....
Wantoat (north-east) ...	Knives	String bags (a few).
	Native tobacco, } exchanged	{ European salt, razors and
	plaited armbands } for	{ European cloth.
Sangan (south) ...	Yams	Sago.
	Taro	Betel nut.
	Clay pots	String bags.
	(from Antiragen and Tsumen).	
Yatsing (south-west) ...	Pigs	Native salt.
	Fowls ... ..	.....
	Taro ... ..	.....
	Yams ... ..	.....
	Spears (from Yaros) ... ..	.....

It will be noticed that Kaiapit villagers are by way of being middle men, through whom such objects as clay pots are passed over a wide area.

As far as pigs are concerned, there is not a very extensive trade in these, most of them being reserved for consumption. There are only sixty-seven pigs in the village, and they are being killed and eaten with remarkable frequency.

Work.

Both men and women work in the garden. Heavy clearing, burning off and fencing are done by the men. Planting of yams, taro and bananas is done by men. Planting of sweet potatoes is done by women and to them also fall the tasks of routine weeding and harvesting of food. As far as planting is concerned, it may be noted that one or two men are married to women from Yampua, where, it is said, women are skilled in the planting of yams, and that it is considered quite suitable that these women should carry out that duty in Kaiapit gardens.

The gardens of Kaiapit may be divided into two groups—those on the flat country close to the village and those in the more remote mountain country. As far as the latter are concerned, they do not receive constant attention, the villagers finding it preferable to go periodically to reside in temporary shelters while they carry out concentrated work for two or three days.

Hunting is a frequent activity of men. According to accounts, organised hunting, involving the burning of grassland, is undertaken only once a year. While Kaiapit villagers would confirm this, they were frequently involved, even during the brief period of the survey, in the burning of most extensive areas of grassland and in hunting parties in whose organisation the majority of the men would be engaged.

Certain skilled crafts, such as the making and ornamentation of bamboo pipes and, in former days, the making of carefully carved spears and well-balanced wooden clubs, are also men's work. The modern spear is simply a piece of European metal attached to a wooden shaft, while the club remains only as a family heirloom.

Though clay pots are largely used in Kaiapit, little pottery has ever been made in the village. The only two resident potters are immigrants from Antiragen. When pottery is made, it is men's work. The first kneading of the clay is done by women, but the skilled work of shaping the pot is done by men.

In the case of women, the only skilled craft is the making of skirts from the frayed fibre of banana stalks or of the leaves of the sago palm. These are dyed, sometimes in colours of quiet elegance, by the use of vegetable dyes.

Education.

In an informal and willing manner, children are continually in contact with the work of their elders. Inclination frequently sends them to the gardens with their parents, and few small boys are absent from hunting activities, involving the burning of areas of grassland and the excitement of driving game towards the spears of waiting hunters.

In this way, an individual will, by the time he or she reaches puberty, have become familiar with most of the community's essential skills, and will generally be adequately equipped to respond to an attitude which fiercely rebukes idleness in a young man or woman.

The village mission school is in the charge of a teacher from the village of Sangan, which is situated about 10 miles to the south-east of Kaiapit. This person has been welcomed by the villagers who have given him every assistance in the construction and maintenance of a suitable school building, in the erection of a house for his accommodation and in the provision of food while his garden is coming into production.

The teacher was trained at the mission institution at Hopoi and appears to be competent in the handling of some fifty pupils in attendance at the school. School work is done on four days of the week from 7 a.m. to 9.30 a.m.

Instruction is given in reading and writing and elementary arithmetic. Most unfortunately, there is a great deal of concentration on the teaching of Yabem, though, as Capell has noted, the Markham languages "have no obvious connections with the Yabem-Bukawa-Labu group, except that both are Melanesian. The shapes of the words are quite different, the languages are not tonal, and the morphology is distinct"(*).

Comments on Some Relevant Local Customs.

(1) *Religion.*

The Lutheran Mission Station was established at Kaiapit in 1916, and, from the point of view of external forms at least, all the villagers have discarded their former spiritual and magical beliefs and now attend the Lutheran services. There was, however, little sign that Christianity had achieved anything of the degree of fusion with local thought and emotion that it had in, for example, the village of Patep Number 2 (see page 56.)

(2) *Marriage Gifts.*

The greater part of the marriage gift is made up of food accumulated by a number of members of the bridegroom's clan and distributed amongst a number of members of the clan of the bride.

European Relations.

Kaiapit was the scene of a good deal of military activity during the war, activity which the people now claim to have been no concern of theirs. They frankly say that they had no particular interest in either Europeans or Japanese, and that their main desires were to keep out of the way and, as much as possible, avoid disturbances.

It seems clear that they took the opportunity created by the temporary withdrawal of the mission to revert to certain of their old customs, such as polygamy and dancing, of which the mission had disapproved. Unlike such villages as Busama and Patep Number 2, there appears to have been in Kaiapit no nucleus of people to keep alive even a token interest in the mission attitude. This has meant that they are now finding it extremely difficult to adjust themselves to the return of the mission.

At the present time, Kaiapit is inclined to look to the Government Station for a great deal of guidance and advice, and one feels that what they are seeking there is not so much the development of European ways as the protection and conservation of native custom. There is, quite probably, also a tendency to manipulate various European groups against one another, without a great desire for friendship with any of them.

The Kaiapit villagers are unlike those of, for example, Patep Number 2 (*vide* Patep section, p. 57), in that they are not greatly influenced by expectations arising from the contacts and movements of the war years. Harmony is, to a slight extent, disturbed by individuals who returned from army and labour enlistment, but it is probable that the community is well capable of absorbing these. At the present time, there are twenty-eight people away as labourers, either in Lae or Rabaul.

The people desire educational and economic development, but not at the expense of disturbance to the things which they regard as fundamental, their adjustments of land tenure and utilisation; their marriage institutions, such as polygamy and inter-clan gifts; and their social contacts and occasions, expressed in feasts and dancing.

Section 6.

PATEP* NUMBER 2.

Situation of the Village.

Patep Number 2 is an inland mountain village, situated 3,550 feet above sea level, and about a mile to the east of the Wampit River, which flows to join the Markham at a point approximately 20 miles in a direct line to the north of Patep.

Taking the shortest distance, the village is roughly 25 miles west of the coast at the mouth of the Buang River. By the patrol and trade route across the Buang Mountains, however, the distance to this point would be something like 35 miles. Eight miles south along the coast from the Buang mouth, lies Busama, the nearest coastal village to Patep Number 2.

Labu, the starting point of the motor road connecting the Wau-Bulolo goldfield with the port and district headquarters of Lae, is twenty-five miles to the north-east of Patep. Allowing for the many curves in this road the distance to be travelled to Labu would be a little over 40 miles. The village thus lies about half-way, by road, between Labu and Wau.

Mumeng, the sub-district station, is situated 7 miles to the south of Patep Number 2, with which it is connected by the main road.

Seven miles south-east from Patep Number 2 is its parent village of Patep Number 1 through which runs the patrol and trade route to the coast. Four miles to the north of Number 2 Patep is the village of Gurukor on the Wau-Labu road. Another close neighbour is Peraklis village, 4 miles to the south-west.

Leaving the main road where it runs at its nearest point to Patep,* not far from the east bank of the Wampit River, one approaches the village by a foot track which rises, through its distance of half a mile, to a height of almost 1,000 feet above the road. Reaching this level, the surrounding country is little more than undulating, with a gradual rise to Patep Number 1, beyond which lie the greater heights of the Buang Mountains.

For a considerable part of the time spent in Patep Number 2 the village was shrouded in clouds, a rather unexpected phenomenon at that height above sea level, and one which may have been due to some peculiarity in the contours of the surrounding country. The damp and somewhat cold atmosphere was not altogether pleasant, though occasional days of clear weather were extremely bracing, and such days may have been more usual in Patep than a month's stay would suggest. There was no way of obtaining any exact indication concerning this point, as conditions appeared to be completely different from those obtaining in neighbouring areas, such as the Government Station at Mumeng, for which satisfactory information was available. The villagers' own discussions of times of "big sun" always had reference to their garden areas, in which they were primarily interested and which, even during the period of the survey, were generally outside the restricted cloud formation covering the village itself. Concerning the atmospheric peculiarities of the latter the people showed little interest and a consequent vagueness.

* Throughout this Report "Patep" refers to "Patep Number 2" unless otherwise stated.

Approaching Patep, one comes to a 5 feet high, carefully constructed outer fence erected about 200 yards from the village itself. This fence runs, forming an arc of a circle with its end points where the hill falls away in almost perpendicular fashion, in such a way that the village area is completely enclosed towards the approach from the Wampit Valley. There is no such fence on the other side of the village, at which the track from Patep Number 1 enters.

Between the outer fence and the village itself the path passes a communal garden, covering an area of something like 4 acres and planted mainly with taro. There, too, are a few of the special houses for pigs, which, generally, are built within a few yards of the dwelling houses.

The Village.

Separating the pigs' houses from the dwelling-houses is the inner fence of the village. This, unlike the outer fence, completely encircles Patep, enclosing its compact group of buildings, a group made up of a men's club house, a school, twenty-one dwelling-houses and two houses under construction.

A central position, close to the point of entry of the track from the Wampit Valley, is occupied by the men's club house, an extremely impressive and excellently constructed building of two stories. This building measures, approximately, 40 feet by 20 feet and, with its fairly high-pitched roof of thatch, rises to a height of something like 35 feet—about double the height of the average Patep building.

The lower portion, well floored with hewn planks, and walled (also with planks) on three sides but open in front, is used for formal gatherings, and meeting friends. The upper portion, approached by an external stairway, serves as sleeping quarters for boys, young unmarried men and, under certain circumstances, for one or two married men. This upper portion, following a pattern general among Patep dwellings, is, apart from its doorway, completely enclosed, so that, even on days of sunshine, little light can enter. At night, with the door closed, fresh air must be fairly effectively excluded—so too, however, must the greater part of the drifting cloud vapour, an important point in considering the comfort of Patep sleeping quarters.

Haphazardly grouped around the rear of this building is a collection of dwelling-houses, while extending from the front of it to the far end of the village is a double line of houses, forming a fairly straight and regular street.

Situated at the farther end of the street, is the school building, an inadequate and neglected structure, unfortunately symbolising the humble position of the school organisation in the village and contrasting sadly with that other educational institution, the men's club house (with which it has, however, one happy link—see page 54).

All Patep buildings are rectangular structures and, apart from the school, all are built on posts standing about 3 feet above the ground. The majority have narrow verandahs on to which their entrance doors open. The walls are constructed of timber, in the newer houses carefully hewn into fine planks, in the older ones more roughly cut and, in a few instances, no more than precarious-looking erections of logs. The roofs are of grass thatch.

There is a good deal of variation in the size of the houses and in their interior layout. The whole village is, in fact, in the process of rebuilding and there is considerable concentration on the erection of larger houses, conforming in structural method more and more to a European pattern. One effect of this tendency may be seen in a general desire to divide the interiors of the newer houses into two or three rooms, rather than to continue the older plan of a single room.

Although one may say that the wish to possess a house of the newer type is universal in the village, the amount of work involved in building one is so great that fewer than half the families of Patep have yet achieved their ambition.

Improvement of housing standards is, no doubt, a worth while aim and one which is generally felt to be deserving of encouragement. In the case of Patep, however, it would seem that efforts are being carried to extremes and are defeating their own ends.

It might, furthermore, have happened that the people would neglect other important activities, such as food production, in order to achieve their desires in housing. This, fortunately is not so in Patep, as the people are, at present, holding strictly to their ordinary routines, while attempting, in somewhat hopeless fashion, to add to them the arduous tasks involved by their self-imposed housing standards.

Occupying the twenty-one completed houses of Patep are one hundred and thirty-four individuals. Table XI shows the situation.

TABLE XI.

<i>No. of Occupants in each House.</i>	<i>No. of Houses.</i>
12	1
11	1
10	1
8	1
7	3
6	6
5	5
4	2
3	1

Average occupants per house : 6.38.

With reference to the house with twelve occupants, it should be noted that this is a building measuring 30 feet by 15 feet and divided into three apartments. The house with three occupants measures 12 feet by 12 feet, this being fairly representative of the size of the older type of Patep house. The newer style would usually measure something like 25 feet by 16 feet.

In addition to the hundred and thirty-four individuals mentioned above, there are, at present, twenty-three men and boys living in the sleeping quarters of the "men's club house." These range from small boys, nine or ten years of age, to young unmarried men of nineteen or twenty, and include one married man awaiting the completion of his own house. This individual's wife and child are living with the wife's brother in a house so extremely small that it could not possibly accommodate more than the six persons occupying it.

Of the eight individuals absent from the village, three are young single men, who would normally be housed in the "men's Club house," while five are married men whom one would expect to occupy one or other of the ordinary dwellings.

The People.

The people of Patep Number 2 belong to what has been called the Wampit group⁽⁷⁾. They have contact with most of the other villages of this comparatively small group, but regard themselves, together with their closely related villages of Patep Number 1 and Deng'galu (sometimes known as Patep Number 3), as a distinct subdivision of the group.

Particulars of population, sex and age groups, marriages and living offspring per married woman are given in Tables XII-XIV. Details of the total population, including births and deaths, which were, unfortunately, available only from June, 1944, are shown in Table XV.

TABLE XII.—PATEP NUMBER 2—AGE GROUPS (23rd August, 1947).
Total Population : 165.

Range.		Males.		Females.	
0—1	...	3	Male children : 35	5	Female children : 32
1—5	...	14		15	
6—10	...	13		10	
11—15	...	5		2	
16—20	...	18		7	
21—25	...	5	Male total : 84	8	Fe- male total : 81
26—30	...	12		13	
31—35	...	3		3	
36—40	...	3		5	
41—45	...	1		1	
46—50	...	3	Male adults : 49	6	Female adults : 49
51—55	...	2		1	
56—60	...	1		...	
60 plus	...	1		5	

Children : 67—40.6 per cent. of total.

Adults : 98—59.4 per cent. of total.

TABLE XIII.—PATEP NUMBER 2—MARRIAGES (23rd August, 1947).

Age.	Males.			Females.		
	Married.	Single.	Widower.	Married.	Single.	Widow.
16 ...	...	2	...	1	1	...
17 ...	1	5	...	3	1	...
18 ...	2	2	...	1	...	...
19 ...	...	3	...	...	...	...
20 ...	...	3	...	...	...	...
21—25 ...	5	...	...	7	1	...
26—30 ...	12	...	...	11	1	1
31—35 ...	3	...	...	2	...	1
36—40 ...	3	...	...	2	1	2
41—45 ...	1	...	...	1	...	...
46—50 ...	3	...	...	4	...	2
51—55 ...	2	...	...	1	...	...
56—60 ...	1	...	...	...	...	...
60 plus ...	1	...	...	1	...	4

TABLE XIV.—PATEP NUMBER 2—
LIVING OFFSPRING PER MARRIED WOMAN (23rd August, 1947).

Ages of Women.	Offspring.						
	Nil.	1.	2.	3.	4.	5.	6.
16—20	2	3	...	...	...	...	...
21—25	1	4	2	...	...	...	...
26—30	...	2	5	2	2	...	...
31—35	...	...	...	1	1	...	...
36—40	...	...	...	2	...	...	...
41—45	...	...	...	1	...	...	...
46—50	...	...	2	...	...	1	1
50 plus	...	...	2	...	...	...	...
Widows	2	2	1	2	2	...	...

Number
of
women.

TABLE XV.—PATEP NUMBER 2—DETAILS OF DEATHS AND BIRTHS.

Date.	Popula- tion.	Births.	Deaths.	Births per thousand per annum.	Deaths per thousand per annum.	Natural increase per thousand per annum.
June, 1944	142	...	...	...	...	...
August, 1946	156	12	5	39	16.25	22.75
August, 1947	165	8	1	51.28	6.41	44.87

It will be noticed that the births and deaths columns in Table XV do not balance with the population column. This is to be explained by the fact that individuals are, from time to time, moving from Patep Number 1 to take up permanent residence in Patep Number 2. There is also a reverse movement, but the balance favours the latter village.

The birth rate for 1946-47 appears unusually high and may, perhaps, be explained by the return of large numbers of men to normal life, following release from service under military conditions of recruitment. It may be mentioned that there is also a considerable rise in the birth rate for the same period in Patep Number 1.

Work.

The focus of work is the garden and from their intense concentration on food getting the people refused to be distracted. It is on the women that the unending routine maintenance of the garden depends. The men's tasks of clearing, fencing and occasionally sharing in the garden work of their wives is not nearly so constant. For this reason, there is a noticeable difference between the attitude of men to a possible disturbance of their programmes of work and that of women. The men appear to feel that they can occasionally defer their duties to future times. The women, on the other hand, firmly repel any threatened disturbance of their chosen rhythm.

It may, furthermore, be said that a man's work is a good deal more varied than that of a woman. One day, he may be clearing bush for a new garden, the next working at house building or fencing a garden. Again, he may work side by side with his wife in the clearing of an established garden, or he may hunt or work on the erection or maintenance of bamboo piping for one of the irrigation systems.

A woman's daily programme, however, rarely varies from its exact sequence of preparation of the morning meal, her day's labour in the garden, her return to the village, carrying food and water, her attention to the pigs and her preparation of the evening meal.

Generally, the people work in groups of three or four and it is unusual to find an individual working alone. Even when a woman's work is not actually group work, in the sense that she may be working in the individual garden of her family, she will have neighbours working close to her, and in their company she will proceed to work and return home.

As far as group work in the real sense is concerned, this is confined to men, examples being the various types of work involved in house building, fence construction or repairs, the erection or maintenance of irrigation pipes and the felling and burning of timber for new garden areas.

It should be noted that marriage does not cancel a young woman's duty to assist her own family in occasional tasks, though it does, of course, shift the emphasis to her obligation to her husband and his family. It is the strong opinion of most Patep husbands that it would be most unbecoming behaviour in a wife completely to desert her own parents on marriage.

Trade.

Direct trade contacts extend from Patep Number 2 only to fairly close villages, such as Mapos, Gurukor, Timne and Peraklis, but, through these villages, Patep has indirect trade contacts with coastal villages, such as Busama, the island people of Laukanu, to the south of Salamaua, the people of Dargan and Gabensis, on the edge of the Markham country, and the people of the Maralinan area, on the Watut River to the west.

The fundamental item of all outward trade from Patep Number 2 is the pig. Pigs are directed mainly towards the Buang villages of Mapos, Meng'ga and Papekeni, and this trade is particularly flourishing at the present time, as the former coastal source of pigs is now closed to the Buang Villages and the people of Patep Number 2 are "making hay while the sun shines"^(3,4). Other villages close to Patep are, and, apparently, have for a considerable period been short of pigs and Peraklis, Gurukor and Timne all, from time to time, obtain pigs from Patep Number 2.

These pigs are now mostly sold for European money, 15s. usually being obtained for a boar and 30s. for a sow. This appears to be a standard price, and the Patep villagers are enthusiastically reserving pigs in each litter for sale.

Village pigs of Patep are marked by various mutilations of the ear, and when a sow has a litter, the owner decides how many pigs he wishes to keep and how many he will sell. He then marks the ear of **any** pig he intends to keep, the ear of the rest being left unmarked. At present, it is usual to see one piglet with a mutilated ear to three unmarked. In making a count of the village pigs, it appeared that there were seventy-nine pigs to be kept as against twenty-eight to be sold. This was shortly after a visit from people of the Buang village of Meng'ga, who had purchased about eight piglets.

Should a man within the village be without pigs, he does not buy them from his fellow villagers. One individual, for example, has at present in his possession two sows. These pigs were "given" to him by an elderly male relative, and from the first litter he obtains he must return two sows to the original owner. The two sows presented to him, the rest of the litter and any further litters remain for disposal mainly as he himself chooses.

Clay pots are obtained from the Buang villages, to which they come from Lababia-Laukanu by way of Busama. A somewhat different type of pot is obtained from the Maralanan area, these coming through Peraklis. Pots are objects of considerable value and are cared for and held by families for very long periods.

An interesting feature of trade history is that it is claimed that European tools came to the Patep villages, along inter-village trade routes, long before the people had themselves had contact with Europeans.

The Patep villagers are particularly interested in the values of various items of trade and any possibility of their disturbance is viewed with a good deal of concern. This attitude has been carried over by the people to their relations with European trade stores, whose post-war increase of prices is a subject for bitter resentment.

The following table gives particulars of the most important items of trade:—

TABLE XVI.

	To—	From—
East—		
Mapos... ..	Pigs	Clay pots (from Lababia-Laukanu via Busama).
Lagis	String Bags ... ..	.....
Meng'ga	Bark blankets ... ..	.....
Papekini, etc. ...	Spears	Yams (when short).
	Dogs' teeth	Shell ropes.
South—		
Mumeng	Shell ropes	Bows and arrows.
Kumarum, etc. ...	.....	Spears.
West—		
Peraklis	Pigs	Clay pots (from Maralanan).
North—		
Gurukor	Bows and arrows	Betel nut.
Timne... ..	Spears	Sago leaves (for the manufacture of skirts).
	Pigs	(From Dargan and Gabensis.)

Certain items, such as bark blankets and dogs' teeth are practically obsolete and are now little used.

Education.

With the advent of the Mission, with its system of primary schools patterned on a European plan, it appears to have become obvious at once to the people of Patep that formal schooling, instead of commencing at puberty, as in the men's house of pre-Mission days, now commenced at

the age of eight or nine. That it was an alien form of schooling and was little concerned with abilities and responsibilities relevant to village life made no difference. It seems quite clear that the resemblance of its principle of institutionalised instruction to the already familiar, indigenous training period impressed itself on the villagers. If then, a boy commenced a period of formal training at the age of eight or nine, it was no less necessary that his novitiate status should be marked by his leaving the family home and going to live under group conditions than if he had done so at puberty. As a result of this argument Patep No. 2 increased the size of its men's club house to include in resident membership all males from the age of 8 until marriage.

This adaptation of the men's club house organisation to link it with the school has probably been the most important result of the existence of the latter in the village. It has involved the formal allotment of a social status to males at a much earlier age than in pre-European days. Also, it has meant that these younger lads are brought into a rather more concentrated contact with the discussions and consideration of village affairs than they would otherwise be.

The school, as it at present functions, does not appear to be a satisfactory institution, though one must allow for the very great dislocation of the war years. One result of this dislocation is to be seen in the presence in the school of a number of young men between the ages of sixteen and nineteen, individuals whose village schooling has been interrupted by the war.

Maximum attendance appeared to be about thirty, made up of twenty males between the ages of nine and nineteen and ten girls aged from seven to about thirteen. There was not, however, a full school attendance at any time during the period of the nutrition survey.

In fact, so absorbed were the teacher and pupils in preparations for the survey and in observing its activities that the school ceased to function a fortnight before the arrival of the party in the village and resumed only when an early interest was shown in its activities. Subsequently, the school would assemble at any hour during the day, sometimes early in the morning (which appeared to be the correct time), sometimes in the middle of the day, sometimes late in the afternoon.

No school session lasted longer than an hour and a half, the late afternoon sessions generally being considerably less than that.

It is stated that, normally, the school functions on four days in a week and that, in addition to their indoor activities, groups of children are expected to work with the teacher in his garden. Of the latter most excellent activity there was no sign during the period of the survey.

The school is not divided into classes, all individuals being put through the same routines of reading and writing and elementary arithmetic.

It was clear that the teacher had found the situation quite beyond his unguided efforts and had become completely discouraged. It is probable that this situation would be rapidly remedied with more frequent attention from the neighbouring European mission station at Mumeng.

Turning from the school to indigenous education one can see, in its results at least, a much better state of affairs. It is noticeable that small boys of eight or nine upwards are expected to carry out quite a number of duties. In the clearing of bush, gardening, hunting, housebuilding and

other activities of their elders, they generally have some share and invariably show the greatest interest. The whole attitude of a Patep boy of eight or nine is typically one of responsibility, self-reliance and an eagerness to share in the work of others. These qualities may, perhaps, be due to their early inclusion in the life of the men's club house, and in this way would be indirectly due to the existence of the school.

Infants and very small children (under the age of about six) do not appear to go so frequently to the gardens or accompany their parents on excursions outside the village as they do in a number of other localities. Often, they are left in the village with elderly relatives or neighbours.

Small girls, above the age of six, do not, on the whole, commence sharing regularly in the garden work of their mothers at so early an age as do corresponding groups of small boys in relation to their fathers. Reaching the age of twelve or thirteen, however, they appear to be somewhat abruptly plunged into full-time female duties. Significantly, the villagers claim that it is most unsuitable that a girl should attend the village school after the age of twelve or so.

Comments on Relevant Local Customs.

(i) Religion.—The Patep villagers are members of the Lutheran Church, and are most conscientious in the performance of their religious duties. Services are held every evening, with an additional service on Sunday mornings, in the lower portion of the men's club house. These are attended by all villagers—men, women and quite young children—and are generally conducted by the village mission leader or, in his absence, by the school teacher.

(ii) Government.—The Patep villages, until the coming of the Europeans, appear to have been complete democracies, in which each family had equal rights in all local enterprises. That age, industry and personality, combined, gave prestige to individuals is probable, but it is now firmly insisted that, in the past, all men had equal rights in village deliberations.

European influence has placed some degree of emphasis on the powers of the Government and mission officials. This, however, has not been unduly developed and most decisions still emerge from the give and take of conversation in the men's club house.

(iii) Marriage.—Marriage, in recent years, has been modified by the fact that the village mission representative now takes part in a formal ceremony of marriage, his oration stressing the desirable qualities of a husband or wife, in fact, being the essential part of the ceremony.

An important modification in the attitude to marriage concerns divorce. In former times, divorce was a matter for family opinion. Nowadays, even the families cannot countenance divorce. It is firmly stated on all sides that "since the mission came" divorce is inconceivable and that marriage is permanent. This feeling is extremely strong and is probably the most widely influential modification of the attitude towards marriage.

The usual ages for marriage would appear to be from eighteen to twenty for males, and from sixteen to eighteen for females. There are, at present, no married men under the age of twenty-one and no married girls under the age of sixteen (vide Table XIII, p. 51).

(iv) Inheritance.—The most important form of property in Patep No. 2 is land. It was a desire to enjoy more extensively this form of property which was the main impulse bringing the villagers to the present site. Normally an individual inherits rights in an area of land in which the families both of his father and his mother have had rights.

Forms of property such as spears, axes and knives will pass from a man to his male heirs, while such things as clay pots (which are subjects of considerable value) are inherited by a woman's female heirs.

Present European Relations.

The building of the motor road from Labu to Wau made the old patrol route passing through Patep Number 2 superfluous and, at the same time, has brought the villagers into a realm of almost continuous European contact.

Only six men are absent from Patep as labourers, five of these being married. All are between the ages of twenty and thirty. In addition, there are two young men, about nineteen years of age, attending the school of the Lutheran Mission at Mumeng, where they are at present living.

Considering the comparatively large number of young single men in the village, it may appear somewhat surprising that several of them have not been attracted by the post-war opportunities of Lae or the goldfields. In actual fact, the people seem so disillusioned by their war-time experiences that they show little wish to leave the village as labourers even to acquire European goods, which they greatly desire.

During the war, large numbers of them worked for considerable periods on the construction and maintenance of the Wau-Labu road. At that time, they seem to have developed some view of a new and better world to be achieved as the reward of their labours, and this has prevented them from feeling any contentment in their settlement into their old routines. At the same time, the fact that a new and better world was not immediately brought into their village, has given them the view that little is to be gained from outside efforts and contacts.

Once only, early in 1946, did the villagers allow their discontent to bring them to the point of failing in their essential work. At that time, there was a mild movement (of the "cargo cult" type) which involved some neglect of gardens. At the present time, though discontent is extremely strong, the people are showing a precise realism in work conscientiously done for themselves.

Of the five villages visited, Patep Number 2 showed the most sustained and intelligent interest in the work of the Nutrition Survey Party. Certain individuals, in the beginning, saw in that work some fulfilment of expectations developed during the war and, in the end, requested advice as to suitable diet. Co-operative (and curious) though other more sophisticated villages were, such an attitude was found nowhere else.

Section 7.

KAVATARIA.

Situation of the Village.

Kavataria is situated in the north-eastern portion of the island of Kiriwina, the largest of the Trobriand Islands, and is a coastal village, on the shores of the Trobriand Lagoon. It is one of a number of fishing villages lining the northern shore of the lagoon, others being Mulosaida, Osaisuya and Tukwu'ukwa. The village closest to Kavataria is Mulosaida, to the east, the two being separated by a space of only a few yards.

About a quarter of a mile to the east of Kavataria is Oiabia, the head station for the Trobriands area of the Methodist Mission. A few hundred yards further is Losuia, the Government Station. Europeans have been in residence both at Oiabia and Losuia for more than forty years. Another Mission Station, that of the Roman Catholic Mission, at Gusaweta, and a trading station at the same place are about four miles from Kavataria.

The nearest inland village is Gumilababa, which is about two miles away. Two miles beyond Gumilababa, is Boitalu.

The Village.

The typical Trobriand Island village has been described by Malinowski: "In the middle, a big circular space is surrounded by a ring of yam houses. These latter are built on piles, and present a fine, decorative front, with walls of big, round logs, laid cross-wise on one another, so as to leave wide interstices through which the stored yams can be seen (see Plate 34). Some of the storehouses strike us at once as being better built, larger and higher than the rest, and these have also big, ornamented boards, running round the gable and across it. These are the yam houses of the chief or of persons of rank. Each yam house also has, as a rule, a small platform in front of it, on which groups of men will sit and chat in the evening and where visitors can rest.

"Concentrically with the circular row of yam houses, there runs a ring of dwelling huts, and thus a street going all round the village is formed between the two rows. The dwellings are lower than the yam houses, and instead of being on piles, are built directly on the ground (¹⁰).

Houses are small, being, on an average, about 16 feet by 12 feet, but are not unduly crowded. The 301 residents of the village live in 85 houses, an average of 3.54 people to each house. This is, in fact, the smallest average found in any village visited by the Nutrition Survey Party, and is roughly comparable with the position in Kaiapit.

The situation in Kavataria is shown in the following table:—

TABLE XVII.

<i>No. of Occupants in each House.</i>	<i>No. of Houses.</i>
1	3
2	17
3	28
4	20
5	6
6	7
7	4

Average occupants per house : 3.54.

A notable feature of Kavataria is that in very few instances do household groups and family groups coincide. In most cases, one or more children belonging to a family would be living with relatives, and, in one or two families, one had the curious position that a husband and wife would have sent one of their children to live with relatives in another part of the village, and would then, in their turn, have taken into their house a child belonging to another group of relatives. One might well have expected, from the kinship and inheritance systems, that children would be sent to live with the maternal uncle, but this was by no means always so. Very many children were living in the houses of their fathers' brothers or fathers' fathers.

The People.

The present population of Kavataria is 301, and particulars of age groups, sex distribution, marriages and living offspring per married woman are given in Tables XVIII-XX. The particulars of the census from 1945-47 are given in Table XXI.

TABLE XVIII.—KAVATARIA—AGE GROUPS—Total Population : 301.

Range.	Males.		Females.	
0—1	2	Male children : 41	2	Female children : 54
1—5	12		22	
6—10	12		13	
11—15	15		17	
16—20	17		13	
21—25	15	Male total : 157	10	Fe- male total : 144
26—30	11		7	
31—35	18		20	
36—40	15		6	
41—45	8		9	
46—50	9	Male adults : 116	2	Female adults : 90
51—55	5		4	
56—60	6		8	
60 plus	12		11	

Children : 95—31·6 per cent. of total. Adults : 206—68·4 per cent. of total.

TABLE XIX.—KAVATARIA—MARRIAGES (20th October, 1947).

Age.	Males.			Females.		
	Married.	Single.	Widower.	Married.	Single.	Widow.
16	...	3	...	...	3	...
17	...	6	...	...	2	...
18	...	4	...	2	1	...
19	...	2	...	1	2	...
20	...	2	...	1	1	...
21—25	7	8	...	9	1	...
26—30	9	2	...	7	...	...
31—35	13	2	3	20	...	...
36—40	13	...	2	6	...	...
41—45	7	...	1	9	...	...
46—50	6	...	3	2	...	...
51—55	4	...	1	3	...	1
56—60	4	...	2	5	...	3
60 plus	8	...	4	6	...	5

TABLE XX.—KAVATARIA—LIVING OFFSPRING PER MARRIED WOMAN
(20th October, 1947).

Age.	Offspring.					
	Nil.	1.	2.	3.	4.	5.
16—20	2	2	...	...	...	...
21—25	4	2	3	...	...	...
26—30	2	...	2	1	1	1
31—35	10	4	1	3	...	2
36—40	3	...	1	1	...	1
41—45	5	2	...	2	...	...
46—50	1	1	...	...	...	...
50 plus	11	1	1	...	1	...
Widows	7	2	...	...	...	...

} Number
of
women.

TABLE XXI.—PARTICULARS OF CENSUS FROM 1945 TO 1947.

Year.	Popula- tion.	Birth	Deaths.	Births per thousand per annum.	Deaths per thousand per annum.	Natural increase per thousand per annum.
1945	291	...	...	...	...	...
1947	301	19	10	32·64	17·18	15·46

Records of the population of the Trobriand Islands are available from 1919 onwards with the exception of those lost during the war years ⁽¹¹⁾, ⁽¹²⁾, ⁽¹³⁾. The figures are conflicting and do not enable a conclusion to be drawn on the trend of the population since 1919.

Economic Organisation.

Kavataria, in common with other Trobriand villages, appears to be a long-established and stable settlement, and, to a degree, contrasts, in this respect, with villages in other areas visited by the Nutrition Survey Party. The population of Kavataria is mainly composed of men who have inherited a right to a house-site in the village and a right to garden on village lands and fish in village waters, together with their wives and children.

In some cases, where the wife comes from another village, a man's children will not have any hereditary right to remain in Kavataria, but will be expected to become members of the mother's village. Conversely, where Kavataria women are married and living elsewhere, their children will be expected to return to Kavataria in due course. In actual fact, the great majority of married women at present in Kavataria were born there and are by right of birth members of Kavataria families. There are only 14 married women in the village who have come from other parts of the Trobriands.

The people of Kavataria divide their time between gardening and fishing. Considerable quantities of fish are obtained and an appreciable percentage is bartered with the inland villages for garden produce (see Plate 40).

Garden Lands.

There are three types of garden in the Trobriands: Kaimata gardens, which supply the bulk of the produce, and which are harvested in July or August; Kaimuga gardens, which may be said to be subsidiary, and which are harvested about March; and Tapopu gardens, in which taro is grown.

In October, 1947, Kavataria villagers were clearing and burning-off land for their Kaimata gardens (see Plate 30). This, apparently, was rather later than it should have been⁽¹²⁾. The area of land being prepared appeared, furthermore, to be somewhat small: about 40 acres. At the same time, there was only a very small total area of Kaimuga gardens, probably no more than 6 acres, in which yams and taitu were growing. Only one man in the village possessed a Tapopu garden, an area of approximately half an acre, in which taro alone was growing.

Records kept at Losuia (which may, for the purpose, be taken as identical with Kavataria) over a period of 23 years, show an annual average rainfall of 154 inches, distributed as follows:—

January, 16 inches.	July, 11 inches.
February, 14 inches.	August, 13 inches.
March, 15 inches.	September, 12 inches.
April, 13 inches.	October, 10 inches.
May, 13 inches.	November, 13 inches.
June, 13 inches.	December, 11 inches.

Food Storage Houses (See Plate 34).

The Bwaima, or storage house for yams and taitu, does not receive all its contents from the garden of the man to whose house it is attached, a proportion coming from the garden of his wife's brother. Thus a storage house in Kavataria may receive some of its yams and taitu from the gardens of another village, if its owner should have married a woman from that village. It was not possible to make any estimate as to the actual amount of produce coming, by this means, from other villages. It would not, however, be a great deal, since it was stated that only 11 store houses are involved.

The amount of food contained in storage houses would usually be a good indication of the prosperity and well-being of a village. Details of the amount of food stored were collected in October, 1947, some two months after gathering of the yam and taitu harvest, which had been completed early in August. These indicated that the amount contained in Kavataria bwaima was most unsatisfactory. This would need to be modified by the fact that Kavataria is recognised as the leading fishing village of Kiriwina, and obtains a good deal of garden produce from inland villages in exchange for fish.

Fishing.

The inland villagers of Kiriwina would generally possess far larger garden areas than those on the coast. Particularly would this be so around Omarakana, the Paramount Chief's village, which lies in the most fertile part of the island. From such villages would come quite large amounts of

garden produce to supplement the stores of coastal villages. Austen has estimated that, in a good year, about 300 tons of taitu would go from inland villages to the coast⁽¹²⁾. This taitu is traded to coastal villages in exchange for fish, and probably the largest share of it would go to Kavataria, which appears to maintain its position as the leading supplier of fish.

On two occasions during the seven weeks' residence of the Nutrition Survey Party, the inland village of Kudukwaikela sent a request to Kavataria to supply fish for funeral feasts. On each occasion, the canoes of Kavataria set off to do a whole day's fishing, and the men of Kudukwaikela came in to the coast, carrying yams in baskets. These were placed in the large conical wooden receptacles known as pwata'i, six of which had been carried in from Kudukwaikela and erected at intervals in the streets of Kavataria. Each of the pwata'i was filled and must have contained about 35 cubic feet of taitu.

In the evening when the Kavataria canoes returned, their hauls of fish were divided amongst the men who had brought in the taitu. The taitu was, in due course, divided amongst the fishermen.

Fishing, on such special occasions as these, would usually be deep-sea fishing carried on far beyond the reef opposite the village. Reef-fishing, however, was constantly being done, the bulk of the catch here being used in Kavataria itself. Each part of the reef is the inherited property of a group of men whose ownership of such fishing sites is clearly recognised.

Work.

The Kavataria people were busy for the greater part of each day, men and women working together in the cleaning of garden sites, women in some cases carrying on this work while the men fished. The felling of secondary growth, burning off and fencing is men's work. Minor cleaning and maintenance of the garden is women's work. Certain species of seed taitu may be planted by women; others only by men.

Within the village, there would usually be a good deal of activity after the day's gardening or fishing was over. Men would be working on the building and repair of canoes, the building of houses or the making or repair of fishing nets. Women who were not preparing food would generally be engaged in making fibre skirts.

Trade.

The Trobriands is a region of specialist localities, and all communities are, to some extent, inter-dependent. This has already been seen in noting the exchanges of fish for garden produce.

European Relations.

Sustained interest in the Trobriands has meant that its people have received a degree of Government protection and assistance in the maintenance of their culture which has probably been unique in the Pacific. It seems, furthermore, that the Trobriander has shown some determination and ability in resisting any very close relationship with European enterprises and activities. Very few Trobrianders have ever left the group, very few of them have even been willing to work for a sustained period for the few Europeans in the Trobriands, and the tendency to resist efforts to entice them into European employment appears now to be at its height.

They have, furthermore, been extremely fortunate in their relations with their missionaries. Both the Methodist and Roman Catholic missions appear to have shown admirable patience and sympathy in dealing with the people. There are, obviously, many elements of Trobriand culture—magic, polygamy, sexual laxity, for instance, of which missionaries can by no means approve. Yet, in the missions' dealing with such matters there does not seem to have been any suggestion of abrupt command (which, notwithstanding all opinion to the contrary, has entered into mission relations with many Pacific people).

The Methodist Mission has an excellent series of village schools, extending over Kiriwina Island. The Roman Catholic Mission, more recently established, has a school at its head station, at Gusaweta, and a school at the inland village of Okaikoda.

Kavataria, being close to the head station of the Methodist Mission at Oiabia, does not have a separate school, its children attending the Oiabia school. Oiabia, in fact, with its range of activities, its organised feasts and occasional gift exchanges, its boy scout troop and its school activities and games, is a centre of considerable interest and stimulation to Kavataria.

A difficulty involved in European contact is the maintenance of the chieftainship—since it is considered that this, for the New Guinea area, unique system is necessary to the maintenance of Trobriand social stability and can be of great assistance to native administration. One of the chief bases of Trobriand chieftainship is polygamy, the right of the chief to a large number of wives. From the brothers of these wives and, indeed, from many other men of the communities from which they come, the chief receives yams and taitu for his food storage houses. He has, consequently, a great deal more food than the ordinary Trobriand man, and this he distributes in feasts and in assistance to the needy in cases of emergency. It appears fairly certain that polygamy will disappear before long, not under any pressure, but through the gradual working of mission influence, and it seems desirable that some other system should be developed to replace the tributary food gifts from the community-fellows of the chiefs' wives. The maintenance of the chief's wealth not for his own enjoyment, but as a form of community "insurance" and treasury, is essential to the maintenance of the office.

The hereditary Tabalu chief of Kavataria, the young man Pulitala, has only one wife, no doubt by his own wish, for he is a staunch member of the church. He has not a great deal of wealth in the form of food, certainly not sufficient to assist his fellow-villagers on any suitable occasion. The paramount chief of the island, Mitakata, of Omarakana, has thirteen wives and possesses considerable stores of yams and taitu, though considerably less than an old-time chief would have held. On one occasion, a few years ago, Mitakata was able to help several people of a neighbouring village whose food storage houses were burnt. On numerous other occasions he has been able to be the centre and organiser at times of festivity. Mitakata, however, had to cease to be a church member on his taking a number of wives, following succession to the chieftainship.

Now the question of the education of Mitakata's heir has arisen. This young man can be educated only in a mission school, and it is probable that his views will be much affected by this. The things from which the chieftainship takes its strength—polygamy, magic, a system of tabus and tributary gifts—are all likely to be called into question, if not discarded.

If the Government is to retain the system of chiefs, it is necessary that the question of adequate substitutes for these things should be carefully considered. Trobriand chiefs, whatever action is taken, will, if they are used in native administration become, to some extent, Government officials. If they are not to retain some independent connections with their people, in the way of substitutes for their old connections, there appears to be no purpose in attempting to conserve the institution.

Section 8.

KORAVAGI.

Situation of the Village.

This village is situated near to the junction of the Beara and Pie Rivers, and is about 8 miles to the north-east of Port Romilly Sawmill, though the distance to be travelled by the winding waterways would be rather more than that. Eight miles beyond the sawmill is Urika, a station of the London Missionary Society. Kikori, the headquarters of the Delta Division, is some 60 miles to the west of Koravagi.

The nearest villages to Koravagi are Vaimuru, some 6 miles to the south-west and Kaimari, about 10 miles to the south-east.

Closer to the village site than these, are the old villages of Oravi and Akiaravi, whose people have joined with the villagers of old Koravagi in the construction of a new village. Oravi is about 4 miles and Akiaravi about 5 miles to the east of the new village site. The site of the old village of Koravagi would be about 2 miles to the north.

The land chosen for the site of the new village appears to be rather drier than is usual in the neighbourhood. At high tide, it would be some 4 or 5 feet above river level, in this differing from the site of old Koravagi, where, at high tide, water flowed under the houses. It is not, however, so elevated as the old Oravi and Akiaravi sites.

During the period of the survey there was little rain and the village area was extremely dry and dusty.

The Village.

The new village of Koravagi, in its plan and methods of house construction, represents a social revolution in the Delta area. This it has in common with a number of other new villages, such as Vaimuru and Kaimari.

The old type of village has been described by Williams (²⁵). He says: "The typical Purari village would be situated on one of the lesser streams, perhaps at the confluence of several. The bush is cleared back only so far as to accommodate the settlement, and many larger trees are spared. An open space or two, clothed with fresh grass by the water's edge, might strike the eye as a wholesome field; it is in reality a shallow morass. In the driest of weather there are few patches where a man may walk in comfort.

"The village is riddled with small creeks, some losing themselves underneath the houses, others acting as waterways at high tide, and at low tide as fishing grounds for the little girls who beat up and down, staggering through the mud with their fishtraps.

"The houses are of the distinctive and very picturesque variety that rises to a high peak in front, and so presents a sort of yawning entrance. Their colouring of greys and browns makes with the surroundings an admirable blend, to which their very raggedness no doubt contributes. In

fact, the Delta village, with its numerous coconut palms, its occasional splashes of scarlet from crotons and hibiscus, and the variegated background of bush into which it partially merges, cannot be denied a very great beauty.

"Here and there a towering ravi rises among the houses, of similar construction to them, but fairly dwarfing them in size. The houses themselves often appear at first glance to be thrown together in a complete jumble; in reality they are, for the greater part, facing the gangways which follow the course of the streams. In most places, however, thanks to the efforts of the Government, they present a more orderly appearance and line the gangway on only one side, viz., that removed from the river."

Villages of this type, in various stages of dilapidation, are still to be seen in the district surrounding Koravagi, examples of these being Oravi and Akiaravi and the old village of Koravagi. They are now almost deserted, though a few people are remaining in them until the new village is completed.

Between the new village of Koravagi and the three villages whence its people have in the last few months come there is no resemblance whatsoever. Its houses are not built in a line facing the river, and are not connected by gangways. Instead, the village is laid out in six regular streets extending back at right angles to the stream. In addition to this collection of streets, there is a semi-circular group of buildings, forming a somewhat separate section of the village.

Nor does the ravi exist in the new village, in which the most prominent places are occupied by the lofty residences of two mission representatives, one of these being in the main part of the village and the other in the semi-circular section.

Above all, the houses are not of the long, rather narrow, Gothic-arched type, of which many examples are still to be seen in the old villages.

This older type of house was generally constructed with considerable skill, some of them being as much as forty or fifty feet in length, and averaging fifteen feet in width. Built on piles sunk in the mud, they were floored with rough timbers and roofed with thatch of nipa-palm.

Examples seen in old Koravagi had not in many instances been occupied by single families, a man with one wife having been likely to share his house with the family of a brother or brother-in-law. A man with two or three wives would, however, not share his dwelling with anyone else.

In the latter case, each wife would have her own hearth and, in addition, there would be likely to be a husband's or family hearth in the entrance porch or verandah.

Dwellings in new Koravagi are square structures, built on posts raised about five feet above the dry ground on which the village is built. None is yet completed, but one is told that they are to be occupied by individual families. Work on them is sufficiently advanced to permit one to make out the interior layout. In each are, apparently, to be four rooms: a room for man and wife, a room for sons, a room for daughters and a room "for visitors." Down the centre of the house runs a passage-way, about three feet in width. Such houses would, on the average, measure about thirty feet by thirty feet. Attached to each is an annexe which one is told with some pride is to be a kitchen, and in such case a hearth of the old type is being constructed there.

The People.

Koravagi belongs to what has been called the Baroi section of the Koriki tribe (¹⁵). Even with the fusion of three villages into a larger one, Koravagi remains, for the Koriki area, a comparatively small group (¹⁶).

No census had been taken for the new village group, and figures available for the three old villages of Koravagi, Akiaravi and Oravi were not satisfactory. A census taken by the Nutrition Survey Party indicated a total population of 421 for the new village, of whom 84 were not seen by the party.

Particulars of sex and age groups, marriages and living offspring for married women are as given in Tables XXII-XXIV.

TABLE XXII.—KORAVAGI—AGE GROUPS (4th December, 1947)—
Total Population : 421.
(Included in table : 421—84 individuals not seen : 337.)

Range.	Males.		Females.	
0—1	...	2	3	
1—5	...	34	26	
6—10	...	30	26	
11—15	...	17	18	
16—20	...	6	10	
21—25	...	9	23	
26—30	...	11	22	
31—35	...	14	19	
36—40	...	15	18	
41—45	...	12	5	
46—50	...	6	3	
51—55	...	1	...	
56—60	...	3	...	
60 plus	...	2	2	
		Male children : 83	Female children : 73	
		Male adults : 79	Female adults : 102	
		Male total : 162	Female total : 175	

Children : 156—46.3 per cent. of total.

Adults : 181—53.7 per cent. of total.

Individuals not seen: Information concerning the names, sexes and whereabouts of individuals not seen was obtained from members of their families. Sixty-eight of them were males and 16 females. This would make the actual totals for the sexes:—

Males: 230.

Females: 191.

There was no possibility of obtaining any indication of the ages of 28 of the absent individuals. With reference to the remaining 56, it was possible to conclude that 46 males and 10 females were adults (in some cases, from the fact that the persons concerned were married, in others, from the fact that they were employed as labourers). It will be noted, in Table XXII, that the male groups between the ages of 16 and 30 are extremely small. It is likely that this is related to the fact that some 36 absent males were stated to be employed as labourers, since it may be taken as practically certain that the majority of these individuals would belong to one of the three groups in question. Considering the probable age distribution of individuals not seen, it seems in relation to total population should be reduced by at least 2 and, perhaps, by as much as 4 per cent.

TABLE XXIII.—KORAVAGI—MARRIAGES (4th December, 1947).

Age.	Males.			Females.		
	Married.	Single.	Widower.	Married.	Single.	Widow.
16 ...	...	2	...	1	3	...
17 ...	...	2	...	...	4	...
18 ...	...	1	...	...	...	...
19 ...	...	1	...	...	...	...
20 ...	...	...	...	2	...	...
21—25 ...	4	5	...	23	...	...
26—30 ...	11	...	...	22	...	...
31—35 ...	13	...	1	19	...	...
36—40 ...	13	...	2	18	...	...
41—45 ...	11	...	1	5	...	...
46—50 ...	6	...	...	3	...	...
51—55 ...	1	...	...	...	...	...
56—60 ...	3	...	...	...	...	...
60 plus ...	2	...	...	1	...	1
Adults not seen ...	26	19	1	10	...	...

Polygamy : 10 men—2 wives each.
2 men—3 wives each.

TABLE XXIV.—KORAVAGI—LIVING OFFSPRING PER MARRIED WOMAN (4th December, 1947).

Ages of Women.	Number of Offspring.						
	Nil.	1.	2.	3.	4.	5.	6.
16—20 ...	2	1	...	...	...	...	...
21—25 ...	9	7	6	...	1	...	...
26—30 ...	5	6	5	3	3	...	...
31—35 ...	3	5	3	3	3	2	...
36—40 ...	1	6	5	1	2	2	1
41—45 ...	...	1	3	...	...	...	...
46—50 ...	1	2	...	...	...	...	...
50 plus ...	1	...	...	...	...	...	...
Widows ...	...	1	...	...	...	...	...
Not seen ...	4	2	2	2	...	...	...

} Number
of
women.

Village books of the detailed type to be seen in certain other villages were not here available, and it was not possible to obtain any information as to population trends. It may, however, be remarked that Keesing (¹⁷) considers optimism for the future justified when more than 40 per cent. of the population is under fifteen years of age and goes on to refer to a Papuan "low of 26 per cent. (the Delta Division)," for the year 1935.

Education.

The children, through association with their parents, gradually acquire the various skills of the community. As a good deal of the villagers' work is periodical and involves absence from the village for days at a time, children accompany their parents to the scene of activity at the earliest age.

Apart from the gradual conditioning of children in local skills, Papuan representatives of the London Missionary Society have established schools in the village. One of these is in the main portion of Koravagi and the other in the semi-circular portion built by certain people of the old Akiaravi village.

These schools had not properly commenced to function, and from a strictly formal point of view can hardly be expected to be very effective. The two teachers in charge of them come from the village of Ipisi, in the Kerema area, and both have had one year's schooling at the Urika station of the London Missionary Society, following a four-year period at school in their own village.

Excellent and impressive buildings have been enthusiastically erected by the villagers, each being half school and half teacher's residence. There is, however, a sad lack of equipment. Something like half a dozen slates to each school, attendance in each being likely to range from twenty to thirty. Of books there are none, apart from the teachers' personal copies of religious translations into the Namau tongue.

The presence of these two mission representatives is, nevertheless, likely to have an excellent effect. The Koravagi people, in their present reforming zeal, are in a suitable mood for the adoption of new ideas of cleanliness and order, and in these respects the teachers and their wives are setting a splendid example.

Work.

The community had not only been engaged in building its new village, but also in the construction of the Beara Police Post, both enterprises having involved some dislocation of the usual routine. It was, therefore, not possible to be certain about the normal rhythm of work.

One thing, nevertheless, seemed clear: work in Koravagi, primarily a sago-collecting village, has not the repeated daily routine of work in villages which concentrate on gardening. It is a matter of days of sago-working activities, interspersed with days of comparative idleness. This may be said of both men and women.

There is, perhaps, some very slight tendency to give more attention to taro-gardening than in the past. Taro gardens at present being prepared are, on the whole, larger than those actually in production.

It is to be noted, that only on one occasion during the survey was sago actually worked in Koravagi village. At other times, it was worked where the palm was cut.

Trade.

This is the most important and most disturbing factor in the life of Koravagi to-day! On careful economic development the future contentment of the community depends. The desertion of old villages, the discarding of old spiritual and social attitudes, the zeal for a new way of life and the loss of faith in old systems are all closely bound up with a post-war wish for a renaissance of trade relations with the outside world. It is probable that this may be said of the majority of the villages of the eastern part of the Delta Division.

Fumblingly and on varying scales of organisation, this Delta area has been attempting to develop a trade in sago, particularly with Port Moresby, in the period since the war. Under many Koravagi houses are piled bundles of sago, awaiting the opportunity for shipment from the Port Romilly area.

In various analyses of recent economic developments in the area, due emphasis has been laid on the influence of various returned labourers with experience of the outside world, both during the war and in the post-war period. Particularly has this been so in the case of one individual who spent some time in Australia during the war and who has since attempted the organisation of an enterprise, based on sago production, on an impressive scale.

While the experiences of such people have, no doubt, been of essential importance in recent movements, it is useful to remember that the traditional attitudes of the community have been no less important. In the past, an avenue for the profitable utilisation of excess sago was of just as much interest to the Delta people as it was to the Motuan receivers of the food. The Motuans, in nearby European employment, money and European stores, have found a substitute for their old time trade. For the Delta people there has been no local substitute. One feels, then, that the present, rather fumbling movement, though it has involved the large-scale discarding of many old ways is, nevertheless, based on a need which is old.

European Relations.

The Koravagi people have had little contact with Europeans in their home territory. The village has, nevertheless, supplied a good deal of labour to other areas. At present, there are thirty-six labourers absent from the area.

The establishment of the Beara Police Post and possible future mission activities will, however, bring the village into a completely different situation.

The community is obviously one ripe for experimental development, and a people who, while they have accumulated some vague and, usually second-hand, ideas concerning European life, have not yet evolved any fixed attitude to European contact, supply a most suitable field for guidance.

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PART 3.

NATIVE AGRICULTURE IN PAPUA—NEW GUINEA.

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Section 1.

INTRODUCTION.

With the exception of some small and strictly limited groups, the native population of the Territory is dependent for subsistence on the production or collection of various vegetable foods. Although the methods used are essentially primitive, they are by no means unsystematic, and although variations are found with varying environmental conditions, it is not difficult to detect an overall similarity of method.

Of prime importance in the native system is the production of the staple foodstuff, invariably a starchy vegetable. Sweet potato (*Ipomoea batatas*), taro (*Colocasia antiquorum*), Yams (*Dioscorea spp.*) sago (*Metroxylon rumphii*) and bananas (*Musa spp.*) are the main crops of this type, and, varying with the environment one or other of them is usually dominant to a marked degree in the agriculture of a particular community. Cassava (*Manihot utilissima*) is the most important accessory starch food crop, while any one of several of those mentioned above may also be grown as accessories.

Both wild and planted stands of sago palm are widely distributed in the extensive low-lying swampy areas associated with the larger river systems. All the remaining staples are treated as annuals, and the basic unit of cultivation is a small garden clearing cut from forest or grassland; interplanting of other annuals such as maize, sugar cane and pit (*Saccharum robustum*) is not uncommon, but is rarely done systematically. With the exception of some limited areas of high fertility, these gardens are abandoned after a single cropping, and are allowed to lie fallow for as long as the local population pressure will permit, with the usual variants such as accessibility and floodability operating. This period of fallow is sometimes long enough for high secondary jungle to develop before the cultivator returns to such a plot—the system has accordingly earned the appropriate name of "Bush Fallowing Rotation."

From observations made during the present survey it would appear that there is often a further large scale rotation in which the whole of the area devoted to gardening is swung from one part of the community's land to another, leaving a large area in fallow for a very long period. A scrutiny of the figures in Table 4, Section 2, will show that the communities examined operate on from two to three times as much land as would be needed if the ordinary period of fallow was adequate to preserve fertility.

A number of perennials are also commonly grown for food, usually as fruits or nuts. The practice is to locate them in irregular groves, usually associated with places of habitation. Of these the most important are the coconut palm (*Cocos nucifera*), breadfruit (mainly *Artocarpus nobilis*), betel nut palm (*Areca catechu*), *Gnetum gnemon* and species of *Citrus*, *Eugenia*, *Canarium*, and *Terminalia*.

Livestock do not play an important part in the land use methods of the people. Pigs and fowls are the only types kept, and the methods of husbandry are primitive. Stock are rarely enclosed, but are mostly allowed to roam free in the habitated area. Hand-feeding is irregular and aimed more at keeping the animals domesticated, than providing them with any definite dietary level. The eating of pig meat is confined almost universally

to ceremonial occasions. The typical native fowl is small, lean and leggy with variegated plumage—it has a very low egg production rate, and is prized principally for its coloured feathers. Dogs are kept as household pets and for hunting and sometimes figure as a source of meat, although this practice has been dying out with the extension of European influence.

Politico-economic Determinants of Native Agriculture.

Numerous authorities have drawn attention to the lack of development of accepted hereditary chieftainship principles in Melanesian society, and to the local form of organisation which produces a large number of small politically independent communities. Within these communities prestige and the right to govern are attained largely by economic activity aimed at the accumulation of food and other goods for gift-making, which builds up a pattern of indebtedness.

This form of political organisation and the associated systems of land tenure have an important determining effect on the nature of agricultural practice. Each community tends to regard itself as having a definite communal right to the agricultural land to which it claims boundary, but within this limitation, communal ownership and communal cultivation are relatively rare and family and individual rights are widely recognised. Matrilineal, patrilineal, and bilineal inheritance patterns may be found.

This situation is adjusted to the system of "bush fallowing rotation," described above, by the wide extension of nonfructory rights within the community, without prejudice to rights of ownership.

Under these conditions large areas of cultivation are a comparative rarity and usually result from some special circumstances such as confusion of tenure in a long-cultivated area. Even when a large area is communally cleared and fenced as a solution to this sort of problem, it is invariably divided subsequently into a number of small plots, which are planted, cultivated, and harvested individually. Another important result is that there has been little tendency in any part of the Territory towards the development of specialised food producing population groups.

The principal economic factors affecting native agriculture in Papua-New Guinea are (1) the generally low population density, (2) the low degree of technological development associated with food production and (3) the limited scope for export and trade provided by local political and geographical conditions. The extensive long-fallow type of land use method which has been described is only possible where the available acreage per head is high, but it must be remembered that a considerable portion of the land so employed is for topographical and climatic reasons of dubious value under any other type of cultivation. The implements used are simple—axes and knives for clearing, and the digging stick and the hoe for cultivation. Inevitably burning is widely used in clearing and has a special significance, which will be mentioned below. Crude irrigation systems are found very occasionally, while fertilisers and manures are virtually unknown.

Cultural and Religious Determinants of Native Agriculture.

As might be expected with a primitive people practising subsistence agriculture, agricultural practice invariably has close ties with local culture and religion. Various magico-religious ceremonies, particularly the conducting of fertility and weather rites, and the casting of good and evil

garden spells by persons accredited with sorcery powers, are commonplace, while local mythology is rich in stories of the first coconut, the first taro, etc., usually involving associations with human fertility.

As with most peasant people women play an important role in agricultural production, and the sharp sexual bifurcation of Melanesian communities is reflected in agricultural procedure. With minor variations in particular communities, certain tasks are invariably regarded as the work of one or other sex. The heavier work such as felling and clearing jungle falls to the men, while the lighter but more tedious jobs such as planting, weeding and harvesting are the women's responsibility. Under primitive conditions this division of responsibility is strictly observed and is reinforced by taboo.

The effect of these factors is to increase the rigidity of the system, giving it a strong resistance towards extraneous factors making for change.

Ecological Determinants of Native Agriculture.

While, with few exceptions, political, economic, cultural and religious factors appear to play a relatively consistent role in their effect on native agriculture, the geography of the Territory is characterised by extreme diversity of physical feature, providing a wide environmental range, and the most obvious variations in agricultural method are those which can be traced to ecological causes.

In the wet, swampy lowlands and in the tropical rain forests of the foothills and lower mountain slopes the forest vegetation is extremely diverse, a variety of trees and palms with edible fruits, foliage, or pith, occur, and collection becomes an important factor in food-getting with cultivation showing limitations accordingly. This is particularly the case in some of the larger river valley plains and in the Delta areas. The sago palm (*Metroxylon rumphii*) grows readily in semi-inundated areas, and representatives of genera such as *Terminalia*, *Pometia*, *Dammaropsis*, *Garcinia*, *Gnetum*, *Artocarpus*, *Ficus*, *Canarium*, *Myristica*, *Aglaia*, and *Mangifera* with edible fruit, nuts, or leaves occur in the forests. Additional food-stuffs are available in the form of edible fungi, the hearts of tree ferns and palms such as *Arenga* spp., and the young unopened fronds of Nipa Palm (*Nipa fructicans*).

At higher altitudes this mixed forest is left behind and zones of Dipterocarp forest are found with belts of Conifers and Casuarinas at still higher levels. In these regions leaching of topsoils, such as is found in cool temperate climates, occurs, and the growing periods of crops as average temperatures decrease. As might be expected, cultivated crops become more and more important in the food production system, and cultivation becomes more and more intensive, reaching its highest development in the cool high plateaux of the main Cordillera.

In inland areas a further factor, namely, shortage of protein foodstuffs, has an effect on land use. Near the coast a variety of sea foods is available, and pigs and a large phalanger (*Phalanger maculatus*) can be obtained readily by hunting in the coastal rain forests. Further inland and particularly at higher altitudes these foods are not available, and hunting for wallabies and various smaller marsupials and rodents is an intensive occupation. These are mainly herbivorous animals of grasslands and they

tend to concentrate in the areas of early regrowth on old cultivations. In the hunt for meat food it is common practice to burn over these areas to drive out the animals for spearing or netting. Agriculturally the significance of this practice is that each time it occurs the regeneration growth receives a serious check, and the soil is more or less exposed to climatic influences with a consequent loss of fertility.

Taro is the characteristic staple food crop in lowland rain forest areas of moderate fertility, and in its cultivation the surface soil is least disturbed. The forest is cleared and the garden area may be lightly burned over, after which the taro shoots are planted in cylindrical holes of no great depth made with a pointed stick. The soil around the top of the holes is tamped in tightly, and the taro plant is then left to mature, with perhaps a light weeding from time to time. Yams are typical of better drained soils of high mineral fertility such as the new volcanic soils of the Prince Alexander and Torricelli Mountains and of some of the smaller volcanic islands such as those lying to the South East of Manus, and also of the richer soils derived from coralline limestones as in the Trobriand Islands. The soil is deeply worked in preparation for planting, and the area around the base of the yam vine receives considerable attention during its growth, the soil being kept loose to facilitate the best development of the tubers. Sweet potatoes are the main crop of cooler upland areas, and in their cultivation the whole of the garden topsoil is usually broken up with digging implements and then scooped up into planting hills or mounds. Bananas become an important crop in areas with a pronounced dry season, such as the belt stretching along the coast of Papua to the east and west of Port Moresby. Cassava is salt-tolerant and sometimes becomes an important subsidiary crop in estuarine areas.

Duality in Relation to Annual and Perennial Crops.

In any approach to the study of native agriculture in Papua-New Guinea, it is considered important that due regard should be given to the duality in relation to annual and perennial crops, to which Conroy (¹) has drawn attention in his report on Manus Island in the Admiralties. A gradient can be traced paralleling ecological conditions from predominantly perennial cultures involving sago in the swamplands to predominantly annual sweet potato cultures of the highlands, but even in the latter case groves of edible-fruited Pandanus are common and considerable importance is attached to their inheritance.

More intensive research is needed to determine to what degree the native cultivator draws a distinction between annual and perennial crops, but it is significant that concepts of tenure differ. In the case of annual crops, tenure to areas of land for cultivation is of prime importance, while in the case of perennials, tenure and inheritance rights are established to individual trees and palms, and are paramount to the ownership of the land on which they are growing.

SECTION 2.
TABLE 1.—ECOLOGICAL DATA.

BUSAMA.	KALAPIT.	PATEP.	KORAVAGI.
TOPOGRAPHY— Mostly broken, consisting of a series of steep ridges and deep valleys roughly parallel to the coast and rising to about 1,000 feet inland. Ridges falling steeply to the sea with narrow coastal platform, except to the north along the Huon Gulf where the coastal flat extends some distance. This flat land is swampy in patches.	Mountain country running to the top of the range bordering the north side of the Markham Valley. Intermediate ridges and hills, and an area of valley floor.	Situated on a small ridged plateau about 4,000 feet above sea level, falling sharply into the Wampit River to the west and rising to a prominent range of mountains in the east, where in both cases the grades are very steep. On the plateau the grades are gentler and slopes are used considerably for gardening.	Wet delta, crisscrossed with many intersecting waterways, mostly tidal, some running alternately fresh and brackish. Considerable areas subject to regular tidal inundation, and other large areas of freshwater swamp. Patches of higher alluvial deposit relatively free from inundation occur throughout.
CLIMATE— Warm and humid. Rainfall between 150-200 inches. A short dry season about February-March. Coolest and wettest in June-July-August.	Generally warm and humid with dry hot weather from June to September. Average annual rainfall (9 years) 93 inches.	Generally cool and moist with cool nights throughout. Rainfall probably about 100 inches. Dry weather with hot days about February-March and weather definitely cold and wet June-July-August-September.	Warm and humid with a poorly marked dry season about October-December. Annual rainfall between 100-150 inches.
SOILS— (a) A shallow greyish-brown sandy soil with a red gravelly subsoil derived from granite rocks. Occupies the bulk of the ridge country. (b) A recent sandy alluvium in the flat country to the north. (c) Raised coralline sands of the narrow coastal platform with some admixture of colluvial material from the ridges.	(a) The valley floor has a shallow surface layer of chocolate coloured loamy soil overlying from about 4 inches to 2 feet of river gravels with blue to grey clayey alluvium beneath. It is of mixed colluvial and alluvial origin. (b) The lower ridges and hills have a jet black soil of varying depth, partly colluvial in origin, overlying limestone. Cracks badly on exposure and drying. (c) The higher mountain slopes have a deep brown friable loam, rich in organic matter developed in situ over limestone.	(a) Clayey soils tending to be impervious developed over granite rocks and metamorphosed sediments varying from bluish grey to orange-red in colour. (b) Fertile chocolate coloured clay loams associated with dioritic outcrops.	(a) The high banks of sediment above the general level of inundation are of a light yellow clayey alluvium. Where exposed in clearings, it cracks on drying. (b) Tidally inundated areas have a deep and viscous grey estuarine mud.

Table 1.—ECOLOGICAL DATA—continued.

BUSAMA.	KAIAPIT.	PATEP.	KORAVAGI.
VEGETATION— The primitive cover is a high rain forest with <i>Ordoles sumatrana</i>, <i>Pometia pinnata</i>, <i>Ficus</i> spp., <i>Pterocarpus indicus</i>, and <i>Terminalia</i> sp. prominent. <i>Viter</i> sp., <i>Alstonia</i> sp., and <i>Elaeocarpus</i> sp., also occur. <i>Albizia</i> sp. are prominent on the ridges and <i>Cudrataona</i> is also found there with some <i>Dipterocarpus</i> on the highest ridge-tops. Of the palms <i>Arenga</i> sp. and <i>Caryota</i> sp. are fairly common. The principal secondary forest types are <i>Trema</i> sp., <i>Kleinhornia hospita</i>, <i>Ordoles sumatrana</i>, <i>Albizia</i> sp. and <i>Calamus</i> sp.	<i>Pometia pinnata</i>, <i>Ficus</i> sp. and <i>Disorylon</i> sp. are prominent in the high forest cover; <i>Pterocarpus indicus</i>, <i>Alstonia</i> sp., <i>Albizia</i> sp., and <i>Arenga</i> sp. also occurring. Secondary forest is very dense and contains <i>Ordoles sumatrana</i>, <i>Kleinhornia hospita</i>, <i>Trema</i> sp., <i>Alsephila</i> sp., <i>Calamus</i> sp. and numerous <i>Euphorbiaceae</i>. Forested country mainly occurs on the mountain slopes showing soil type (c) described above. Passing through the lower ridges to the valley floor this runs out into a sparse savannah type vegetation with <i>Albizia procera</i> and <i>Nauclea orientalis</i> the tree species.	The primitive cover is forest in which <i>Quercus</i> sp., <i>Sarcocephalus</i> sp., <i>Podocarpus</i> sp., and <i>Ficus</i> sp. occur. <i>Macaranga</i> sp., <i>Trema</i> sp., and tree ferns (<i>Alsophila</i> sp.) are very common in secondary growth which is very dense.	Drier areas above water table level are covered with a very mixed high rain forest in which <i>Terminalia</i>, <i>Ordoles sumatrana</i>, <i>Alstonia</i> sp., <i>Pometia pinnata</i>, <i>Ecdia</i> sp., <i>Wormia querifolia</i>, <i>Ficus</i> sp., <i>Arenga</i> sp., <i>Pterocarpus indicus</i>, <i>Caryota</i> sp., and <i>Albizia</i> sp., all occur frequently. Inundated areas are of two types:— (a) Saline swamp forest in which mangroves (notably <i>Rhizophora mucronata</i>) and Nipa palm predominate; and (b) Fresh water swamp forest where <i>Pandanus</i> spp. abound. <i>Melaleuca</i> sp., <i>Blanchonia</i> sp. and <i>Nauclea</i> sp. also occur.

TABLE 2.—LISTS OF THE MORE IMPORTANT FOODSTUFFS OF VEGETABLE ORIGIN SHOWING MODES OF PRODUCTION.

Legend: C — From cultivations in forest or grassland clearings.

G — From groves of perennials.

N — By collection from naturally occurring species.

BUSAMA.			KALAPIT.			PATEP.			KORAVAGI.		
C.	G.	N.	C.	G.	N.	C.	G.	N.	C.	G.	N.
Taro (<i>Colocasia</i> anti- quorum).	...	...	Bananas (<i>Musa</i> <i>sapientis</i>).	...	(1) Major supply of starchy Foodstuff. ...	Sweet potato (<i>Ipomoea</i> <i>batatas</i>).	...	...	...	...	Sago (<i>Metrozylon</i> <i>rumphii</i>), <i>Bush dasheen</i> (<i>Xanthosoma</i> <i>sagitti-</i> <i>folium</i>).
Yams (<i>Dioscorea</i> spp.), Tapioca (<i>Manihot</i> <i>utilissima</i>), Sweet potato (<i>Ipomoea</i> <i>batatas</i>), Bananas (<i>Musa</i> <i>sapientis</i>).	Sago (<i>Metrozylon</i> <i>rumphii</i>).	...	Sweet potato Taro (<i>Colocasia</i> <i>antiquorum</i>), Tapioca, Yams.	...	(2) Accessory Starch Foodstuffs. ...	Taro (<i>Colocasia</i> anti- quorum and <i>Alo-</i> <i>casia</i> sp.), Yams, Tapioca, Bananas.	...	...	Taro (<i>Colocasia</i> anti- quorum), Tapioca, Sweet potato, Bananas.	...	

TABLE 3.—COMPARISON OF AGRICULTURAL METHODS OF THE FOUR COMMUNITIES.

BUSAMA.	KAIAPIT.	PATER.	KORAVAGI.
This community displays an energetic and well defined agricultural effort, with very little dependence on collected natural foods, which is rather surprising in view of its nearness to the coast. Explanations for this appear to lie partly in— (i) the very steeply rising nature of much of the land which the community owns, the coastal foothills rise sharply to ridges as high as 600 feet from a very narrow coastal platform on which the community is housed; and (ii) the mixed origins of the present-day population, the original community having been formed in part from migrants from completely agricultural communities in the hinterland. The phase of <i>cultivation in temporary clearings</i> is strongly developed, only forested land being used for this purpose. The principal crop produced thus is taro (<i>Colocasia antiquorum</i>) and cleared areas are only planted once to this crop. The clearings are made by cutting down the forest, allowing it to dry and then burning off. Without further treatment, taro shoots are planted in the mixed ashes and topsoil in cylindrical holes made with a digging stick, there is a minimum of disturbance of the topsoil. These taro gardens are interplanted to varying extent with other rapidly-maturing crops, such as maize (<i>Zea mays</i>), tapioca (<i>Manihot utilisima</i>), pit (<i>Saccharum robustum</i>), sugar cane (<i>Saccharum officinarum</i>), and spinach plants of several types. Some weeding is done during the growth of the taro crop, mostly during the first month. The taro takes about six months to mature, after which it is harvested and the progress of regeneration of natural species is not further hindered.	As with Busama, cultivated annuals and perennials play a major part in food production, the source of the staple foodstuff being the banana (<i>Musa sapientis</i>). <i>Cultivation in temporary clearings</i> is strongly developed, and contributes the bulk of the day-to-day food supply. However, in contrast to the uniform taro culture of Busama, there is some diversity in gardening methods, in the main crops used, and in the periods for which gardens are left in cultivation. The three principal types of gardening patterns are as follows:— (i) Garden clearings on the flat grasslands of the Markham Valley floor. The principal crop plant here is the banana, propagated by transplanting sword suckers. The pre-treatment of the land consists only in burning off the indigenous grasses, after which the suckers are planted in holes, and Albika (<i>Hibiscus abelmoschus</i>), pit (<i>Saccharum robustum</i>), sugar cane (<i>Saccharum officinarum</i>), beans and cucurbits are planted freely among them. Later smaller quantities of taro, yams, and sweet potato are planted, when the bananas are well established. Planting may commence at any time within several weeks of the original burning off. Regrowth of indigenous grasses and herbs is restrained by hand weeding. Both rapidly-maturing and more slowly maturing varieties of the banana are used. These gardens are distinguished by their relatively long period of use, the average life being five years, and some	The agriculture of this community is notable for the extreme development of the clearing type cultivation, a new feature being a marked technological advance in the use of both pipe and ditch systems of irrigation. <i>Cultivation in temporary clearings</i> shows a diversity of crop types and gardening methods as at Kaiapit, but grassland areas are not used for gardening to any extent. The principal crop is the sweet potato, and the method of gardening consists in clearing, burning and planting cuttings of the vine in the ash, with pollarding of the larger trees, as at Kaiapit. Gardens may be planted with sweet potato alone or with a wide range of crops in which sweet potato, taro (both <i>Colocasia</i> and <i>Alacasia</i>) and maize, tapioca, sugar cane, pit, tomatoes, beans, pumpkins and a number of annual-type spinach crops are all well represented. In the latter case, sweet potato is allowed to spread and completely cover the garden area after the harvesting of the other crops. Harvesting of sweet potato is piecemeal and continuous once a good coverage has been established, and the gardens continue in use for as long as three years from the original time of clearing. Irrigation appears to be particularly associated with taro production and two different methods are associated with two different types of gardens:— (i) Creeks are roughly dammed, the water diverted along ditches which follow the contours, and simple flood irrigation provided by breaking the wall of the ditch above the garden	In contrast with the other three communities, Korovagi is distinguished by the dominance of food collection over cultivation in its economy. Stands of sago palm are a feature of the local vegetation (vide note to Table 2), while food trees such as the breadfruit (<i>A. nobilis</i>) and <i>Gnetum gnemon</i> develop considerable stands whenever banks of river alluvium are thrown up above the general level of tidal and swamp water. Cultivation in the temporary clearings is greatly reduced, and is represented by small gardens carrying a type of taro which is tolerant of both inundation and salinity. These gardens are not more than from 10 to 20 yards square as a rule and are made by cutting down and burning the Nipa palm where it is established on river margins. The "soil" thus exposed is a viscous mud, and the growing crop often completely disappears at high tide. On the drier landward margin a few sticks of sugar cane, or a few banana palms may be found. Associated with the village site is a relatively large area which has been devoted principally to Cucurbits (a recent introduction of great popularity), sweet potato, and tapioca. The salt tolerance of the cucurbits and tapioca is marked, the latter being planted in recently cleared and burnt mangrove swamp. The only food perennial which is planted to any extent is the coconut palm but there are no extensive groves and the palms are given little attention. Betel nut palm is widely planted on banks of alluvial deposit.

TABLE 3.—COMPARISON OF AGRICULTURAL METHODS OF THE FOUR COMMUNITIES—continued.

BUSAMA.	KALAPIT.	PATEP.	KORAVAGI.
Plantings of bananas (<i>Musa sapientis</i>), pit (<i>Saccharum robustum</i>), and sugar cane (<i>Saccharum officinarum</i>) are usually so arranged as to give a light cropping during the early phase of secondary regrowth in the taro clearings. This type of cropping is usually finished about six months after the completion of the taro harvest, and the surviving plants (mostly banana palms) are swamped by regrowth species at the end of a further six months. The cultivation of perennial food trees and palms is also well developed. Extensive groves occupying a coastal strip which includes the village housing area, and stretches for several miles to either side of it. Predominant in these groves are the coconut palm (<i>Cocos nucifera</i>), and the breadfruit tree (<i>Artocarpus nobilis</i>). The trees comprising these groves are in the main self-sown in situ or transplanted self-sown seedlings. Protection from competition with naturally occurring species is afforded, a grass sward being maintained underneath the trees. The bulk of the coconut palms are well spaced, but apart from these the distribution of the groves is irregular. Groves of the sago palm (<i>Metrorhylon rumphii</i>) are distinct from those mentioned above and occur principally in an area of about 3,000 acres of swamp forest land at the northern end of the Busama territory. These are ill defined, occurring in small scattered stands of the palm which merge closely with the natural vegetation.	being kept in cultivation as long as seven years. During the whole period aged and weather-damaged banana palms are constantly being replaced and new plantings of the minor crops already mentioned are being made. (ii) Garden clearings made in the forested land on the higher hill slopes. The method of gardening used here is virtually identical with that used at Busama, with the exception that some of the larger trees are merely pollarded without being felled. After the initial clearing and burning, taro is planted freely among the ashes, and tapioca yams, pit, sugar cane and bananas are interplanted. After the taro harvest the garden yields bananas, yams, sugar cane and pit for about six months by which time weed and grass growth is dense, and small shrubs are beginning to take charge. Reproductive portions of pit and sugar cane, and banana suckers are transferred to other gardens, until the clearing vanishes with the advance of secondary forest. (iii) Garden clearings on the grasslands of the lower hill slopes. These are small gardens usually not more than ¼ acre in extent, and they are distinguished by a relatively intensive preparation of the ground. After the grasses are burnt off a layer of soil about 6 inches deep is completely inverted and broken up. This tillage begins at the bottom of the slope and the large clod is levered	site, and directing it via one or more furrows into the garden. Land is usually irrigated in this way before taro is planted as well as during the growth of crops. (ii) Water is piped off from a creek with bamboo piping and carried to the garden site in the same way, long lengths of bamboo being carefully joined to prevent leakages. These are relatively small gardens in the shape of a narrow rectangle running up and down the hill slope. These gardens are devoted solely to the cultivation of taro, and appear to provide a reserve of both food and planting material. Individual plants may be left in the ground for as long as two years. The cultivation of perennials is poorly developed, the only important crop of this type being the edible-fruited mountain Pandanus. This is propagated vegetatively by planting branches in wet soil, and small clumps are established usually on old garden areas, being found dotted throughout the secondary bush.	

TABLE 3.—COMPARISON OF AGRICULTURAL METHODS OF THE FOUR COMMUNITIES—continued.

BUSAMA.	KAIAPIT.	PATEP.	KORAVAGI.
	down the slope with a long pole, thus inverting it. Sometimes a fissure is made along a contour, and with many digging sticks a complete furrow is inverted by five or six men. This process is continued up the slope until the whole of the plot has been thus treated. With regard to crops planted and the period of use these gardens are similar to those described under (ii) above, with the exception that the drought resistant tapioca completely replaces the banana. Of the three types of cultivations described above, the banana gardens on the valley floor yield the great bulk of the food supply, the harvest from the taro gardens on the forested mountain sides is used mainly during the drier part of the year when production falls off badly in the grassland areas, whilst the yield from the small gardens on the grassy lower hills is of least relative importance. <i>The cultivation of economic perennials in permanent groves</i> is well developed, although less diversified and extensive than at Busama. Coconuts predominate and of minor perennial crops, the drug crop, betel palm (<i>Areca catechu</i>) is the most important. A few breadfruit, spinach trees (<i>Ficus</i> sp.) and papaws are also found. The coconuts and other perennials form a more or less continuous belt around the village varying in depth from 10 to 200 yards. They are also planted in the village area itself and in several small groves at some distance from the village.		

TABLE 4.—CONCERNING AREAS UNDER CULTIVATION, ETC., IN THREE COMMUNITIES.*

	BUSAMA.	KALAPIT.	PATEP.
(1) Total area of land owned by community...	32,000 acres (approximately) ...	2,520 acres ...	4,000 acres (approximately).
(2) Area of tillable land ...	18,000 acres (approximately). Sea frontage, inundated area, and high ridge tops comprise the bulk of the unsuitable land.	2,043 acres comprising— 937 acres of valley floor; 806 acres of grassed lower hill slopes; 300 acres of forested higher ridges. Unsuitable land consists mainly of areas destroyed by river action during floods.	3,000 acres (approximately). Of the total area of 4,000 acres, there are about 1,000 acres of barren hills, covered with rough grass, only small areas at the bases being cultivable. Of the remaining 3,000 acres about 500 acres are grassed but occasionally cultivated, while the remaining area is covered with secondary forest and contains the bulk of the gardens.
(3) Duration of bush or grass fallow ...	8-10 years as a rule but may be as long as 17 years.	2-6 years for forested country. From 3-10 years for banana gardens on flat depending on soil fertility.	6-10 years (usually 6-8 years) for forested country.
(4) Areas under cultivation (bush or grass fallowing rotation)	260 acres comprising— 180 acres fully planted; and 80 acres from which taro had been harvested leaving light residual crops of bananas, pit, and sugar cane.	65 acres comprising— 53 acres of banana gardens on the valley floor; 4 acres on lower grassy slopes (local information. This area increases sharply to about 20 acres in wet season); 8 acres on forested hill slopes (local information. This area has been decreased from about 20 acres in the recent past).	125 acres comprising— 58 acres under sweet potato alone; 44 acres of sweet potato and other mixed crops. 22 acres of taro. 1 acre of pit.

* It is to be noted that the figures for areas and yields given in this table were collected by sampling during the period which the party spent at each village (about a month), and cannot therefore be used for accurate assessment (*e.g.*, for such purposes as a direct comparison with the nutritionist's data presented in Part 4, Table 2).

TABLE 4.—CONCERNING AREAS UNDER CULTIVATION, ETC., IN THREE COMMUNITIES—*continued*.*

	BUSAMA.	KAIAPIT.	PATEP.
5) Numbers of perennial food trees ...	2,650 coconut palms, 300 breadfruit trees, 30 eugénias, 20 terminalias. Smaller numbers of others mentioned in Table 2.	1,600 coconut palms, 30 breadfruit trees. Small numbers of others mentioned in Table 2.	(The mountain pandanus is the only important species and it was not possible to obtain an accurate assessment owing to the nature of its distribution in small patches in the bush).
(6) Yields ...	Taro—2 tons/acre. (Local information described season as particularly poor. Usual figure is probably nearer 4 tons/acre.) Pit—180 lb./acre Sugar cane—400 lb./acre Bananas—600 lb./acre From light plantings harvested subsequent to taro harvest.	Bananas—12 tons/acre/annum (approx.). Taro—5-8 tons/acre (from gardens in forested count y).	Sweet potato—15-20 tons/acre/annum. Taro—Unirrigated, 5 tons/acre; irrigated, 15 tons/acre.
(7) Average area of cultivation per household	3.75 acres. (Allowance should be made for the fact that the 80 acres under the mixture of pit, bananas, and sugar cane are only in very light use.)	1 acre	5 acres.
() Average area of cultivation/head...	0.4 acres	0.2 acres	0.8 acres.

* See note page 84.

TABLE 5.—GENERAL ACCOUNT OF LAND USE METHODS AND EFFECTS ON LOCAL RESOURCES.
(Refer to Table 3 for cultivation methods.)

BUSAMA.	KALAPIT.	PATEP.	KORAVAGI.
(a) <i>Plants used for purposes other than Food.</i> <i>Drug Plants</i>.—The plants used in this category are all cultivated. Betel nut palm (<i>Areca catechu</i>) is grown to a considerable extent in the perennial tree groves. The betel pepper (<i>Piper betle</i>) is also found in the groves, being usually planted at the base of trees so that the vine curls up around the base of the tree. Tobacco (<i>Nicotiana glauca</i>) is grown to a limited extent only, being sown mainly in the annual type gardens. <i>Fibres</i>.—The inner bark of <i>Gnetum gnemon</i> and of <i>Hibiscus tiliaceus</i> provides the principal supply while additional sources are ferns, several members of the family <i>Melastomaceae</i>, and the "prop" roots of pandanus. The material is obtained from naturally occurring species. <i>Timber</i>.—Timber for household construction and firewood is obtained from naturally occurring suitable species. Some species used for special purposes such as canoe building are planted near the village with other perennials. (b) <i>Livestock</i>. Only about half a dozen pigs were held in the village at the time it was visited—an abnormal situation due to complete wiping out of the pigs during war time. Normally the number of pigs held is one or two per household, supplied from five specialised pig breeders who would own about 100 head altogether. Pigs are fed on food scraps and refuse. The village has about 250 fowls of very mixed type although there were a few specimens of introduced Australian breeds. Their diet is mainly obtained by scavenging in the village area.	(a) <i>Plants used for purposes other than Food.</i> The position is similar to that in Busama, betel nut, betel pepper and tobacco being cultivated and fibre and timber materials obtained largely from naturally occurring species. (b) <i>Livestock</i>. The pigs kept by the villagers originate from domesticated wild pigs, and number about 67. Apart from scraps obtained around the village, the pigs have special food regularly cooked for them, in which the principal item is the banana, sweet potato, pumpkin and green paw paw also being used. There are 87 fowls of mixed breed, which are also fed, mainly on ripe banana, and forage in the village area. Egg production is poor and eggs are kept for reproduction, rather than for use as food. (c) <i>Hunting</i>. The principal hunting method used is to burn over grass land, driving out the animals for spearing. Pigs, wallabies, bandicoots, small rodents, and reptiles are hunted in this way. Trapping, netting, and hunting with dogs are also used in the case of pigs.	(a) <i>Plants used for purposes other than Food.</i> The position is much the same as at Busama and Kalapit, with the exception that very little betel nut is grown locally. (b) <i>Livestock</i>. Some care is given to the raising of pigs and they represent an important export trade from the village. They are provided with special houses in which fires are built on cold nights. Sweet potato and scraps from other foods are cooked and given to the pigs. Of 107 pigs in the village when it was visited, 79 were to be kept and 28 traded away. Eight had recently been exported. Fowls are kept under similar conditions to those mentioned at Busama and Kalapit. They do not figure as an important source of food. (c) <i>Hunting</i>. Pigs and bandicoots are hunted by the grass fire method, burning being a regular procedure throughout the year. The Kapul (<i>Phalanger maculatus</i>) is hunted in forest areas, a variety of snares and traps being used.	Koravagi differs radically in its land use pattern from the three agricultural villages. Land use is centred around the relatively static sago palm with its long growing period while the bulk of the remaining vegetable food is obtained from the swamp forests without permanent damage to the trees. Neither pig nor fowl keeping is practised to any extent, about 20 pigs being noted in two small enclosures and a very few fowls wandering in the village. The only burning practised is that used in making the small riverside gardens and re-establishment of vegetation proceeds satisfactorily on these areas.

TABLE 5.—GENERAL ACCOUNT OF LAND USE METHODS AND EFFECTS ON LOCAL RESOURCES—continued.
(Refer to Table 3 for cultivation methods.)

BUSAMA.	KAIAPIT.	PATEP.	KORAVAGI.
(c) <i>Hunting.</i> The wild pig is the main animal hunted, both for food and for domestication after capture. The principal methods used are cage and pit traps, and netting. Burning of forest or grass is <i>not</i> practised in association with hunting. (d) <i>Reaction of Soil and Vegetation.</i> In this area there is no sign of any permanent alteration in the natural tendency for land after being cleared to progress back through various stages toward climax forest. After weeding ceases, there is a rapid development of grass cover, in which <i>Imperata arundinacea</i>, <i>Paspalum conjugatum</i>, <i>Chloris</i> sp., and <i>Sporobolus</i> sp. are common. These are rapidly followed by tree ferns, and soft wooded tree species such as <i>Kleinhovia hospita</i>, <i>Ocoteles sumatrana</i>, <i>Disorylon</i> sp. and <i>Ficus</i> sp., with subsequent steady progress towards the mixed coastal rain forest type. Serious flooding of agricultural land does not occur and seasonal droughts are practically unknown, the inhabitants being able to recall only two during the last twenty years.	(d) <i>Reaction of Soil and Vegetation.</i> There are marked signs of interference with the process of forest regeneration, and there is every indication that the principal factor operating is the method of hunting, which involves burning of grassland. <i>Albizia procera</i> and <i>Naudia orientalis</i> appear to be the only tree species which can withstand periodic burning, and these form a very open savannah. The margin of the forested land on hillsides is steadily retreating and it would not be difficult to imagine a shortage of such basic commodities as firewood. The fertility of the alluvials on the valley floor (where most of the bananas are grown) does not seem to be greatly affected but there is a marked depreciation, with signs of erosion on the hillsides. In addition the general use of burning by other communities higher up the valleys of the Markham River tributaries is having an effect which is being felt at Kaiapit. Denudation of forests on hillside catchment areas is causing regular and excessive flooding after rainfall, and valuable land is being thus destroyed. The Maniang River which flows into the Markham near Kaiapit, has recently carried away about 150 acres of arable land belonging to that community, while some other nearby villages have suffered to a greater extent.	(d) <i>Reaction of Soil and Vegetation.</i> As at Kaiapit, there has been considerable depreciation of land on hillsides kept under grass but the position appears to be more stable, the extension of grassland having ceased. The natives of Patep have recognised the danger to their economy and have deliberately adjusted their hunting and cultivation to ensure that the remaining forest land being used for gardening gets a 6-8 year rest period after each usage. This is most interesting when it is remembered that they have no fertile alluvial flats to fall back on, as the Kaiapits have. Droughts and floods are unknown, and both these factors probably assist them in their attempt to maintain the fertility of their local soils.	

Section 3.

COMMENTARY.

Only one agriculturist was present with the Nutrition Survey Party at each of the villages listed in Section 2 and the time available was unfortunately not sufficient to make detailed studies of some factors, such as soil conditions, which would have been of value. However, the information which has been presented enables us to make a number of differentiations which should afford interesting comparison with the nutritional, medical and dental findings. The information presented in Sections 1 and 2 should be considered in relation to the comparative data presented in the nutritionist's report in particular.

The villages visited by the party provide an excellent range of environmental samples from delta swampland of an inundated and semi-inundated nature at Koravagi, through lowland littoral rain forest as at Busama, and valley alluvials at Kaiapit, to true upland conditions at Patep. Kavataria is somewhat exceptional in being located on a low-lying coralline island, but approximates to the conditions at Busama. There is an appropriate variation in agricultural methods. At Koravagi, food winning centres mainly around the perennial crop, sago, which requires a minimum of attention, and is actually available in wild strands, and the production of annual-type crops is restricted to a few small gardens on higher areas of alluvial deposit. At Busama, a typical taro culture is found with cultivated perennials (*e.g.*, *Artocarpus*, *Eugenia*) occupying an important position. At Kaiapit, cultivation is becoming more and more intensive, with the cultivation period for staple foodstuffs lengthening (*e.g.*, the long period of use of banana gardens) but perennials are still of some importance. Lastly, at Patep, perennials have practically no importance, while the cultivation of the annuals is most intensive, there is a wide variety of interplanted annuals, and interplanting is done to a much greater extent, some annual crop garden areas are kept in use for as long as three years, and there are signs of technological development in the form of irrigation systems.

Kaiapit and Patep afford useful examples of inland agricultural type villages. In both cases the period of the forest rotation is relatively short, there is considerable evidence of degrading of forest country to grassland, some gardens in which staple foods are produced are left in cultivation for several years, and some gardens are made on grassland before any forest regeneration has taken place, and yet there is scope for a sharp comparative differentiation, in that Kaiapit has elements of lowland conditions, while Patep is located in a typically cool, moist upland area.

In Busama, Kavataria and Koravagi, satisfactory forest regeneration takes place in areas which have been cleared for cultivation.

Efficiency and Output.

Of primary importance from the point of view of both the nutritionist and the agricultural economist, is the efficiency of these native agricultural methods. The output can be measured by measuring the gross yields of the various foodstuffs concerned and assessing them in terms of their nutrient

values. The values obtained can then be balanced against the energy expenditure involved in production. A number of important variables must, however, be taken into account in making such an assessment. These are discussed below:—

- (a) *Soil Fertility*.—The effect of the bush fallowing rotation system is to even out fertility variations since the basis of the method is to use land which has been under at least a good growth of secondary forest for some years. However, under the heavy rainfall conditions obtaining generally in Papua-New Guinea it can be expected that there will be a detectable downward fertility gradient from the time of clearing and cultivation and that the slope of the gradient will vary with such factors as degree of slope of agricultural and physical composition of the soil. This effect should be particularly marked in areas such as Kaiapit and Patep where cultivation is intensive, burning takes place, and garden areas are liable to be in cultivation for several years.
- (b) *Climatic Variations*.—Variations in average temperatures, correlated mainly with changes in altitude, have an important bearing, particularly in their effect on the growth period of cultivated plants. Seasonal variations in rainfall, which are of common occurrence, are also of importance in their effect on yields and in restricting the time available for growing particular crops.
- (c) *Variations in Yield of Crops Due to Strain Variations*.—Native agriculturalists do recognise the fact that strain differences occur, and particularly in their staples, efforts are made at selection. However, it is possible in travelling about the Territory to discern wide strain variations in the crops grown by different communities and there can be little doubt that significant variations in yield, which would have an effect on productive efficiency, occur for this reason.

Only the most approximate estimates of comparative efficiency could be obtained from the data collected by the present survey, since accurate measurements of energy expenditure were not made, and the time spent in each village was inadequate for statistically significant observations to be made concerning soil fertility variations, or the effect of seasonal variations. Observations lasting over a full year would be needed to obtain satisfactory data concerning these variables.

It could be expected that local conditions would depress efficiency to the greatest extent in an upland area such as Patep, where average temperatures are relatively low, prolonging the growth period of crops, and the cool moist climate would make for leached conditions in topsoils.

From the figures for areas of land in cultivation per head and per household presented in Section 2, Table 4, it would appear that Kaiapit derives considerable benefit from ownership of the fertile valley alluvials on very gently sloping land of the Markham Valley floor.

Possibilities of Improvement of Native Agriculture.

The nutritionist is naturally interested in the possibilities for variation of native agricultural methods, particularly such variations as might include the introduction of new crops of a particular nutritional value, or the expansion of native livestock production with a subsequent increase in the amount of meat foods and related livestock products.

Some experience in this field is already available from the attempts of previous Australian administrations, principally in the field of introducing cash crops into the native economy. All this experience indicates that the native system exhibits considerable rigidity towards change, as might be expected, having in view the factors discussed in Section I of this report.

Briefly the introduction of several annual crops which could be easily adopted into the bush fallowing rotation (notably rice in the Mekeo District and peanuts in the Gazelle Pa. area) has been moderately successful, while attempts to induce native growers to cultivate perennials in European type plantation blocks (as in the coffee project at Sangara) have met with considerable difficulty. Economic inducement to produce new crops would also appear to be an important factor—in the vicinity of most of the larger towns native production of vegetables for cash sale in the town markets occurs. It is to be remembered, however, that in the latter case there has been long-term association with Europeans with a consequent breakdown of native culture and that the native producers involved are to some extent dependent on imported processed foodstuffs.

Much criticism has been levelled at native agricultural practice in Papua-New Guinea in that it is wasteful of land and that it only supports a low population density. It is to be remembered, however, that the methods used function very often in the face of unusual environmental hazards—ragged mountainous country predominates in the New Guinea landscape and rainfalls are high; they are to be given credit for even partial success. Army engineers roadbuilding in the Territory during the recent war very often found that large sections of mountainside had fallen down on top of their roads. Under these conditions, food production of any sort can be regarded as an accomplishment.

Improvements in the technology of native agriculture aimed at increasing its efficiency, and permitting of the production of greater quantities of nutritionally and economically desirable crops and fodder crops for livestock, are undoubtedly desirable, but for the reasons indicated above any approach to such a development must be made with extreme care, and its effect over the whole population of the Territory can be expected to be gradual. In the meantime the efficiency of existing methods deserves attention, to determine whether there is any reserve of labour potential for the production of either nutritionally or economically desirable new crops under the influence of suitable stimuli. That such a reserve does exist in some cases is indicated by the experience at Mekeo in Southern Papua, where the local population each year now includes several hundred acres of rice in its bush gardens, and at the same time contributes a relatively high proportion of the younger men for labour in other parts of the Territory.

It is necessary, of course, to emphasise that investigations of this sort and any resulting planned developments cannot proceed satisfactorily unless basic survey data in the political, economic and cultural fields (*e.g.*, census data, soil survey, biological and climatological surveys) are available. Complete information of this sort is not at present available for the Territory, or for any of its major physiographic regions.

Section 4.

RECOMMENDATIONS.

It is recommended that the most desirable work which could be undertaken as a sequel to this preliminary survey would be an investigation of the efficiency of native agricultural practice over a similarly comprehensive ecological range, the output of various food crops to be evaluated in terms of their nutrient values and balanced against the appropriate energy expenditures. Subsidiary investigations should be made into soil fertility variations after exposure for cultivation under varying physical conditions, the effects of seasonal variations during a full year, and the significance of varietal differences in the major food crops. Such investigation can only be profitably undertaken inside the framework of more widespread survey activity, aimed at obtaining the basic data in the economic, political, and cultural fields which should be to hand before any changes likely to influence any of these aspects of native life are initiated.

The introduction of new and nutritionally desirable crops such as peanuts into native agriculture, the expansion of native livestock production as a source of protective animal foodstuffs (and the progressive improvement of native agricultural technology), is the responsibility of the Department of Agriculture, Stock and Fisheries of the Territory, which is developing appropriate research and extension programmes.

There is little doubt that the information to be obtained from the type of research programme recommended above would be extremely valuable to that Department in planning and implementing such developments.

PART 4.

FOOD CONSUMPTION AND DIETARY LEVELS.

by

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Section 1 : Introduction.

Section 2 : Summary.

Section 3 : Technique of Collecting Quantitative Data.

- (a) Selection of households.
- (b) The weighing techniques.

Section 4 : Description of the Domestic Characteristics of People of the Five Areas Surveyed.

- (a) Economy.
- (b) Degree of co-operation with survey unit.
- (c) Activities of family group in meal preparations.
- (d) Meal times.
- (e) Community meals.
- (f) Boys' house.
- (g) Visitors.

Section 5 : The Food Pattern of the Five Villages.

- (a) Cooking equipment.
- (b) Cooking methods.
- (c) Foods available.
- (d) Eating habits, including food tabus.
- (e) Infant feeding.
- (f) Feasts (including practice of chewing betel nut).

Section 6 : Food Consumption—Quantitative Data.

- (a) The mean daily per capita intake of foodstuffs.
- (b) Requirements of nutrients for natives in the five areas.
- (c) Nutritive value of diets consumed by each household surveyed.
- (d) Comparison of intake of nutrients by each household expressed as a percentage of the requirements of that household.
- (e) Discussion.

Tables 1-13.

Section 1.

INTRODUCTION.

Hitherto data on Papua and New Guinea has been collected by the anthropologist, the economist, and the medical and the administrative authorities. These data frequently refer to the general food pattern of the native peoples, but little quantitative data is available. Clements ⁽¹⁾ and Hogbin ⁽²⁾ have recorded actual weights and estimates respectively of the main foodstuffs eaten by the natives in areas visited. In both cases the subsidiary foodstuffs are included.

This report presents both the qualitative and quantitative study of the food pattern in the native villages visited. Within certain limitations, it has been possible to assess the diet of these natives expressed in definite amounts of calories, protein, calcium, thiamin and ascorbic acid.

The advantages of recording such quantitative data are threefold:—

(a) *Study of Nutritional Status.*

For the full interpretation of the medical and biochemical findings it is necessary to know as accurately as possible the nutrient intake of the group studied.

(b) *Future Policy.*

A comparison of the intake and requirement figures would indicate where any nutrients fell short of the suggested requirements. A consideration of foodstuffs providing these nutrients would act as a guide to future agricultural and educational planning in these areas and similar economies.

(c) *Planning of Native Dietaries.*

Actual figures of foods consumed by village natives will be useful for those who desire to plan a diet of native grown food for urbanised natives.

Section 2.

SUMMARY.

(1) Data were collected on the food consumption and dietary patterns of a number of native households in five villages in New Guinea. The villages were selected to each represent a particular economy.

(2) An attempt was made to ascertain the quantities of all foodstuffs eaten by the members of the households investigated.

(3) During the collection of this data a great deal of related information on such aspects of family life as the activities of the family group in meal preparation, community meals, feasts, food tabus, etc., was collected.

(4) Information on the food pattern of the five villages was also obtained.

(5) The quantities of food consumed by members of each household investigated on the day of investigation showed that the staples in each village contribute a very high percentage of the total food both in weight of foodstuff and calories.

(6) Supplementary foodstuffs such as green leaves, berries and fruits contribute a not insignificant quantity of food and make very valuable contributions to the intake of nutrients particularly minerals and vitamins.

(7) (i) Calories. The per capita intake of calories seems to be in the vicinity of 1,600 per day. That is about 80 per cent. of the computed per capita calorie requirements.

(ii) Protein. The protein intake of all villages was low, and very low in villages where there was no regular supply of animal foodstuffs. The figure suggests that the protein intake is below the desirable level and it is probable that this deficiency is most marked in children.

(iii) Calcium. Although the calcium intake was found to be below the computed requirements, it may be within the physiological requirements of the natives. Attention is drawn to the fact that a considerable amount of work yet requires to be done on the calcium requirements of New Guinea natives.

(iv) Thiamin and ascorbic acid. The intakes of thiamin and ascorbic acid were well above the computed requirements.

Section 3.

TECHNIQUE OF COLLECTING QUANTITATIVE DATA.

(a) *Selection of Households.*

To integrate this enquiry with the work of other members of the party it was necessary to study the dietary pattern of between 120 and 150 persons in each village. The number of households investigated varied with the number of people per household. In only one instance was it practicable to survey the whole village. No standard method for the selection of households was used as each village presented its own problem. However, the group surveyed in each village was representative of the whole village population. In those villages where the whole population was not studied, the composition of the sample investigated was compared with the village census to ensure that it was a representative sample. Factors influencing selection of households in each village were as follows:—

(i) *Busama*. Twenty-one households (28 per cent. of the total village) were surveyed. Two visits were made to nineteen of these households. The data covered the food intake of 340 people. Households which were in the process of food preparation when the village was visited were selected. The village was divided into two sections and the same number of households were surveyed from each section. The population surveyed was checked against village census to ensure true sample. Households were large and where possible two visits were made.

(ii) *Kaiapit*. Twenty-eight households were surveyed (40 per cent. of total village). Two visits were made to five of these households. The food intake of 137 people was obtained. All houses in the village were numbered and from a rough map of the village, groups of houses in different parts of the village were selected. Groups of two or three households built close together were chosen so that several could be studied at the one time.

(iii) *Patep*.—Twenty-four households were surveyed (100 per cent. of population). Two visits were made to five of these households. The food intake of 211 people was obtained.

(iv) *Kavatara*.—Twenty-eight households were surveyed (45 per cent. of population). Two visits were made to one household. The food intake of 124 people was obtained. The method of selection was the same as for Kaiapit. It should be noted that houses 1 to 14 were in one section of the village. These selections had been made prior to commencement of work by the nutritionist, but it is believed that the validity of the whole sample is unaffected. The only differences between sections of the village was one of clan rather than habits.

(v) *Koravagi*.—It was not possible to collect quantitative data at Koravagi. These people were food collectors rather than gardeners, and for this purpose they made frequent trips away from the village. Moreover, it was impossible to collect quantitative data from the natives who remained in the village for the normal activity was always interrupted by the arrival of a member of the survey party. If cooking was already in progress, a large crowd would gather and all would share in the distribution of food. On other occasions they would begin to cook in order to please the visiting party.

Here, too, the whole problem was complicated, because satisfactory arrangements could not be made for an interpreter. The fact that the village was built on small islands necessitated canoe transport and this was often difficult to secure just when it was required.

(b) *Weighing Technique.*

The object was to weigh all food eaten by a household during a twenty-four hour period.

Before any quantitative work could be attempted it was necessary—

- (i) to have the co-operation of the village, particularly the "housewives";
- (ii) to be familiar with the native foodstuffs; and
- (iii) to have some knowledge of cooking methods, eating times, and general village life.

Towards this end the first week in a village was spent in gaining the confidence of the inhabitants, particularly the women, and in collecting qualitative data. If possible a longer period should be devoted to this preliminary stage.

Households selected were visited at the time of meal preparation. Scales used were of the single pan variety with a clock face showing weights to twenty pounds in ounces. The following household records were made:—

- (i) The harvested weight of foodstuffs used;
- (ii) the weight of prepared food;
- (iii) the weight of waste material;
- (iv) the sex and age of people consuming the food;
- (v) the weighed distribution of cooked foods (not possible in all cases).

It was essential to sight the final distribution of cooked foods in order to record any foods received or given as gifts.

Foodstuffs eaten at times other than the main meal were estimated by questioning. This was not particularly accurate, for two reasons:—

- (i) Many such snacks were not considered an important part of the diet by the natives, and therefore they tended to overlook them when questioned.
- (ii) It was impossible to estimate amount of some foods eaten as snacks, *e.g.*, coconut.

In the final assessment of the diets, these factors will be considered.

Section 4.

DESCRIPTION OF THE DOMESTIC CHARACTERISTICS OF THE PEOPLE IN THE FIVE AREAS SURVEYED.

(a) *Economy.*

The villages were originally chosen as representative of stable economies using the five main vegetable food staples common to New Guinea and Papua, *i.e.*, taro, banana, sweet potato, yam and sago economies. It was hoped that each village would have one principal staple, but in some instances two staples were eaten in practically equal amounts, and in all cases four out of five of the staples were eaten in varying proportions.

The expected and the actual position in each village was as follows:—

<i>Village.</i>	<i>Expected Staple.</i>	<i>Actual Staple.</i>
(i) Busama	Taro	Taro. Sago replaced or supplemented the staple on ten occasions.
(ii) Kaiapit	Banana	Banana (green and ripe) —55%. Sweet potato —45%.
(iii) Patep	Sweet Potato	Sweet potato—47%. Taro kong kong—53%.
(iv) Kavataria	Yams	Yams supplemented by sweet potato and taro plus fish and sea foods.
(v) Koravagi	Sago	Sago.

(b) *Degree of Co-operation with Survey Unit.*

The native peoples of Papua-New Guinea possess an innate courtesy and in all villages surveyed the inhabitants were most helpful.* The attitude towards the survey party was influenced by the particular temperament of each group and conditions existing in each village. In some instances, it was difficult to create an understanding of the function of the survey unit, and that one's object was to study their normal, every day eating habits. A brief comment on each village and their attitude follows.

* Language was a major difficulty. In general, native women speak the local dialect only. Most men in New Guinea spoke "pidgin English" and in Papua "police motu." The investigator required a working knowledge of these languages in order to get even indirect contact with women.

(i) *Busama*. These people frequently remarked that their gardens had not returned to pre-war production, and a food shortage did exist. Families who were still building new gardens were often short of food and were assisted by other slightly more prosperous households. Where there was a shortage the people were not anxious to have the food weighed, and appeared to feel ashamed. Both men and women worked hard, and there was not the carefree and leisurely atmosphere found in some of the other villages.

(ii) *Kaiapit*. These people were a direct contrast to the Busamas. Food was abundant and fairly accessible, and the people themselves were a happy group who enjoyed good living and good company. The arrival of the survey party did not affect their way of life, and in the village a welcome was always extended and an invitation to join their meals. They would willingly give assistance when asked, but were quite indifferent to the objects of the food consumption survey and never volunteered any information.

(iii) *Patep*. Here there was a distinct difference between the attitude of the women and the men and boys. The men and boys were most helpful, cheerfully acted as interpreters to contact the women and volunteered much information. The women, with one or two exceptions, adopted an attitude of sullen indifference. Perhaps the fact that the women had to work hard all day in the gardens whilst the men had an interesting and easier life in the village influenced their attitude.

(iv) *Kavataria*. The men and more particularly the women took an active and intelligent interest in the work of the survey party. The assistance of a mission-trained interpreter with a fair knowledge of English was invaluable in establishing friendly relations with the women. These people were intensely interested in food and food preparation; yams play a vital part in their culture.

(v) *Koravagi*. The women here were eager to be most friendly, but had no appreciation of the data required by the survey party. Apparently they had had little contact with white women before, and a stay of several months would be necessary before they would accept one without altering their normal routine.

(c) *Activities of Family Group in Meal Preparation.*

In every village the women did the major part of food preparation and cooking.

The general pattern of activity was the same in all villages. The food preparation was carried out on the verandahs of the houses or, where there were no verandahs as at Kaiapit and some Koravagi houses, on the ground outside the house. The cooking was done outside the house for preference, but when the weather was unsuitable, food was cooked inside as at Patep (and occasionally at all other villages) or sheltered by the eaves of the houses as at Kaiapit.

Whilst the type of activity was always similar—peeling the tubers, preparing leaves or grating coconut, the social atmosphere was varied in the villages according to the temperament of the people.

(i) *Busama and Patep*. Women brought food to their houses using netted bags (P.E.* bilum) slung across the front part of the head and allowed to hang down the back. Loads of food and firewood thus carried may weigh seventy pounds or more, and several infants may be carried as well. At Busama two or three women prepared the food together, either in silence or talking quietly. They were very tidy in their work, the peel being collected in a "bilum." Whilst the food was cooking the women sat quietly talking. The Busama housewives did some household task such as mending or making "bilums." The women of Patep usually prepared the food by themselves and did nothing whilst it was cooking. Men took no interest in food preparation, cooking or distribution of the cooked food.

The young girls were ordered to fetch and carry wood and water, make the fire, etc., but did not assist in the actual preparation of food.

(ii) *Kaiapit*. Food was brought to houses as in Busama, except that such large loads did not appear usual. The infants were carried in tapir cloth slings and not in bilums. Food preparation was a noisy and untidy performance, in distinct contrast to Busama and Patep. The women either sat outside in small groups or shouted gossip across from one woman to another. Dogs and pigs and crawling children freely mingled with the foodstuffs. Scraps were thrown at the animals rather than being tidily collected. Whilst cooking was in progress the women continued their gossip or visited neighbours.

If the men were present they assisted by grating coconuts. Theirs was also the privilege of organising the distribution of cooked food. The young girls were loudly bullied to do similar jobs to the Busama girls.

(iii) *Kavataria*. The staple was stored in yam houses (see Plate 34), in the village so that only additional foods had to be brought from the gardens. The women carried the food in baskets balanced on their heads, and men brought in supplies of coconuts.

Food preparation was a social time, but not noisy and untidy like Kaiapit. At all times the harvested and prepared foods were grouped in attractive arrangements—these people appeared to have a highly developed artistic sense. Scraps were neatly and efficiently disposed of. During cooking time the women usually chatted either together or with their men, at the same time busily making new grass skirts or plaited mats for their houses.

The men when present took an active interest in food preparation, and frequently scraped the coconuts. In one particular dish (Mona) part of the cooking was the special prerogative of the men. The children did not assist.

(iv) *Koravagi*. Sago was stored in the houses, and other foods needed were brought by canoe by both men and women to the village so that individual carrying by women was not necessary.

The men were not interested in food preparation though occasionally they assisted in coconut shredding.

The young girls did small tasks as in other villages, and very young children would help in preparing breadfruit, etc., in the nature of a game.

* P.E. = Pidgin English.

It was impossible to assess the normal social activity, as during the visit of the survey party groups of women were always present. They appeared tidy in their methods and during the cooking time would sit and talk and chew betel nut.

(d) *Meal Times.*

The general practice was to eat one main meal at the end of the day's gardening activities. This would take place sometime between 3 p.m. and 7 p.m. In place of the conventional European breakfast natives eat some cold food left from the previous evening's meal, or at Kavataria a few yams were left to cook overnight in the native oven. At Patep where the climate was much colder than at other villages a meal similar to the evening meal was cooked between 6 p.m. and 7 p.m. Meal times at Kaiapit however, followed no rule, as preparing, cooking and eating of food would continue throughout the day. At Kavataria, a fishing village, a meal would be cooked and waiting for the fishermen on their return at any time from noon to 3 p.m. Again it is difficult to assess the normal habits of the people of Koravagi. It is thought that a breakfast of baked sago stocks was fairly universal. Some people cooked a meal at midday and others in the evening, but whether it was customary to eat two main meals is not known. It would probably be governed by the day's activities.

Snacks of cold cooked food, edible raw fruits, vegetables and nuts, or easily cooked foods, were eaten during the day by all natives, especially the children.

(e) *Community Meals.*

As has already been noted in the introduction, community cooking and eating can be a regular feature of the life of some villages, and in two of the villages visited, Kaiapit and Kavataria, this was so. In the former small or large feasts, sometimes for no apparent reason were popular. At Kavataria feasts were confined to definite occasions, but it was common for one housewife to stay home and cook for a group who would be away for the day—the men fishing and women gardening. Where a group of men were helping another man in his garden, or making a canoe, they would be fed by the wife of the owner. This communal working was extremely practicable and typical of the community spirit in the villages.

(f) *Boys' House.*

Although boys' houses were once a fairly general institution in native villages, only one was sighted at Patep. This is an example of the whole village entering into the food organisation of one establishment. Although the inhabitants of the boys' house received food at the houses of their relatives, every house in the village considered it a privilege to contribute some extra food to the boys' house. This was shared by the older boys, the young ones being pushed aside. The boys of the 14-20 age group were noticeably fatter than similar age groups in other villages visited.

(g) *Visitors.*

The general attitude of the natives towards visitors is one of friendliness and a willingness to share whatever food is available, even if it means the family having less. In Kaiapit the arrival of visitors was the time for a feast and a display of good food. A feast also took place at Patep during a visit of their kinsmen, and although during that time other visitors who were not popular arrived, they too, shared in the spoils. During the period at Busama and Kavataria outside visitors were not frequent although several kinsmen visited relatives.

Section 5.

THE FOOD PATTERN OF THE FIVE VILLAGES.

(a) *Cooking Equipment.*

(i) "*Kitchen.*" The cooking equipment and kitchen of a native housewife are reduced to absolute essentials. The exact location of her "kitchen" will depend on the weather and on the particular activity of the housewife. Her "kitchen" is sometimes a cover of her one-roomed house, sometimes the verandah, and sometimes immediately outside the house. Storage of utensils and food, food preparation, cooking and eating take place at these three places. To the native housewife washing the dishes is no problem. When dishes are used the sun dries the already clean plates. Once a week all pots and plates are taken to a nearby stream and thoroughly cleaned. Garbage is also no problem; it can either be burnt, thrown in the sea, or fed to the pigs or eaten by the scavenging dogs and fowls.

(ii) *Cooking Pots.* Patep was the only village where European cooking pots or four-gallon kerosene tins were preferred to native-made clay pots. The reason given for the preference being that clay pots were scarce as they were purchased from other villages over a long and rather difficult mountain track. A second possible reason was the preference the Patep natives showed for any European goods.

At the four other villages European pots and tins were occasionally used. The native clay pots had in all cases to be obtained from other villages, the staple foodstuffs being used as payment.

(iii) *Other cooking equipment.* Busama and Patep housewives had enamel basins, tin or enamel plates, drinking vessels, forks, etc., much of the equipment being recognisable as ex-army stores. The other three villages used native-made utensils and had few European goods. Every housewife possessed at least one sharp European cutting knife for peeling vegetables. All households used sharpened skewers of wood or palm ribs as forks. In the four villages where coconuts were used coconut scrapers were standard equipment. At Kaiapit they were made from hard coconut shell and at the other three from bivalve shells, in both cases serrations being made on the scraping edge. In addition, all villages possessed a few scrapers made from slightly serrated metal about 1½ inch wide mounted on a wooden base.

The native has developed a wide range of useful domestic utensils from the products of the garden and forest. Carved wooden platters were used at Busama and in the Trobriands, whilst peelers and skewers made from animal bones or wood were in common use in other areas. Water carriers and containers were made by scraping out dried gourds or melons or coconuts.

(b) *Cooking Methods.*

(i) *General criticism.* Cooking methods in the villages surveyed were good when judged by modern conservative cooking standards. However, the standard for the five villages was not uniform. At Busama and Patep the staple and the green leafy vegetables were generally cooked separately. Apart from the fact that cooking time was too long by our standards reducing the green leaf to a mush, the method for cooking greens was satisfactory.

At Kaiapit the leaf lids were not so perfectly sealed as at the other villages, and in addition part of the cooking water was discarded.

At Kavataria much less water and hotter fires were used, cooking time reduced and cooking water consumed as soup.

Koravagi is not comparable with the other villages as the bulk of food was soup. All cooking water was therefore used, but cooking was done without a lid. For further details see Tables I-V and Appendix—Recipes.

(ii) *Wastage*. There was no wastage of any cooked food. Although the vegetables were peeled thickly, the peel itself was usually used as pig food. Taro, yams, sweet potatoes were all peeled, except at Kavataria where the sweet potatoes were scraped and washed. Food for baking was left in the skin.

Edible portions of taro, sweet potatoes and yams were about 70-75 per cent. of their harvested weights. Taro kong kong was about 65 per cent. of harvested weight. In the case of green leaves the loss was a minimum as the coarse veins and stems only were removed.

(iii) *Use of Salt*. The salt problem did not arise in the two coastal villages of Busama and Kavataria where all food was cooked in a mixture of salt and fresh water. Similarly at Koravagi the river and well water had a slightly salty taste. However, at the mountain village Patep and the valley village of Kaiapit, salt had to be made from native grasses and leaves. At Patep this was a particularly complicated and difficult task, therefore native-made salt was scarce. European salt could be purchased at the trade store some ten miles away. Where a household had salt it was added to the greens, if plenty, some was also added to the taro or sweet potato. If there was any choice the natives preferred their own salt for greens and meat, and European salt for sweet potato and taro. When salt was added to the cooking water of these vegetables the water was generally drunk as soup.

At Kaiapit salt making was a simple process as the crude ash resulting from burning certain leaves was used. This ash was placed in a half-coconut shell and water allowed to drip through the shell into the cooking pot. This "salt solution" was extremely weak but was preferred to European salt for cooking pig meat.

(c) *Foods Available.*

(i) *Native foods*. (See Tables I-V.) Tables I-V are summaries of the foods available at each village, with a brief description of the cooked food and the method of cooking. It should be noted that only foodstuffs used by the households at the time of the survey are recorded. Reference to the agricultural report will indicate any additional foods and any effect of seasons on the food pattern. Detailed descriptions of foodstuffs common to several villages are given for one village only.

(ii) *Purchased European Food*. Busama was the only village visited where the natives were anxious to purchase European foods at the stores in Lae (20 miles by canoe). Fresh bread, rice, flour, sugar, and as a luxury tinned meat, were the chief items purchased. It was impossible to assess exactly what contribution they made to the diet. The goods were not displayed and it was only occasionally that children were sighted eating the foods. However, in view of the accessibility of well stocked stores in

Lae, the problem will increase with time. Education as to the best purchases seems an answer to the problem, remembering as well as food value, the difference in texture between the firm taro, corn, sugar cane, etc., and the softer European foods.

(iii) *Trade of Foodstuffs.* A trade in foodstuffs existed both into and out of the villages studied. It was an important factor at Kavataria in that these natives depended to a considerable extent for their staple food, namely, yams, on those grown in the inland villages. For these they provided fish. In the other villages inward trade did not affect the nutritive value of the diet, its main contribution being to add variety to the diet. There was a large outward trade in pigs at Patep, and sago at Koravagi. The home consumption of the pigs in Patep would have materially improved the nutritive value of the diet of these natives.

(iv) *Storage of Foods.* Apart from the storage of yams at Kavataria, other garden produce would only be stored one to three days in the houses. The yam houses are a feature of each village, and the yams are successfully stored for six to eight months.

The strict observance of Sundays and holy days by the Busama people should be noted. It was unfortunate if insufficient food had been collected on the previous day, as the women were forbidden to go to the garden.

At Koravagi, sago was packed into cylinders about 15 inches diameter by 2 feet high, made from two sago leaves bound together and held by circular bindings of the mid rib of sago leaf. Sago would be removed from this solid block as required. When the block was cut a definite 1 inch to 2 inches margin of waxy material was noted. The whole block smelt as if it was fermenting and no attempt was made to dry the sago adequately before storage. Sago stored as above lasted two to three months.

The fish also were stored at Koravagi. After being smoked and dried they were kept in the rafters inside the houses. They were used when fresh fish or shell fish were not available. At Busama and Kavataria the storage of fish was not observed.

(d) *Eating Habits, Including Food Tabus.*

(i) *Main Meal.* The eating group for the main meal of the day was generally based on the family. Families living together would normally eat together as at Busama. At Kaiapit visitors were frequent, and at Kavataria the children visited from house to house. Here, also, it was practical for several families to combine to form an eating group. At Kaiapit feasts the group changed from a family group to a predominantly male group. As previously noted, the normal procedure at Koravagi was unknown, but here again the main eating group is probably the family group.

Distribution of the food at the main meal varied in the five villages. At Busama, Patep and Kavataria the housewife served out portions to as many members of the group as there were suitable dishes, etc., sometimes two members sharing a plate. It was usual for the men and the boys from twelve to thirteen onwards to get larger portions than the other children or the women, the latter usually having a relatively small portion.

At Kaiapit the man distributed the cooked food, the visitors and other men were given first servings. Leaves and a few dishes were used as plates, more generally the eaters gathered around the cooking pot. At Kavataria groups of men would eat round the pot for certain prepared meals. At Koravagi the soup was distributed into bowls by the housewife.

As well as the family sharing in the distribution of cooked foods, gifts of food would be sent aged relatives, in payment for services rendered or to some other household as at Kavataria.

(ii) *Fluid Intake.* The main fluids are the vegetable cooking water (as soup) and the water from green coconuts. Natives do not find tea easily procurable. The natives of Papua-New Guinea have no alcoholic beverage, although fermented coconut fluids can be easily made. The daily water intake of all natives is much less than Europeans existing under the same conditions. At Kaiapit, where probably the fluid intake was higher than at Busama, Patep or Kavataria, the women would share the fluid from the coconuts during food preparation, then the coconut and vegetable water soup would be sipped in between mouthfuls of solid food—probably about 12 to 15 ounces of fluid a day. At Koravagi very few green coconuts were seen, but the main meal was in the form of soup.

(iii) *Snacks and Additional Foods.* At every village some food was eaten during the day other than at the main meal. Foods consumed were either cold cooked food (as at Busama), or easily cooked or raw foods, *e.g.*, corn, coconut, etc. The amounts eaten varied with the villages—a minimum amount of extra food being eaten at Patep where two main meals were eaten, and possibly a maximum at Kaiapit where coconut, bananas, and breadfruit were easily obtainable and easily cooked.

(iv) *Food Tabus.* It is interesting to note that natives may have certain food tabued, they also have preferences. Although tabus were supposed to operate at times like pregnancy and lactation, it is doubtful if they did in reality. It was not possible to confirm most of the reported tabus. For this reason it is highly unlikely that they had any effect upon the nutritional status. Mourning tabus in Kavataria would affect the nutritive value of the diet.

(e) *Infant Feeding.*

Although all infants are breast fed until they are twelve to eighteen months old, they are given supplements from an early age. The exact age when they cease to get any milk from the breast was not determined. Toddlers of two to three years would be allowed to suckle when they were unhappy. However, during the collection of milk samples, women after eighteen months' lactation could still provide 60 ccs. of milk.

The stage when supplementary feeding commences varied in the villages. It is probable that supplements are introduced at about one week in Koravagi, and about three weeks in Kaiapit. At Patep supplements were delayed, the longest being introduced for the first time when the infant was three months old.

The nature of the supplements followed the food pattern of the adults. At Koravagi the infant was fed clear sago soup with a specially made small spoon. As soon as he can hold objects he is allowed to play with small sago sticks and encouraged to suck them. At twelve months the Koravagi baby will be eating sago, taro, bananas, ripe paw paw, crabs and fish. The last foodstuff permitted is coconut. In Kavataria and Kaiapit, also, coconut was the last food to be introduced. Taro, which has been previously well chewed by the mother, is the first supplement in villages other than Koravagi. At Busama the premasticated taro was wrapped in

a leaf and baked for a few minutes before being given to the infant. Pre-masticated sweet potato is next introduced and so on through all the foods, allowing them the plain cooked products as they get older. Pig meat is not permitted at Kaiapit or Patep, but fish was allowed at Kavataria.

The amount of supplement consumed by the infant also varied. At all villages except Busama and to a lesser extent Patep, the infants were encouraged to eat supplements, the food often being forced into their mouths. It was impossible to obtain any accurate quantitative data on infant feeding, but a child of eighteen months at Kaiapit would receive about twelve ounces of sweet potato at the main meal plus some of the soup.

(f) *Feasts (Including Practice of Chewing Betel Nut).*

(i) *Betel Nut.* Although the natives of Papua-New Guinea have no native alcoholic liquor, they consider the practice of chewing betel nut and lime produces a feeling of intoxication similar to alcohol. In addition, it is thought to lessen the desire for food, but from observation the chewing of betel nut seemed to be a distinctly social practice. Whenever a group of men formed betel would be produced, passed round the group and all chew and spit.

Three ingredients are need to obtain the desired effect, viz.:—

- (a) The betel nut or "nut" of the palm *areca catechu*;
- (b) a leaf from the pepper vine (*Piper betle*);
- (c) powdered lime prepared from various sources.

In some places other roots or bark would be added. A piece of the nut, some leaf and lime are put in the mouth and chewed vigorously, the red coloured saliva is expectorated frequently, and from time to time more lime is added. From personal experience, betel nut chewing had little to recommend it—the taste was unpleasant and had a decided astringent quality.

In Busama, Kaiapit and Patep the women did not chew betel nut, although at Kaiapit the men probably chewed more than at any other village. At Kavataria, betel nut chewing was very popular with both men and women, but unfortunately the island did not grow sufficient areca palms to meet supply, and betel nut thus became a valuable trade item. At Koravagi the women were particularly keen on betel chewing and their social groups were very similar to the exclusive male groups at other villages.

An estimate of nutrients derived from chewing betel nut and its accompanying leaf and lime cannot be given. Clements has arrived at a figure for the intake of calcium oxide for the natives on Manus. However, to do any accurate analysis the expectorate saliva would have to be collected. As well as receiving calcium from the lime, the leaf would probably contribute some Vitamin A, but little ascorbic acid (5 mgrms./100 gms.) (').

(ii) *Feasts.* Apart from Kaiapit feasts did not influence the average daily food pattern in the villages.

Feasts are usually held to observe some special occasion—the building of a house or a canoe, the gathering of the yam harvest, and some introduced Christian festivals, such as Christmas.

At Kaiapit large feasts were a major part of village life. Four or five men would meet for a discussion in the morning, the women would commence cooking and the group would eat, talk and chew betel for the rest of the day. Then in the late afternoon, each man would return to his own household and eat more food. These minor feasts contributed to the diet, but it was impossible to gather any quantitative data.

Larger feasts would invariably include a pig as main dish and would be supplemented with ten to twenty pots of sweet potatoes, bananas, beans, yams, etc. At these more public feasts the leading men of the village were always present so that their food intake was greatly increased. Their wives and families would sometimes be present. During the period at Kaiapit six feasts occurred.

Section 6.

FOOD CONSUMPTION—QUANTITATIVE DATA.

(A) *The Mean Daily Per Capita Intake of Foodstuffs.*

Furnishing a comprehensive picture of the food patterns of each village, an extended description of the foodstuffs consumed by each village has been given in Table 1. Included in this is a record of the average daily per capita consumption of each item. In the case of the principal or staple foodstuffs the average figure represents a fairly true picture of the intake. In the case of snacks the average figure is fictitious in that snacks were frequently eaten by small groups of individuals and did not necessarily form part of the overall food pattern in any one day, nor probably over a period of time.

Table 2 provides a comparison of the four villages for which quantitative data were obtained. Foodstuffs have been divided into six major groups. It will be noticed that the staple foodstuffs contribute by far the greatest bulk of food consumed, but although the average consumption of green leaves and other supplements is small compared with the intake of staples, they do, however, contribute to the overall food consumption.

In two villages the staples are well defined. Busama has a taro economy and Kavataria is primarily a yam economy. Although Patep was selected as a sweet potato economy, there was during the month that the survey party was in the village, a greater consumption of taro than of sweet potatoes. Kaiapit partly because of its situation in a fertile valley has a mixed economy with bananas predominating. It is interesting to note the low consumption of green leaves in Kavataria. The general production in the area is low and leaves do not seem to have become part of the food pattern of these people. In contrast to this is the relatively high intake of fish in Kavataria providing quite a considerable amount of animal protein. In the other villages the intake of sources of animal protein is noticeably low.

The most outstanding feature of Table 2 is the multiplicity of items entering into the daily pattern of three of the villages surveyed. In planning ration scales based on native dietary patterns it is important to appreciate the significant place in the diet of items other than the staples.

(B) *Requirements of Nutrients for Natives in the Five Areas.*

To assess the nutritive value of a list of foodstuffs it is necessary to know—

(i) the analyses of all foodstuffs;

(ii) the requirements of the natives for various nutrients.

Analyses of all foodstuffs were made and are reported in Part 9 of this report.

The selection of figures for the nutrient requirement of natives was a difficult matter. No physiological studies which would give a picture of the metabolism of Melanesian people have been made. The Recommended Dietary Allowances drawn up by the National Research Council of America have been used extensively for both planning diets and for assessing the nutrient intake of a population. These allowances have, however, been based on experimental work on Caucasian peoples and, in addition, contain a wide "margin for safety." They were last amended in 1945* and the considerable amount of research work which has been carried out in the intervening three years has thrown doubt on the validity of some of the figures. It seemed that in order to derive figures for New Guinea natives it would be necessary to make certain corrections based upon differences in stature between the New Guinea people and the average North American, and also to make certain assumptions relating to the mode of life and degree of activity of the New Guinea native. The latter were based upon observations made in the field of both the degree of activity and the length of time occupied in various degrees of physical work by the average native.

A table of recommended allowances has been prepared on this basis and the figures are given in Table 3. Details of the methods used and the references are set out below.

Calories.

(a) Adults 21-50. The caloric requirement is the sum of the calories utilised by the basal metabolism, the calories utilised in activity, and a number of calories utilised as a result of the Specific Dynamic Action of food, or what is probably better described as the Calorigenic Action of food.

The basal metabolism is directly related to the surface area of the body and can be computed from the observed weight and height. A subtraction of 0.1 calories/kilogram/hour was made for sleep.

The allowance of calories for activity was based on the observed activity of natives and related to the comparable activity for which metabolic figures have been obtained on Caucasian peoples. This introduced a possible error in that in our opinion the Melanesian native in his own environment moves with a minimum of physical effort in contrast to the apparent over-exertion of the European in the same situation. Using this line of reasoning the following figures were derived for the average activity: Males, 950 calories per 24 hours; females, 800 calories per 24 hours.

No information could be found in the literature as to the magnitude of the Specific Dynamic Action of the vegetable diet of Melanesians. On the assumption that the S.D.A. of this type of diet would be less than the usual 6 per cent. of total calories, 4 per cent. of the total calories was added.

* Since revised in 1948.

(b) Adults over 50.—Figures for this group were obtained in a similar manner except that the calories required for activity were reduced to: Males, 550 calories; females, 450 calories.

(c) Pregnant and Lactating Women.—The difference between the National Research Council Recommended Dietary Allowance for calories for a moderately active woman and pregnant and lactating women were added to the suggested caloric intake for adult native women derived under (a) above.

(d) Children.—The caloric requirement for children was derived in the following way. It was thought that the smaller stature of the New Guinea child would have a lower basal metabolic rate and so a lower caloric requirement for basal metabolism than Caucasian children. From data collected of the height and weight of New Guinea children a table was computed of basal metabolic requirements from comparable Caucasian height-weight data. A subtraction was made for sleep using 0.2 cal./kilo./hr. for 1-9 years of age, and 0.1 cal./kilogram/hr. over 9 years of age. The specific dynamic action of the food was assumed to be 4 per cent. of the total calories. The factor for growth and activity was added to the above figures.

Since it was not known whether the smaller stature of the New Guinea native was due to a failure of the native to reach his potential height and weight due to inadequate diet during the growing period or whether it was due to a genetic inheritance of a smaller stature and build, it was considered safer to assume that inadequate diet was possibly the causal factor. Therefore the increment for growth and activity was the same as that considered to be required by Caucasian children.

Protein.

(a) Adults.—When considering the protein requirements of adults of Caucasian origin it is customary to assume that the requirements are on the basis of 1 gram of protein per kilogram of body weight. In recent years, however, there have been a number of studies which suggest that these figures are unduly high. Hegsted, Stare and their colleagues (²) consider that 18 grams of protein per square metre of body surface in a diet devoid of animal protein was sufficient for the maintenance of health in the adult. On these grounds it has been assumed that 40 grams of protein would provide adequately requirements for New Guinea adult natives;

(b) and (c) Pregnant and Lactating Women and Children.—In the absence of any other data it has been assumed that the protein requirements of this group are the same as those of the National Research Council Recommended Dietary Allowances.

Calcium.

Figures for calcium in the National Research Council Recommended Dietary Allowances are based solely on North American data, and the figures carry a 50 per cent. "margin for safety." Many factors influence the absorption of calcium. The average absorption of European peoples seems to be about 50 per cent. of intake, whereas it has been claimed for Singhalese that calcium absorption figures are in the vicinity of 90 per cent. of intake. In the complete absence of data for any Melanesian peoples it was decided to accept as a temporary measure the National Research Council Recommended Dietary Allowances, realising that these figures are probably well in advance of the actual calcium requirements of the natives.

Thiamin.

(a) and (b) Adults and Children. A figure of 0.35 milligrammes/1,000 calories was used as the basis for calculation. This corresponds to the 70 per cent. restricted allowance for adults based on the National Research Council Recommended Allowance now in wide use, and is slightly above the mean value of 0.3 milligrammes/1,000 calories suggested by the Canadian Council for Nutrition for Planning Food Supplies of a Population (*).

(c) Pregnant and Lactating Women. The difference between the National Research Council Recommended Dietary Allowance for thiamin for a moderately active woman and for pregnant and lactating women was added to the suggested thiamin requirements for the adult native woman.

Ascorbic Acid.

More or less arbitrary figures were selected for the ascorbic acid requirement of native peoples. There is, however, considerable scientific evidence to suggest that even these figures are too high (*), (*), (*), (*).

The figures finally selected were:—

Adults—50 mg./day.

Children—30 mg./day except 50 mg./day for children over 12 years.

Pregnant and Lactating Women—80 and 130mg./day respectively, calculated in the same manner as the thiamin figures.

(C) Nutrient Value of Diets Consumed by Each Household Surveyed.

Tables 4 and 7 show the per capita consumption of nutrients by each household surveyed in the four villages. Table 8 provides a comparison of the averages.

(D) Comparison of Intake of Nutrients by Each Household Expressed as a Percentage of the Requirements of that Household.

Tables 9 and 12 give the intake of nutrients by each household expressed as a percentage of the suggested requirement for that household based upon the actual composition of the household in men, women and children, collected according to the figures provided in Table 3. Table 13 gives a comparison of the four villages.

(E) Discussion.

(a) Assessment of Data.

The quantitative data of each village are not strictly comparable because of the difficulties encountered in their collection. These difficulties were associated with the way of life of the people and whilst the same factors did arise in each village they varied in their intensity. A further interfering factor is that the work of the survey party did in a few instances upset the general daily routine. From the personal angle collection of data was probably more correct when the camp of the survey party was close to the village and the nutritionist had frequent and easy access to village activities. Thus it is probable that the facts collected for Patep and Kavataria are more reliable than those for Kaiapit and Busama. Despite these factors the figures given in Tables 4 to 13 are a sufficiently close approximation of the average intake of each village to allow comparisons to be drawn.

(b) *Comparison of Intake of Nutrients.*

The most outstanding feature is the wide variation from household to household even between two visits to the same household. This particularly applies in Busama where most of the households were visited on two occasions, but it applies throughout to the four villages surveyed. This variation calls for some explanation.

I am confident that the figures obtained for the food consumed by the members of a household on the day that the survey was made, represent a true picture of the actual food consumption on that day. The variation is not due to errors in observation but probably represents a true picture of the native dietary pattern. In three of the villages studied the day's routine followed along standard lines. The natives had little to eat before going to work, worked steadily throughout the day in their gardens or repairing their houses, the women collected food during the day, returning to the villages late in the afternoon when the food was cooked. Thus the main meal was taken at the end of the day. The food eaten on any one day was, as a rule, collected that day and was just sufficient to meet the anticipated requirements of a household. The listed figures for a village probably represent the dietary pattern of any one household in the village over a period of time. That is to say, in contrast to the typical European food pattern when approximately the same amount of food is eaten each day, the natives' daily intake fluctuates fairly widely.

Calories.

The calorie intake of Busama is significantly below that of the other three villages and does represent a true picture at the time the survey was made. Busama was a battle-ground during the recent war and both the houses and the gardens were destroyed by the conflicting armies. Although a great deal of rehabilitation has gone on the total area necessary to supply the food for the village has not yet been brought under cultivation. The lower calorie intake is also supported by figures collected by Dr. Hipsley that show that during the month that the survey party was in the village many natives lost weight.

The significantly higher intake of calories at Patep also confirms observations made in the field. It probably meets the higher physiological demand for foodstuffs by these natives who live in an area where the climate is much less tropical than the other three villages. It is interesting to note that the two villages where the economy was stable, and each were similar from the point of view of climate, that their average caloric intakes per capita were almost identical. Patep is also the only village where calorie intakes reach the computed average requirement of the village. In both Kavataria and Kaiapit there was ample food available, so it can be assumed that the food intake of the natives met their requirements. This means that the figures suggested for the calorie requirements of New Guinea natives is higher than their actual physiological needs.

Protein.

With the exception of Kavataria almost the whole of the protein is of vegetable origin and the dietary intake is well below the computed requirements even in Kavataria where the vegetable protein is appreciably augmented by protein from fish. Little is known of the biological value of protein from green leaves and root vegetables. Most of the work on the biological value of vegetables has been concentrated on cereals. Animal husbandry

suggests that certain vegetable proteins are adequate to meet the requirements of live stock. However, not only is the total intake of protein below what is probably a desirable intake, but the food pattern of the people is such that the inadequacy operates with a bias against children. Such animal protein as was available in the villages of Busama, Kaiapit and Patep seemed to be reserved for adults and particularly adult males, and was eaten mainly on festive occasions.

Because vegetable protein forms such a low percentage of the foodstuffs large quantities of foods have to be eaten to provide anything like a reasonable amount of protein. This is a physical impossibility in the case of young children, and the absence of any concentrated source of protein such as milk or animal flesh in the diet of children must mean an intake well below adequate amounts. It is probably in this age group that the protein deficiency is most marked.

Attempts to increase the protein intake of the village native in New Guinea must be directed towards the production of vegetables which are a concentrated source of protein and which provide in an ordinary diet a balanced protein intake. This will mean not only a revision of the agricultural policy, but also a revision in the native concept of food requirements. The native will need to be convinced that young children need protein-rich foods. If the improvement is in the direction of production of agricultural foods rich in protein, *e.g.*, peas and beans, then the native would need to be educated to include these in the diet of children.

Fat.

It will be noticed that there is no reference to the intake of fat in the Tables 4-8. No calculations were possible because of the small amounts appearing in the dietary of New Guinea natives. It is estimated that fat would provide less than 5 per cent. of the total intake of calories.

Calcium.

With the exception of Kavataria the calcium intake approaches the calcium intake of many European populations. A high percentage of this calcium is provided from green leaves some of which are extremely rich in calcium. On the debit side, however, some of these leafy products are also rich in oxalic acid. Assays carried out by the chemists (see Part 9) show that the amount of oxalic acid present in some green leaves is sufficient to immobilize about 50 per cent. of the calcium, if this takes place according to the ordinary chemical formulae.

Dr. Hipsley found a few cases of mild rickets which were probably of a vitamin D origin and not of a calcium origin. (See Part 5.) The fact that calcium is supplied by bulk foodstuffs such as green leaves can well operate against the young child, and whilst the calcium intake of the normal adult is probably well up to computed requirements, it is **certain** that the intake of young children is well below that considered **desirable**. A remedy for this must be in the provision of foodstuffs of less bulky nature which can be worked into the dietary pattern of children. This, of course, is the great advantage of milk in that it does supply a very high percentage of calcium, and the absence of mammalian milk other than human milk in the New Guinea diet means a relatively low calcium intake in young children.

Thiamin.

In all instances (with the exception of Busama) the thiamin intake is well above the computed requirements. The low intake in Busama is probably related to the low calorie intake and consequently the deficiency is relative rather than absolute since thiamin is needed for the metabolism of carbohydrates. If the caloric intake is low then the thiamin requirements will be less than normally. The high figures for thiamin are due to the fact that practically all foodstuffs eaten by the natives contain significant quantities of thiamin and there are no foodstuffs similar to sugar and white flour as in the European dietary which require considerable amounts of thiamin for their metabolism and which in one case does not contain any thiamin and in the other relatively small amounts.

The figures indicate that it is not necessary to plan to increase the thiamin intake of the village native in New Guinea.

Ascorbic Acid.

Figures for ascorbic acid intake are very high when measured by European standards. This is due to the fact that practically all foodstuffs eaten contain some ascorbic acid, whilst some foodstuffs are particularly rich in this nutrient. In general the methods of cooking follow conservative lines so that whilst these figures have not taken into account cooking losses it is probable that the cooking losses would not exceed 30 per cent. Even with these losses the ascorbic acid intake of the native is well above computed requirements.

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TABLE 1 (a).—BUSAMA.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption, ozs.	No. of Times Seen in 40 Visits.	Description.	Cooking Method.
<i>Colocasia antiquorum</i> (taro).	taro	gu	staple	18.2	37	Cultivated plant. Several varieties known. The swollen stem or tuber forms the basis of the Busama diet. When cooked has a waxy texture and an earthy taste, unpalatable to Europeans.	Is peeled, using an European knife or a special piece of metal (N.N. senegu). Cooked whole or cut in two if large. Placed in cold water (half salt and half fresh), covered with a tight perfect seal of leaves, and allowed to cook for 40-60 minutes. Cooking water discarded.
<i>Dioscorea alata</i> (yam)	yam	ambj	suppl. to staple	0.4	4	Cultivated in small amounts. Several varieties known. To European palates has pleasanter flavour than taro, but rather stringy texture.	As for taro.
<i>Manihot utilisima</i> (tapioca).	tapioc manioc	...	suppl. to staple in times of great scarcity.	...	Nil	Cultivated in small amounts. Root is used only in times of emergency, more generally is used as pig food.	Was not sighted. Said to be roasted.
<i>Saccharum robustum</i> ...	pit	apu	relish	0.4	8	Cultivated. There is no English equivalent. In external appearance it resembles corn. The part that is eaten is the unopened flower tassel. When its sheathlike covering is removed, this edible portion is exposed. This is white to creamy colour, rather like very young cauliflower flowerets packed close together. When cooked the taste and texture is between cauliflower and asparagus. For	(1) Can be roasted in the ashes in similar fashion to corn. (2) Remove outside sheath and cook with green leaves in boiling water.

<i>Metroxylon rumphii</i> ... (sago).	sak-sak.	api.	Chief suppl. to staple.	1-9	10	growing shoots of palm or arec. When eaten raw is rather like sweet young celery and very palatable. When cooked becomes limp and tasteless. Both wild and cultivated palms are found. The sago flour is prepared by chipping the inside of the trunk and then, by means of crude native washing methods and filters, the sago flour is collected. During times of taro shortage sago is used. The cooked sago balls have a gelatinous, sticky exterior, and a dry, crumbling, tasteless interior. They are very filling as well as difficult to eat, and Europeans could only eat half a ball (average weight 8-12 ozs.), whereas natives ate 1-2 balls. Sago mixed with coconut has more distinct and pleasanter flavour than plain sago balls. The "heart" of the sago palm. This is said to replace meat and fish in the diet. Is similar to "kru bilong gras" on a much larger scale; one may weigh 10-11 lbs. The more tender pieces are eaten raw like celery, or the whole or tough pieces may be cooked for soup. Bananas are cultivated near the village and in the gardens. Ripe bananas are eaten raw as snacks during the day. Green bananas are occasionally cooked to supplement taro.
Do	kru bilong sak-sak.	...	relish ...	...	3	The crude sago flour is moistened with water and made into dumplings weighing from 8-12 ozs. each. These dumplings may be wrapped in leaves and baked, or dropped in boiling water (half fresh and half salt) and boiled for 30-40 minutes. Cooked sago is improved if the raw sago is first mixed with grated coconut. This was usually done. Sago gruel mixed with certain scented leaves is used for invalids.
<i>Musa sapientis</i> (banana).	banana	lung	snacks ...	0-3	snacks ...	Is cut into pieces $\frac{1}{2}$-in. long, mixed with greens, squeezed coconut meat, and boiled for soup. The "kru" of sago is thought to have beneficial effects if given to women the week preceding birth of a child. Green bananas are boiled in water in similar method to taro.

Table 1 (a).—BUSAMA—continued.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 40 Visits.	Description.	Cooking Method.
<i>Cocos nucifera</i> (coconut)	kokonas ...	N'dip ...	(a) as a drink (b) as a suppl. to sago.	0.6 ...	frequently ... 9	Coconuts are cultivated close to and along the length of the village. The "kulau" or green coconut is used for its pleasantly refreshing drink, and the soft sweet meat layer of the "kulau" is always eaten—mainly by the children. The "drai" is the ripe coconut containing less water than the "kulau," but a firm layer of coconut meat about 1/4-in. in depth. Children frequently eat this rather tough fibrous but very palatable coconut meat. Housewives use the shredded meat, or the "gris" obtained from squeezing the meat.	The "drai" coconut is removed from husk, the fluid drunk or saved. The shell is then broken in two, and the coconut meat is shredded out of the shell. This resembles moist household desiccated coconut. This may be added direct to the dish, e.g., sago, or may be treated further to make "gris." This is made by squeezing the shredded meat by hand, first by itself, then adding either coconut water or a mixture of fresh and salt water, until no further "gris" can be extracted. "Gris" is sometime strained through some coconut fibre. The squeezed-out meat is discarded.
<i>Colocasia antiquorum</i> (hillside taro leaves).	lip taro ...	bi'loun ...	relish ...	2.5	22	Large heart-shaped leaves, often over 12 inches long. The leaf has a coarse stem and prominent veins which are removed before cooking. The young and smaller leaves do not have the veins removed. When cooked the leaves are a soft, slimy green mush, with an indefinable taste, not very attractive in texture or taste to European palate. Is served as a sauce to taro tubers.	Stem and veins removed and leaves then torn into even pieces about 2 in. x 1/2 in. Water is brought to boil, and then the greens are gradually added, water being kept boiling. The pot is sealed firmly with a large leaf, and left to cook for 1/2-1 hr. Except for the unnecessarily long cooking time, this cooking method is excellent. The cooking water is kept as soup. The larger stalks are removed and very large leaves are torn in two, otherwise method is as above.
<i>Hibiscus abelmoschus</i> (bush spinach).	albaka ...	kandi ...	relish ...	0.9	6	Cultivated. Two chief varieties grown. Leaves grow on a bush 2-3 feet high, the leaves themselves being similar in shape to vine leaves. Some varieties have very deeply dissected	

<i>Gnetum gnemon</i> (bush tree).	tulip	...	su loun	...	relish	...	0-6	2	delicacy. However, again to European palates, the taste of the cooked product is dull, and the texture soft and slimy, and there seems to be little distinction between the different greens in flavour. Bush food. These leaves are a paler green, sometimes with a reddish tinge rather like young eucalypt leaves in appearance, though lacking the decisive aroma of eucalypt. The cooked product is indistinguishable from the other cooked greens. Bush food. The leaves are dark green, covered with small prickles, and this does distinguish the cooked product. Has a slightly spicy taste. The berries when cooked look like green peas, but are rather tasteless.	As for albika.
	<i>Ficus</i> sp. (bush flg leaves).	kumu	...	so	...	relish	...	3	Bush food. Leaves and root similar to young radish. The young leaves of very small plants are cooked whole, the root of the plant being removed first. No distinguishable taste. Bush food. These fungi are found on damp logs, etc., and are mixed in with the greens and lose any identity they may have had.	As for albika.
	<i>Ficus</i> sp. (bush flg berries).	pikanini bilong "so."	...	slip	...	relish	...	1	Coconut "gris" sometimes added to berries.	As for albika.
	<i>Amaranthus</i> sp.	kumu	...	nitam (large leaves). glam (smaller leaves).	...	relish	...	2		
	<i>Auricularia</i> sp. (fungi)	kumu	...	tarina	...	relish	...	1		

TABLE 1 (b).—KAIAPIT.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 33 Visits.	Description.	Cooking Method.
<i>Musa sapientis</i> (bananas).	banana	marafe	staple and snacks	11.3	22	Cultivated. Thirty-six named varieties were sighted, all having distinct differences in texture, flavour and sweetness to the native palate. The green banana or plantain type was more popular than the sweet ripe banana, and of these two varieties, Ganairan and Ganau were most commonly used. Size of peeled bananas varied from 0.8-5.25 ozs. with type. Cooked green bananas have little flavour, texture varies from a waxy firmness to distinct "cotton wool" effect. They are not acceptable to European palates. The sweet bananas as soup or baked are very palatable.	Green bananas were peeled, using a sharpened pig bone. Cooked in cold water, generally together with some green leaves, and the pot sealed with a banana leaf. When cooked (time varied from 30-60 mins.), part of the cooking water was removed, and coconut "gris" added. The "gris" was prepared as for Busama. Ripe bananas— (i) Baked in skins on fire. (ii) Soup. Skins removed and cooked till soft. Remove about half cooking water. Mash bananas and stir in coconut "gris."
<i>Ipomoea batatas</i> (sweet potato).	kau kau	unas	staple	9.2	14	Cultivated. Seven named varieties were sighted, being recognisable by shape and colour of skin or flesh. No difference between varieties in flavour or texture, according to European palates. Boiled and baked sweet potatoes had a firm texture, and a pleasant flavour, enhanced by the addition of coconut "gris."	(i) Boiled as for green bananas but cooking time only 20-30 mins. (ii) Baked—left in skins and tossed on fire.
<i>Dioscorea</i> sp. (yam)	yam	dari	suppl. to staple...	3.4	7	Cultivated. Reputed to be nine-teen named varieties. One yam sighted weighed 117 lbs. Firm but rather stringy texture. Flavour better than taro, more like common European potato.	As for sweet potatoes.

Table 1 (b).—KALAPIIT—continued.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 33 Visits.	Description.	Cooking Method.
<i>Clorasia antiquorum</i> (taro).	taro	ument	suppl. to staple...	2.6	6	Cultivated. Six varieties were sighted differing in colour of flesh. The addition of coconut "gris" improved the flavour. Scraped taro in aibika leaves had a pleasant salty taste, which disguised the usual earthy flavour of the taro.	(i) Boiled as for green bananas. (ii) Scraped—the peeled taro was scraped into fine shreds, using a metal scraper. This was then wrapped in an aibika leaf to make a roll and boiled in water for a short time. Coconut "gris" added at conclusion of cooking.
<i>Manihot utilisima</i> (tapioca).	tapioc or manioc.	bumpuna	suppl. to staple...	0.7	2	Cultivated. The tapioca root was more popular than at Busama. The root when peeled is long, thin and snowy white. Tapioca and aibika rolls had a similar salty taste to taro and aibika rolls.	(i) Scraped as for taro. (ii) Pancakes. Not seen, but tapioca flour mixed with water and fried in fat. When available was said to be popular
<i>Metrostylon rumphii</i> (sago).	sak-sak	...	gift ...	0.1	1	Not grown at Kalapit. Sago sighted was a gift from a visitor. The sago was cleaner than at Korovagi and more palatable when cooked than at Korovagi or Busama. The texture was the same.	Sago mixed with shredded coconut, wrapped in betel leaves and baked on fire. Mashed bananas may also be mixed with the sago and coconut before baking. The sago stick was not as efficiently made as at Korovagi.
<i>Cucurbita mazima</i> (pumpkin). <i>Cucurbita moschata</i> (squashes).	punkin	bring kring	suppl. to staple...	0.9	4	Cultivated. Cooked whole pumpkin was often used as pig food. Pumpkin soup was liked and had a pleasant nutty flavour.	As for ripe banana soup.
<i>Coccos nucifera</i> (coconut)	coconut (a) kulau (b) dral.	hamping	as for Busama	3.4	23 (1 cooking)	See Busama. Note.—Coconuts were larger than at any other village. The nuts were also allowed to sprout, in which case the liquid would be replaced by crisp, spongy, soft flesh, with a bland flavour. For want of a better name this is referred to as the triplold endosperm. It was eaten raw and was very popular with the children. The meat in sprouting coconuts was	As for Busama but more universally used. Note.—"Gris" was always squeezed by hand, and was never strained. The discarded meat was thrown to the pigs.

Botanical name (bush spinach).	Local name	Family	Preparation	Quantity	Weight	Number	Description	Remarks
<i>Cucurbita maxima</i> (pumpkin leaves).	lip punkin...	...	...	...	0-7	10	Cultivated. Pumpkin leaves did not have any appreciable difference in taste to other green leaves.	As above.
<i>Cucurbita moschata</i> (squash leaves).	lip taro	...	...	...	0-1	3	Cultivated. As for Busama, but small young leaves only used.	As above.
<i>Colocasia antiquorum</i> (taro leaves).	lip bin	...	...	...	...	1	Cultivated. As pumpkin leaves.	As above.
<i>Phaseolus lunatus</i> (bean leaves).	tulip	...	...	...	...	2	Bush tree. As for Busama	As above.
<i>Gnetum gnemon</i> (bush tree).	kumu	...	...	...	0-2	1	Cultivated. Small leaves. No appreciable difference in taste from other leaves.	As above.
—(<i>Umbelliferae</i>)	kumu	...	...	...	...	1	Cultivated. The cooked leaf has a hot, spicy flavour.	As above.
—(<i>Liliaceae</i>)	pit pit	...	...	...	0-2	2	As for Busama. Is very popular in season.	(i) Baked in ashes. (ii) Outside sheath removed and cooked with staple and green leaves.
<i>Saccharum robustum</i>	...	...	...	...	...	1	One vine growing in village. The fruits were about 12 ozs. in weight. Had a green wrinkled skin; immediately underneath skin was firm yellow flesh for about 1/2 inch. Then large blackish seeds in a greenish yellow semi-solid matrix formed the centre. Seeds and yellow flesh were eaten. Appearance of fruit was repulsive and not tasted.	As for albika.
—(<i>Cucurbitaceae</i>)	...	...	...	...	...	1	Cultivated. The flower heads of the banana were sometimes used. The flower consists of a series of segmented frills and the outer segments are removed before cooking. Was not tasted.	As above.
<i>Musa sapientis</i> (banana flower).	plous bilong banana.	...	...	...	...	1	Cultivated. The flower heads of the banana were sometimes used. The flower consists of a series of segmented frills and the outer segments are removed before cooking. Was not tasted.	As above.

with the staple, not separately as at Busama. A layer of green leaves put at bottom of pot and on top of the other vegetables before sealing pot. Part of the cooking water was usually discarded. The rest, after the addition of "gris," would be used as soup.

differentiated by shape of leaf and appearance and colour of veins. As for Busama.

Cultivated. Pumpkin leaves did not have any appreciable difference in taste to other green leaves.

Cultivated. As for Busama, but small young leaves only used.

Cultivated. As pumpkin leaves.

Bush tree. As for Busama

Cultivated. Small leaves. No appreciable difference in taste from other leaves.

Cultivated. The cooked leaf has a hot, spicy flavour.

As for Busama. Is very popular in season.

One vine growing in village. The fruits were about 12 ozs. in weight. Had a green wrinkled skin; immediately underneath skin was firm yellow flesh for about 1/2 inch. Then large blackish seeds in a greenish yellow semi-solid matrix formed the centre. Seeds and yellow flesh were eaten. Appearance of fruit was repulsive and not tasted.

Cultivated. The flower heads of the banana were sometimes used. The flower consists of a series of segmented frills and the outer segments are removed before cooking. Was not tasted.

Cultivated. The flower heads of the banana were sometimes used. The flower consists of a series of segmented frills and the outer segments are removed before cooking. Was not tasted.

Table 1 (b).—KAIAPIT—continued.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption, ozs.	No. of Times Seen in 33 Visits.	Description.	Cooking Method.
<i>Panicum palmarum</i> ...	kru bilong gras.	itat	relish ...	...	1	See Busama ...	As for pit pit.
<i>Psophocarpus tetragon- olobus</i> (winged bean type).	bin	opis	relish and suppl. to staple.	...	3	Cultivated. Seven varieties sighted. Although only weighed three times, beans were very popular. Long thin snake beans would be cooked whole and then "gris" added. In other varieties the seeds only would be cooked and "gris" added. Both were very palatable. Did not observe any dried beans. See Busama ...	.....
<i>Saccharum officinarum</i> (sugar cane).	suga	...	snack ...	not as popular or as plentiful as at Busama. 0-1	...	...	See Busama.
<i>Artocarpus nobilis</i> (wild breadfruit).	kapiak	koni	snack ...	not used at main meal, but eaten almost daily by children.	...	Bush tree. The breadfruit itself has a green rough skin and weighs about 1½ lb. The soft flesh was not eaten but the nuts inside were very popular. These are like soft-skinned large chestnuts in appearance and taste. Wild or village pigs are used. Are killed with native spears.	Whole breadfruit roasted on fire for 20-30 minutes. Skin removed and nuts extracted from flesh. Peeled and eaten.
Meat— Pig	pig	enof	feasts ...	0-6	...	...	The whole pig is singed over the fire. It is then cut into sections. The only parts not eaten are bladder and gall bladder. The gut is washed out, then chopped and boiled in several lots of water. Blood, heart, liver and lungs are considered delicious. Sec- tions of pig are boiled with water and green leaves in cooking pots. The soup is not discarded.
Rats, rabbits, snakes	mumet	...	delicacy ...	...	...	Wild rats, snakes, etc., are speared when the kunai is burnt. The contribution made to the diet was difficult to assess, as the time for burning the kunai was after the departure of the survey party.	

TABLE 1 (c).—PATEP.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 29 Visits.	Description.	Cooking Method.
<i>Ipomoea batatas</i> (sweet potato).	kau kau ...	kuruba ...	staple ...	18.4	27	Cultivated. Six varieties are named and identified by the natives. Baked sweet potato is more appetising than the plain boiled.	(i) Baked—unpeeled and baked in ashes. (ii) Boiled—Peeled, left whole, put in cold water sealed with lid or leaf, and boil for 20-30 mins. Cooking water discarded.
<i>Alocasia</i> sp. (Samoan taro).	taro kong kong.	kapung ...	staple ...	22.4	28	Cultivated. This is giant taro. The leaves are not eaten and the tuber will store in the ground for about a year. The raw cut tuber has a slimy surface. Little difference in flavour between this and hill- side taro when cooked.	As for boiled sweet potato. Note.—Natives maintained— (i) Salt must only be added immediately before completion of cooking. (ii) Cooked product must not be allowed to stand, otherwise is only fit for pig food. As for boiled sweet potato.
<i>Colocasia antiquorum</i> (taro).	taro ...	niang ...	suppl. to staple...		5	Cultivated. Six varieties are named and identified by the natives. See Busama.	As above.
<i>Manihot utilisima</i> (tapioca).	tapioc manioc.	...	suppl. to staple...		1	Cultivated. Root peeled and cooked whole. Rather taste- less; not as firm a texture as taro.	As above.
<i>Dioscorea alata</i> (yam)	yam ...	krenup ...	suppl. to staple...	0.1	1	Cultivated. Four varieties are named and identified by the natives.	As above.
<i>Cucurbita maxima</i> (pumpkin).	punkin ...	...	suppl. to staple...		1	Cultivated ...	As above.
<i>Hibiscus ablenoschus</i> (bush spinach).	albika ...	kili ...	relish ...		13	Cultivated. At least two varieties can be identified by the natives. See Busama.	Remove thick stems. Place in bamboo with a little water, seal bamboo with a handful of leaves, and rotate in fire for 15-20 mins. Cooking water used as soup. As above.
—(<i>Cruciferae</i>)...	kumu ...	gwen ...	relish ...	...	5	Cultivated. Small green leaves, undistinguishable by taste from other leaves.	As above.
<i>Amaranthus tricolor</i> ...	kumu ...	vena ...	relish ...	1.1	3	Cultivated. See Busama	As above.
<i>Ficus</i> sp. (bush fig) ...	kumu ...	wogo ...	relish ...	...	4	Bush tree. See Busama	As above.
<i>Dryopteris</i> sp. (fern) ...	kumu ...	lip bwango	relish ...	...	1	Bush fern. See Busama	As above.

Table 1 (c).—PATEP—continued.

Botanical Name (Common English Name).	Pidgin English Name.	Local Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 40 Visits.	Description.	Cooking Method.
<i>Phaseolus lunatus</i> (leaf of bean).	lip bin ...	pil ...	relish ...	0.4	3	Cultivated. The leaves taste similar to other greens when cooked.	As above.
<i>Dammaropsis</i> sp. ...	kumu ...	putu'hy ...	relish for pig ...	...	1	Bush tree. Leaves similar in shape to breadfruit tree, but very concentrated, and the young leaves display magnificent autumn colourings. Not tasted.	These leaves are primarily cooked with pig, though "gwantni" was seen cooked in the usual fashion.
<i>Alseophila</i> sp. (tree fern)	kumu ...	gwantni ...	relish for pig ...	...	1	Bush tree fern. The young lea- ves of the tree fern are used.	.....
<i>Cucurbita maxima</i> (pumpkin leaves).	lip punkin...	logolo ...	relish ...	0.3	3	Cultivated. See Kalapit ...	Eaten raw.
<i>Saccharum robustum</i> ...	pit ...	...	relish ...	0.3	2	Cultivated. See Busama ...	Roasted or cooked with greens in bamboo.
<i>Panicum palmarum</i> ...	kru bilong gras.	katyin ...	relish ...	1.0	9	Cultivated. See Busama ...	As above.
<i>Agaricus</i> sp. (fungus)...	...	kendi ...	relish ...	...	1	Bush fungus. Grows on decaying or damp timber in the shade. Is greyish white in colour. Not collected in large amounts.	Cooked in bamboo with green leaves.
<i>Musa sapientis</i> (banana).	banana ...	deung ...	snack ...	0.2	popular with children.	Cultivated. Twelve named varieties were recognised by natives. The ripe bananas are used and the flavour is excellent, in some cases better than Kalapit.	Eaten raw, occasionally baked.
<i>Carica papaya</i> (paw paw).	popo ...	planon ...	snack ...	...	only eaten in hot weather.	Cultivated. Excellent pawpaws in size and flavour were grown, but were sold to Europeans.	Eaten raw.
<i>Zea mays</i> (corn or maize).	kon ...	sokom ...	snack and suppl. to staple.	1.5	7 (at main meal)	Cultivated. More corn eaten here than at any other village.	Baked on fire.
<i>Pandanus</i> sp. ...	marita ...	mier ...	relish ...	...	1	Cultivated. The long red fruits had a similar external appear- ance to corn cobs. The edible portion is the extracted red oil, which is like thin tomato sauce in appearance and has a slightly spicy flavour. The core has a texture similar to cooked celery.	Strips about $\frac{1}{4}$ inch deep are cut from the fruit, leaving a central core. The outside strip, consisting of seeds and some matrix, and the core are cut in sections about 1 inch long. The marita is then cooked in bamboo with leaves (<i>ficus</i> sp. preferred), salt and water. When cooked the seeds are squeezed by hand to extract the oily liquid. Seeds are discarded and the oily liquid, the core and leaves are

<i>Cucumis sativus</i> (cucumbers).	kukamba ...	katima ...	snack ...	...	0-3	very popular with children. eaten in gardens occasionally.	peas. They are eaten as snacks in the garden. Cultivated. See Busama ...	Eaten raw.
<i>Ananas cosmosus</i> (pineapple).	painap ...	...	snack ...	...	...	...	Cultivated. Small but well- flavoured pineapples grown.	Eaten raw.
<i>Saccharum officinarum</i> (sugar cane).	suga ...	york ...	snack ...	...	0-5	...	Cultivated. See Busama ...	See Busama.
<i>Psophocarpus tetragon-</i> <i>olobus</i> (lima beans).	bin ...	pil ...	relish ...	...	...	...	Cultivated. Whole young beans used. Compare with Kalapit.	As for albika.
Pig ...	pig ...	bua ...	feasts ...	...	0-1	6 pigs killed for 1 feast.	Village pigs were killed by bashing with an axe.	As for Kalapit, although actual dissection of the carcase was slightly different.
<i>Phalanger maculatus</i> (possum).	kapul ...	...	feasts ...	...	...	nil	Possums, rats and bandicoots were trapped by various methods described in agricultural report.	Singed, cleaned and partly cooked whole. Then smoked.
<i>Phalanger maculatus</i> var (rat).	mumet ...	...	...	...	...	...	Those seen had been partly cooked and then smoked, and were tied on racks above the fires in several houses. Approx- imately 200 small animals were thus stored. All animals were small and thin, and it is doubtful if they would make a large contribution to the protein intake when distributed over the whole village.	When required the animals will be washed and skinned, broken up and cooked in bamboo with green leaves.
Birds ...	...	...	delicacy...	...	...	...	Bush birds were occasionally trapped and were eaten straight away.	Plucked, cleaned, cut and cooked in bamboo with green leaves.
Eggs ...	kiau ...	...	delicacy...	...	...	...	Two eggs weighing seven ounces each were brought in from the bush by a native.	Bolled in shell, contents mixed with cooked sweet potato or taro.
Grubs, snakes and lizards.	...	nel lugwel	delicacy...	...	...	...	Bush grubs, snakes or lizards are sometimes caught and eaten in gardens. Snakes and lizards were said to be common round Christmas time.	Cooked in bamboo with leaves or roasted on fire.

TABLE 1 (d).—KAVATARIA.

Botanical Name (Common English Name).	Native Name.	Place in Diet.	Mean Daily per capita Consumption, ozs.	No. of Times Seen in 29 Visits.	Description.	Cooking Method.
<i>Dioscorea</i> sp. (yam)	... taitu kuvi	... staple ...	24.5	29	"Taitu" are generally used for household cooking. This yam has an average weight of approximately 1½ lb. It is the important yam in trade, and is stored in the yam houses. The vine of taitu is trained to grow up the stakes. Twenty-seven named varieties have been recorded by the Roman Catholic Mission at Kiriwina. "Kuvi" are prized as a food for ceremonial and important occasions. The vines are trained along the ground and the aim appears to be to produce large yams. The size would vary from small ones weighing about 1 lb. to long ones several feet in length and weighing 12-15 lb. Thirty-seven named varieties have been recorded by the Mission. The yams were identified according to shape, size, colour of flesh, texture of flesh. Apart from the colour, there seemed little difference between the cooked product, although one variety of very white "kuvi" was less fibrous and more like European potatoes. A number of varieties according to size, shape and colour were known. See Kalapit.	(i) Yams were peeled, frequently washed, and cut into fairly even large pieces. The cooking pot was lined with leaves, often chosen for their flavour. Cold water was added and pot sealed with leaves. Relatively small amounts of water and very hot fire were used. The cooking water was used as soup. Green leaves were generally not eaten but used to line wooden platters for serving. Coconut "gris" was added to a number of cooked dishes. (ii) Can also be baked on fire.
<i>Ipomoea batatas</i> (sweet potato).	simsimwayi	suppl. to staple	6.1	18		(i) and (ii) as above, except that sweet potatoes were usually scraped—not peeled.
<i>Colocasia antiquorum</i> (taro). Do.	uri sikwaku or mwedu.	suppl. to staple suppl. to staple	3.8	14 1	Several varieties known ... These are very young sprouting taro and the whole taro, stem and young leaves would be cooked whole and	As for boiled yams. As for boiled yams.

		and snack.	(includes some snacks).		above.
<i>Dioscorea acroides</i> (air yam).	kasiena ...	suppl. to staple...	...	1	FOR BOILING COOKING AND EATING RAW. MOKINANA—Large yellow-skinned. Used ripe or half ripe for cooking. Good flavour and very popular for both cooking and eating raw. Used for cooking and eating raw. An excellent flavour and very sweet. Rather dry and sugary. USIKELA—Long yellow-skinned. Eaten ripe only. Not as good flavour as S'AINA. USIGUMANUVU—Long thin bananas. Very sweet and good flavour. Small knobby tubers resembling artichokes. Seven varieties recognised according to colour and texture of flesh. See Kaiapit. Coconut palms are individually owned.
<i>Cocos nucifera</i> (coconut)	nuya ... (a) bweibwei (green). (b) lumatutula (dry). (c) variaga (triple endosperm) pumpkin	as for Busama ...	1-2	12	As for Kaiapit.
<i>Cucurbita maxima</i> (pumpkin).	taploc ...	suppl. to staple...	0-6	3	As for boiled yams.
<i>Manihot utilissima</i> (tapioca).	yokaigo'u ...	suppl. to staple... flavouring ...	0-6 ...	4 not recorded ...	As for boiled yams. For lining pots and as lids, then discarded.

Table 1 (d).—KAVATABIA—continued.

Botanical Name (Common English Name).	Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 29 Visits.	Description.	Cooking Method.
<i>Hibiscus abelmoschus</i> (bush spinach).	lokwaē ...	relish ...	...	2	Leaves from a bush tree. No particular marks of identification. <i>See Busama</i> } In January, February and March, when the stored yam supply is dwindling, these greens are used as a supplement. Were not seen during visit, as yams, sweet potatoes and fish were plentiful.	Cooked with boiled yams, fish, etc. Not sighted.
<i>Gnetum gnemon</i> ...	gayasu ...	relish and suppl.	...	nil	<i>See Busama</i>	
<i>Colocasia antiquorum</i> (taro leaves).	naita ...	relish and suppl.	...	nil	<i>See Busama</i>	
(seaweed) ...	yakakasi ...	snack ...	...	not recorded	Pale green seaweed eaten raw by the women.	Eaten raw.
<i>Zingiber minor</i> (wild ginger leaf).	dadum ...	...	...	...	These are leaves from bush trees and vines which are used as pot coverings. It is doubtful if any are edible.	Not eaten.
	duwaku ...	...	...	...		
	nunotu ...	...	...	...		
	yorobuwa ...	...	...	...		
	gidewebu ...	...	...	...		
	bole'ita ...	...	...	...		
	kakaf'ila ...	...	...	...		
	yelobugwa ...	...	...	...		
<i>Saccharum officinarum</i> (sugar cane).	to'u ...	snack ...	...	not eaten in large amounts.	<i>See Busama</i> ...	<i>See Busama.</i>
<i>Zea mays</i> (corn or maize)	maisi ...	snack ...	...	...	Is not as frequently seen as at other villages.	<i>See Busama.</i>
<i>Carica papaya</i> (pawpaw)	mom yepu ...	snack and suppl. to staple.	1.0	4	Green and half-ripe pawpaw was cooked, the taste being similar to European marrow. Pawpaws both green and ripe were more popular at Kavataria than other villages.	(i) Green and half-ripe cooked as for boiled yams. (ii) Ripe and half-ripe eaten raw.
	gigiku ...	snack ...	...	ripe at time of visit and very popular with children.	Small dark red fruit, external appearance is like small plum. Texture is crisp and taste slightly acid, otherwise tasteless. Is extremely popular.	Eaten raw.
<i>Morinda citrifolia</i> ...	noku ...	snack ...	...	does not appear very popular.	One tree in the village. Fruits are a pale yellowish green in colour and have a disgusting smell and taste, but are considered palatable by the natives. According to Malinowski this fruit becomes a main item of diet during times of famine.	Eaten raw.

<i>Mangifera indica</i> (mango)	wai'iwa	...	snack	...	ripen from Sept.- Dec., just com- mencing to become ripe at time of visit. Very popular. not sighted ...	a chestnut. The taste of the cooked flesh is like passion fruit, texture very soft. The nuts after preparation are completely taste- less and limp. Mango trees were close to the village and the fruits were watched with interest by the children. The mangoes here were not sufficiently ripe to taste.	(11) Nuts.—The nuts are first roasted, the very hard shell is broken with a stone, the meat is removed, cut into match strips, soaked overnight in salt water and then eaten. Eaten raw.
<i>Artocarpus incisa</i> (bread- fruit).	kum	...	snack	...	very popular ...	The soft flesh rather than the nuts are supposed to be eaten.	.....
.....	natu	...	snack	...	...	One large tree close to village. The fruits, about size of an apple, is crisp when raw. When it is cooked and completely ripe the texture is more like soft custard apple.	Eaten raw or roasted on fire.
<i>Canarium nchenbethe</i> (nuts).	viwi	...	snack	...	popular in season (Dec.), seen once during stay.	The nuts have a black hairy shell. The appearance and taste of the inner nut is like a chestnut.	Nuts removed from shell and roasted on fire.
<i>nziber minor</i> (wild Zigiber flower).	pwakikita	...	snack	...	popular with women and children.	The seeds of the ginger flower were very crisp and sweet.	Eaten raw.
	seisuya	...	snack	...	popular with women and children.	In appearance like small black currant. Very sweet to taste.	Eaten raw.

Table 1 (d).—KAVATARIA—continued.

Botanical Name (Common English Name).	Native Name.	Place in Diet.	Mean Daily per capita Consumption. ozs.	No. of Times Seen in 29 Visits.	Description.	Cooking Method.
Fish	18 native names recorded.	protein staple ...	3-8	14	Kavataria was a fishing village, and large hauls were made 2-3 times a week. Fishing was done mainly by stunning fish with derris root, and then collecting the fish as they came to the surface in a netted area. Spearing would be used for larger fish. Many varieties were caught, often with magnificent colours, and there would be many sizes in the one type of fish. The most frequently seen in the cooking pot was "Dub simila," a type of bream, the average size being about 1 lb.	(i) Cooked with the yams, etc. (ii) Placed between leaves and steamed on top of pot of yams. (iii) Placed on fire either wrapped in a leaf or plain. (iv) Using "native oven." Fire made in scooped-out portion of ground, allowed to die down. Earth sprinkled over hot coals, then fish wrapped in leaves, then a covering layer of earth. The fish would be cooked in about half-an-hour. (i) and (iii) were most popular methods.
Similar to whitebait	vaya	suppl. to fish ...	...	4	Small fish about 1 inch long, eaten whole and caught in nets.	Boiled with yams, etc., in pot.
Oysters	lapi	snack and suppl. to fish.	...	recorded once but frequently seen being eaten as snacks.	Quantities of large oysters were brought up in net baskets by the men, who were expert divers. Some were set aside for pearls, but the greater proportion would be cooked. Large crabs, the body sometimes being 12-18 inches across, were brought in by the fishermen.	(i) Roasted on fire. (ii) Boiled in shell with yams, etc.
Crab	kimago	snack and suppl. to fish.	0-4	not as popular as oysters.		As above.
Shellfish	4 native names recorded.	snack and suppl. to fish.	...	similar to oysters.	These are univalves collected close in to the beach by the women.	As above.

TABLE 1 (c).—KORAVAGI.

Botanical Name (Common English Name).	Native Name.	Place in Diet.	Frequency of Consumption.	Description.	Cooking Method.
<i>Metroxylon rumphii</i> (sago)...	pu	staple	two or three times a day	Cultivated and wild. The powdered sago is dirty grey to pinkish in colour. When cut it appears to have a waxy texture, but for cooking is crumbled into small pieces. The flavourings used in cooking could not disguise the earthy flavour. Baked sago sticks had a gelatinous exterior and a dry crumbling interior, and sago gruel was a watery gelatinous mass.	(a) <i>Baking</i> .—Sago was used alone or mixed with other ingredients to make sago sticks (N.N. Pu Kfai). The long thin leaves from the undeveloped nipa palm are made into a casing by doubling a leaf, holding it in place with three or four wooden needles, fill with sago, smooth down and seal down the side with three or four more needles. Toss into the fire. The sticks are turned on the fire and cook in about 15–20 mins. The leaf sheath is removed and sticks may be eaten hot or cold. Weights vary from 12 ozs. to 1 lb. 8 ozs. Sago sticks eaten for breakfast and for snacks. (b) <i>Boiling</i> .—Green leaves, nuts, bananas, etc., are added to cold water. When these foods are almost cooked, the sago is added—either in crumbs or patted into small cakes (o'oi), coconut (shredded or grs) is lastly added. (a) Cut into small pieces, boiled with greens, sago and coconut added. (b) Boiled, then mashed and added to sago soup.
<i>Colocasia andiquorum</i> (taro)	omera	suppl. to staple, esp. from May–July.	small amounts used once or twice a week.	Cultivated in gardens at old village sites and along banks of river. See Busama. Tuber only is used—leaves were not used. Taro grown in the Delta has a more earthy taste than taro in other districts. Taro eating natives from Busama district would not eat Delta taro. As above.	
<i>Xanthosoma sagittifolium</i> (bush dasheen).	alpu	suppl. to staple, esp. from May–July.	not sighted ...		Not sighted but treatment would be as above.
<i>Ipomoea batatas</i> (sweet potato).	mau	suppl. to staple, esp. from May–July.	more popular than taro, large amounts used.	Cultivated. Similar to sweet potatoes at other villages.	(a) As for taro (a) and (b). (b) Baked in ashes. (c) Cooked in small pieces with scented leaves and coconut. Becomes substitute for sago.

Table 1 (e).—KORAVAGI—continued.

Botanical Name (Common English Name).	Native Name.	Place in Diet.	Frequency of Consumption.	Description.	Cooking Method.
<i>Cucurbita maxima</i> (pumpkin)	...	suppl. to staple, esp. from May-July.	more popular than taro, large amounts used.	Cultivated in village garden. Grew well.	As for taro (a) and (b).
<i>Musa sapientis</i> (banana) ...	kavaia ...	suppl. to staple, esp. from May-July.	more popular than taro, large amounts used.	Cultivated in gardens at old village sites. Both green and sweet bananas were grown.	(a) Green bananas are peeled and sliced and cooked with greens, fish, etc. Then sago and coconut added. (b) Ripe bananas are cooked whole then mashed and returned to soup sago and coconut added. Is included in any sago soup.
<i>Artocarpus nobilis</i> (bread- fruit).	imara...	suppl. to staple, esp. from Nov.-Feb.	very popular seen about once a day.	Bush tree, very common. The nuts of the breadfruit only are eaten. Like chestnuts in flavour.	Shredded coconut added to every dish just before serving. The "gris" from squeezed coconut is not so popular, but is sometimes mixed with the mashed pumpkin, banana, etc., before being returned to the soup.
<i>Cocos nucifera</i> (coconut) ...	beda (mature coconut = imua).	...	eaten at every meal ...	Cultivated. Coconuts here were allowed to mature, the green coco- nuts (for drinking) being scarcely sighted. Shredded mature coconut meat was added to practically every dish of sago soup and most sago sticks. The shredded coconut was preferred to coconut "gris". The triploid endosperm (opu) was very popular as a snack with children and women.	
<i>Zea mays</i> (corn) ...	...	snack or suppl. to staple.	not very much grown...	Cultivated in small amounts only, but is popular and will probably be more widely grown.	(a) Roasted. (b) Boiled with sago soup.
<i>Nipa fruticans</i> (nipa palms)	kora (nuts = kora urui).	used for feasts ...	...	Bush. The nipa palm grows along the banks of the river, and whilst there was no doubting the uses of its leaves (basket making, unopened leaves for sago sticks, etc.), its actual place in food seemed un- certain. The nuts did contain a small quantity of sweet, colourless, and otherwise tasteless jelly, a very poor return for the effort expended in breaking up the hard case of the nut. The unopened leaves (or in P.E. kru and N.N. bayal onopu)	Nuts eaten raw. The growing stem said to be eaten raw or cooked with sago soup.

<i>Garcinia</i> sp. ...	ma'a puvaki	...	snack	...	unknown	...	colour, texture soft, and taste is practically restricted to a mild astringent effect. The fruit looks particularly palatable and is most disappointing.	Eaten raw.
<i>Myristica</i> sp. (wild nutmeg).	ma'a uni	...	snack	...	unknown	...	Green-skinned, oval-shaped fruit. The flesh is crisp, white, and tasteless.	Eaten raw.
<i>Eugenia malaccensis</i> (Malay apple).	ma'a ari'ivaki	...	snack	...	unknown	...	Outside appearance like a firm apricot. The flesh is white, very hard, and has a decided astringent and spicy flavour, rather like ginger. Only a little can be eaten at one time.	Eaten raw.
<i>Zingiber minor</i> (ginger plant).	kakua	...	snack	...	unknown	...	See Busama	Eaten raw.
<i>Carica papaya</i> (pawpaw)	...	...	rarely eaten	...	unknown	...	The seeds and flowers are reputed to be eaten.	Eaten raw.
<i>Ananas cosmosus</i> (pine-apple).	...	...	rarely eaten	...	unknown	...	Very poor quality and not popular ... The largest pineapples seen on the trip were grown at another delta village. As well as being enormous, the flavour was excellent. However, similar pineapples were not seen at Koravagi.	Eaten raw.
<i>Citrus</i> sp. (lemons)	...	...	snack	...	unknown	...	Lemons were eaten whole and without sugar. This was unusual compared to other villages.	Eaten raw.
Green Leaves (N.N. ura)— <i>Cassia leschnaultia</i> (cassia)	ura	...	relish	...	unknown	...	Bush. Tiny bipinnate leaves. No particular flavour.	Cooked with water, sometimes only, sometimes combined with other foods before adding sago and coconut.
<i>Hibiscus exultentus</i> (okra)	ura uri	...	relish	...	unknown	...	Bush. Leaves similar to <i>abelmoschus</i> the leaves the nuts were cooked. These were encased in a tough skin, easily removed on cooking, and were rather like soft almonds. Very palatable raw or cooked. Kemu is seasonal and is not available during March-July.	As above.
<i>Gnetum gnetum</i> ...	(kemu uru—nuts; kemu o'o—leaves)	...	relish	...	very popular every day	...	See Busama. In addition to the leaves the nuts were cooked. These were encased in a tough skin, easily removed on cooking, and were rather like soft almonds. Very palatable raw or cooked. Kemu is seasonal and is not available during March-July.	The most popular of the green leaves. A frequent ingredient in sago soup.
—(<i>Pteridophyta</i>) (fern) ...	dape darai	...	...	...	unknown	...	Bush. Young fern leaves. See Busama.	As for other green leaves.
<i>Morus</i> sp. ...	barva...	...	...	...	unknown	...	Bush. Dark green oval leaves.	.....
<i>Ficus</i> sp. (bush fig)	awe	...	...	...	...	...	Bush. See Busama.	.....

Table 1 (c).—KORVVAGI—continued.

Botanical Name (Common English Name).	Native Name.	Place in Diet.	Frequency of Consumption.	Description.	Cooking Method.
<i>Erodia</i> sp. (tree)	koromua ...	flavouring ...	unknown ...	Bush. Lemon-scented leaves either used green, or dried and crumbled into pot.	Cooked with sago soup. The green leaves are not eaten.
<i>Cymbopogon citratus</i> (lemon grass).	biku ...	flavouring ...	unknown ...	Bush. Lemon grass. Tied in bundles and added to cooking pot—removed before serving.	.....
(aniseed bush)	ka'uli ...	flavouring ...	unknown ...	Cultivated. Aniseed flavouring ...	.....
<i>Miscellaneus</i> <i>Arenga</i> sp. (slim bamboo-like palms).	kawapa bayai ...	snack ...	unknown ...	Bush. The growing shoots of the palm, similar to the "krus" (P.E.) found in New Guinea villages. Very like soft and rather sweet celery.	Eaten raw.
<i>Auricularia</i> sp. (fungus)...	vevere ...	relish ...	unknown ...	As for Busama...	.....
family <i>Cerambycidae</i>	kikira ...	snack ...	unknown but considered a delicacy.	Bush. These are the grubs of the sago palm. In appearance they were 1-1½ inches long, fat, soft and white. After the initial psychological nausea had been overcome, the taste of roasted grub was most palatable, resembling a fried pork sausage.	Eaten raw, or roasted on fire.
Fish ...	inapel ...	suppl. to staple ...	almost every second day	Many varieties of river and mud fish, including "lung fish" caught by well-made nets and traps.	Dried fish crumbled and added to sago soup. Fresh fish, cleaned and cut in sections, and cooked with sago soup.
Shellfish ...	kea (oysters), numerous univalves.	suppl. to staple ...	unknown ...	Many varieties of univalves and a good supply of large oysters.	Cooked with sago soup.
Shrimps ...	kikeni ...	suppl. to staple ...	unknown ...	Good supply of shrimps and king prawns. Plentiful supply of crabs in the mud.	Cooked with sago soup.
Crocodile ...	komara ...	delicacy ...	unknown ...	One baby crocodile was sighted being fattened for eating.	Unknown.
Pig ...	a'oli ...	... ..	unknown ...	Pig was eaten once during visit. Very few village pigs, but some wild pigs are found in the bush.	Unknown.

TABLE 2.—MEAN DAILY CONSUMPTION OF FOODSTUFFS IN FOUR OF THE VILLAGES SURVEYED (Ounces per head per day).

Group.	Foodstuff (Edible Portion).	Busama.	Kaiapit. *	Patep. *	Kavataria.
Staple and substitute for staple.	Taro and Taro kong kong.	18.2	2.6	22.4	3.8
	Sweet potato ...	.....	9.2	18.4	6.1
	Bananas ...	0.3	11.3	0.2	2.4
	Yams ...	0.4	3.4	0.1	24.5
	Sago ...	1.9	0.1	.....	.....
	Pumpkin ...	.....	0.9	0.4	0.6
	Tapioca ...	.....	0.7	0.1	0.6
	Total ...	20.9	28.2	41.7	38.1
Cereals and legumes ...	Corn ...	0.1	.....	1.5	.....
	Rice ...	{ 0.03 0.2	0.1	0.4	{ 0.01 0.1
	Bean seeds ...	.....	0.1	.....	.....
	Total ...	0.3	0.2	1.9	0.1
Nuts ...	Coconut (meat only)..	0.6†	3.4†	.....	1.4
Green leaves ...	Taro leaves ...	2.5	0.1	.....	.....
	Aibika ...	0.9	2.3	1.2	.....
	Pumpkin leaves ...	.....	0.7	0.3	.....
	Other green leaves ...	0.6	0.2	1.1	0.1
	Total ...	4.0	3.3	2.6	0.1
Other fruits and vege- tables.	Whole beans ...	0.03	.....	0.4	.....
	Pit Pit... ..	0.4	0.2	0.3	.....
	Growing shoots ...	1.1	Neg.	1.0	.....
	Tomatoes ...	.....	.....	0.03	.....
	Cucumber melon ...	0.2	.....	0.3	.....
	Paw Paw ...	0.2	.....	.....	1.0
	Sugar cane ...	0.1	.....	0.5	.....
	Breadfruit ...	.....	0.1	.....	.....
	Others ...	0.03	0.4	.....	.....
	Total ...	2.0	0.7	2.2	1.0
Meat and fish ...	Pig ...	.....	0.6	0.1	.....
	Canned corn beef ...	0.1	0.1	0.2	0.03
	Fish and shell fish ...	0.8	.....	.....	3.8
	Whole small fish ...	.....	.....	.....	0.4
	Total ...	0.9	0.7	0.3	4.3

* In the cases of both Kaiapit and Patep it would appear that the time of visiting both communities disturbed the food intake picture from what might be overall average for the year. This can be seen from the figures presented in Table 4 of Section 2 of the Agricultural report. It can be seen that the intakes of taro at Patep and Sweet Potato at Kaiapit are greater than would be expected from the acreages devoted to their production. This is thought to be particularly the case in relation to Sweet Potato at Kaiapit where only an area of six acres was under crop.

† Incomplete record. Actual intake will be higher.

TABLE 3.—SUGGESTED DIETARY ALLOWANCES FOR NEW GUINEA NATIVES.

	Calories.	Protein. gms.	Calcium. gms.	Thiamine. mgm.	Ascorbic Acid. mgm.
Man—					
Age 21-49—54 kg. ...	2,500	40	0.8	0.84	50
Age 50 and over—48.6 kg. ...	2,000	40	0.8	0.70	50
Woman—					
Age 21-49—46 kg. ...	2,100	40	0.8	0.77	50
Age 50 and over—40 kg. ...	1,600	40	0.8	0.53	50
Pregnancy ...	2,100	85	1.5	1.44	80
Lactation ...	2,600	100	2.0	1.64	130
Children up to 12 years—					
1 year—8.2 kg. ...	850	35	1.0	0.30	30
2-3 year—11.2 kg. ...	1,000	40	1.0	0.35	30
4-6 year—15.5 kg. ...	1,300	50	1.0	0.46	30
7-9 year—20.9 kg. ...	1,650	60	1.0	0.56	30
10-12 year—27.3 kg. ...	2,000	70	1.2	0.70	30
Children over 12 years—					
Girls 13-15—35.9 kg. ...	2,200	80	1.3	0.77	50
Girls 16-20—46.4 kg. ...	2,050	75	1.0	0.72	50
Boys 13-15—35.4 kg. ...	2,400	85	1.4	0.84	50
Boys 16-20—49.5 kg. ...	2,900	100	1.4	1.01	50

TABLE 4.—MEAN DAILY PER CAPITA INTAKE OF NUTRIENTS BY HOUSEHOLDS IN BUSAMA.

Household.		Calories.	Protein.		Calcium.	Thiamine.	Ascorbic Acid.
			Animal. grams.	Vegetable. grams.	grams.	Milligrams.	Milligrams.
2.	1st visit ...	1,101	...	10.6	0.296	0.761	47
	2nd visit ...	1,373	...	7.9	0.232	0.553	34
3.	1st visit ...	491	...	8.8	0.353	0.406	156
	2nd visit ...	327	...	4.8	0.264	0.263	50
4.	1st visit ...	997	2.1	16.6	0.711	0.823	171
	2nd visit ...	1,085	2.1	10.9	0.250	0.749	40
5.	1st visit ...	642	...	15.9	0.404	0.500	102
	2nd visit ...	959	...	13.0	0.513	0.713	95
6.	1st visit ...	589	...	11.1	0.230	0.542	114
	2nd visit ...	1,919	...	6.0	0.114	0.243	9
7.	1st visit ...	2,376*	{ 6.8* 82.2 }	36.7*	1.475	1.657	488
	2nd visit ...	1,009*		14.2*	0.288	0.806	96
8.	...	2,491	...	15.6	0.587	0.818	171
9.	1st visit ...	1,365	...	9.6	0.324	0.580	32
	2nd visit ...	544	...	9.3	0.036	0.499	20
10.	1st visit ...	1,420	...	13.7	0.383	0.980	61
	2nd visit ...	891	...	8.6	0.240	0.616	38
11.	1st visit ...	1,032*	1.7*	14.6*	0.455	0.800	120
	2nd visit ...	1,485*	2.1*	16.3*	0.346	0.615	99
12.	1st visit ...	2,400	...	17.4	0.721	0.736	229
	2nd visit ...	4,422	...	33.8	1.031	1.827	262
13.	1st visit ...	1,756	29.4	15.4	0.724	0.390	130
	2nd visit ...	1,635	...	17.3	0.381	0.765	131
14.	1st visit ...	811	...	22.8	1.624	0.978	498
	2nd visit ...	985	...	13.9	0.617	0.779	193
15.	1st visit ...	1,620	...	14.9	0.379	0.992	232
	2nd visit ...	1,387	...	17.1	0.574	1.069	120
16.	1st visit ...	631*	1.6*	16.9*	0.287	0.600	72
	2nd visit ...	1,272*	2.0*	22.9*	0.886	1.143	357
17.	1st visit ...	487	...	7.4	0.382	0.411	107
	2nd visit ...	973	...	13.9	0.657	0.805	219
18.	1st visit ...	1,398	26.1	20.5	1.094	1.210	422
	2nd visit ...	1,253	...	22.6	1.305	1.049	249
19.	1st visit ...	1,258	...	12.1	0.338	0.869	54
	2nd visit ...	761	...	13.2	0.844	0.685	254
20.	1st visit ...	2,683	61.8	21.2	0.711	1.700	94
	2nd visit ...	1,615	...	21.0	0.440	1.058	66
21.	1st visit ...	655	...	7.1	0.263	0.454	38
	2nd visit ...	420	...	7.9	0.193	0.260	99
22.	...	983	...	9.5	0.265	0.680	42
Average ...		1,223	0.9* 3.8	14.4 19.2	0.5	0.7	137

* 1 lb. rice and 4 oz. tinned meat supplied to members of household working at camp. This increases calories and vegetable protein and provides animal protein in amounts shown.

TABLE 5.—MEAN DAILY PER CAPITA INTAKE OF NUTRIENTS BY HOUSEHOLDS IN KAIAPIT.

Household.	Calories.	Protein.		Calcium.	Thiamine.	Ascorbic Acid.
		Animal.	Vegetable.			
		grams.	grams.	grams.	milligrams.	milligrams.
1. 1st visit ...	3,135	38.3	29.4	0.526	3.261	118
2nd visit ...	1,481	...	18.6	0.716	1.083	271
2. 1st visit ...	667	...	9.2	0.122	0.291	134
2nd visit ...	2,203	...	25.4	1.216	1.882	473
3. ...	1,062	...	14.4	0.404	0.542	130
7. ...	1,591	...	23.1	0.594	0.966	255
10. ...	3,484	...	29.1	0.976	2.987	661
11. ...	843	...	10.4	0.320	0.338	102
15. ...	3,027	...	45.6	1.350	1.802	389
16. 1st visit ...	1,091	...	13.5	0.287	0.462	136
2nd visit ...	856	...	12.2	0.273	0.586	44
17. ...	835	...	14.2	0.446	0.506	156
18. ...	2,387	...	16.9	0.239	1.952	439
19. ...	1,762	11.3	20.7	0.249	1.643	125
22. ...	1,286	...	20.1	1.079	1.132	211
23. ...	1,018	...	8.4	0.347	0.976	231
24. ...	631	...	15.0	0.933	0.456	186
36. ...	1,866	...	32.4	0.469	1.143	122
42. ...	2,756	...	34.1	0.653	2.145	485
45. ...	869	...	25.3	0.853	0.915	132
40, 46. ...	2,384	...	28.4	0.508	1.404	333
49. 1st visit ...	1,418	...	21.9	0.641	0.771	190
2nd visit ...	1,211	...	17.6	0.202	0.579	154
50. ...	1,676	...	18.0	0.520	1.137	181
51. ...	1,803	...	48.6	0.454	0.230	158
52. ...	4,834	...	52.8	1.117	3.582	891
53. 1st visit ...	1,590*	9.1*	24.9*	0.956	0.964	129
2nd visit ...	1,372*	9.1*	21.0*	0.540	1.119	118
63. ...	475	...	6.3	0.246	0.217	84
64. ...	1,342	...	19.1	0.706	0.617	222
65. ...	2,346	...	24.4	0.339	1.668	344
66. ...	1,126	...	22.6	0.965	1.072	250
Average ...	1,609	{ 0.4* 2.7 }	21.7	0.59	1.05	216

* 10 oz. rice and 4 oz. tinned meat supplied to member of household working at camp. This increases calories and vegetable protein and provides animal protein in amounts shown.

TABLE 6.—MEAN DAILY PER CAPITA INTAKE OF NUTRIENTS
BY HOUSEHOLDS IN PATEP.

Household.	Calories.	Protein.		Calcium.	Thiamine.	Ascorbic Acid.
		Animal.	Vegetable.			
		grams.	grams.	grams.	milligrams.	milligrams.
1. 1st visit ...	1,651	...	18.2	0.827	1.32	222
2nd visit ...	1,690	...	12.1	0.491	1.39	231
2. 1st visit ...	752†	...	9.3	0.430	0.62†	110
2nd visit ...	1,682	...	12.0	0.336	1.28	171
3. ...	2,628	...	34.4	1.309	2.02	337
4. ...	1,910*	6.0*	36.9	0.725	1.74	245
5. ...	2,487*	6.0*	36.9	0.746	2.06	176
6. 1st visit ...	2,260	...	30.2	0.552	2.11	144
2nd visit ...	1,768	...	14.3	0.321	1.46	235
7. ...	2,057*	9.1*	99.3§	0.431	3.85§	138
8. ...	2,391	...	28.6	0.862	1.73	222
9. ...	1,503	...	10.1	0.200	1.32	264
10. ...	1,506	7.0	11.1	0.276	1.55	154
11. ...	1,965*	10.9*	18.7	0.382	1.41	115
12. ...	2,171	...	22.4	0.550	1.74	231
13. 1st visit ...	2,115*	6.8*	14.5	0.219	1.84	364
2nd visit ...	1,805*	6.8*	14.1	0.246	1.52	252
14. ...	1,911	...	17.8	0.443	1.41	150
15. ...	2,504	...	21.0	0.707	2.36	589
16. ...	1,689	...	20.3	0.894	1.26	162
17. ...	2,050	...	24.2	0.637	1.70	230
18. ...	2,196	...	32.5	1.080	2.14	477
19. ...	2,100	...	32.5	1.419	1.72	251
20. 1st visit ...	1,283	...	9.4	0.208	1.08	189
2nd visit ...	1,422	...	8.1	0.142	1.31	297
21. ...	2,669	...	49.7	2.058	2.65	321
22. ...	2,304‡	...	16.4	0.299	2.02	413
23. ...	2,050	...	14.6	0.311	1.76	322
24. ...	1,321	11.3	9.5	0.241	1.67	142
Average ...	1,904	$\left\{ \begin{array}{l} 1.6^* \\ 0.5 \end{array} \right\}$ 22.3 24.4		0.6	1.7	244

* Receive rations from camp :—brown rice 14 oz., bully beef 8 oz.

† Exceptional day due to work of survey party—was supplemented with rice (not weighed).

‡ Small household contributing appreciable quantity of food to house boy.

Consumed 10 lb. 10 oz. corn.

TABLE 7.—MEAN DAILY PER CAPITA INTAKE OF NUTRIENTS
BY HOUSEHOLDS IN KAVATARIA.

Household.	Calories.	Protein.		Calcium.	Thiamine.	Ascorbic Acid.
		Animal	Vegetable.			
		grams.	grams.	grams.	milligrams.	milligrams.
1.	852	10.2	8.9	0.275	0.691	93
2.	2,400	50.8	31.6	0.769	2.153	280
3.	997	5.8	13.4	0.124	0.875	79
4.	957	...	14.9	0.091	0.894	77
5.	824	...	11.8	0.076	0.745	72
6.	1,488	25.7	13.9	0.477	1.261	133
7.	1,392	2.1	20.4	0.155	1.079	80
8.	1,532	12.3	23.6	0.177	1.269	128
9.	1,521	...	29.1	0.212	1.403	109
10.	1,284	...	23.6	0.071	1.163	65
11.	1,950	34.9	19.8	0.972	1.157	190
13.	1,164	...	14.8	0.145	1.094	232
14.	1,661	91.2	16.8	0.295	1.061	46
19.	1,026*	{ 10.2 5.4* }	12.8*	0.109	0.737	58
24.	1,578	...	16.0	0.168	1.364	287
32.	1,593	40.7	15.3	0.720	1.370	192
33.	2,582	...	36.8	0.213	1.656	104
39.	2,227	58.8	26.0	0.320	1.721	154
44.	845	...	11.9	0.081	0.789	85
45. 1st visit	2,200	...	26.9	0.412	1.558	86
2nd visit	1,465	...	25.7	0.137	1.364	79
55.	2,149	50.3	26.5	0.263	1.381	107
56.	1,104	...	15.2	0.147	0.951	87
64.	1,842	27.1	17.1	0.292	1.458	351
69.	2,092	...	22.3	0.289	1.309	195
70.	2,942	68.7	25.2	0.695	2.128	393
72.	2,643	67.5	36.5	0.426	2.236	145
82.	1,490	23.2	10.5	0.207	1.058	263
84.	1,154	...	18.9	0.100	0.936	51
Average ...	1,600	{ 22.2 0.2 }	18.9	0.3	1.25	142
		41.3				

* 8 oz. rice and 4 oz. tinned meat supplied to member of household working at camp. This increases calories and vegetable protein and provides animal protein in amount shown.

TABLE 8.—COMPARISON OF NUTRIENT INTAKE PER CAPITA PER DAY
OF THE HOUSEHOLDS SURVEYED IN FOUR VILLAGES.

	Calories.	Protein.			Calcium.	Thiamine.	Ascorbic Acid.
		Animal.	Vegetable.	Total.			
		grams.	grams.	grams.	grams.	milligrams.	milligrams.
Busama ...	1,223	4.7	14.4	19.2	0.5	0.7	137
Kaiapit ...	1,609	3.1	21.7	24.8	0.6	1.05	216
Patep ...	1,904	2.1	22.3	24.4	0.6	1.7	244
Kavataria ...	1,600	22.4	18.9	41.3	0.3	1.25	142

TABLE 9.—INTAKE OF NUTRIENTS BY HOUSEHOLDS IN BUSAMA]
EXPRESSED AS PERCENTAGE OF REQUIREMENTS.

Household.	Calories.	Protein.	Calcium.	Thiamine.	Ascorbic Acid.
	per cent.	per cent.	per cent.	per cent.	per cent.
2. 1st visit ...	64.5	21.3	30.7	156.0	100
2nd visit ...	79.0	16.0	23.3	109.0	73
3. 1st visit ...	26.8	15.5	33.7	57.2	359
2nd visit ...	17.5	8.4	26.0	37.0	114
4. 1st visit ...	57.0*	39.6*	76.0	114.0	354
2nd visit ...	62.0*	27.5*	26.6	104.0	82
5. 1st visit ...	32.5	27.5	41.2	71.8	247
2nd visit ...	47.3	23.3	53.6	103.0	225
6. 1st visit ...	30.1	18.7	21.4	76.0	258
2nd visit ...	108.0	10.3	10.6	34.9	21
7. 1st visit ...	128.0*	205.0*	137.0	227.0	1,055
2nd visit ...	51.7*	35.5*	25.9	105.0	205
8. ...	126.0	34.7	65.2	119.0	362
9. 1st visit ...	79.8	20.8	35.3	97.4	85
2nd visit ...	31.8	20.3	3.9	83.5	54
10. 1st visit ...	90.0	26.7	38.0	151.0	142
2nd visit ...	56.5	16.7	24.0	95.0	89
11. 1st visit ...	52.1	27.9	43.6	108.2	27
2nd visit ...	80.7	31.8	33.3	97.4	221
12. 1st visit ...	120.8	32.1	76.5	105.2	422
2nd visit ...	226.0	62.9	114.5	265.0	580
13. 1st visit ...	90.1	68.3	61.9	44.5	276
2nd visit ...	84.0	26.3	32.6	87.2	279
14. 1st visit ...	43.7	41.5	157.0	151.0	1,290
2nd visit ...	53.6	25.2	61.0	121.0	500
15. 1st visit ...	88.6	25.8	37.9	155.5	580
2nd visit ...	77.5	31.0	60.0	172.0	286
16. 1st visit ...	60.0*	33.6*	29.6	86.8	156
2nd visit ...	72.5*	48.5*	91.3	174.0	820
17. 1st visit ...	29.0	14.2	38.2	69.2	306
2nd visit ...	72.0	32.7	82.1	169.0	783
18. 1st visit ...	89.1	93.1	113.0	184.0	938
2nd visit ...	81.0	45.2	135.0	159.0	555
19. 1st visit ...	67.0	25.2	34.5	112.0	111
2nd visit ...	40.2	27.2	85.8	88.1	525
20. 1st visit ...	137.0	170.0	75.8	210.0	168
2nd visit ...	74.5	37.0	42.2	131.0	131
21. 1st visit ...	39.5	14.1	27.7	78.3	103
2nd visit ...	25.2	15.7	20.3	44.9	264
22. ...	50.0	21.9	30.5	99.2	98
Average ...	67.2	33.7	50.0	100.0	309

* 1 lb. rice and 4 oz. tinned meat supplied to member of household working at camp increases calories and protein.

TABLE 10.—INTAKE OF NUTRIENTS BY HOUSEHOLDS IN KAIAPIT
EXPRESSED AS PERCENTAGE OF REQUIREMENTS.

Household.		Calories.	Protein.	Calcium.	Thiamine.	Ascorbic Acid.
		per cent.	per cent.	per cent.	per cent.	per cent.
1.	1st visit ...	.....	130.0	52.0	481.0	267
	2nd visit ...	84.9	33.6	68.5	155.5	633
2.	1st visit ...	32.0	21.1	14.1	42.1	310
	2nd visit ...	112.9	58.8	142.0	282.0	1,090
3.	...	48.0	26.9	41.8	68.4	260
7.	...	85.5	45.3	60.6	148.9	606
10.	...	217.5	72.6	122.0	563.0	1,320
11.	...	52.0	20.2	32.9	50.0	227
15.	...	160.7	80.4	135.2	276.0	1,060
16.	1st visit ...	59.8	24.5	27.9	.....	237
	2nd visit ...	52.3	26.3	29.2	71.0	74
17.	...	47.3	24.0	40.9	74.9	336
18.	...	115.8	28.9	25.6	276.2	1,011
19.	...	76.0	68.6	27.8	204.0	247
22.	...	95.5	41.6	112.0	157.0	373
23.	...	60.3	16.8	36.5	129.0	440
24.	...	32.0	34.5	107.0	66.0	427
36.	...	89.8	40.5	37.5	105.9	188
42.	...	153.0	85.0	81.4	349.0	969
45.	...	54.4	53.2	90.0	125.0	251
40. and 46.	...	125.0	47.3	50.2	188.0	679
49.	1st visit ...	75.7	39.0	61.0	92.8	330
	2nd visit ...	64.4	31.2	19.4	69.7	268
50.	...	104.0	35.6	54.2	198.0	378
51.	...	103.0	97.2	47.3	38.6	415
52.	...	268.0	96.0	111.7	581.0	2,230
53.	1st visit ...	92.2*	73.0*	102.0	116.4	214
	2nd visit ...	80.5*	64.4*	58.0	135.0	197
63.	...	21.6	9.7	21.0	21.9	157
64.	...	64.5	39.7	80.2	86.4	529
65.	...	130.0	61.0	42.4	261.0	687
66.	...	58.8	36.9	87.6	134.0	570
Average ...		87.8	47.0	60.0	143.0	446

* 10 oz. rice and 4 oz. tinned meat supplied to member of household working at camp increases calories and protein.

TABLE 11.—INTAKE OF NUTRIENTS BY HOUSEHOLDS IN PATEP
EXPRESSED AS PERCENTAGE OF REQUIREMENT.

Household.	Calories.	Protein.	Calcium.	Thiamine.	Ascorbic Acid.
	per cent.	per cent.	per cent.	per cent.	per cent.
1. 1st visit ...	93.0	36.0	85.0	216.0	577
2nd visit ...	87.5	16.0	50.5	210.0	555
2. 1st visit ...	40.0†	16.0	41.0	83.7†	234
2nd visit ...	90.1	21.0	32.0	170.0	362
3. ...	124.5	51.5	118.0	249.0	687
4. ...	111.6*	94.3*	77.7	286.0	630
5. ...	134.0*	72.0*	71.5	257.0	310
6. 1st visit ...	104.8	44.0	47.0	206.0	264
2nd visit ...	85.2	22.0	29.0	170.0	453
7. ...	109.3*	240.0*§	48.0	578.0§	318
8. ...	122.6	60.3	94.5	214.0	413
9. ...	88.0	22.0	22.0	222.0	690
10. ...	87.2	45.0	32.0	258.0	355
11. ...	93.6*	45.0*	34.0	162.0	240.0
12. ...	110.9	35.3	53.0	223.0	476
13. 1st visit ...	115.0*	42.5*	23.0	250.0	720
2nd visit ...	98.2*	41.9*	26.0	208.0	491
14. ...	112.4	39.6	50.0	230.0	377
15. ...	119.7	30.0	58.0	286.0	1,120
16. ...	89.7	42.5	99.4	196.0	405
17. ...	121.5	58.6	70.8	287.0	577
18. ...	121.0	66.0	111.2	334.0	1,150
19. ...	103.5	57.6	138.0	243.0	568
20. 1st visit ...	73.0	17.0	20.0	151.0	415
2nd visit ...	81.0	15.0	14.0	184.0	630
21. ...	133.0	89.4	277.0	338.0	624
22. ...	192.0‡	35.0	28.5	305.0	773
23. ...	120.0	32.0	34.0	293.0	840
24. ...	77.0	38.0	24.0	233.0	294
Average ...	102.0	46.0	60.5	231.0	521

See Notes *, †, ‡, § on Table 6.

TABLE 12.—INTAKE OF NUTRIENTS BY HOUSEHOLDS IN KAVATARIA
EXPRESSED AS PERCENTAGE OF REQUIREMENT.

Household.	Calories.	Protein.	Calcium.	Thiamine	Ascorbic Acid.
	per cent.	per cent.	per cent.	per cent.	per cent.
1.	45.2	40.2	30.6	104.8	233
2.	109.0	164.8	83.0	280.0	560
3.	44.3	30.3	11.5	111.8	167
4.	42.6	25.4	8.6	113.6	171
5.	51.5	24.9	8.0	101.5	136
6.	70.2	89.4	51.4	171.0	265
7.	68.0	40.8	15.7	134.0	163
8.	73.0	61.7	17.7	174.0	305
9.	78.7	54.5	21.9	210.4	211
10.	55.9	59.0	8.9	145.0	130
11.	111.0	121.5	108.0	161.0	367
13.	64.8	27.0	14.5	177.0	580
14.	87.0	176.5	27.8	134.0	103
19.	60.0*	52.5*	10.7	99.0	112
24.	75.1	38.1	20.0	185.5	625
32.	88.5	124.0	80.5	215.0	479
33.	129.1	66.8	21.0	236.0	260
39.	125.0	182.5	34.3	234.0	298
44.	44.9	20.3	7.5	95.7	178
45. 1st visit	110.0	63.4	47.9	219.0	191
2nd visit	73.2	60.5	16.1	192.0	176
55.	136.1	149.5	26.4	212.5	251
56.	45.8	38.0	18.4	118.0	175
64.	114.8	93.1	30.8	199.0	665
69.	92.5	37.2	28.9	166.9	387
70.	134.0	187.5	74.5	277.0	835
72.	148.8	260.0	50.1	370.0	321
82.	88.5	81.8	23.0	178.5	659
84.	56.8	37.8	10.7	138.5	117
Average	81.7	81.7	21.5	172.0	300

* 8 oz. rice and 4 oz. tinned meat supplied to member of household working at camp increases calories and protein.

TABLE 13.—COMPARISON OF FOUR VILLAGES ON THE BASIS OF THE
DAILY PER CAPITA INTAKE OF NUTRIENTS EXPRESSED AS A
COMPARISON OF REQUIREMENTS.

Village.	Calories.	Protein.	Calcium.	Thiamine.	Ascorbic Acid.
	per cent.	per cent.	per cent.	per cent.	per cent.
Busama	67.2	33.7	50.0	100	309
Kaiapit	87.8	47.0	60.0	143	446
Patep	102.0	46.0	60.5	231	521
Kavataria	81.7	81.7	21.5	172	300

PART 5.

REPORT ON HEALTH AND NUTRITIONAL STATUS.

BY

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The Health.

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Hookworm disease—

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Tuberculosis—

Technique of tuberculin tests.

Results and discussion.

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Framboesia, scabies, tinea and leprosy.

The Nutritional Status.

Observations on General Physique and Function.

Evidence of deficiency of specific nutrients:—

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Protein.

Vitamin A.

Thiamin (vitamin B₁).Riboflavin (vitamin B₂).

Niacin.

Iron.

Ascorbic acid (vitamin C).

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Rickets.

Iodine.

Summary.

Recommendations.

Introduction.

The health and nutritional status of the native populations investigated were evaluated as a result of clinical examination supplemented with parasitological, biochemical and radiological examinations.

The first step in estimating the nutritional status of the population is to observe the appearance and behaviour of the people. The first impression so gained is usually not far from the final conclusion. The next step is to ascertain the trend of the number of the population, whether it be increasing, stationary or decreasing. This is often a useful guide to the nutritional status of a people.

The people are then examined by the more detailed "indicators" available, such as the clinical, biochemical and parasitological examinations. The results obtained are compared with standards derived from other types of people—usually from Europeans or Americans living under very different circumstances. For this reason these "standards" have to be applied with realization of their limitations.

Methods.

VITAL STATISTICS.

The "village rolls" were examined together with the records held at the district offices. (The data obtained from these sources were of little use, because during the war records were lost.)

THE DETAILED EXAMINATION.

In each village approximately twenty household groups were selected at random. Each individual in the group was examined by a combined clinical, biochemical, parasitological and radiological examination and the result recorded on a punch card system.

CLINICAL.

Notes were made of the general appearance, age, sex, height, and weight, the health of the skin and appendages, degree of subcutaneous tissue present, tonicity of musculature, and bony structures (especially for signs of rickets); knee reflexes and squatting test; and appearances of the eyes, lips, teeth and gums. Records were made of splenic enlargement and other evidence of disease such as tropical ulcer, tinea, scabies, framboesia (yaws), leprosy, tuberculosis, etc. Because of the short time spent in each village and the risk of alienating the people it was not considered advisable to make an examination for venereal disease.

* BIOCHEMICAL.

Measurements of concentrations in the blood of haemoglobin, serum protein, and plasma ascorbic acid were made on each individual.

The ascorbic acid content of the breast milk of lactating mothers was estimated.

* PARASITOLOGICAL.

From each individual of the household groups selected, simultaneous parasitological examinations were made of faeces for ova of helminths, and of blood films for malarial protozoa.

* Full reports of these sections of the survey will be found in Parts 7, 6, 8. Data relating to nutritional status will, by agreement with the respective authors, be incorporated in the discussion of this report.

* DENTAL.

At three of the villages a dental officer made a survey of the health of the teeth and gums, and a dental bacteriologist collected data of the mouth bacteriology of the native groups.

RADIOLOGICAL.

In all infants under two years of age, the lower ends of the forearm bones were examined radiologically.

TUBERCULIN TESTS.

The contact of the village population to tuberculosis was measured by their response to Mantoux Tests.

EPIDEMIOLOGICAL HISTORY.

Information about the possible influence of past epidemics was sought from elders of the village and from patrol records—where the latter were available.

Health.

MALARIA.

An examination of the spleen rates recorded in Table I, shows that malaria was present in all the villages examined, varying from hyperendemic areas at Busama and Kaiapit to areas of low endemicity at the mountain village of Patep and at the island village of Kavitaria. The epidemiology is discussed fully in the Parasitological Report.

Effect of Malaria on General Health. The effect of malaria on the well being of the people is generally most noticeable in the infants and less noticeable as age advances. The healthy appearance of the infants seen at Patep and Kavitaria who were all free of malaria, was in marked contrast to the pallid, listless infants seen at Busama and Kaiapit. In the young children, higher spleen and parasite rates were paralleled by the listlessness and depression of normal childhood activities. In adults, malaria is still a menace to health and well being. This was particularly noticeable amongst members of the native staff of the expedition who were under closer observation than the village people. The usual manifestation was the complaint of headache and a disinclination for work and sometimes pain in the left hypochondrium. Examination usually revealed a low fever and a conjunctivitis which when seen in these natives led us to suspect an attack of malaria. Not infrequently amongst the village natives were seen more severe grades of the disease, of acute and chronic type, which offered a real threat to life.

Effect of Malaria on Hæmoglobin Levels.

A correlation of the hæmoglobin levels with the spleen and parasite rate gives a highly significant correlation coefficient (Tables II and III). This indicates that malaria had an important effect in reducing the hæmoglobin

*(See note p. 144.)

level of the blood. Confirmation of this finding comes from the fact that significant differences of the mean hæmoglobin levels of each village did occur (see Biochemical Report), and that on comparing this result with the spleen and parasite rates of the villages, generally high hæmoglobin values were found where there were low spleen and parasite rates.

Attention is drawn to the comments of the biochemist relating to the reliance that can be placed on the hæmoglobin figures as absolute values. On the evidence it appears that the hæmoglobin values reported are much lower than corresponding values for people of Caucasian origin. Undoubtedly malaria plays a part in producing this finding, but other environmental, and even racial factors may operate. This possibility can only be decided by further work.

Native Treatment of Malaria.

Almost all the natives encountered were well aware of the identity of the disease and of the value of quinine in treatment, and were always anxious to obtain supplies of this drug. Sometimes native methods of treatment were employed. An interesting example was at Kaiapit where the bark of the cinnamon tree was chewed and reputed to be effective. If this was unobtainable, wild ginger, or, in fact, any other vegetable product which produced a hot feeling in the stomach, was used. At Kavataria headache was treated by crushing a certain leaf with an odour somewhat resembling eucalyptus, rubbing it on the forehead, and inhaling the vapour. (Personal experience of the latter treatment confirmed its efficacy for headache.)

HOOKWORM DISEASE.

This has been discussed fully in the Parasitological Report.

It was found that except in the case of infants under two years of age, hookworm occurred practically universally. Comparatively few of the people, however, carried heavy worm burdens, although there were undoubtedly some.

Effect of Hookworm Disease on Hæmoglobin Levels.

Correlation of the worm burden with the hæmoglobin values obtained was made and the results are recorded in Table IV. No relationship was established. It is, however, possible that if more figures were available, and if the effects of malaria could be satisfactorily excluded in the analysis, significant correlation might become manifest. But on the evidence, hookworm disease does not appear to offer any comparison to malaria as an important menace to health.

It is worth drawing attention to the work of Cort, Otto and Foster ⁽¹⁾, ⁽²⁾ on experimental hookworm disease in dogs. In these animals a protective specific immunity to the disease apparently develops, and the resistance can be broken and rendered ineffective by dietary deficiency. In the words of Pincoff ⁽³⁾, "it would be entirely premature to assume that the man-hookworm system will interact as the dog-hookworm system has been shown to do. Nevertheless there is abundant epidemiological evidence to suggest that this relationship may prevail and, as far as I know, none to refute it." It may well be therefore that a most important factor in the control of hookworm disease will be the maintaining and raising of the nutritional standards.

TUBERCULOSIS.

Introduction.

It is well known that tuberculosis is an important disease in many parts of New Guinea. In 1937 Heydon (⁴) reported the result of 114 Mantoux tests on natives (mainly adults), of the Upper Ramu (presumably not far from Kaiapit). There were eleven reactors, none of them very pronounced. Using the same material and technique, Dr. Backhouse found 50 per cent. reactors in forty-four adult indentured natives in Rabual—some of them strongly positive. In 1936, Clements (⁵) conducted a tuberculosis survey in Hanubada village, Port Moresby, and reported a tuberculosis rate of 21.5 per 1,000, and drew attention to the fact that one-third of the deaths could be attributed to tuberculosis, a death rate of 700 per 100,000 for the year 1933. His tuberculin tests showed infection with tuberculosis was not as extensive as amongst South African natives, but much more extensive than in the natives of Sudan, Tanganyika and Zanzibar. Dr. Baldwin, in a personal communication, states that 23 per cent. of deaths occurring in New Guinea native hospitals to-day are due to tuberculosis in some form.

Many of the New Guinea natives recognise pulmonary tuberculosis as an identity and to which they refer as "the big sick."

The Technique of the Investigation.

Clinical Examination.—During the course of the general clinical examination, a brief examination of the chest was made by means of the ordinary technique of inspection, palpation, percussion and auscultation, paying particular attention to the apical regions. A case was labelled pulmonary tuberculosis only if unequivocal signs of the disease were present, such as impaired percussion note, râles and tubular breathing.

The presence of bone and joint tuberculosis was revealed by the ordinary physical examination. Glandular tuberculosis was diagnosed when enlarged glands matted together were palpated in the cervical region.

It was intended that a chest radiograph should be obtained where the tuberculin reaction was strongly positive and there was no clinical evidence of tuberculosis, but the output of the X-ray apparatus and power unit employed was not sufficiently great.

Tuberculin Tests.—In each village as many household groups as could be mustered were tested.

The technique used was similar to that described by Anderson and Harvey (⁶).

A single intradermal injection was given into the left arm at about the level of the insertion of the deltoid muscle.

The solution used was 0.00125 mgm. of P.P.D. in 0.025 cc. of diluent.

Reading and Grading Reactions. The site of the injection was inspected at forty-eight hours. The area of oedema and the surrounding blush was measured with a millimetre scale and the diameter recorded, together with a note of lymphangitis, vesication, vesiculation or necrosis. An area of oedema of less than 5 millimetres in diameter was classified as negative; if more than 2 centimetres or if vesication, vesiculation or cellulitis occurred, it was classed as a strong positive.

The Results. The results of the tuberculin tests and the clinical examinations are recorded in Tables V and VI. In Graph I, a comparison is drawn between the tuberculin reactions of each village and with Papuans (Port Moresby, 1936), normal English, natives of Tanganyika, and Zanzibar quoted by Clements (⁵).

It will be seen that the degree of tuberculization was highest at Kavataria and Busama, and lowest at Kaiapit and Patep. In both the former places the figures were slightly higher than the figure found by Clements in Port Moresby in 1936.

The incidence of gross clinical tuberculosis found in the present survey followed the same distribution in the villages as the percentage of tuberculin reactors. It is emphasised, however, that only the evident cases were diagnosed.

Comments.—Although the results presented are far from conclusive in themselves, yet when interpreted in the light of the other evidence quoted, indicate that in at least three of the areas, the amount of tuberculosis reaches serious proportions.

The relationship between poor nutrition and the spread of tuberculosis is obscure. The harmful effect of crowded housing is, however, well established. For instance, Daley (⁷) who reported on the increase in tuberculosis in London in wartime (1942), came to the conclusion that contact and droplet infection due to overcrowding were important causes for the increase of pulmonary tuberculosis. In comparing the state of housing of the various villages and correlating this with the incidence of tuberculosis, there is suggestive evidence that crowded housing conditions may have been one of the factors in spreading tuberculosis.

Attention is drawn to the sociologist's report of the average number of persons living in houses in the villages examined: Busama 7.4; Patep 6.38; Kaiapit 3.8; Kavataria 3.5; Koravagi—no estimate. It is quite possible that the relative freedom from tuberculosis of the people of Kaiapit is a result of the less crowded housing and wider spacing of houses in this village. In Kavataria where there were a large percentage of tuberculin reactors, there was an average of the small number of 3.5 persons per house. The housing position would appear to compare favourably with Kaiapit. On closer examination this was not so, however, because the houses themselves were small and huddled very closely together. There was thus a considerable amount of social contact amongst the people, giving opportunity for the dissemination of tuberculosis. As described by the sociologist, it was common for relatives to exchange children, and in only a few instances did household groups and family groups coincide. This free exchange of household groups would tend to enhance the opportunities for the spread of tuberculosis.

At both Busama and Patep the houses were crowded. The sociologist has commented on the fact that at Patep the crowding has been aggravated by the high standard of house design self-imposed by the villagers, and the consequently limited number of these which can be constructed with available resources of labour.

TROPICAL ULCER.

Tropical ulcer is an acute sloughing ulcer which usually occurs on the leg below the knee. Clements (⁸) in 1936 showed that in New Guinea there is a definite geographical distribution of tropical ulcer and he presented evidence that dietetic factors may have been a predisposing factor in the aetiology of the disease. Many workers have shown that spirochaetes and fusiform bacilli are very closely associated with the aetiology of tropical ulcer. The majority of observers are agreed that the ultimate cause of the disease is some organism or organisms.

In the present survey the lower extremities were inspected for the presence of active tropical ulcers and ulcer scars. The punched-out appearance of the ulcer is readily distinguished from the usually heaped-up lesion of yaws. In Table VII the acute tropical ulcer and the ulcer which has become indolent are included, under the classification Tropical Ulcer. An "ulcer scar" was any extensive scarring of the lower extremities which in the opinion of the observer might have been due to tropical ulcer. This figure therefore is subject to the usual error of this type of evidence.

The results: The incidence of tropical ulcer in the different villages is recorded in Table VII. The only cases seen in the village groups were three at Kavitaria and one at Koravagi.

Discussion: A sufficiently large number of ulcers was not seen for any comparisons of incidence to be made between the villages. Moreover, analysis of the diet patterns of each village has revealed that the degree of differences in actual nutrients consumed are not great.

CORNEAL OPACITY.

Corneal opacities were not infrequently seen. In most cases a definite history of trauma could be obtained. However, in the Kavitaria group, three cases of bilateral corneal opacity were seen in 195 people of all ages observed. All cases were females over the age of about 40 years; in one an infection occurred seven years ago, and examination showed that the iris of the left eye had prolapsed through a perforated cornea; the two other women became blind with discharging eyes when they were young women.

On casual inspection of the surrounding villages it became evident that corneal opacities due to an infective conjunctivitis were not of uncommon occurrence. In one case an infant of three weeks of age was seen with acute purulent conjunctivitis in which both irises had prolapsed through perforations in the cornea.

It is probable that most of these cases were of gonococcal origin, but as indicated previously no special survey of venereal disease was attempted.

OTHER DISEASES.

In this report mention only is made of framboesia (yaws), tinea, scabies and leprosy. The incidence of these diseases found in the five villages is recorded in Tables VII, VIII and IX. Yaws was seen commonly throughout the survey, but it was evident that where frequent medical patrols were followed by appropriate treatment the disease was brought under control. Scabies and tinea were more frequently seen at Koravagi, and the higher incidence here was apparently related to the crowded, dirty conditions under which these people were living at the time of the survey. The two cases of leprosy seen were both in young women, and in both the disease had eroded the nasal septum. In one case the palate also was perforated.

Nutritional Status.

OBSERVATIONS ON GENERAL PHYSIQUE AND FUNCTION.

The native peoples encountered were of average healthy appearance. Exceptions were the Trobrianders who exhibited good physique and appearance, and the Koravagi people who were abnormally thin. The infants varied from those at Patep and Kavitaria, who had a healthy appearance, to sick pale babies at Busama and Kaiapit, and the frequently emaciated, scabies-ridden babies at Koravagi. Some of the younger children were thin and pot-bellied except at Kavitaria, where they usually displayed fine physique. As a rule, in all areas the adolescents and young adults were of athletic build. There is a definite tendency towards leanness in middle age in New Guinea natives. This finding contrasts strongly with the tendency towards increase in weight which is found in most middle-aged Australians. (See Graph 2).

Weight-for-age and height-for-age Tables X and XI are given. These tables are mostly based on an approximation of age and therefore the values given should not be interpreted too strictly.

The following are special observations of general appearance and physique:—

At Busama the people were mentally quite alert. Their skin and clothes were clean and neat.

The people of Kaiapit appeared taller on the average than the Busamas. At the time of the survey the people appeared to have considerably more leisure than the Busamas who usually worked from dawn until the late afternoon on the ordinary occupations of living, such as food procuring, housebuilding and maintenance. In spite of an apparently greater amount of leisure, the Kaiapit people were not as clean and many had impetiginous sores. The proximity of Busama to the sea possibly was an important factor in the apparently greater personal cleanliness of its people.

In general the people of Patep resembled those of Busama and Kaiapit with the exception that they were of smaller build. The people resembled the Busamas in that they apparently had little leisure time at their disposal. A noteworthy feature was the healthy physical appearance of the infants and young children. Without exception these babies were plump, alert, of happy disposition, with bright pink mucous membranes, and firm, almost glossy brown bodies. They were in marked contrast with the infants frequently seen at Busama and Kaiapit, which were of an unhealthy appearance, exhibiting listlessness, a sallow complexion, and pallor of the mucous membranes.

The first impression of the people of Kavitaria was a striking contrast to the three populations previously surveyed. These people were self confident in their approach, and obviously proud of their fine physique and bearing. The clothing worn by the majority was the traditional native costume. The males wore only a pubic covering of banana leaf, with usually armlets and some hair decoration; the females wore colourful grass skirts. The tendency in the previous villages had been to wear clothing of native materials as little as possible, usually only when trade cloth was not available. The infants and children at Kavitaria appeared to be happy and well nourished. The habit of the women balancing loads on the head, gave their body posture and carriage a pleasing, upright appearance.

The general appearance of the people at Koravagi was the reverse of well-being. The majority appeared poorly nourished and under-weight and with poor body posture. Many, including adults, children and infants, had a severe degree of scabies infestation and impetigo, and many of the children had large neglected sores. The clothes, which were mainly trade-cloth skirts and ramis, were usually very dirty. A conspicuous feature was the absence from the village of a large number of young adult males. These people had recently moved their village from another site and were poorly housed in hovels. Although a large number of houses was under construction none of these was occupied.

EVIDENCE OF DEFICIENCY OF SPECIFIC NUTRIENTS.

The evidence here presented for assessing the adequacy of the intake of the various nutrients is of a clinical and biochemical nature.

The evidence provided by measurement of the actual food intake is dealt with in the nutritionist's report on Food Consumption and Dietary Levels.

Calories.

Undernutrition results from insufficient calorie intake. When there is an inadequate intake of calories there is a disinclination for work resulting in a reduction of activities; and a gradual disappearance of the subcutaneous fat and other fat deposits, so that the body loses its normal rounded contours, the skin becomes loose and inelastic and the bony prominences stand out. Protein tends to be metabolised as fuel so that even if no protein deficiency existed at first, it may later complicate the picture.

The amount of subcutaneous tissue that is optimum or normal in New Guinea natives is not known. Climatic and other environmental factors undoubtedly affect the amount that is optimum. The role of the subcutaneous tissue as an insulation from cold suggests that the normal amount of subcutaneous tissue for instance of a Busama native who lives in a hot humid environment, would be less than the amount normal for a native of Sydney, or of Patep where colder temperatures are the rule. These factors make it difficult to measure undernutrition on a quantitative basis.

Table XII shows the mean weight of natives of given height during the age period 2-20 years, and a comparison is made with a group of Australian children. It can be seen that there is a tendency for natives of a given height to weigh from 1 to 3 lbs. less than Australian children of the same height—at least until adolescence. Towards the end of the growing period, however, the native of a given height is heavier than the Australian of the same height. This observation is explained no doubt by the fact that the natives are of smaller build when mature, and the latter group would contain a larger percentage of mature natives than the Australian group of these heights.

It was noted that although adolescent and young natives are of athletic build there is a definite tendency towards leanness in middle age. (See Graph 2.)

To what degree these findings represent undernutrition, racial characteristics, the effect of disease, or a physiological adaption to a tropical environment is not known. There is obviously a need for some fundamental physiological research into the growth characteristics of native groups living in their own environment.

Comparison between the height and weight data from the different villages did not reveal numerical differences which aided the solution of the problem. On the basis of observation, however, there appeared to be some differences which it is thought justifiable to note here. In Busama, Kaiapit, Patep and Kavitaria the individuals appeared moderately well nourished, except for the pre-adolescent children and the older adults. At Koravagi almost all the individuals appeared abnormally thin. If these data mean anything they indicate that the calorie intake was satisfactory except at Koravagi, and in the pre-adolescent children and possibly older adults.

Protein.

In the presence of an adequate intake of calories, signs of protein deficiency are probably limited to interference with growth. In the period of childhood failure to grow at a normal rate, and "stunting" or a failure to reach the full growth potential, may be the only result. In adult life protein deficiency is even more difficult to detect. It may, however, become manifest during periods of active muscle growth such as follow debilitating illnesses, or when it occurs as a physiological response to extra demands on its strength.

In the course of the survey it was not possible to make any observations of rate of growth of children because the stay in each village was so short. Without a long-term experiment involving the use of control groups fed different levels of protein it is not possible to state whether on the present intake these people reach their maximum growth potential.

When the diet contains inadequate supplies of protein, the tissue reserves (notably the muscles) are drawn upon to supply the needs of the essential tissues, particularly the blood. The body endeavours to keep the concentration of plasma protein within the normal range because of its important effect upon osmotic pressure of tissue fluids. It is not until the level of the plasma proteins themselves fall that oedema develops. Thus muscle wasting is an early, and low serum protein and oedema, a late sign of protein deficiency. In this survey no cases of oedema which could have been due to protein deficiency were seen.

Reference is made to the Biochemical Report where tables record the serum protein levels found. It can be seen that in general the serum protein levels tended to be higher than the values usually found in Caucasian peoples (6.9 gms. per 100 mls.), the mean value found in New Guinea natives being 7.2 gms. per 100 mls.

The serum protein levels of those natives showing evidence of malaria were compared with those of natives who had no malaria. (See Table XIII). The mean value was higher in those with malaria and the difference was found to be statistically significant. No special abnormality was found to be associated with the lower values in the series.

To summarise, signs of gross inadequacy of protein were not detected. The significance of the low protein intakes at four of the five villages surveyed cannot be interpreted at this stage.

Vitamin A.

No special dark adaption test apparatus was taken into the field. However, with each individual examined a careful search was made for xerophthalmia and for follicular keratosis, conditions which are attributed to a deficiency of vitamin A. No cases of these diseases were seen.

Thiamin (vitamin B₁).

The knee reflexes and squatting test revealed no signs of beri-beri in any of the villages surveyed. No cases of infantile beri-beri were seen.

Riboflavin (vitamin B₂).

A record was made of any angular stomatitis or cheilosis of the lips.

It was noticed that as a rule the mucous membrane of the lips (and cheeks) appeared thicker and whiter in those who chewed betel nut.

Only one case, a woman of 35 years of age at Busama, showed mild angular stomatitis which was manifested as several small radiating fissures at the angle of the mouth. This case was not necessarily regarded as due to a riboflavinosis because this type of lesion is recognised as being due sometimes to conditions other than a riboflavin deficiency.

Niacin.

A naked eye inspection of the tongue was made and any abnormalities of colour, abnormal swelling, or atrophy of papillae, or fissuring were noted (see Table IX). The general appearance of the great majority of the tongues was normal, being clean over the anterior two-thirds and pink in colour. In each village, a few tongues were seen with superficial central fissuring, but no association with any other symptom or sign was evident. In a few cases the papillae over the anterior half of the tongue were darkly pigmented, giving a fine mottled appearance. This was regarded as normal pigmentation occurring in a dark-skinned people.

In this survey the tongue did not reveal any positive information of a nutritional deficiency. No cases of dermatitis or pigmentation of the extremities suggestive of a niacin deficiency, were seen.

Iron.

From the clinical examination it was not possible to obtain data of value in estimating the adequacy of the iron intake, because the complicating factors of malaria and hookworm disease influenced the haemoglobin levels. In the case of malaria, a large proportion of the breakdown products of haemoglobin, both the iron containing and the bilirubin fractions, is retained in the body and re-used in haemoglobin formation; in hookworm disease, however, the iron would tend to be lost to the body.

It can be seen from the Biochemical Report that, as in the case of Caucasian people, the percentage of haemoglobin in the female of the age group 11 to 60 years is slightly lower than that of the male. The lower levels found in adult females is in accordance with the lower standards for this group amongst Caucasian peoples which are usually accepted as normal. It is probable that the lower values found are due to the additional strains of menstruation, pregnancy and lactation. Yudkin (1944) (12) showed that the haemoglobin of a group of W.A.A.F. enlistments improved within six months on service diet, and he attributed the improvement mainly to a higher iron intake. It is possible that the haemoglobin of the adult female natives would improve with a higher level of iron in the diet.

Ascorbic Acid (vitamin C).

Throughout the survey no clinical cases of scurvy were seen. Inspection of the radiographs taken on the infants under two years of age revealed no appearances suggestive of scurvy.

The Gums: As some of the first and most obvious signs of an ascorbic acid deficiency are revealed in the condition of the gums these were studied in detail. The results of the examinations are summarised in Table XIV. In natives under 21 years of age abnormality of the gums was rarely encountered and these are not included in the table. The table shows that abnormalities of the gums occurred frequently in this older age group, and that these abnormalities are not confined to any particular village. As loss of interdental papillae appeared to be the most advanced pathological sign present, an attempt was made to correlate the mean plasma ascorbic acid values of the individuals showing this abnormality, with the mean values for normal people. The correlation was not statistically significant.

Plasma Ascorbic Acid.

Reference is made to the Biochemical Report, giving the values of plasma ascorbic acid obtained in the five villages.

The mean level of plasma ascorbic acid in all the villages with the exception of Kavitaria is higher than the value of 0.4 mgm. per cent., which is regarded as the minimum satisfactory level amongst Caucasian people. In many cases considerably higher levels were obtained.

Breast Milk Ascorbic Acid.

The biochemists found that the ascorbic acid content of breast milk of the native women was satisfactory, a finding indicative that ascorbic acid requirements were being met.

The absence of any sign of scurvy, and the high values for plasma ascorbic acid and for breast milk ascorbic acid leave no doubt that the intake of ascorbic acid was adequate.

Vitamin D and Calcium.

In 1932 Maddox (⁹) showed that 52 per cent. of the infants attending the out-patient department of an infants' hospital in Sydney had unmistakable signs of rickets. In 1938 Clements (¹⁰) reported that out of 255 infants and children between the ages of nine months and two years examined by him, 60 showed the accepted signs of active rickets. Clements (¹¹) in 1942 reported a further series of 134 full-term infants in their first year of life, of which 63 or 47 per cent. had radiographic evidence of definite mild rickets at some period. Thus it is seen that amongst Australian infants under two years the incidence of radiographically demonstrable rickets is surprisingly high. As it has not been possible to find any previous figures for the incidence of rickets in New Guinea native infants, these Australian figures are selected to serve as a comparison for the results obtained in the present survey.

The source of the material: All the infants from birth to two years in the villages surveyed were examined. To augment the numbers, mothers from surrounding villages up to a half day's journey were persuaded to bring their infants.

The diagnosis of rickets: The results of this study depended on a radiographic demonstration of defective calcification at the distal end of the radius or ulna. One radiograph was taken and if this showed definite rachitic changes the infant was considered to have suffered from rickets. Doubtful cases were classified with the normal.

The interpretation of the radiographs was carried out by Dr. F. W. Clements who used the same standards of diagnosis as he used in his 1938 and 1942 surveys. Therefore, the present results can be compared legitimately with his two Australian surveys, and, probably also with the findings of Maddox which agree closely with the incidence found by Clements.

A clinical examination for signs of florid rickets was also made, but in one case only (T35) was rickets suspected and subsequently confirmed by radiological examination.

The Incidence of Rickets in New Guinea Infants.

Of 160 infants examined in this series, 9, or 5.6 per cent., had radiological evidence of definite mild rickets, all of whom were under one year of age. Of this series, 101 were under the age of one year, so that nine out of 101, or 9 per cent. is the figure which can be compared with Clement's 1942 Australian figure of 47 per cent. Thus, apparently rickets is a much less common disease in New Guinea infants than amongst Australians.

Table XV shows the village by village distribution of rickets. It can be seen that nearly one-half the cases were concentrated at the mountain village of Patep. Reference has already been made to the generally healthy appearance of the Patep infants. Table XVI shows the weight-length ratios of these infants with rachitic changes. It can be seen that in only one case was the infant underweight when judged by the average standards of weight and length obtained for New Guinea infants (see Table XVII). Thus, as has frequently been stated by previous observers rickets is more likely to become manifest in infants whose rate of growth is not retarded.

The Incidence of Heavy Calcification in New Guinea Infants.

Of the 160 infants examined in the series, 6 or 2.6 per cent. had radiological evidence of heavy calcification at the metaphysis. This figure excluded a number of other cases where evidence of previous heavy calcification was revealed as "lines of arrested growth." The six cases occurred at Koravagi (Table XIX), and all occurred in infants which were underweight, and in most cases suffering from severe scabies and impetigo.

Heavy calcification is regarded as a result of the opposite tendency to that operating in rickets. In the former the growth of the infant is arrested and excessive calcium has time to be deposited in the slowly growing bones; whereas in the case of rickets there is often rapid body growth and insufficient calcium is available for deposition in the rapidly growing bones.

Discussion: Clements ⁽¹¹⁾ is of the opinion that the percentage absorption of calcium is probably the most important post-natal factor in both the development and the persistence of rickets during the first half of the first year of life.

It is well known that the degree of calcium absorption is largely dependent on adequate vitamin D in the diet, or by adequate exposure to sunlight or ultra violet radiation.

In contrast to the Australian who is extensively covered with clothes, the New Guinea woman and her infant wear few clothes and their naked bodies obtain a maximum amount of exposure to the sun. Thus, the

New Guinea infant is assured of adequate vitamin D. This ensures maximum calcium absorption and utilization, not only in its pre-natal existence, but also post-natally from its mother's breast milk and from supplies manufactured in its own skin.

It may be of significance that the greatest percentage of rickets was seen at Patep where, owing to peculiar topographical formation, the village was shrouded in cloud (see Anthropologist's Report). It is probable that these conditions would have lessened considerably the exposure of both mother and baby to sunlight.

The fact that rachitic changes were comparatively rare, indicates that under the conditions of maximum exposure to sunlight, the calcium intake of the New Guinea native was adequate.

Iodine.

In the village of Kaiapit were seen four cases of goitre which were of interest. Three were children and one was a female of forty-five, all of whom had never left the environment of the village and gardens. A male of eight years and a female of twelve years were siblings, and, but for the presence of moderate enlargement of the thyroid,*neither these two children nor the older female were abnormal in any way. The other child, a female of five years, appeared to be definitely mentally retarded, obese and sluggish and was regarded as being definitely sub-thyroid. The three cases mentioned were thought to be simple endemic goitre. It is possible that a wider survey of the area might disclose other cases and prove the existence of a mildly goiterous area.

During one afternoon, forty natives, including twelve females, visited the camp. They had journeyed two days walk from their village in the headwaters of the Maniang River which is a tributary of the Markham. Without exception the thyroid gland was hypertrophied, and in some cases the visible swelling was the size of two clenched fists (see Plate 43). It was interesting to note that the males apparently tended to have larger thyroids than the females. The natives appeared normal in every other respect.

The existence of goiterous areas in other tributaries of the Markham is known. Thus, J .D. Ryan in a patrol report in 1946, refers to the prevalence of goitre in the headwaters of the Irumu River. The abnormality is undoubtedly associated with an iodine deficient food and water supply.

Summary.

MALARIA.

An investigation into the health and nutritional status of the natives revealed that malaria was a significant factor in the production of anaemia and thus interfered with nutritional status.

HOOKWORM DISEASE.

Almost all persons over the age of two years were infected with hookworm disease, but comparatively few carried heavy worm burdens. No evidence was obtained that hookworm disease was a serious menace to health compared with malaria.

TUBERCULOSIS.

Tuberculosis is a serious menace in some parts of New Guinea. Evidence from elsewhere in the world and suggestive evidence obtained during the survey, indicate that overcrowding is an extremely important factor in spreading tuberculosis disease.

FRAMBOESIA (YAWS).

Where frequent medical patrols were combined with appropriate treatment, framboesia was well controlled. Elsewhere framboesia was widespread.

CALORIES.

As judged by clinical evidence it is probable that the general level of calorie intake was satisfactory, except in the case of pre-adolescent children, older adults, and at the village of Koravagi.

PROTEIN.

Signs of gross inadequacy of protein were not detected, but the technique of the survey did not provide the opportunity to detect lesser degrees of protein inadequacy.

ASCORBIC ACID (VITAMIN C).

The intake of ascorbic acid was adequate in all areas.

OTHER VITAMINS.

No signs suggestive of vitamin A, thiamin, riboflavin or niacin deficiency were seen.

IRON.

It is possible that the adult females would benefit from a greater intake of iron.

IODINE.

Attention is directed to the existence of areas of endemic goitre in New Guinea.

CALCIUM AND VITAMIN D.

Comparatively few cases of subclinical rickets were detected by radiological examination. This has been attributed to an adequate calcium intake combined with a maximum exposure of the skin of both the mothers and babies to sunlight.

Recommendations Arising Out of the Report on Health and Nutritional Status.

The purpose of this report is to help to disclose the nature of the nutritional problems, and to add information as to the extent of some problems of disease in New Guinea.

1. Malaria was found to be a prime factor responsible for lowering the physical status of the natives. It was a significant factor in the production of anaemia and thus interfered with nutritional status.

It is recommended that—

“First consideration be given to finding ways and means for preventing and controlling malaria in native villages.”

2. Tuberculosis is a serious menace in some parts of New Guinea. Evidence from other parts of the world and suggestive evidence obtained during the survey indicate that overcrowding in the huts and propinquity of huts is an important factor in spreading tuberculosis disease.

It is recommended that:—

“Every effort should be made to prevent overcrowding in villages. No encouragement should be given to building more elaborate huts if overcrowding is likely to be a result.”

3. Where frequent medical patrols were combined with appropriate treatment framboesia was well controlled. Elsewhere framboesia was widespread.

It is recommended that:—

“Every effort should be made to increase the scope and frequency of medical patrols.”

4. The work of the survey was often handicapped because of the lack of comprehensive village records.

It is recommended that:—

“The essential need for accurate and comprehensive village records in any plan of medical research in the field should be stressed.”

5. The intake of ascorbic acid was adequate in all areas examined. This finding is no doubt due to the fact that the village diet consists largely of fresh foods of vegetable origin. Although the dietary problems of native labourers who work either on plantations, or in urban occupations, were not within the scope of the survey, yet the fact that such people are usually dependant upon food grown at a distance (often imported from overseas) which has frequently lost much of its nutritive value, emphasises the need in labourers for a plentiful supply of supplementary foods (*e.g.*, green leafy foods).

It is recommended that:—

“Consideration be given to the development of native gardens of supplementary foods (*e.g.*, green leafy vegetables) in and around plantations and urban areas, and of the more widespread use of these foodstuffs.”

6. Most of the basic scientific data of the physiology of the human body has been obtained by studies on people of Caucasian origin, who are living in the temperate zones of the world.

It is doubtful if the application of these facts to Melanesian and Polynesian peoples, is justified. There is some evidence at present available to suggest that the physiological “make up” of these people differs significantly from that of Caucasian stock living in temperate zones.

It is recommended that:—

“Consideration be given to the long-term study of the physiological characteristics, particularly those relating to physiological food requirements of Melanesian and Polynesian peoples. This must be done in the areas and preferably on people living under as near as possible natural conditions. This would involve the development of high-grade physiological and nutritional laboratories at suitable sites in the area.”

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TABLE I.—SPLEEN RATES—NEW GUINEA AND PAPUAN VILLAGES.

Age Group.	Village.									
	Busama.		Kaiapit.		Patep.		Kavitaria.		Koravagi.	
	Observa- tions.	No Positive.	Observa- tions.	No Positive.	Observa- tions.	No Positive.	Observa- tions.	No Positive.	Observa- tions.	No Positive.
0-5	36	26 (72)	23	22 (96)	41	5 (12)	30	9 (30)	31	14 (45)
6-10	35	25 (71)	17	13 (76)	18	2 (11)	21	11 (52)	25	16 (64)
11-15	19	14 (74)	12	4 (33)	7	3 (42)	23	6 (26)	8	4 (50)
16-20	10	3 (30)	8	3 (37)	20	11 (55)	12	1 (8)	7	4 (57)
21-30	34	8 (24)	19	6 (32)	35	9 (26)	34	7 (21)	33	11 (33)
31-40	17	6 (35)	19	5 (26)	13	6 (46)	32	5 (16)	25	4 (16)
41-50	8	1 (12)	8	...	9	1 (11)	17	2 (12)	12	2 (17)
51-60	4	1 (25)	1	...	8	2 (25)	17	...	1	1 (100)
Over 60	4	...	4	1 (25)	5	...	9	1 (11)	1	1 (100)
Total ...	167	84 (50)	111	54 (49)	156	39 (25)	195	42 (21)	143	57 (40)

Figures in brackets are percentages.

TABLE II.—EFFECT OF MALARIA ON HAEMOGLOBIN LEVELS.

	Blood Parasites.	Spleen Palpable.	No Evidence of Malaria.
Busama—			
No. of observations	67	80	55
Mean Hæmoglobin	10.26	9.71	10.23
Kaiapit—			
No.	49	49	38
Mean Hb.	9.495	9.118	11.665
Patep—			
No.	22	40	101
Mean Hb.	10.95	11.155	11.64
Kavitaria—			
No.	13	33	78
Mean Hb.	9.884	9.484	10.656
Koravagi—			
No.	31	46	60
Mean Hb.	11.483	11.008	11.668
Total—	182	248	332
No.	10.3	10.0	11.1
Mean Hb.	1.789	1.974	1.643
S.D.			

Haemoglobin Hb expressed as grams per 100 mls. of blood.

SIGNIFICANCE OF CORRELATION DIFFERENCES (total villages).

	Spleen Palpable (10.0.)	No Evidence of Malaria, (11.1.)
Blood Parasites + (10.3)	Not significant.	Very highly significant. $P < 0.001$
Spleen palpable (10.0) ... ..	.....	$P < 0.001$ Very highly significant.

TABLE III.—CORRELATION OF SIZE OF SPLEEN WITH HAEMOGLOBIN AND SERUM PROTEIN LEVELS.

	Spleen not Palpable.	Spleen Palpable 1 Finger- breadth.	2F.	3F.	4F.	5 or More.
Hæmoglobin gms./100 mils.	11.1 (332)	10.3 (73)	10.1 (64)	9.7 (56)	9.6 (34)	9.5 (16)
Serum Protein gms./100 mils.	7.2 (350)	7.44 (74)	7.45 (70)	7.6 (47)	7.1 (28)	7.5 (16)

Figures in brackets are number of observations.

TABLE IV.—EFFECT OF HOOKWORM DISEASE ON HAEMOGLOBIN LEVELS.
(Haemoglobin Hb expressed as grams per 100 mils blood.)

Village.			Egg Count/gram.				
			Below 1,000.	1,001– 4,000.	4,001– 8,000.	8,001– 12,000.	Above. 12,000.
Busama ...	No. ...	...	45	39	15	8	6
	Hb. ...	...	9.9	10.0	10.0	9.7	10.4
Kaiapit ...	No. ...	...	47	34	17	3	2
	Hb. ...	...	9.68	10.25	9.9	10.5	11.6
Patep ...	No. ...	...	51	60	29	13	2
	Hb. ...	...	11.4	11.5	11.5	11.0	8.85
Kavitaria ...	No. ...	...	65	41	7	2	2
	Hb. ...	...	10.5	10.7	10.7	10.7	8.5
Koravagi ...	No. ...	...	46	44	12	2	3
	Hb. ...	...	10.8	12.5	11.6	13.4	11.5
Total ...	No. ...	...	254	218	80	28	15
	Hb. ...	...	10.597	10.82	10.853	10.839	10.94

Comment : No apparent effect noted.

TABLE V.—TUBERCULIN REACTIONS.

Village.	Age.	Negative.		Positive.		Strong Positive.		Total.
		No.	%	No.	%	No.	%	
Busama ...	0—10	67	97.7	3	2.3	...	...	70
	11—15	50	77	10	15.4	5	7.6	65
	16—20	26	57.8	16	35.6	3	6.7	45
	21—30	23	32.9	36	51.5	11	5.1	70
	31—40	12	24	31	62	9	18	50
	41—50	6	17.2	18	51.5	11	31.4	35
	51—60	1	10	7	70	2	20	10
	Over 60	2	33.3	1	16.7	3	50	6
Kaiapit ...	0—10	17	100	...	...	...	...	17
	11—15	23	95.9	1	4.1	...	...	24
	16—20	15	83.4	2	11.1	1	5.6	18
	21—30	43	76.8	10	17.9	3	5.4	56
	31—40	46	80.8	11	19.3	...	...	57
	41—50	14	82.4	3	17.6	...	...	17
	51—60	6	54.6	4	36.4	1	9.1	11
	Over 60	13	81.2	3	8.7	...	...	16
Patep ...	0—10	43	91.5	2	4.3	2	4.3	47
	11—15	5	100	...	...	...	...	5
	16—20	12	92.4	...	...	1	7.6	13
	21—30	14	66.7	5	23.8	2	9.5	21
	31—40	5	45.4	3	27.3	3	27.3	11
	41—50	7	87.5	1	12.5	...	...	8
	51—60	5	62.5	2	25	1	12.5	8
	Over 60	...	...	1	100	...	...	1
Kavitaria ...	0—10	29	96.9	...	...	1	3.1	30
	11—15	11	42.4	11	42.4	4	15.2	26
	16—20	9	41.0	10	45.5	3	13.5	22
	21—30	6	14.0	28	65.2	9	20.9	43
	31—40	3	6.25	25	52.1	20	41.7	48
	41—50	4	16	13	52	8	32	25
	51—60	1	5.3	12	63.2	6	38.0	19
	Over 60	2	9.1	13	59.1	7	32.8	22
Koravagi ...	0—10	45	81.7	9	16.4	1	1.8	55
	11—15	6	37.5	10	62.5	...	...	16
	16—20	2	25	6	75	...	...	8
	21—30	8	21.0	30	79	...	...	38
	31—40	5	20.8	19	79.2	...	...	24
	41—50	4	44.4	5	55.6	...	...	9
	51—60	1	50	1	50	...	...	2
	Over 60	...	...	3	100	...	...	3
Total ...	0—10	201	96	14	64	4	1.82	219
	11—15	95	70	32	23.6	9	6.61	136
	16—20	64	40	34	21.2	8	5.01	106
	21—30	94	41.2	109	83.5	25	11	228
	31—40	71	37.5	89	47	32	16.8	190
	41—50	35	37.4	40	42.6	19	20	94
	51—60	14	28	26	52	10	20	50
	Over 60	17	35.5	21	44	10	21	48

TABLE VI.—INCIDENCE OF CLINICAL TUBERCULOSIS.

Village.	No. of Observations.	Suspected Pulmonary Tuberculosis.	Bone and Joint T.B.	Glandular T.B.
Busama ...	167	3	...	1
Kaiapit ...	111	...	...	...
Patep ...	157	...	...	1
Kavataria ...	195	3	2	1
Koravagi ...	143	2	...	...
Total villages ...	773	8	2	3

TABLE VII.—MISCELLANEOUS DISEASES—ALL AGES.

Village.	No. of Observations.	Framboesia Skin Lesions.	Leprosy.	Goitre.	Tropical Ulcer.	Ulcer Scars.	Scabies.	Tinea with "Grille."
Busama	167	11 (6.6)	Nil.	Nil.	Nil.	Nil.	Nil.	1 (0.6)
Kaiapit	111	13 (11.7)	Nil.	4 (3.7)	Nil.	7 (6.3)	Nil.	6 (5.4)
Patep ...	157	8 (5.1)	Nil.	Nil.	Nil.	2 (1.3)	Nil.	10 (6.4)
Kavitarai	195	Nil.	Nil.	Nil.	3 (1.5)	5 (2.5)	Nil.	1 (0.5)
Koravagi	143	17 (11.9)	2 (1.4)	Nil.	1 (0.7)	Nil.	17 (10.2)	14 (9.8)
Total ...	773	49 (6.3)	2 (0.26)	4 (0.52)	4 (0.5)	14 (1.8)	17 (2.2)	32 (4.1)

Figures in brackets are percentages.

TABLE VIII.—DISEASE PATTERN INFANTS UNDER TWO YEARS APPROX.

(Group A, under 29 inches in length approximately under 1 year.)

(Group B, 29 to 34 inches in length approximately 1 to 2 years of age.)

Village.	Malaria Parasites.		Spleens Palpable.		Hook-worm.		Framboesia (Yaws).		Scabies and Impetigo.		Tinea.	
	A	B	A	B	A	B	A	B	A	B	A	B
Busama ...	+ 7 — 0	+ 8 — 2	+ 5 — 5	+ 7 — 3	+ 1 — 2	+ 0 — 2	+ 1 — 9	+ 1 — 9	+ 0 — 10	+ 0 — 10	+ 0 — 10	+ 0 — 10
Kaiapit ...	+ 8 — 0	+ 4 — 0	+ 10 — 0	+ 5 — 0	+ 4 — 5	+ 4 — 1	+ 1 — 9	+ 2 — 9	+ 0 — 10	+ 0 — 5	+ 0 — 10	+ 0 — 5
Patep ...	+ 0 — 9	+ 1 — 16	+ 0 — 9	+ 1 — 16	+ 0 — 9	+ 10 — 7	+ 0 — 9	+ 3 — 14	+ 0 — 9	+ 0 — 17	+ 0 — 9	+ 1 — 16
Kavitarai ...	+ 2 — 6	Nil Nil	+ 0 — 8	Nil Nil	+ 0 — 8	Nil Nil	+ 0 — 8	Nil Nil	+ 0 — 8	Nil Nil	+ 0 — 8	Nil Nil
Koravagi ...	+ 2 — 6	+ 3 — 3	+ 3 — 7	+ 6 — 4	+ 5 — 3	+ 4 — 0	+ 2 — 8	+ 1 — 9	+ 3 — 7	+ 4 — 6	+ 0 — 10	+ 0 — 10

TABLE IX.—EYE AND TONGUE CHANGES.

Village.	No. of Observations.	Eye Pathology.		Tongue Appearances.			
		Pterygium.	Corneal Opacity.	Fissure Central.	Fissure Lateral.	Papillae Swollen.	Papillae Atrophied.
Busama ...	167	Nil.	1	2	3	5	2
Kaiapit ...	111	1	Nil.	Nil.	2	11	1
Patep ...	157	Nil.	3	3	Nil.	Nil.	Nil.
Kavitaria ...	195	7	3	5	2	2	Nil.
Koravagi ...	143	Nil.	1	6	2	3	6

TABLE X.—WEIGHT FOR AGE—NEW GUINEA NATIVES.

Age Group.	Under 1 year.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16-20	21-30	31-40	41-50	51-60	Over 60
Males—																						
Weight in lb. ...	13½	18	24	26½	32½	33	41	42	48	51	56	59½	63	70½	80½	88½	109	121	118	115	108	105
No. of readings ...	32	23	18	22	30	25	14	23	16	24	18	13	25	17	8	43	94	94	49	22	22	13
Range ...	8½-13½	12-21	18-34	18-33	26-41	26-44	32-54	35-52	40-63	36-65	46-66	42-89	46-88	48-90	62-	61-	61-	70-	72-	71-	87-	86-
															104	112	131	148	166	146	135	451
Females—																						
Weight, in lb. ...	12	18	22	26½	29	32½	38	40	44	50	53½	59	66½	69	82	88	102	105	100½	92	86½	90
No. of readings ...	29	22	21	16	18	10	19	34	7	25	16	25	18	12	11	10	68	130	102	46	24	20
Range ...	6½-20	12½-25	16-29	21-38	19-36	28-42	28-49	32-49	36-55	38-66	39-63	41-72	48-91	57-79	69-96	62-	71-	70-	72-	69-	69-	68-
																101	123	148	135	126	104	112

WEIGHT FOR AGE—NEW GUINEA NATIVES (N.R.C. CLASSIFICATION).

[illegible]

TABLE XI.—HEIGHT FOR AGE—NEW GUINEA NATIVES.

Age Group.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16-20	21-30	31-40	41-50	51-60	Over 60
Males—																					
Height in ins....	28.5	31.3	34	38.4	38.4	42.7	44.4	49.0	48.3	48.7	51.4	53.0	53.9	54.6	56.4	62.1	62.7	62.5	63.1	61.6	62.3
No. of readings	22	19	21	30	24	12	25	16	25	16	15	22	17	12	7	46	95	98	49	24	13
Range	24-32½	25-38½	27½-37½	33-43½	33-45	39-46	35-48	36-50	42-52½	37-53	47-58½	42½-58	48-60½	39½-61	46½-62½	55½-66½	40-69	50½-74	53-67½	53½-66	59-65½
Females—																					
Height in ins....	29.4	31.5	34.1	36.4	38.8	41.3	44.2	44.9	48.4	49.7	50.7	51.8	54.7	56.2	57.0	59.6	60.0	59.3	59.9	58.5	58.8
No. of readings	19	17	15	20	10	20	36	5	23	19	26	18	12	12	11	65	139	83	47	24	18
Range	24½-38½	27-34½	31-39½	32½-41½	36-42½	28-46	38-49	41-49	43-54	37½-58	38-59½	30½-59	49-57½	46-60	46½-62½	45½-64	54-68	50-63½	48-62½	55½-64	56½-62½

TABLE XII.—WEIGHT FOR HEIGHT—NEW GUINEA NATIVES—2-20 YEARS

Australians.*			Natives—Male.				Natives—Female.			
Height in ins.	Males Wt. in lb.	Females Wt. in lb.	Height in ins.	Wt. in lb.	No. of Read- ings.	Range.	Height in ins.	Wt. in lb.	No. of Read- ings.	Range.
35	29.41	28.93	35	30.7	9	26-44	35	28	5	25-30
36	31	30.49	36	32.8	13	28-50	36	31.1	5	27-34
37	31.71	32.08	37	31	8	27-46	37	28.7	6	22-32
38	33.85	33.19	38	33.8	12	31-40	38	31	6	29-34
39	34.72	34.68	39	33.8	13	30-38	39	33.8	5	31-38
40	36.32	35.82	40	34.2	9	32-37	40	33	2	30-36
41	37.96	36.97	41	37.3	3	35-41	41	38.9	11	32-57
42	39.61	39.9	42	39.2	12	28-63	42	38.6	10	31½-56
43	41.4	41.8	43	39	9	35-43	43	41.1	11	34-62
44	44.1	42.8	44	41.5	8	39-45	44	40.8	9	38½-44
45	45.1	45.2	45	44.5	14	36-67	45	50.8	9	39-94
46	48.1	47.8	46	48	12	45-50	46	46.1	13	38-83
47	49.6	50.4	47	51	14	42-77	47	45.7	8	41-49
48	51.7	52.4	48	50.7	12	47-54	48	47.7	11	40-55
49	54	55.3	49	52.3	8	48-62	49	53.6	12	49-59
50	57.2	56.4	50	56.5	12	46-64	50	54	8	47-62
51	59.5	59.81	51	56.7	9	53-61	51	55.6	11	50-61
52	62	62.2	52	63.6	12	55-105	52	59.4	11	51-63
53	65.5	66.4	53	64.8	11	56-70	53	64.1	8	58-76
54	68.3	69.3	54	68.5	10	61-77	54	72	5	66-77½
55	71.2	72	55	73.5	3	67-83	55	76.5	11	61-99
56	76.1	77.6	56	77	9	70-84	56	77.1	11	64-101
57	79.9	78.8	57	86.5	2	85-88	57	83.1	11	71-101
58	83.7	83.6	58	84.8	7	75-90	58	88.5	9	73-101
59	89.1	88.5	59	97.4	5	86-113	59	95.1	12	83-113
60	91.9	95.4	60	92.2	5	84-104	60	96.7	11	77-112
61	97.8	99.7	61	103.5	10	81½-120	61	100.8	8	86-105
62	101.2	107.1	62	111.7	11	100-126	62	110.3	13	91-122
63	104.4	115.3	63	113.8	7	111-120	63	118.4	5	108-131
64	113.4	...	64	113.2	4	107-123	64	107.2	4	105-110
65	117.7	...	65	127.3	3	119-132	65	104	1	104
66	121.5	...	66	116.5	2	112-121	66	...	...	...
67	...	...	67	...	...	...	67	...	...	...
68	...	...	68	...	...	...	68	...	...	...

(35"—41") taken from "The Health Record of the Lady Gowrie Child Centres," Commonwealth Department of Health, assembled by F. W. Clements and Margaret Macpherson, Canberra, 1945.

(42"—66") taken from "Medical and Physical Surveys of School Children of N.S.W." by A. E. Machin. Report of 24th Meeting of the Australian and New Zealand Association for the Advancement of Science, Canberra, 1939, page 198.

TABLE XIII.—EFFECT OF MALARIA ON SERUM PROTEIN LEVELS.

Serum Protein (Total Villages).								
Blood Parasites +.			Spleen Palpable.			No Evidence of Malaria.		
Mean.	S.D.	No. in Sample.	Mean.	S.D.	No. in Sample.	Mean.	S.D.	No. in Sample.
7.4	1.2	184	7.6	0.8	256	7.2	0.6	350

SIGNIFICANCE OF CORRELATION DIFFERENCES.

			Blood Parasites + (7.4).	Spleen Palpable (7.6).
No evidence of malaria (7.2)	...		P < 0.001 Very highly significant.	P < 0.001 Very highly significant.
Spleens palpable (7.6)	...	...	P = 0.05 Just significant.	.....

TABLE XIV.—GUMS—OVER 21 YEARS.

Village.	No. of Observations.	Hyperæmia.		Swollen.		Loss of Interdental Papillae.		Recession.		Retraction.		Bleeding on Pressure.		Pus on Pressure.	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Busama	67	1	1.5	7	10.4	1	1.5	12	18.2	8	12	4	5.9	7	10
Kaiapit	51	9	17.7	4	7.8	10	19.9	32	62.8	17	33.4	1	1.9	8	15
Patep	71	3	4.2	1	1.4	4	5.6	13	18.4	6	8.5	...	...	4	5
Kavitaria	109	1	.9	4	3.6	16	14.7	44	36.8	25	23.0	1	9	5	4
Koravagi	72	4	5.5	1	1.3	10	13.9	25	34.8	13	18.1	...	...	5	6
Total	370	18	4.8	17	4.6	41	11.1	126	34	69	18.6	6	1.6	29	7

TABLE XV.—INCIDENCE OF RICKETS AND HEAVY CALCIFICATION
IN NEW GUINEA INFANTS.

Village.	Number X-rayed.	Deficient Calcification (i.e., rachitic changes).	Heavy Calcification (excludes old lines of arrested growth).
Busama	40	Nil.	Nil.
Kaiapit	40	1 (0.25)	Nil.
Patep	33	4 (12)	Nil.
Kavitaria	14	2 (14)	Nil.
Koravagi	33	2 (6)	6 (18)
Total Villages ...	160	9 (5.6)	9 (4)

Figures in brackets are percentages.

TABLE XVI.—WEIGHT LENGTH RATIOS OF INFANTS WITH RADIOLOGICAL EVIDENCE OF RICKETS.

Serial No.	Name.	Sex.	Approximate age in months.	Weight in lb.	Length in inches.	Relation to mean weight/length Ratio (Table xviii).	Clinical Remarks.
O65	Inu ...	M.	6	11½	22	+	Healthy appearance.
P6	Hemila ...	F.	3	11	22	+	Very healthy appearance (photo).
P26	Zingi ...	F.	8	14	24	+	Healthy appearance.
P29	Warumatu ...	M.	8	14½	24	+	Healthy appearance.
P31	Nein Bo ...	M.	3	10	20½	+	Healthy appearance.
C11	O'Oro-Dobe ...	F.	6	9¾	22	—	Healthy appearance.
C4	Aimari-Biai ...	M.	9	16	25	+	Healthy appearance.
T35	Toboyaka ...	M.	9	19	25	+	Very well nourished. Bony enlargement of wrists.
T38	Bobu Bukaku ...	F.	9	13½	23	+	Healthy appearance.

AGE DISTRIBUTION OF CASES EXAMINED RADIOLOGICALLY.

Under 29 inches—(approx. birth-1 year)—101 examined.

29-34 inches—(approx. 1-2 years)—59 examined.

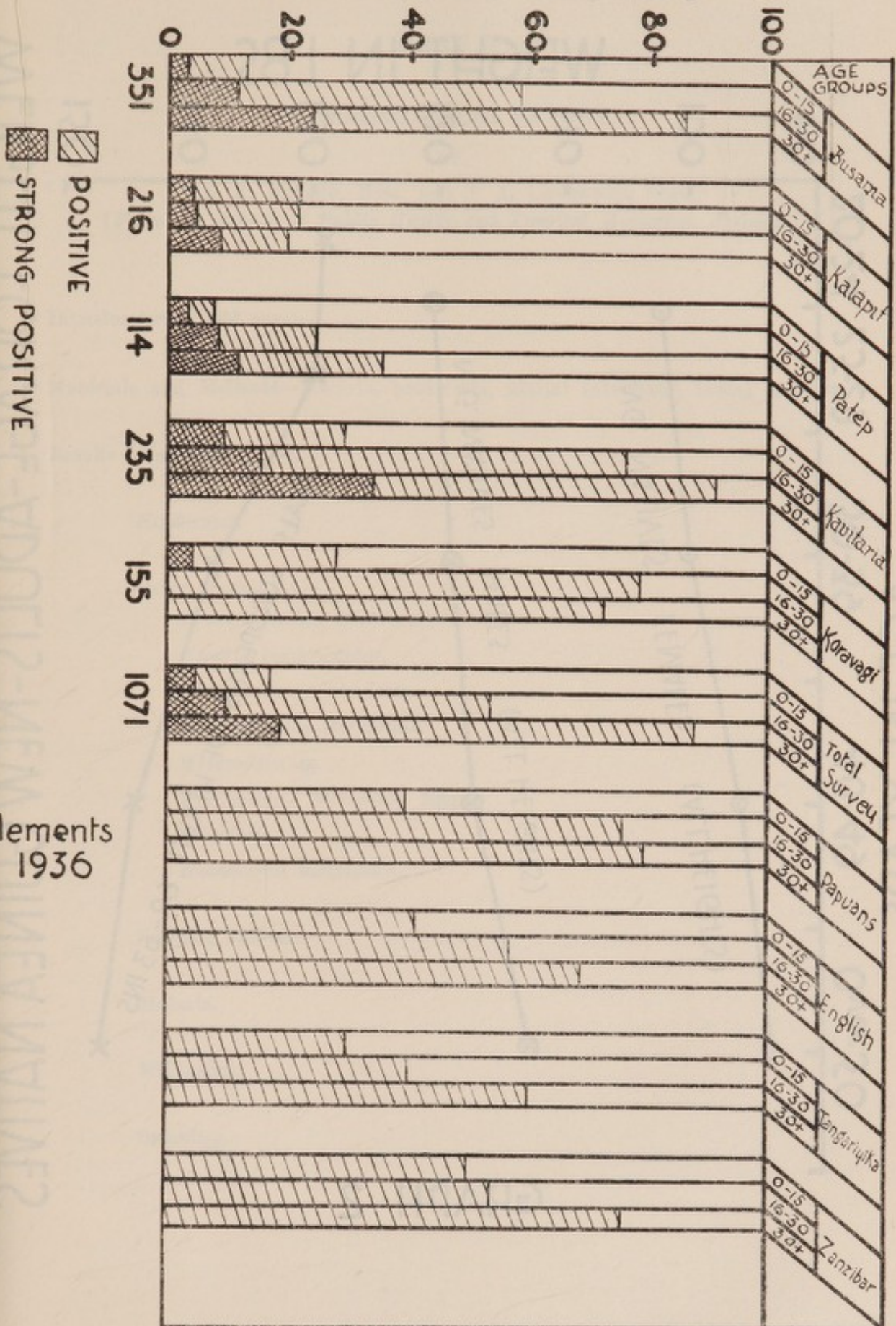
TABLE XVII.—WEIGHT LENGTH RATIOS OF INFANTS WITH RADIOLOGICAL EVIDENCE OF HEAVY CALCIFICATION.

Serial No.	Name.	Sex.	Approximate age in months.	Weight in lb.	Length in inches.	Relation to mean weight/length ratio (Table xviii).	Clinical Remarks.
C30	Koiui-Auwa	M.	12	18	30	—	Scabies and impetigo.
C5	Aupaka-Aida	M.	12	12	24½	—	Scabies and impetigo.
C17	Kau'u-Auwa	F.	6	7½	20½	—	Scabies and impetigo.
C15	Ia-Kwei	F.	6	7½	20½	—	Pallor, scabies.
C33	Bai-i-Auwa	M.	2	22½	33	—	Scabies and impetigo.
C19	Karua-Auwa	M.	18	18	30	—	Spleen not palpable.

TABLE XVIII.—WEIGHT LENGTH RATIOS—NEW GUINEA INFANTS, BIRTH—TWO YEARS APPROXIMATELY.

Length in inches	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Busama—														
Weight in lb.	9½	...	10½	11½	14½	13½	16½	15½	18	20½	20½	22	24½	25½
No. of Readings	2	...	1	4	4	2	5	5	3	4	6	7	4	11
Range	5½-10	...	10½	9-13½	13-15	12½-15	15½-18	14½-17½	16½-21	16½-24	19-22	21-25	22½-26	20-31
Kaipit—														
Weight in lb.	12½	11	11	12½	15½	15	17	17½	20½	20	22½	21½	25½	25
No. of Readings	2	3	4	6	5	7	7	6	3	4	2	2	2	2
Range	11-14	10-12	7½-13	10-15½	14-16½	14-16	15-20	15½-20	19-22	19-21	22-23	21-22	25½-26	24-26
Patep—														
Weight in lb.	10½	11½	11½	14	14½	...	17½	17	18½	18½	21½	22	24½	24
No. of Readings	2	2	2	4	1	...	2	5	1	3	4	2	3	4
Range	10-10½	10-13	9½-13	11½-16	14½	...	17½-18	15½-18	18½	18-19½	20-22	21-23	23-26	21-26
Kavitaria—														
Weight in lb.	10½	12	13½	13½	16½	17	18	17	19	21	...	...	23	...
No. of Readings	3	5	4	9	5	5	11	7	5	1	...	...	1	...
Range	8½-12½	10½-14½	12½-14	12½-16	14-19	15-20	14-20½	16-18½	17-21½	21	...	...	23	...
Koravagi—														
Weight in lb.	8½	9½	10½	14	13½	16½	18	17	18½	18½	22	...	22½	23
No. of Readings	3	3	1	2	5	2	2	5	6	4	3	...	6	1
Range	7½-10	8-10½	10½	12½-15½	12-16	16½-17	16-20	13½-19½	16-19	16½-20½	18½-25	...	19-27	23
Total—														
Weight in lb.	10	11	11½	13½	15	15½	17½	17	18½	19½	21½	22	24	25
No. of Readings	12	13	12	25	20	16	27	28	18	16	15	11	16	18
Range	8-14	8-14½	7½-14	9-16	12-19	12½-20	14-20½	14½-20	16-22	16½-24	18½-25	21-25	22½-26	26-31

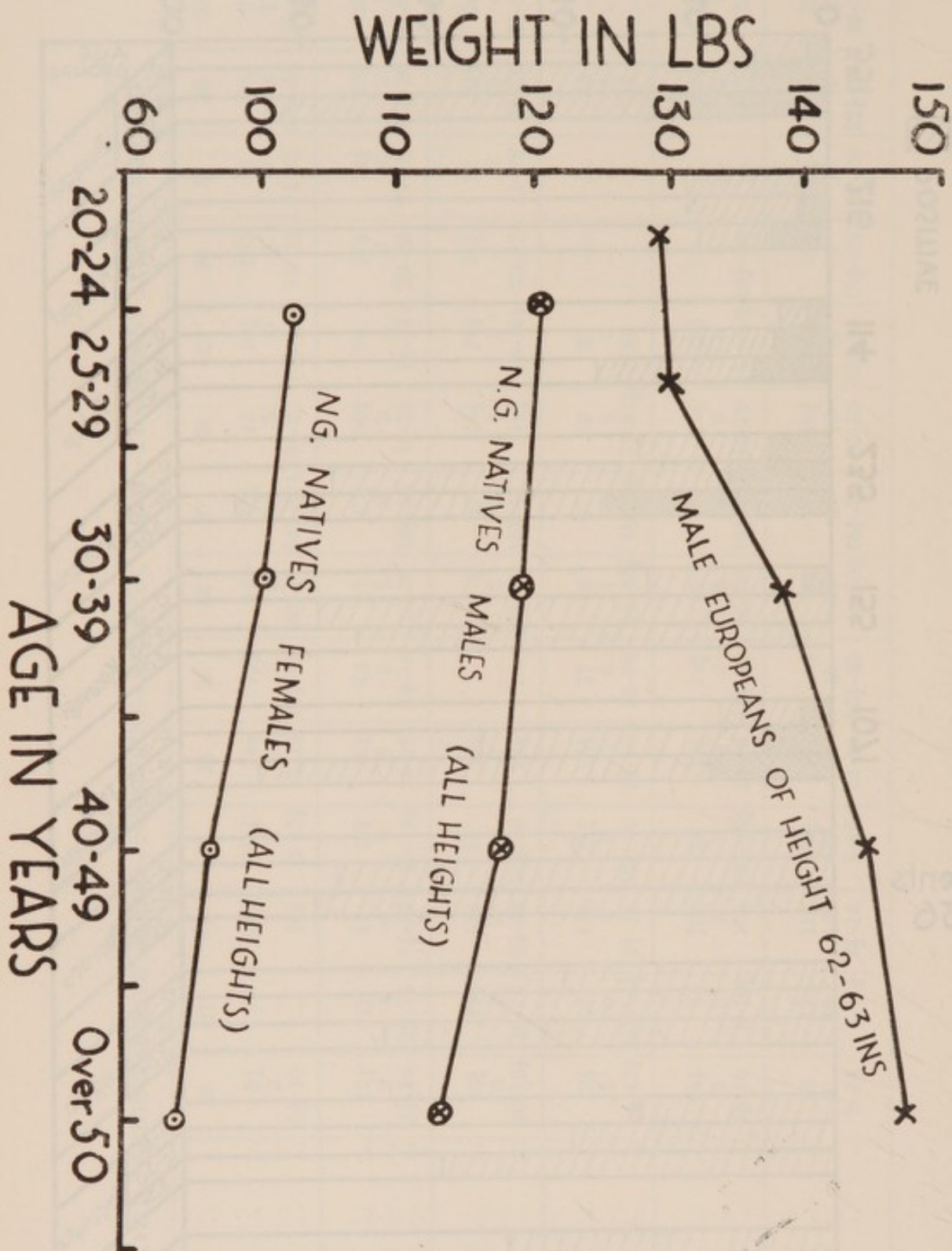
PERCENTAGE POSITIVE



Clements
1936

GRAPH I
TUBERCULIN REACTION

WEIGHT FOR AGE-ADULTS-NEW GUINEA NATIVES



GRAPH 2

PART 6.

PARASITOLOGICAL REPORT.

BY

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Introduction—Field covered.

Materials and Methods—Malaria, hookworm, filarial infections, faecal protozoa.

Results: Incidence of:—

Hookworm.

Other Helminths—

Trichocephalus trichiura.*Ascaris lumbricoides*.*Enterobius vermicularis*.*Strongyloides stercoralis*.*Heterodera* sp.Unidentified *Nematode* Eggs.*Filariasis*.*Entamoeba histolytica*.*Isospora hominis*.

Malaria.

Millipedes.

Sandflies.

Introduction.

This report deals with a parasitological investigation of the natives of the five villages selected for the nutrition survey. The programme allowed about four weeks' work in each village, starting at Busama in May and ending at Koravagi in December, 1947. As far as possible all those natives examined for nutritional status were subjected to a parasitological examination. Most attention was directed to malaria and hookworm disease as both are of wide distribution in New Guinea, and both can lower the level of haemoglobin in the blood. In addition, some idea was obtained of the incidence of infection with *Ascaris*, *Trichocephalus* and intestinal protozoa in each village. A few examinations for microfilariae were made.

Material and Methods.

MALARIA.

Blood for a thick and a thin film was taken from the patient directly after the biochemist had taken a drop of blood for the estimation of haemoglobin. Approximately 1 cu. mm. was used for the thick drop, using the method described by Mackerras and Aberdeen (1946). The thick film was stained by Giemsa or Field's stain and the whole cu. mm. examined. The thin was stained only if it was thought it would assist in the identification of the parasites seen in the thick.

Dr. Hipsley in the course of his clinical examinations recorded splenic enlargement, and his results are included in this section so as to facilitate comparison with the parasite rates.

HOOKWORM.

Faecal specimens to be examined for helminth eggs and for faecal protozoa were collected in waxed paper cups (ice cream cups). The cups were handed out to each person the day before the specimen was wanted and collected the next morning. It was therefore impossible to be certain that the specimen really came from the individual who handed it in. This source of error was avoided as far as it could be by questioning each person as he or she handed in the specimen and by only getting one specimen from each household on any one day, where this could be arranged. It is thought that the results are fairly reliable on the whole but that in this respect the results for Patep, Busama and Kavataria are more reliable than those for Kaiapit and Koravagi.

Egg counts by means of the "McMaster" method (Gordon and Whitlock, 1939), were carried out on each specimen so as to get an estimate of the intensity of hookworm infection in each village. This method does not appear to have been used previously for intensity studies on human hookworm although it has been in use for several years in veterinary laboratories for counting nematode eggs. It is quicker and easier than the well-known Stoll Dilution Counting Method and appears to give results that are at least as reliable (Gordon and Whitlock, 1939), (Peters and Leiper, 1940).

As only 1/150 g. of faeces is examined, light infestations may be missed. On the average a count of one egg to 1/150 g. corresponds to an infestation with about three or four female *Necator americanus* so the figures for the incidence of hookworm (and of *Ascaris* and *Trichocephalus*) will be slightly lower than if the Willis method were used. To overcome this, if no hookworm eggs were seen, the top liquid from the dilution tube used in the

McMaster method was poured off into an $\frac{1}{2}$ oz. container and a slide inverted over it as in the Willis method. Occasionally extra positives were found in this way. These are recorded in the tables as positives with zero count.

The egg counting technique actually used deviated slightly from the original McMaster method. The sample of faeces (1 g. instead of 2 g.) was weighed out on a small piece of sanitary paper and the whole transferred to a 6 in. by 1 in. dilution tube marked at 45 ml. Five ml. of water were added and the tube was allowed to stand for half an hour or longer. The faeces were then thoroughly mixed with the water by means of a glass rod. Finally, saturated salt solution was added to the 45 ml. mark, and the tube was stoppered and shaken well. The rest of the technique was exactly as described by Gordon and Whitlock save that the volume of the faecal suspension examined for eggs was 0.3 ml. (a square chamber 0.15 cm. deep with a side of 1.42 cm. was used). Hence the eggs in 1/150 g. of faeces were examined as against 1/200 g. in the original method. As the specific gravity of the emulsion is 1.17-1.18 other kinds of nematode eggs, such as *Ascaris* and *Trichocephalus*, are also recovered.

The actual counts were multiplied by 150 so as to express them as per gram of faeces. They were also corrected for the consistency of the stool. The factors used were $\times 1\frac{1}{2}$ for soft formed stools, $\times 2$ for mushy stools and $\times 4$ for diarrhoeic stools. Thus all the counts are expressed per gram of formed faeces.

As is usual in people living largely on vegetable food the stool classifications of "soft formed" and "mushy" were in the majority.

TABLE 15.—STOOLS CLASSIFIED IN TERMS OF CONSISTENCY.

Village.	Stool Classes.			
	Formed.	Soft Formed.	Mushy.	Diarrhoeic.
Busama	29	55	16	...
Kaiapit	19	48	31	2
Patep	28	31	41	...
Kavataria	24	31	44	1
Koravagi	31	29	40	...

CULTURES FOR HOOKWORM LARVAE.

Sterilised earth was mixed with a portion of the stool in a waxed container and left at room temperature for ten days or more. The infective larvae were recovered by a modified Baermann apparatus and identified as *Necator* or *Ancylostoma* by an examination of the buccal structure confirmed, if thought necessary, by measuring the position of the genital rudiment. These and other characteristics used to differentiate the infective larvae of the two species are summarised by Heydon (1927).

FILARIAL INFECTIONS.

A few of the people in each village except Koravagi were examined at night (after 9 p.m.) for microfilariae. A large drop of blood was examined either directly under a coverslip or after staining with Giemsa's or Field's stain. Positive films were fixed in alcohol and stained with haematoxylin for the complete identification of the microfilariae.

FAECAL PROTOZOA.

Faecal smears were examined in iodine and in 1/300 eosin or in physiological saline. If further examination was necessary smears were fixed in Schaudinn's solution and stained with haematoxylin. Only one specimen from each person was examined.

Results.

HOOKWORM.

Practically all the natives, with the exception of infants, were found to be infected with hookworm. (See Table 1 and Tables 2 to 6.) There was no marked difference in the incidence in the five different villages. If children less than two years old are excluded the percentage infected in each village became:—Busama, 94.7 per cent.; Kaiapit, 94.4 per cent.; Patep, 97.2 per cent.; Kavataria, 98.2 per cent.; Koravagi, 98.3 per cent.

The Hookworm Campaign Survey (Lambert, 1920, 1921) found the incidence in Busama to be 100 per cent. (77 people examined), while the incidence in a number of Purari delta villages averaged 72.2 per cent. (1,033 people examined).

The egg counts are set out in Tables 2-6 so as to show the number of people of each sex in their different age groups who had counts of zero, 150-999, 1,000-2,999, and so on, as well as the number who were negative. These tables also give the mean and the median of the positives in each age group. The median is given as well as the arithmetic mean because egg counts have a very skew or even a J-shaped distribution and consequently the latter is not a very useful average. The median is the egg count above which lie 50 per cent. of the values found. Although the egg count gives only a very rough idea of the number of worms infecting an individual an adequate conception of the level of infection in a community is obtained by carrying out a large number of egg counts.

It has been shown by a number of investigators that the egg count and the haemoglobin level are related. One investigation that seems useful for comparison with the results obtained in New Guinea is that of Hill and Andrews (1942), who examined the egg counts and haemoglobin values of 1,141 white residents of South Georgia, United States of America. In this area hookworm is prevalent and is due, as in New Guinea, to *Necator americanus*, but malaria is unimportant. They found that counts below 5,000 eggs/c.c. caused little change in the haemoglobin levels, while above this figure the haemoglobin fell rapidly. (For practical purposes 1 c.c. faeces may be taken as equal to 1 gm.)

The following table shows our findings in New Guinea for males over the age of fifteen. It was thought best to exclude adult females whose haemoglobin level is affected by pregnancy and menstruation and also children below 16 years as the haemoglobin varies with age. The numbers of natives with high hookworm counts are too few for much reliance to be placed on the figures. However, there is no evidence of a marked fall in haemoglobin levels at egg counts over 5,000/g. It would probably be worth while carrying out an extended investigation to determine the worm burden that causes measurable loss of haemoglobin in New Guinea natives, especially as some native peoples are believed to have more resistance to *Necator* infections than whites. Probably the central highlands where malaria is less of a complicating factor would be the best place.

TABLE 16.—COMPARISON OF HAEMOGLOBIN VALUES WITH HOOKWORM EGG COUNTS.

Village.	Mean Hb. in g./100 ml. for males, 16 and over, with egg counts falling in the range.								Mean.
	Neg.	0.	150-999.	1,000-2,999.	3,000-4,999.	5,000-7,499.	7,500-9,999.	10,000+.	
Patep No. 2 ...	.....	.....	12.3 (12)	12.6 (13)	11.7 (3)	11.9 (7)	11.7 (4)	15.2 (1)	12.3
Busama ...	.....	.....	11.0 (9)	11.7 (6)	11.2 (6)	.....	11.2 (1)	11.7 (2)	11.3
Kaiapit ...	9.6 (1)	10.9 (2)	11.8 (7)	11.4 (8)	11.2 (1)	.....	12.5 (1)	11.2 (1)	11.4
Koravagi ...	.....	.....	12.9 (15)	13.1 (9)	12.1 (5)	.....	.....	14.8 (2)	13.0
Kavataria ...	12.0 (1)	12.1 (3)	11.6 (22)	10.6 (6)	11.8 (4)	.....	11.6 (1)	.....	11.5

The figures in brackets are the number of individuals in each group.

In the various villages the number of people (and the percentage) who have counts of over 5,000 eggs per gram were Busama, 29 (20 per cent.); Kaiapit, 17 (14 per cent.); Patep, 37 (24 per cent.); Kavataria, 7 (6 per cent.); Koravagi, 15 (12 per cent.).

It will be seen from Tables 2 to 6 that the intensity, as well as the incidence, is fairly uniform for the five villages. Busama and Patep showed the highest intensity and Kavataria and Kaiapit the lowest.

In three of the villages, namely, Busama, Kaiapit and Patep, there were well made latrines that appeared to be regularly used by the adult natives, while in the other two, latrines were used little or not at all. It is probable that infection occurs in the gardens rather than in the village in many cases. Indeed, at Busama, where the village is built on bare sand exposed directly to the sun's rays and probably unsuitable for the development of hookworm larvae, the natives could accurately describe the symptoms of "ground itch," and blamed it on visits to the gardens after heavy rains. Also the egg count for adult females was higher than that for adult males in all villages, and the women spend much more time in the gardens than the men.

It may be mentioned here that hookworm egg counts were made on a series of hospital patients at Kiriwina who were not supposed to be suffering from hookworm disease. Considering only those who came from inland villages the egg counts on 13 males (aged from 10 years upwards) had a median of 4,350 and an arithmetic mean 6,880, while those on 12 females (aged from 8 years upwards) had a median of 2,400 and a mean of 4,050. Comparing these figures with those for Kavataria (Table 5) it seems that the hookworm intensity in Kavataria is lower than might be expected, presumably due to its position on the shore.

Close to Busama, but about a mile from the coast, is the small hamlet of Guado. The half dozen huts are surrounded by thick vegetation which comes right to the edge of the village clearing. No latrines were in use and it was evident that the surrounding bush served the purpose. Compared with Busama the incidences of hookworm and *Trichocephalus* were at the same high level, but *Ascaris* infection rates rose from 10 per cent. (Busama) to 50 per cent. The hookworm egg counts also showed a slight average increase as compared with Busama, probably due to a heavier soil infestation in the immediate vicinity of the village.

Lambert (1920, 1921) in the course of the Hookworm Campaign in Papua and in the Mandated Territory, carried out worm counts on some natives at Moresby and at Rabaul. These worm counts would tend to underestimate the number of worms per native as it is difficult to recover all the worms. The figures are set out in Table 7, together with the equivalent number of eggs/g. of stool calculated on the basis of 50 eggs/gm. = 1 female worm and that the sexes are equal in number.

TABLE 7.—CALCULATED HOOKWORM EGG COUNTS (after Lambert 1921).

	Number of People.	No. of Worms Recovered.	Average.	Calculated Eggs/g.
Papua	20	1,746	87.3	2,200
Mandated Territory ...	187	17,850	95.5	2,400

It will be seen that these figures are of the same order as ours.

Larval Examinations.

The species of hookworm found in New Guinea is almost always *Necator americanus*. Lambert (1920, 1921) found a ratio of 21,354 *Necator americanus* to 12 *Ancylostoma duodenale* from 258 natives in the Mandated Territory and a ratio of 2,111 *N. americanus* to 22 *A. duodenale* from 68 natives in Papua. It was thought that in view of the great movements of native people during the war, together with the presence of numbers of troops, in particular the Japanese, who might have been infected with *A. duodenale*, that this latter species may have become more common. However, the results do not support this supposition (Table 8).

TABLE 8.—EXAMINATION OF HOOKWORM LARVAE TO DETERMINE THE SPECIES.

Village.	No. of Persons Examined.	No. with <i>Ancylostoma</i> larvae.	Species of larvae.	
			No of <i>Necator</i> .	No. of <i>Ancylostoma</i> .
Busama	17	...	674	...
Kaiapit	13	1	739	2
Patep	16	...	797	...
Kavataria	15	...	717	...
Koravagi	20	3	1,163	10

These *Ancylostoma* larvae may, of course, have been *A. braziliense* and not *A. duodenale*. *A. braziliense* was found in the local dogs at Koravagi.

OTHER HELMINTHS.

Trichocephalus trichiura.

The incidence of infection with this worm is strikingly higher in the three coastal villages than in the two inland villages. (See Table 1.) Busama, Kavataria and Koravagi have incidences of 76 per cent., 88 per cent. and 82 per cent., respectively, as compared with

4.5 per cent. and 10 per cent. for Kaiapit and Patep. The reason for this difference is not clear. Kaiapit would seem from inspection to be an ideal place for the propagation of *Trichocephalus* infections; most of the huts have earthen floors, and the overhanging eaves provide shade in addition to that of the numerous trees between the houses, while just beyond the boundary fence is a belt of trees where the children play. The difference is not due to the type of house, as the houses in Busama, Patep and Koravagi are similar, being the type built on piles, while those at Kavataria and Kaiapit very often are built low on the ground and have dirt floors.

Kaiapit and Patep probably both have somewhat lower rainfall than the other places. Kaiapit has an average annual rainfall of 97 inches with a well marked dry season from May to November, the monthly falls then being two-three inches. The rainfall for Patep is not known, but is probably about the 100 inches mark. (Bulolo has an average rainfall of about 70 inches.) During our stay (July-August) it was usually cloudy, often there was a mist, and a fine drizzle of rain would fall. The rainfall at Busama is probably similar to that at Lae and Salamaua (177 inches and 154 inches, respectively), with the S.E. season definitely wetter than the N.W., but the rainfall is heavy in all months. The rainfall at Losuia (about half a mile from Kavataria) averages 153 inches per annum; rainfall is heavy in all months with a maximum in the middle of the N.W. season. The rainfall at Koravagi is not known, but is believed to be very much less than at Kikori, the nearest place where rainfall records are kept, and one of the wettest places in Papua. (Average rainfall for the five years ending June, 1941, 229.8 inches.)

It is hard to see that the difference in intensity of infection is due to differences in rainfall.

Patep is situated at about 4,000 feet above sea level and the nights are distinctly cold. However, this should not affect transmission. Heydon (1940) found the natives in the neighbourhood of Mogay, near Mount Hagen, who live in villages at 5,000 feet or more above sea level, were heavily infected with *Trichocephalus* (85 per cent.).

Ascaris lumbricoides.

The incidence of *Ascaris* is shown in Table 1. It was always less than that of *Trichocephalus*, in most cases much less. In spite of some differences in the life cycles, the epidemiology of the two worms is similar and *Ascaris* eggs seem to withstand adverse conditions better than *Trichocephalus* eggs. Once again the incidence is higher in the three coastal villages than in the two inland ones. However, Heydon (1940) found the Mogay natives to be 90 per cent. infected.

Enterobius vermicularis.

The examination of faeces is useless for determining the incidence of *Enterobius*, special techniques such as swabbing the anal folds being necessary. Consequently the figures shown in Table 1 are no indication of the true incidence. At Patep there was an unexplained increase in the number of infections found in the course of the egg counts.

Strongyloides stercoralis.

Two people in Koravagi were found to be infected with *Strongyloides*. The infections were found during the examination of cultures for hookworm larvae. *Strongyloides* larvae float up in salt solution and heavy infections would have been found while counting the hookworm eggs. Lambert (1920) in the course of the hookworm campaign in Papua found 8 infected with *Strongyloides* out of 10,372 native villagers (0.08 per cent.). It must be remembered that in these campaigns the specimen was rejected as soon as one hookworm egg had been seen, so the incidence of other worms is understated.

Heterodera sp.

Eggs of this vegetable parasite are found occasionally in the faeces having passed through the intestinal tract unchanged. The worm lives in, and causes, root nodules in many plants, such as carrots, parsnips.

Unidentified Nematode Egg.

An egg resembling *Trichostrongylus* was found in one specimen from Kaiapit (together with hookworm and *Trichocephalus*). The egg was colourless, slightly narrowed towards one pole and measured 114 by 65 microns. The content was finely granular, with some larger granules towards the periphery. Only hookworm larvae were recovered from cultures.

Filariasis.

Only a few examinations for the presence of the microfilariae of *Wuchereria bancrofti* were made in each place. These were found, as expected, to be the periodic type. At Busama and Guado of 24 examined 5 were positive, at Kaiapit of 25, 11 positive; at Patep of 15, none positive; at Kavataria and Mulosaida (Mulosaida is about 50 yards from Kavataria) of 65, 11 were positive. None of the Koravagi natives were examined, but 3 out of 10 natives of the Purari Delta were positive. (Elephantiasis is not common, but a few cases were found in Busama and Kaiapit.)

INTESTINAL PROTOZOA.

The incidence of the various species is given in Table 9.

The percentage of people passing *E. histolytica* cysts varied from 9 per cent. at Koravagi to 26 per cent. at Patep, which is rather high as compared with the 1 per cent. of cyst-passers found by Avery (1946) among the natives of a village near Samarai. Since only one specimen from each person was examined, the true incidence is even higher, possibly 2 or 3 times higher. However, cases of amoebic dysentery seem rare. One was encountered at Busama. Heydon (personal communication) in an investigation of dysentery outbreaks in the labour lines at Wau and Bulolo found one case of amoebic dysentery among 26 natives suffering from dysentery. Lancaster (personal communication) saw no pathological features of amoebiasis in about 150 post-mortems (including 30-40 dysenteries) in an Angau hospital.

Backhouse (personal communication) saw a chronic case of amoebiasis, with liver abscess, in a New Guinea native at an autopsy in Rabaul; a small percentage of natives there had *E. histolytica* cysts but there were no acute intestinal amoebic infections. Natives in villages near Finschhafen (examined in 1937) had a fairly high percentage of cyst-passers (about 10 per cent.) but no acute amoebiasis. Many of these cases showed only uninucleate cysts.

In the five villages included in the present survey these cysts, morphologically *E. histolytica* but with one or two nuclei, were relatively common and in many cases no quadrinucleate cysts were found. Heydon (1940) records only one quadrinucleate cyst from 49 cyst-passers in villages near Mogay; nearly all were uninucleate.

Isospora hominis.

Oocysts of *Isospora hominis* float up in salt solution but may be easily missed when one's attention is concentrated on the larger nematode eggs. Only one case was found, a 24 year male of Busama. Oocysts were still present on a second examination four days later, but it was impossible to get any more specimens of stool from the native. The cysts measured $27\ \mu \times 11.5\ \mu$ and were cultured to the sporozoite stage.

Infections with *Isospora hominis* are rare in most parts of the world but Heydon (1940) found it to be common in Mogay district (12 out of 227 natives = 5.3 per cent.).

MALARIA.

With the exception of Patep all the villages show a high rate of malaria transmission and fall into the hyperendemic category. The spleen rates for the 2-9 year group are:—Busama, 74 per cent.; Kaiapit, 83 per cent.; Patep, 15 per cent.; Kavataria, 63 per cent.; Koravagi, 52 per cent. If Mulosaida is included with Kavataria (it is a similar village only 50 yards away) the spleen rate is 47 per cent. Ford in 1938-39 (Malaria in the S.W. Pacific) found the spleen rates in a number of Trobriand villages to vary from 4-30 per cent.

The age distribution of the spleen rates is set out in Tables 10-14.

Patep is situated at an altitude of 4,000 feet and probably owes its lesser incidence of malaria to this fact. During our stay mosquitoes of any kind were rare in the houses and anophelines were never found. The infants appeared to have escaped infection. Perhaps transmission occurs during visits to other villages at low altitudes, or while working in the gardens which extend down the sides of the valley and are well protected by vegetation.

The three species of *Plasmodium* were found in each village but in varying amounts. Films classed as unidentified were those which showed an occasional ring in thick films; too few parasites for a search of the thin films to be worth while. Films of this type were found in every village, including Busama, where the transmission rate of *P. vivax* was greatly in excess of *P. falciparum*. They were rare in films from infants.

The parasite rates are also set out in Tables 10-14. It will be seen that the high rate of transmission indicated by the spleen rate at Busama and Kaiapit is confirmed by the high proportion of infants infected, 11 out of 12 and 9 out of 9 respectively. At Busama a baby only 7 weeks old was found to be infected with *P. vivax*. Both in Busama and Kaiapit the great majority of infections in the infants were with *P. vivax*. Presumably transmission in the months before our arrival was mainly confined to *P. vivax*.

The anophelines of Busama and Kaiapit were *A. punctulatus farauti*; they were common at Busama, much less so at Kaiapit. At Kavataria no anophelines were found in the huts or in our camp. The anopheline population is said to breed up during the N.W. season, while we were there at the end of the S.E. season. At Koravagi also no anophelines were encountered. However, at one of the other villages in the Purari delta *A. punctulatus punctulatus* and *A. punctulatus farauti* were found breeding in an old canoe.

Hairston, Bang and Maier (1947) give the results of parasite and spleen surveys for nine areas of New Guinea, two of them (Chivasing and Butibum) are comparable to two villages visited by the present survey (Kaiapit and Busama).

Chivasing and Kaiapit are two similar villages in the Markham Valley, the former about 30 miles downstream.

TABLE 17.—MALARIA—PARASITE AND SPLEEN RATES.
Chivasing Village.—4th October, 1944. (Hairston, Bang and Maier.)

Age Group.	No. Studied.	<i>P. vivax.</i>	<i>P. malariae.</i>	<i>P. falciparum.</i>	Unclassified.	Mixed.	Positive Parasites.	Palpable Spleen.
							per cent.	per cent.
Less than 2	0	...	...	...	...	...	...	...
2—5	11	2	0	2	4	VF. 1.	82	91
6—10	15	6	0	0	5	0	67	80
11—15	0	...	...	...	...	0	...	...
16—over	25	2	0	0	5	0	27	24

Figures for three surveys of Butibum villages (near Lae) are also given in the same paper. Another examination of this group of villages is given in a typescript report to Australian Army Authorities from Major T. C. Backhouse, 2/7 Australian General Hospital, Lae (personal communication).

TABLE 18.—MALARIA—PARASITE AND SPLEEN RATES.
Butibum Villages.—July, 1945. (Backhouse.)

Age.	No. Exmd.	<i>P. vivax.</i>		<i>P. malariae.</i>		<i>P. falciparum.</i>		Uncl.	Mixed.	% Pos. Parasites.	% Palpable Spleen.
		Trophozoites.	Game-toocytes.	Trophozoites.	Game-toocytes.	Trophozoites.	Game-toocytes.				
0—1...	15	4	1	0	0	6	4	0	VF/3 FM/1	...	...
2—5...	50	3	1	2	3	23	11	2	VF/7 VM/1 FM I	93	87
6—10...	92	2	1	0	1	46	5	1	VF/5 VM/1	...	...
11—15...	51	2	0	1	0	13	2	1	0	35	86
16—18...	18	1	1	0	0	2	0	1	0	22	} 44
Over 18	200	1	2	0	0	20	2	2	VF/2	12.5	

The villages included in this survey were on the Busu River several miles from the coast. The transmission rate seems to be higher than at Busama judged by the higher spleen rates and the predominance of *P. falciparum* infections.

MILLIPEDES.

Large (10 centimeters) shiny black millipedes were common; when disturbed they ejected a copious yellowish fluid from a number of lateral pores. The exudate was very irritating to skin abrasions; on the skin surface it soon changed from yellow to red and later dark-brown and disappeared in about a week. Natives are afraid and take pains to avoid them. They say the exudate will cause blindness if it reaches the eyes, or sores if on the skin. This is partly borne out by Mr. Gordon Scott (Talks Officer, A.B.C., Sydney, and formerly Intelligence Officer with the Australian Army), who states that he knows of one case of temporary blindness (lasting ten or twelve days) in an Australian soldier at Kiriwina, and several cases of desquamation after contact with the exudate of this animal. They had the habit of crawling up the legs of stretchers and across the bodies of sleeping men and were plentiful wherever there was rotting vegetable debris.

A summary of the literature in dealing with this subject is given by Burt (1947).

SANDBLIES.

These are a pest in Busama village and bite day and night, but are especially active at dawn and dusk. Day-biting specimens were identified as *Styloconops albiventris de Meyere* by Mr. D. J. Lee (Sydney University), who also has species collected from Kaiapit and Koravagi for description.

TABLE 1.—INCIDENCE OF WORM PARASITES.

Village	Number. Examined.	Hook- worm.	Tricho- cephalus.	Ascaris.	Enter- obius.	Hetero- dera.	Strongy- loides.
Busama ...	134	124	102	13	0	1	0
Kaiapit ...	125	109	13	1	1	1	0
Patep 2 ...	156	139	7	0	14	0	0
Kavatania ...	119	108	105	84	0	0	0
Koravagi ...	125	120	102	24	3	0	2

TABLE 2.—BUSAMA—HOOKWORM INTENSITY BY SEX AND AGE.

Age.	Negative.		Positive Egg Count/Gram.												Total.		Median of Positives.		Mean of Positive.	
	0.		150-999.		1,000-2,999.		3,000-4,999.		5,000-7,499.		7,500-9,999.		10,000+.		M.	F.	M.	F.		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.								
0—	1	2	0	0	1	1	0	0	0	0	0	0	0	0	2	2	...	...	...	
2—	2	3	1	0	4	5	0	0	1	1	1	0	0	1	10	5	380	5,890	2,340	
6—	0	0	1	0	8	3	2	4	2	1	1	0	0	1	19	9	1,100	3,500	3,180	
11—	0	0	1	0	2	0	4	2	1	2	0	0	0	2	6	12	900	3,200	2,680	
16—	0	0	0	1	3	1	2	1	0	0	1	0	0	1	7	6	1,350	1,230	5,520	
21+	0	1	1	1	7	5	6	6	0	3	1	2	2	5	25	31	1,350	3,750	3,075	
Total ...	4	6	4	2	24	10	16	14	10	15	4	6	4	2	69	65	G.T. 134	...	...	
%*	5.8	9.2	5.8	3.1	34.8	15.4	23.2	21.5	14.5	23.1	5.8	9.2	5.8	3.1	...	...	.....	...	...	
% of G.T.	7.5		4.5		25.4		22.4		18.7		7.5		4.5		...	...	.....	...	...	

* Percentage of total males and females respectively.

TABLE 3.—KAIAPIT—HOOKWORM INTENSITY BY SEX AND AGE.

Age.	Negative.		Positive Egg Count/Gram.												Total.		Median of Positives.		Mean of Positive.												
			0.						150-999.												1,000-2,999.		3,000-4,999.		5,000-7,499.		7,500-9,999.		10,000+.		
	M.		F.		M.		F.		M.		F.		M.		F.		M.		F.		M.		F.		M.		F.				
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.			
0—	5	5	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150	190	
2—	1	2	0	0	5	1	5	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	790	1,790	
6—	0	0	0	0	3	2	2	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,450	2,480	
11—	0	0	0	0	3	1	1	1	1	1	2	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1,380	5,550	
16—	0	0	0	0	0	1	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,590	3,980	
21+	1	2	2	0	7	14	7	13	0	3	0	3	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	900	1,200	
Total ...	7	9	3	0	19	21	16	18	3	9	5	6	1	2	2	1	56	66	G.T. = 122	...	...	...	...	...	...	...	...	...	...	...	...
%*	12.5	13.6	5.3	0	34.0	31.8	28.6	27.3	5.3	13.6	8.9	9.1	1.8	3.0	3.6	1.5	...	...													...
% G.T. ...	13.1		2.5		32.8		27.9		9.8		9.0		2.5		2.5																...

* Percentage of total males and females respectively.

TABLE 4.—PATEP No. 2—HOOKWORM INTENSITY BY SEX AND AGE.

Age.	Negative.		Positive Egg Count/Gram.												Total.		Median of Positives.		Mean of Positive.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
			0.						150-999.												1,000-2,999.		3,000-4,999.		5,000-7,499.		7,500-9,999.		10,000+.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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* Percentage of total males and females respectively.

TABLE 5.—KAVATARIA—HOOKWORM INTENSITY BY SEX AND AGE.

Age.	Negative.		Positive Egg Count/Gram.												Total.		Median of Positives.		Mean of Positive.				
			0.						150-999.		1,000-2,999.		3,000-4,999.								5,000-7,499.		7,500-9,999.		10,000+.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
0—	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2—	0	1	1	1	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6—	0	0	0	0	3	3	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11—	0	0	0	0	3	3	5	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
16—	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21+	1	1	3	6	21	9	6	9	3	4	0	0	1	1	0	2	35	32	640	1,200	1,235	2,175	...
Total ...	4	7	4	7	29	17	16	19	4	5	0	2	1	1	0	3	58	61	G.T 119	...	...	...	...
%*	6.9	11.5	6.9	11.5	50.0	27.9	27.6	31.1	6.9	8.2	0	3.3	1.7	1.6	0	4.9	...	...	.....	...	...	...	...
% of G.T.	9.2	9.2	9.2	9.2	38.7	29.4	7.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	2.5	.....	.....	.....	.....	...	...	...	...

* Percentage of total males and females respectively.

TABLE 6.—KORAVAGI—HOOKWORM INTENSITY BY SEX AND AGE.

Age.	Negative.		Positive Egg Count/Gram.												Total.		Median of Positives.		Mean of Positive.	
	M.	F.	0.		150-999.		1,000-2,999.		3,000-4,999.		5,000-7,499.		7,500-9,999.		10,000+.		M.	F.	M.	F.
			M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.				
0—	3	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	6	1	1,050	1,250
2—	0	2	2	1	3	1	4	1	0	0	2	1	0	0	1	1	12	7	1,430	2,705
6—	0	0	0	1	1	1	4	4	0	0	1	1	0	0	0	0	6	8	1,950	2,350
11—	0	0	1	0	0	4	1	0	1	0	0	1	0	0	0	0	3	8	1,050	1,524
16—	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	3	8	1,050	1,780
21+	0	0	0	1	20	9	10	11	4	8	0	0	1	1	2	3	37	33	2,100	2,675
Total ...	3	2	3	3	25	19	23	18	6	8	3	3	1	1	3	4	67	58	900	2,170
%* ...	4.5	3.4	4.5	5.2	37.4	32.7	34.4	31.0	9.0	13.8	4.5	5.2	1.5	1.7	4.5	6.9	...	...	G.T. 125	...
% of G.T.	4.0		4.8		35.2		32.8		11.2		4.8		1.6		5.6		...	...	...	...

* Percentage of total males and females respectively.

TABLE 9.—INCIDENCE OF INTESTINAL PROTOZOA.

Village.	Number Examined.	Number Negative.	E. histolytica.	E. coli.	E. nana.	I. butschlii.	Trichomonas.	C. mesnili.	G. lamblia.	Isospora hominis.	Unident.	Mixed Infections.
Busama	51	37	6	7	0	0	1	0	3	1	0	Eh Ec 3 GI Cml Eh Ec 3
Kaiapit...	49	38	8	1	4	0	1	1	1	0	2	Eh En 1 Eh Th 1 Eh Ec 2 Eh En 4 Ec En 1 Eh Ec En 1 Ec En Cml Eh Ec En Ib Eh Ec 3 Ec En 1 Eh Ec En 1 Eh Ec 1 Ec GI 1.
Patep 2	73	38	19	18	9	2	0	1	0	0	0	
Kavataria	73	52	7	16	2	0	1	0	0	0	0	
Koravagi	79	68	7	2	0	0	0	0	3	0	0	

TABLE 10.—BUSAMA—MALARIA—PARASITE AND SPLEEN RATES.

Spleens.										
Parasites.										
Age.	Number Examined.	Number Positive.	% Positive.	P.v.	P.m.	P.f.	Unclass.	Mixed.	Number Examined.	% Palpable
0	12	11	92	9	1	1	0	0	18	12
—	23	20	87	7	3	8	3	V.M.I.	18	14
6	28	21	75	6	2	4	9	0	35	25
11	21	11	52	4	1	4	3	F.M.I.	19	14
16 +	80	14	17.5	3	0	1	10	0	77	19
Totals ...	164	77	47	29	7	18	25	2	167	84
										50

Spleen rate (2-9 years)—74 per cent. of 49 examinations. Parasite rate (2-9 years)—82 per cent. of 49 examinations.

TABLE II.—KAIAPIT—MALARIA—PARASITE AND SPLEEN RATES.

Parasites.											Spleens.		
Age.	Number Examined.	Number Positive.	% Positive.	P.v.	P.m.	P.f.	Unclass.	Mixed.	Number Examined.	Number Palpable.	% Palpable		
0 —	9	9	100	6	1	3	2	V.F.2. V.M.1.	9	9	100		
2 —	11	11	100	2	1	5	3	0	11	10	90		
6 —	16	10	62	1	0	5	4	0	16	12	75		
11 —	11	7	63	1	0	2	4	0	11	3	27		
16 +	57	13	23	5	0	3	5	0	57	15*	26		
Totals ...	104	50	48	15	2	18	18	3	104	49	47		

Spleen rate (2-9 years)—83 per cent. of 24 examinations.

Parasite rate (2-9 years)—79 per cent. of 24 examinations.

* All in females.

TABLE 12.—PATEP No. 2—MALARIA—PARASITE AND SPLEEN RATES.

KAVATARIA Parasites.											Spleens.	
Age Group.	Number Examined.	Number Positive.	% Positive.	P.v.	P.m.	P.f.	Unclass.	Mixed.	Number Examined.	Number Palpable.	% Palpable.	
0 —	14	0	0	...	...	...	...	...	14	0	0	
2 —	27	6	22	4	2	1	0	F.M.I.	27	6	22	
6 —	18	5	29	1	0	1	3	0	18	2	12	
11 —	7	2	29	1	1	0	1	V.M.I.	7	3	43	
16 +	90	9	10	1	0	4	4	0	90	29	32	
Totals ...	156	22	14	7	3	6	8	2	156	40	26	

Spleen rate (2-9 years)—15 per cent. of 40 examinations.

Parasite rate (2-9 years)—25 per cent. of 40 examinations.

TABLE 13.—MALARIA—PARASITE AND SPLEEN RATES.

Age Group.	KAVATARIA. Parasites.						KAVATARIA. Spleens.				MULOSAIDA. Spleens.			
	Number Examined.	Number Positive.	% Positive.	P.v.	P.m.	P.f.	Unclass.	Mixed.	Number Examined.	Number Palpable.	% Palpable.	Number Examined.	Number Palpable.	% Palpable.
0 —	8	2	25	0	1	0	1	0	8	0	0	3	1	33
2 —	11	4	33	0	2	0	2	0	11	6	50	8	2	25
6 —	14	2	17	1	0	1	1	V.F.1	14	10	83	7	1	14
11 —	15	3	19	1	0	1	1	0	15	4	25	8	2	25
16 +	71	4	6	2	2	1	0	F.M.1	71	13	18	58	3	6
Totals ...	119	15	12.5	4	5	3	5	2	119	33	28	84	9	11

Spleen rate (2-9 years)—63 per cent. of 24 examinations. Spleen rate (2-9 years)—48 per cent. of 36 examinations for Kavataria and Mulosaida. Parasite rate (2-9 years)—25 per cent. of 24 examinations.

TABLE 14.—KORAVAGI—MALARIA—PARASITE AND SPLEEN RATES.

Parasites.											Spleens.		
Age Group.	Number Examined.	Number Positive.	% Positive.	P.v.	P.m.	P.f.	Unclass.	Mixed.	Number Examined.	Number Palpable.	% Palpable.		
0 —	9	2	22	1	0	1	0	0	17	5	29		
2 —	16	6	37.5	1	1	2	2	0	23	10	43		
6 —	17	4	22	1	1	1	1	0	25	17	68		
11 —	9	2	25	0	0	0	2	0	9	5	56		
16 +	70	17	24	9	2	0	6	0	78	21	27		
Totals ...	121	31	26	12	4	4	11	0	152	58	38		

Spleen rate (2-9 years)—52 per cent. of 42 examinations

Parasite rate (2-9 years)—33 per cent. of 30 examinations.

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PART 7.

BIOCHEMICAL REPORT.

BY

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Introduction.

Procedure and Methods.

(1) Blood Tests—

- (a) Serum Protein and Haemoglobin;
- (b) Plasma Ascorbic Acid.

(2) Ascorbic Acid in Breast Milk.

(3) Riboflavin Load Tests.

Results and Discussions.

(1) Serum Protein and Haemoglobin.

(2) Plasma Ascorbic Acid.

(3) Ascorbic Acid in Breast Milk.

(4) Riboflavin Load Tests.

Introduction.

A number of studies were made upon biological material collected from groups of natives, in the hope that the results would aid in the interpretation of clinical observations.

Naturally the scope of the biochemistry carried out in such a survey was limited by two factors, (i) the time that was available at each village surveyed, *i.e.*, approximately three working weeks; (ii) the methods used needed to be rapid and reliable, using apparatus that was both portable and reasonably robust; the survey planned to disturb the native economy as little as possible, so methods involving much of the native's times, for instance, prolonged vitamin load-tests lasting several days, could not be used.

Procedure and Methods.

An attempt was made to carry out the blood tests below on all the natives who were examined clinically by the medical officer. If, however, there was any protest by the parent no attempt was made to obtain blood from very young babies. The blood was obtained by a prick in the ball of the finger after it had been warmed and washed in hot water. The washing and warming in hot water, besides facilitating the obtaining of blood, ensued that all the subjects followed a standard procedure, *i.e.*, standing for several minutes and then walking across to where the blood was obtained. This uniform procedure was probably of value in eliminating certain fluctuations in the plasma protein levels (¹).

From the lactating women of the villages milk was obtained for the determination of ascorbic acid. An attempt was made to carry out thiamin assays on the milk by the visual method described by Slater (²), but satisfactory results could not be obtained under the field conditions of the survey.

In each village a representative sample of the males above the age of fourteen years participated in the riboflavin load test. After appropriate treatment the urines were despatched to Canberra where they were analysed by Miss Catherine F. Fysh.

The methods used and comments on their accuracy and convenience are given below.

1. BLOOD TESTS.

(a) *Serum Protein and Haemoglobin.*

From a maximum of 0.15 c.c. of whole blood the specific gravities of whole blood and serum protein were determined by the gradient method of Linderstrom-Lang as described by Lowry and Hunter (³).

Serum proteins were calculated from the specific gravity of serum by the formula of Lowry and Hunter (³).

Haemoglobin values were obtained by using revised nomogram of Phillips *et al.* (⁴) after the specific gravities of serum and whole blood had been appropriately adjusted. Lowry and Hunter (³) point out that the specific gravities obtained by this gradient method are heavier by 0.0016 than those obtained by the copper sulphate method of Phillips *et al.* (⁴). In addition to applying this correction to both serum and whole blood specific gravities the serum specific gravity was converted to plasma specific gravities by the addition of 0.0005. The haemoglobins could then be calculated on the nomogram.

The method was used without modification except that copper sulphate specific gravity standards were used instead of potassium sulphate. Copper sulphate was less liable to support mould growth than potassium sulphate under the conditions of the survey. The copper sulphate standards were prepared according to the method of Phillips *et al.* (4).

The figures obtained in the survey were used to calculate the experimental error of the method. The specific gravity determinations were carried out in duplicate and from the differences between the duplicate determination the standard error of a single estimation, in which duplicate specific gravity determinations are carried out, was calculated. For plasma protein determinations, at the 5 per cent. level the error was ± 0.10 gm./100 ml. and haemoglobin error ± 0.4 gm./100 ml. also at the 5 per cent. level.

(b) Plasma Ascorbic Acid.

The dichlorophenol indophenol method used by Farmer and Abt (5) as described and slightly modified by Pecover (6) was selected. This method requires only 0.3 c.c. of blood easily obtainable by finger prick and did not necessitate the use of a colorimeter or spectrophotometer, the end point being judged visually.

Two factors which affect the ease of accomplishing the method were noted in the survey and are discussed as follows:—

- (i) *Effect of light on the titration:* For a visually clear end point it was found essential that the titration be carried out in a diffuse white light. This is ideally obtained in the open with the sun obscured by the clouds. However, using reflectors, fairly good conditions were obtained when working in front of a window. It was found impossible to judge the end point in light in which there was an undue amount of red, *e.g.*, light from the setting sun.
- (ii) *Effect of depth of depression in titration tile:* The shallower the depressions of the porcelain tile the easier it is to obtain suitable lighting conditions (there is less shadow from a direct light in the shallower depression). Whereas tiles of 20 mm. diameter and 6 mm. depth were found quite troublesome, depressions of the same diameter and $3\frac{1}{2}$ mm. depth were quite satisfactory. Unfortunately only tiles of $6\frac{1}{2}$ mm. depth were available for the survey.

The experimental error was calculated as for serum protein and found to be 0.062 mg./100 ml., at 5 per cent. level for a single estimation based on duplicate titrations. This is approximately 50 per cent. higher than the experimental error obtained by Pecover (6).

2. ASCORBIC ACID IN BREAST MILK.

The breast milk was expressed by hand usually by the women themselves and the milk was collected away from direct sunlight. The samples were placed in brown bottles and kept at atmospheric temperature until titrated $\frac{1}{2}$ –1½ hours after collection. The 2:6 dichlorophenol indophenol method described by Winikoff (7) was used in the actual determination.

As Winikoff (7) has shown that there is no variation in the ascorbic acid content of first, middle and end milk, the size of the sample expressed in no way affected the ascorbic acid content of the milk. There was no

difficulty in obtaining the co-operation of the women. While the samples were being collected the babies were offered milk from a bottle, but this was quite often refused.

Unfortunately, the number of lactating women in each village was small and consequently only relatively few assays could be carried out.

3. RIBOFLAVIN LOAD TESTS.

An attempt was made to gather approximately forty specimens of urine from the men of each village. The men were assembled about 8 o'clock in the morning and emptied their bladders prior to being given 5 mgm. of riboflavin dissolved in about 500 ml. of water. The subjects passed all their urine for the next four hours into waxed paper cups, fitted with lids. It was emphasised that as little light as possible fall on to the urine at any stage during collection. After collection 1 ml. of concentrated hydrochloric acid was added to each sample and the volume made up to 500 ml. with water. This removed the formation of any precipitates, etc., which occlude riboflavin in them. Aliquots of 100 ml. preserved with 2 ml. of toluene were despatched to Australia and analysed by the fluorometric method of Slater and Morell (*).

The relatively large amount of water given with the riboflavin was necessary to induce a satisfactory flow of urine within the four hours. Even under such conditions the majority of the urinary volumes were between 150 and 200 mls. over the four hours.

Owing to losses in transit and the lack of co-operation by the natives in some villages the number of analyses from each village were considerably lower than that aimed for.

Results and Discussion.

1. SERUM PROTEIN AND HAEMOGLOBIN.

The mean values, together with their standard deviations, of the serum protein and haemoglobin levels, of the villages surveyed have been set out in Tables I and II. The villages have been divided into sex and age groupings to show the trends and differences in those groupings.

It will be seen that the 0-5 years group consistently has serum protein values lower than the remaining groups in the village. This is quite consistent with the findings of Trevorrow *et al.* (*) who found that adult levels of plasma protein are reached by the third year. As is expected, there is no consistent difference between the males and females in the serum protein levels.

TABLE I.—TOTAL AND AGE GROUPS.
SERUM PROTEIN LEVELS—VILLAGE BY VILLAGE.

Village.	Total Population.			0-5 years.			6-10 years.			11-60 years.		
	Mean.	S.D.	No.	Mean.	S.D.	No.	Mean.	S.D.	No.	Mean.	S.D.	No.
Busama	7.56	0.93	157	7.07	0.86	21	7.45	0.74	21	7.89	0.97	36
...				6.90	0.89	9	7.46	0.87	11	7.88	1.02	59
Kalapit ...	7.26	0.76	108	6.82	1.13	14	7.31	0.44	11	7.24	0.50	30
...				6.80	1.19	6	7.42	0.66	6	7.46	0.54	41
Patep ...	7.23	0.77	156	6.48	0.61	21	7.13	0.81	8	7.67	0.60	47
...				6.61	0.62	19	7.24	0.42	10	7.38	0.37	51
Kavataria ...	7.24	0.69	117	6.49	0.74	7	7.12	0.58	5	7.37	0.51	45
...				6.36	0.58	10	7.10	0.41	9	7.48	0.66	41
Koravagi...	7.94	0.78	121	7.38	0.65	16	7.67	0.35	9	8.20	0.72	35
...				7.14	0.71	9	8.15	0.78	8	8.12	0.67	44

TABLE II.—TOTAL AND AGE GROUPS.
HAEMOGLOBIN LEVELS—VILLAGE BY VILLAGE.

Village.	Total Population.			0-5 years.			6-10 years.			11-60 years.		
	Mean.	S.D.	No.	Mean.	S.D.	No.	Mean.	S.D.	No.	Mean.	S.D.	No.
Busama ...	9.93	1.76	157	9.10	1.02	21	10.10	1.01	21	10.64	1.44	36
...				9.42	1.10	9	9.49	1.25	11	9.89	1.27	59
Kalapit ...	9.94	1.63	108	8.10	1.64	14	10.42	1.38	11	11.12	0.59	30
...				7.60	1.81	6	9.73	0.52	6	9.95	1.01	41
Patep ...	11.47	1.36	156	10.71	1.42	21	11.30	0.93	8	11.98	1.31	47
...				11.27	1.30	19	11.09	0.42	10	11.51	1.40	51
Kavataria ...	10.33	1.58	117	8.67	1.16	7	9.64	1.20	5	11.02	1.48	45
...				9.53	0.81	10	10.36	1.13	9	10.13	1.66	41
Koravagi...	11.45	1.83	121	9.77	1.89	16	11.55	0.95	9	12.49	1.64	35
...				9.29	1.93	9	10.73	1.37	8	11.78	1.34	44

TABLE IV.—FREQUENCY DISTRIBUTION OF HAEMOGLOBIN LEVELS

Haemoglobin Levels in gm./100 ml.	BUSAMA.			KAIAPIT.			PATER.			KAVATARIA.			KORAVAGI.			TOTAL.		
	M.	F.	M. and F.	M.	F.	M. and F.	M.	F.	M. and F.	M.	F.	M. and F.	M.	F.	M. and F.	M.	F.	M. and F.
Up to 6.0	...	1	1	2	1	3	...	1	...	1	2	3	...	1	1	3	5	8
6.1—7.0	...	1	2	2	2	4	...	1	1	1	1	2	...	...	1	6	5	11
7.1—8.0	...	5	11	2	1	3	...	...	...	...	...	...	...	...	3	10	7	17
8.1—9.0	...	14	21	5	11	16	...	...	...	...	...	...	...	...	9	28	38	66
9.1—10.0	...	25	50	14	16	30	...	...	...	...	...	...	...	...	7	54	68	122
10.1—11.0	...	21	44	13	17	30	...	...	...	...	...	...	...	...	21	74	86	160
11.1—12.0	...	12	23	8	5	13	...	...	...	...	...	...	...	...	31	73	82	155
12.1—13.0	...	...	4	6	...	6	...	...	...	...	...	...	...	...	28	51	30	81
13.1—14.0	...	...	...	3	...	3	...	...	...	...	...	...	...	...	13	17	12	29
14.1—15.0	...	...	1	...	...	...	...	...	...	...	...	...	...	...	6	8	...	8
15.1—16.0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	...	2

The haemoglobin levels show the same tendency to rise as age increased. The 0-5 years group values shown in Table II are noticeably lower than the 6-10 years groups and the 11-60 years groups. This is in harmony with the figures summarized in 1945 by the English Committee on Haemoglobin Levels (¹⁹). It will be noted that the sex difference in the haemoglobin levels, which is quite marked in the 11-60 years groups, is not apparent in the other groups. Although the 6-10 years group shows the tendency it is not marked at this age level.

The frequency distribution of the values for serum protein and haemoglobin are shown in Tables III and IV. These show the values for the five villages totalled and separately. A sex division but not an age division was carried out.

A number of tests of the significance of the difference (using the "t" test) between the mean values of the villages was carried out and the results are summarized in Table V (Serum Protein) and Table VI (Haemoglobin).

It will be seen that Koravagi (mean 7.9 gm./100 ml.) is significantly higher than the remaining four villages for serum protein values, with Busama coming next. The Busama mean value is significantly higher than the means for the remaining three villages which are very close together.

Patep and Koravagi show the highest mean of haemoglobin values (11.5 gm./100 ml.) whilst the mean values of the remaining three villages was quite close to each other and well below the level of 11.5 gm./100 ml. The values as a whole are quite low compared to populations in England (¹) and probably can be explained on the basis of hookworm and malaria infection (see Parasitological and Medical Reports). Patep was situated at an altitude of 4,000 feet and during the party's stay there were very few mosquitoes seen. Also Koravagi was lacking in mosquitoes whilst the party was stationed there (during the dry season).

It will be noted from Table I that the mean serum protein values are much higher than are usually found. For instance, a summary (¹⁰) of the published values of plasma and serum protein levels, obtained throughout the world and by various methods shows that a value of 6.9 gm./100 ml. for plasma protein concentration could be taken as the world average. A value of 7.2 gm./100 ml. was the lowest mean value obtained in this survey for serum protein concentration.

As a check several determinations were made on white subjects while on the survey. Table VII shows the values obtained were quite normal and were much lower than the values obtained from natives in the same places when the same equipment and standards were employed. Thus it would seem that either the values obtained are correct or that the method used is not giving correct answers for natives.

TABLE V.—COMPARISON OF UNDISSECTED SERUM PROTEIN LEVELS (MEAN).

	KAIAPIT.	PATEP.	KAVATARIA.	KORAVAGI.
Busama Mean 7.6 gm./100 ml.	Difference H.S. 0.01 > P > 0.001	Difference H.S. P > 0.001	Difference S. P = 0.05	Difference H.S. P < 0.001
Kaiapit Mean 7.3 gm./100 ml.		Difference N.S. 0.4 > P > 0.3	Difference N.S. 0.4 > P > 0.3	Difference H.S. P < 0.001
Patep Mean 7.2 gm./100 ml.			Difference N.S. P = 1	Difference H.S. P < 0.001
Kavataria Mean 7.2 gm./100 ml.				Difference H.S. P < 0.001
Koravagi Mean 7.9 gm./100 ml.				

N.S. = No significant difference — P > 0.05 S. — Significant difference — 0.05 > P > 0.01 H.S. — Highly significant difference — P < 0.01

TABLE VI.—COMPARISON OF UNDISSECTED HAEMOGLOBIN LEVELS (MEAN).

	KAIAPIT.	PATEP.	KAVATARIA.	KORAVAGI.
Busama Mean 9.9 gm./100 ml.	Difference N.S. 0.6 > P > 0.5	Difference H.S. P < 0.001	Difference S. P = 0.05	Difference H.S. P < 0.001
Kaiapit Mean 9.9 gm./100 ml.		Difference H.S. P > 0.001	Difference N.S. 0.9 > P > 0.8	Difference H.S. P < 0.001
Patep Mean 11.5 gm./100 ml.			Difference H.S. P < 0.001	Difference N.S. P = 1
Kavataria Mean 10.3 gm./100 ml.				Difference H.S. P < 0.001
Koravagi Mean 11.5 gm./100 ml.				

TABLE VII.—HAEMOGLOBIN AND SERUM PROTEIN LEVELS OF WHITES IN NEW GUINEA.

Village at which determined.	Subject.	Age.	Sex.	Protein.	Haemoglobin.
Kaiaipit	1	28	F.	6.5	10.9
	2	28	M.	5.9	12.6
	3	48	M.	6.5	11.6
	4	26	M.	6.2	13.8
Patep	5	32	M.	6.4	13.9
	6	22	M.	6.9	13.9
	7	28	F.	5.4	11.5
Kavataria	1	28	F.	6.8	10.8
	2	28	M.	6.6	14.4
	8	6	F.	5.2	10.9
	9	10	M.	6.2	11.8
Koravagi	1	28	F.	7.5	13.8
	10	29	M.	6.6	15.6
				Mean 6.36	Mean 12.7

The conversion from specific gravity of serum to serum protein concentration is accomplished through an equation of the general form:

Serum Protein gm./100 ml. = K (Specific Gravity — A) where K and A are constants about which there has been some controversy.

The particular equation used in this survey was:

Serum Protein = 348.6 (Specific Gravity — 1.0069) gm./100 ml.

The latter equation has been found accurate for Caucasian peoples, but it is possible that different constants should be used for New Guinea natives.

If, for instance, constant A was unduly high for the natives surveyed (due, say, to some soluble constituent of serum being high compared to Caucasians) then high values for serum protein concentrations would be obtained using $A = 1.0069$ as in equation. This possibility could be checked using the Kjeldhal method simultaneously with the specific gravity method. The possible cause would not be a racial difference except that as a race New Guinea peoples have a certain environment, diet, mode of life and disease pattern. Hence it is suggested that the values from this survey be considered only relative to each other and not as absolute values; limiting their use to that extent does not impair their usefulness for this survey. The same limits must be placed on the haemoglobin values obtained in this survey, because as Table VII shows, quite normal figures were obtained for white subjects but lower figures for the natives (although these lower values might be expected as due to hookworm and malaria, etc.).

2. PLASMA ASCORBIC ACID.

Table VIII sets out the mean values and standard deviations of the plasma ascorbic acid levels of the five villages surveyed. A division into age groups is given but no division on the sex basis.

TABLE VIII.—TOTALLED AND AGE-GROUPED PLASMA ASCORBIC ACID LEVELS—VILLAGE BY VILLAGE.

Village.	0-5 years.			6-10 years.			11-60 years.			Total 0-60 years		
	Mean.	S.D.	No.	Mean.	S.D.	No.	Mean.	S.D.	No.	Mean.	S.D.	No.
	mgm./100 ml.			mgm./100 ml.			mgm./100 ml.			mgm./100 ml.		
Busama ...	0.49	0.20	29	0.48	0.25	34	0.472	0.188	94	0.477	0.203	159
Kaiapit ...	0.57	0.29	19	0.53	0.18	17	0.474	0.223	69	0.500	0.230	106
Patep ...	0.50	0.29	36	0.50	0.26	17	0.417	0.215	92	0.449	0.244	147
Kavataria ...	0.38	0.24	17	0.49	0.23	14	0.374	0.181	83	0.395	0.211	118
Koravagi ...	0.45	0.31	24	0.50	0.26	17	0.406	0.210	80	0.425	0.241	120

It will be seen that there is no great variation of the mean value for each age group within the village although the inter-village variation is considerable. Kaiapit has the highest mean values of the five villages in all age groups and Kavataria has the lowest except in the 6-10 year groups.

These mean plasma scorbic acid levels are well above those usually obtained in European peoples ⁽¹¹⁾ or natives who have adopted more or less the white man's dietary ⁽¹²⁾.

Table IX shows the actual distribution of the plasma scorbic acid values from the total populations surveyed in each village as well as that from the total survey.

Of the total survey 12.1 per cent. of the values were below 0.2 mg. per cent., 64.5 per cent. between 0.2-0.6 mgm. per cent., and 23.4 per cent. above 0.6.

TABLE IX.—FREQUENCY DISTRIBUTIONS OF PLASMA ASCORBIC ACID LEVELS.

P.A.A. Levels in mgm. per cent.	Total Survey.	Busama.	Kaiapit.	Patep.	Kavitararia.	Koravagi.
0-0.1 ...	14	2	1	2	8	1
0.1-0.2 ...	65	11	7	14	16	17
0.2-0.3 ...	103	19	13	32	14	25
0.3-0.4 ...	117	26	18	25	25	23
0.4-0.5 ...	125	37	22	25	24	17
0.5-0.6 ...	77	22	12	20	13	10
0.6-0.7 ...	53	18	9	10	8	8
0.7-0.8 ...	53	17	13	7	4	12
0.8-0.9 ...	17	3	5	4	3	2
0.9-1.0 ...	10	1	2	3	3	1
1.0-1.1 ...	10	2	4	2	...	2
1.1-1.2 ...	3	...	...	1	...	2
1.2-1.3 ...	1	1	...	...	...	...
1.3-1.4 ...	1	...	...	1	...	...
1.4-1.5 ...	1	...	...	1	...	...

The significance of the differences between the plasma scorbic acids mean values for the villages surveyed is summarized in Table X. The means are for the whole of the values obtained from each village and take no account of age distribution of the villages, for instance, Busama had a much higher percentage of children than Kavataria.

TABLE X.—COMPARISON OF UNDISSECTED PLASMA ASCORBIC ACID LEVELS (MEANS).

Village.	KAIAPIT.	PATEP.	KAVATARIA.	KORAVAGI.
Busama	Difference	Difference	Difference	Difference
Mean mg.	N.S.	N.S.	H.S.	N.S.
0.447 mg. %	0.4 > P > 0.3	0.3 > P > 0.2	0.01 > P > 0.001	0.1 > P > 0.05
Kaiapit	.....	Difference	Difference	Difference
Mean		N.S.	H.S.	S.
0.500 mg. %		0.1 > P > 0.05	P > 0.001	0.02 > P > 0.01
Patep	.....	.....	Difference	Difference
Mean			N.S.	N.S.
0.449 mg. %			0.1 > P > 0.05	0.5 > P > 0.4
Kavataria	.....	.....	.....	Difference
Mean				N.S.
0.395 mg. %				0.4 > P > 0.3
Koravagi	.....	.....	.....	.....
Mean				
0.425 mg. %				

The mean values from the villages can be compared because each can be regarded as fasting samples. With the exception of Patep the natives had no early morning meal prior to coming to be examined (the meal of the day was generally in the early evening). At Patep a quantity of food was eaten in the morning and this may have provided sufficient ascorbic acid to affect the plasma ascorbic acid levels.

If a value of 0.4 mgm. per cent. is accepted as the dividing line between a satisfactory and unsatisfactory ascorbic acid nutrition, as has been done by Borsook, Alpert and Keightley⁽¹³⁾ after a thorough investigation of the literature, it is seen that on a group basis all the villages exhibit satisfactory ascorbic acid nutritional status with the possible exception of Kavataria (mean level of ascorbic acid in plasma 0.395 mgm. per cent.). This satisfactory state is to be expected on a vegetable diet, since the staples, with one exception, contained ascorbic acid.

Further discussion on the relationship between the estimated intake of the ascorbic acid, and the plasma ascorbic acid levels will be found in Part 4.

No correlation was observed between the condition of the gums (loss of interdental papillae, etc.) and the plasma ascorbic acid levels. This is similar to the experience found by other workers seeking correlation between the condition of individual's gums and plasma ascorbic level.

(3) ASCORBIC ACID IN BREAST MILK.

The mean, standard deviation, and range for the milks from six villages are shown in Table XI. Mean plasmic ascorbic acid values for the total village population which was examined are also included.

TABLE XI.—ASCORBIC ACID IN BREAST MILKS AND PLASMA.

Village.	No. of samples.	Mean mgm./100 ml.	Range mgm./100 ml.	Standard Deviation mgm./100 ml.	Mean Plasma Ascorbic Acids mgm./100 ml.
Busama ...	11	6.88	4.6 —9.56	1.75	.477
Kaiapit ...	14	5.74	3.45—7.54	1.00	.500
Patep ...	8	6.09	4.53—7.80	1.22	.449
Kavataria ...	8	6.05	4.70—8.32	1.23	.395
Koravagi ...	12	5.42	3.82—6.38	0.78	.425
Kaimari*	9	4.13	2.61—5.20	0.84	...

* A village similar to Koravagi.

It will be seen that the mean value at all villages is higher than the figure 3.7 mg. per cent. found by Winikoff (7) for Melbourne women. Many investigators consider a level of 4.0 mg. per cent. in milk as the lower limit if the infant is to receive adequate supplies of ascorbic acid. In a total of 62 estimations only four had values of 4.0 mg. per cent. or less.

Munks *et al.* (14) found that the analysis of a single sample did not provide an accurate measure of the ascorbic acid content of human milk during the 24 hours. Unfortunately it was not possible to take more than one sample, so it could not be determined whether their conclusion applies to these women whose food pattern is quite different from the group they investigated. Analyses were made on all samples available, because Winikoff (*loc. cit.*) found that there is no constant variation in the ascorbic acid content of first, middle and end milk. In point of fact these terms have little meanings with a group such as this, as the babies are suckled whenever they cry.

No attempt could be made to trace the variation in ascorbic acid content of milk with the length of lactation because the results could not be regarded as a homogeneous sample. Furthermore, age records are not always sufficiently reliable for such an analysis.

The mean ascorbic acid level in breast milk does not bear any direct relationship to the mean plasma ascorbic acid level of the village. Nor was a correlation found between the plasma ascorbic level and the breast milk ascorbic acid for 28 women from whom both estimations were made. The corresponding blood and milk estimations were not made in the same day. Munks *et al.* (15) found no correlation in women from whom samples of blood and milk were collected at the same time, and they suggest that the low values found in the blood of lactating women in their experiment may have resulted from the demands for milk production during the preceding twelve hours of fasting. Patep was the only village in this series from Papua-New Guinea where it was customary to eat a substantial meal before the tests were made, and it is likely that the suggestion of Munks *et al.* would also apply to this group of women.

When the ascorbic acid content of the milk of 18 women was compared with the plasma ascorbic acid of their infants a coefficient of correlation of 0.61 ($P = .01$) was obtained. The smaller number in this series is due to the fact that plasma ascorbic acid values were not determined on all of the babies. Again, the corresponding estimations were not made on the same day. It is possible that on a high and regular ascorbic acid intake there might be little variation from day to day in the ascorbic acid content

of the women's milk and hence in the child's intake. Assuming that the child's intake is reflected in plasma ascorbic content, such a correlation would be accounted for.

A comparison of the results for Kaimari and Koravagi villages is interesting. In these two villages, which are only 12 miles apart on the Purari Delta, sago is the staple food. The values of ascorbic acid in milk in the two villages are significantly different. Not all of the lactating women of Kaimari were tested, but there is no reason to believe that those who came to Koravagi were a special group from the point of view of their vitamin C intake. It was the opinion of the agriculturalist who had visited Kaimari that the villagers there had smaller amounts of vegetable foods other than sago in their diet, the difference being made up of a higher animal protein intake as the village is on the sea coast. The result of this test indicates that the finding for one village cannot be indiscriminately applied to others in the same area, even if they have the same staple food-stuff. It is likely, however, that in areas where the staple food itself makes a large contribution of the vitamin C intake, the relatively small difference in diet would not have such a significant effect as in this case.

(4) RIBOFLAVIN LOAD TESTS.

The results of the analyses of the urines collected are summarized in Table XII.

TABLE XII.—MEAN LEVELS OF RIBOFLAVIN EXCRETED IN LOAD TESTS.

Village.	No. of Samples.	Mean Level Excreted in four hours.	Standard Deviation.
		micrograms.	
Busama	29	639	346
Kaiapit	27	510	275
Kavataria	36	378	241
Koravagi	40	984	348

It will be noted that no figures are given for Patep. Owing to leakage in transit to Australia and also subsequent destruction of identification labels the figures for riboflavin content of these urines had no value and are therefore not given.

There is considerable variation in the mean values shown, and the results of "t" tests show in Table XIII the significance of differences obtained.

TABLE XIII.—COMPARISON OF DIFFERENCES BETWEEN MEAN VALUES.

	KAIAPIT.	KAVATARIA.	KORAVAGI.
Busama	N.S.	H.S.	H.S.
Mean 639 γ ...	P>0.10	0.01>0.001	P<0.001
Kaiapit	.....	S.	H.S.
Mean 510 γ ...		0.05>P>0.02	P<0.001
Kavataria	.....	.....	H.S.
Mean 378 γ ...			P>0.001
Koravagi	.....	.....	.....
Mean 984 γ ...			

It will be seen that there are significant differences in the values obtained as shown by statistical examination. However, it is not certain that difference is entirely due to significantly differing dietary intakes of riboflavin. While it can be stated that at the time of the survey party's visit Koravagi villagers consumed relatively large amounts of foods with high riboflavin contents (*e.g.*, green leaves, etc.) and the Kavatarian diet was probably lower in this regard than other villages surveyed, other factors have probably influenced the results.

For instance, the urinary excretion of a vitamin after an oral dose would depend on two factors at least—

- (i) the state of the body's reserves (reflecting previous intake);
- (ii) the rate of metabolism of the vitamin.

Whilst (i) is the information required for the purposes of the survey it is suggested that (ii) plays an important part also. It is possible that the rate of absorption may depend on the type of diet of the subject, *i.e.*, vegetables or high in meat products. These rates would influence the result where a time limit of 4 hours, as in these studies, is imposed. Hence as groups of natives on different types of diet have been examined in these tests this factor may be important.

The mean levels of excretion obtained on this survey are all above the minimum of $200\gamma/4$ hours as suggested by Johnson *et al.* (¹⁶) as the minimum level indicating adequate riboflavin nutrition. Owing to practical difficulties it was not possible to analyse samples of fasting urine and hence check the riboflavin excretion in this manner also. Thus from the chemical tests as well as clinical examination the natives surveyed seem to have an adequate riboflavin nutrition.

However, it should be noted that the New Guinea levels are all below the mean values (namely 2,155, 1,065 and 1,675 γ) obtained on American Army Personnel by this technique (¹⁷) and also the 1,515 γ obtained by Johnson (¹⁸) on American Army Personnel who were subsisting on a combat ration providing on the average 1.5 mg. riboflavin/day (1.5 mg. being the recommended dietary intake for a moderately active man of 70 kg. weight).

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PART 8.

OBSERVATIONS ON DENTAL CONDITIONS AMONG NATIVE PEOPLES
IN PAPUA-NEW GUINEA.*

BY

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WITH

A SHORT NOTE ON THE FLUORINE CONTENT OF SELECTED WATERS.

BY

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General Summary—Anatomy, occlusion and malocclusion.

Developmental abnormalities, attrition, periodontal disease, dental caries.

Anatomy—Size and shape of maxillary dental arches.

Occlusion and malocclusion—Types observed and their incidence.

Developmental aberrations—Types observed and their incidence.

Attrition—Degree of attrition seen in different age groups.

Periodontal disease—Incidence, discussion on etiology.

Dental caries—Types observed and their incidence; odontoclasia, aetiological considerations.

Fluorine content of selected waters.

* A fuller and somewhat amended version of this report appears in the Dental Journal of Australia 22, 58-93 and 120-157.

General Summary.

Data are presented under the headings of anatomy, malocclusion, anatomical aberrations, attrition, periodontal diseases and dental caries, in that order. Because the material studied was scanty, the observations are of value more as pointers for subsequent researches than as the basis of definite conclusions.

ANATOMY.

(a) Measurements according to Pont's system indicate that the proportion between the size of the anterior teeth and the width of the arch of these native Papuans and Melanesians approximated fairly closely the ideal proportions which were originally described for Caucasian races.

(b) The most frequently seen type of arch is that in which both the anterior and the posterior segments are rounded. Straight and tapering forms of the anterior arch occur but rarely; when seen they are followed by either straight or rounded posterior segments. In any one village there are among people with normal functional occlusion arch-forms which are entirely different.

OCCCLUSION AND MALOCCLUSION.

Malocclusion as a whole was observed as frequently in New Guinea natives as in a group of white children in Wisconsin (approximately 50 per cent.), but very few of the New Guinea cases were severe. Class 1 malocclusion was more frequent, class 2 less frequent in New Guinea natives than in the white children. The most common types of malocclusion seen were a deep anterior overbite in Koravagi and one or more upper incisors locked behind the lower incisors in Pātep II.

DEVELOPMENTAL ABNORMALITIES (including Impaction, etc.).

Congenital aberrations were by no means rare among the native peoples. Impaction of canines and of third molars was, however, very uncommon: the incidence of these abnormalities was ten times greater in a group of white students (young adults).

ATTRITION.

Only 8/112 models showed the absence of attrition. Moderate or more severe grades occurred in 26 per cent. of the adults of Pātep II, 66 per cent. of those at Kavataria and 80 per cent. of those at Koravagi. Its relationship to caries-susceptibility is discussed.

PERIODONTAL DISEASE.

Generalised periodontitis was commonly encountered. Bone-loss as determined radiographically was used as a basis for the assessment of degrees of severity. In Pātep II*, Kavataria and Koravagi, respectively, 53, 68 and 76 per cent. of the adult population exhibited loss of alveolar bone caused by periodontitis; the incidence of this disease is, therefore, very high. In middle and old age many of the population show stages of the disease which would by modern standards undoubtedly be considered as detrimental to the health of the body as a whole.

Lack of occlusal attrition does not appear to be a sufficient reason for the initiation and progress of periodontal disease as observed in New Guinea.

* Pātep II = Patep Number 2 (see note, page 48).

DENTAL CARIES.

Between 200 and 250 persons in all were examined clinically, radiographically and bacteriologically. Methods used in the examination and in recording the results are set out.

Dental caries exists in each of the three groups of New Guinea natives which were studied.

Its incidence is, however, much lower than that usually observed among most "civilised" peoples.

The incidence of the disease is different in each of the three villages. It was lowest among the inhabitants of Koravagi (sago staple diet), next lowest among those of Kavataria (yams and fish) and greatest among those of Pātep II (sweet potato).

The incidence of the disease is sometimes different in the two dentitions. In Pātep II the incidence of caries of the deciduous teeth is quite low, while that of the permanent teeth is considerably higher. On the other hand, in Kavataria this relationship is reversed.

The incidence of caries of the approximal surfaces of the teeth is very much lower in New Guinea natives than in civilised peoples. The incidence of caries of pits and fissures is also lower in New Guinea natives but the difference between native and civilised peoples is smaller in relation to caries of pits and fissures than in relation to caries of the approximal surfaces.

Differences in the characteristics (*e.g.*, age-distribution, clinical features and surface-incidence) of lesions classified as caries suggest (*a*) that the disease manifests itself in a number of different forms and (*b*) that differences in the form of the disease exist not only as between native and civilised peoples but also as between groups of native peoples exposed to dissimilar environments.

It is very desirable, therefore, that we should attempt both to define dental caries more satisfactorily and to describe more accurately the criteria (clinical, histopathological, chemical, etc.) necessary for its certain recognition.

The condition named "Odontoclasia," which is described as occurring in Hawaii and Manus, was prevalent in Kavataria and seen occasionally in Pātep II and Koravagi.

The bacteriological investigations are still in a preliminary stage but offer strong presumptive evidence in favour of the occurrence of *Lactobacillus* and *Monilia* in the oral flora of the people of Pātep II and probably of Kavataria and Koravagi.

The general body of data obtained by the Survey has been examined for possible relationships between diet, nutrition and disease.

General Introduction.

This communication is more a statement of progress made in the investigation into certain aspects of the oral conditions of the populations of selected New Guinea villages than a final report upon the results of those observations. The work was undertaken largely because the data to be collected on nutrition and related aspects of native life seemed likely to form a good background for the interpretation of our observations. The original intention was to make clinical and bacteriological studies of the mouths of selected groups to determine the incidence of dental caries and of the *Lactobacillus* and, where possible, to include subsidiary studies of periodontal and anatomical conditions: in general this plan was followed.

The data are presented under a series of sectional headings covering anatomy, malocclusion, anatomical aberrations, attrition, periodontal diseases and dental caries, in that order. It must, however, be emphasised that the material studied was unfortunately very scanty; hence the observations assembled in Sections I-V inclusive cannot be regarded as more than pointers for subsequent researches.

Section I. Anatomy.

INTRODUCTION.

The material available for study has imposed strict limitations upon the information which could be assembled. Three sets of features have been studied, namely:—

A = (i) size of maxillary arches, (ii) proportion between size of the maxillary incisors and the width of the maxillary arches;

B = (iii) shape of the maxillary arches.

The first two are conveniently grouped under heading "A," the third under "B."

The data discussed in this section of the paper represent the results of a study of plaster casts of the maxillary dental arches of people in the three villages visited. Casts were made of nearly all the adult population in Pātep II, but in Kavataria and Koravagi lack of time prevented us from making them for more than about twenty subjects in each village. Unfortunately we were unable to obtain skulls on which to study the anatomy of the face and cranium and measurements were not made in the field.

A. SIZE OF MAXILLARY ARCHES AND PROPORTION BETWEEN SIZE OF MAXILLARY INCISORS AND THE WIDTH OF THE ARCHES.

Methods.

In determining the size of the arch only those models (of adults) were studied which showed no evidence of distortion or of gross malocclusion or of malposition of the teeth due to loss of adjacent or opposing teeth. Three systems of measurement were employed, Flower's, Wilder's and Pont's.

Flower's method (1) was used to measure the external width of the maxillary arch: with internally curved calipers the measurement was taken between the outer borders of the alveolar arch immediately above the second

molar teeth. Wilder's method (²) was used to measure the palatal width, that is, the distance between two points on the surface of the gingivae a millimetre above the gingival margin where it is in apposition with the lingual surface of the maxillary second molar: this distance was measured with the aid of straight dividers. The palato-maxillary length could not be measured because it was impossible to be certain of the position of the landmark forming the posterior end of this line, that is, the posterior border of the horizontal plate of the palatine bones.

Pont (³) computed an index for Caucasian races, which in subjects with normal occlusion and ideal arches relates the sum of the widths of the upper four incisor teeth to (i) the distance between the occlusal fossae of the two maxillary first premolars and to (ii) that between the mesio-occlusal pits of the two maxillary first molars. Thus, if a particular individual has rather wide incisors, he should ideally have a wide span across the palate between the two upper first premolars.

For each individual are recorded in millimetres (a) the sum of the greatest width of each of the upper four incisors (measured with orthodontic calipers), (b) the distance between the posterior termination of the occlusal fossae of the maxillary first premolars and (c) the distance between the mesio-occlusal fossae of the maxillary first molars.

The table given by Pont shows the ideal magnitudes of (b) and (c) for the various incisor-widths. For each of our subjects the difference between the ideal given in Pont's table and the observed measurements was calculated.

Results and Discussion.

When the material to be studied consists of plaster models, any measurements other than those between points on the teeth themselves lose in accuracy because of the thickness of the mucosa and the variable amount of compression of the soft tissues during the taking of the composition-impression. Thus Pont's system of measurements is more suitable for specimens of the type available to us than is Wilder's or Flower's. However, as far as we know, no other anthropometric data have been recorded on the basis of Pont's reference points: these are mainly employed by orthodontists, who use them as a guide when correcting the occlusion and arch-forms of their white patients. On the other hand, Wilder's and Flower's measurements are widely used and quoted. We have, therefore, presented our data in both forms.

Table I shows the means and the standard deviations of the measurements of the maxillary arch-width (Flower) and of palatal-width (Wilder). For comparison the table includes some results given by Campbell (¹) for Australian aborigines. It is apparent that the maxillary arches examined were large. This particularly appears to be so in relation to the palatal widths of the people in Koravagi, among whom, allowing for the thickness of the mucosa, the mean palatal-width (40 mm. and thickness of mucosa on each side—probably about 1 mm. each side) would be nearly as great as the largest measurement (44.5 mm.) obtained on the Australian aborigines.

TABLE I.—SIZE OF THE MAXILLARY ARCHES.

Population.	Arch-Width.			Palatal Width.		
	Mean (mm.).	σ .	No. measurements.	Mean (mm.).	σ .	No. measurements.
Pātep II	66.5	± 2.3	38	36.5	± 2.75	45
Kavataria	67.0	± 4.2	10	36.0	± 2.8	10
Koravagi	68.5	± 3.5	15	40.0	± 3.5	15
Australian Aborigines Skulls (Campbell)	62.1	Range 56-75	106	39	Range 32-44.5	106

 σ —Standard deviation.

TABLE II.—THE DIFFERENCE BETWEEN THE OBSERVED AND PONT'S IDEAL DISTANCE.

Difference (mm.) between observed and ideal distance.	Distance between upper first premolars : P_1 .			Distance between upper first molars : M_1 .		
	No. subjects at—			No. subjects at—		
	Pātep II.	Kavata- taria.	Kora- vagi.	Pātep II.	Kavata- taria.	Kora- vagi.
— 6 to — 8	2	2	0	0	1	1
— 3 to — 5	17	3	1	13	0	0
0 to — 2	15	2	2	11	2	2
0	2	1	3	3	0	0
0 to + 2	7	2	1	8	4	1
+ 3 to + 5	1	0	0	3	1	3
+ 6 to + 8	0	1	0	1	0	1
+ 9 to + 11	0	0	0	0	1	0

Table II shows the frequency distribution of the differences between the observed measurement and the calculated ideal measurement for Pont's M_1 and P_1 distances. It will be noted that in Pātep the general tendency was for the measured M_1 and P_1 distance to be slightly lower than the calculated ideal for any particular individual. In Kavataria also the P_1 distance tended to be slightly lower than the ideal; of the M_1 distances more fell just above the ideal, though the scatter was wide. A somewhat similar position existed in Koravagi.

Conclusions.

Because the number of observations is small and the measurements were made on plaster-models instead of skulls, it is difficult to draw any justifiable conclusions from the data obtained by the methods of Flower and Wilder. On the other hand, measurements according to Pont's system indicate that the proportion between the size of the anterior teeth and the width of the arch of these native Papuans and Melanesians approximated fairly closely the ideal proportions, which were originally postulated for Caucasian races.

B. SHAPE OF THE MAXILLARY ARCHES.

Various systems for describing and classifying the shapes of the dental arch have been devised. Some observers discuss the arch or palate as a whole when describing its shape, others confine themselves to a description of the arrangement of the upper six anterior teeth.

Topinard (4) described four types of arch:

- (a) hyperbolic, when the arms of the arch are widely divergent posteriorly;
- (b) parabolic, when they diverge somewhat less so;
- (c) hypsiloid or U-shaped, when they are exactly parallel;
- (d) elliptical, when they converge posteriorly, whatever the degree of such convergence may be.

On the other hand, Swenson (5) from the point of view of a Prosthetist described the line of only the six anterior teeth and considers there are three types, square, ovoid and tapering. Other observers believe that this nomenclature can be applied to the upper arch as a whole and also to the outline of the face and of the upper central incisors; that is to say, in any one individual, if the upper arch is ovoid, then ideally the face and upper central incisors are also ovoid.

Materials.

As in Sub-section A, plaster casts provided the data. After an examination of these models (only those with normal occlusion were studied in this connection) it became apparent that, whichever classification was employed, only a limited number of models fell easily into one or other group. In some cases the direction and the shape of the posterior arms of the arch were independent of the shape assumed by the line of the six anterior teeth. For example, some were seen which presented rounded arrangement of the anterior six teeth and two straight diverging lines of bicuspid and molars. The following basis of classification was therefore devised for the New Guinea populations.

The arrangement of the anterior six teeth was described as by Swenson. This usually resolved itself into a consideration of the position of the cuspids as related to that of the central incisors. When the cuspids were nearly as far forward as the centrals the arrangement was described as straight; and, when they were well behind the centrals, it was considered to be tapering. However, because there were forms intermediate between the straight, ovoid and tapering, in many cases the classification was of necessity somewhat arbitrary.

The posterior arch-form was assessed on the line of the occlusal fossae of those teeth including and posterior to the first premolars. Three forms have been described:—Straight, slightly rounded and distinctly rounded. The line of the posterior teeth could be rounded in several ways: the most frequent was where the first and second premolars and first molar were in a straight line, and the second and third molars were placed slightly towards the midline in the sagittal plane. Sometimes it was only the third molar which was so placed and gave the line its rounded appearance. However, there were some subjects who had a truly rounded posterior segment in which all the teeth were on a curve.

Results.

The results are set out in Table III. The most frequently seen type of arch was that in which both the anterior and the posterior segments were rounded. Straight and tapering forms of the anterior arch occurred but rarely; when seen they were followed by either straight or rounded posterior segments. In any one village there were among people with normal functional occlusion arch-forms which were entirely different. For examples from Pātep II see Plate 1 and from Kavataria see Plate 2.

TABLE III.—NUMBER OF PERSONS WITH THE DIFFERENT FORMS OF THE MAXILLARY DENTAL ARCH.

Population.	Anterior Arch.		Posterior Segment.	
	Form.	Number of Subjects Examined.	Form.	Number of Subjects Examined.
Pātep II	Straight	5	Straight	2
			Slightly rounded	1
			Rounded	2
	Rounded	27	Straight	8
			Slightly rounded	8
			Rounded	11
	Tapering	3	Straight	2
			Slightly rounded	1
			Rounded	0
Kavataria	Straight	0	Straight	0
			Slightly rounded	0
			Rounded	0
	Rounded	4	Straight	2
			Slightly rounded	0
			Rounded	2
	Tapering	3	Straight	1
			Slightly rounded	1
			Rounded	1
Koravagi	Straight	1	Straight	0
			Slightly rounded	0
			Rounded	1
	Rounded	3	Straight	0
			Slightly rounded	1
			Rounded	2
	Tapering	0	Straight	0
			Slightly rounded	0
			Rounded	0

Discussion.

In consideration of the fact that these subjects came from comparatively isolated communities, such variation between individuals as was observed in the shape of the maxillary arches is somewhat unexpected.

The fact that to describe adequately the arch-forms seen it was found necessary to consider the anterior and posterior arches separately (because in many cases they were arranged independently) also raises the question of whether there may not be more racial admixture among the New Guinea natives than is generally supposed.

It is usually considered that in white races the tapering form is the most frequently seen. Price (°) has described the perfectly rounded arches of the Peruvians, and Campbell (') considers that the shape of the palate in Australian aborigines is usually hypsiloid or U-shaped. Thus it would appear that these New Guinea natives with their preponderance of rounded arches resemble the Peruvians more than they do the Caucasians or the Australian aborigines. However, it is difficult to compare different observers' descriptions of the *shape* of any given feature. !Kontig

The arch-form in any single individual may not be a static feature throughout life, but rather one subject to gradual change; hence data collected from a group of people, of which each individual was studied over a number of years, would be a very valuable contribution to our knowledge of arch-forms.

(For references see end of report.)

Section II. Occlusion and Malocclusion.

INTRODUCTION.

This section presents the results of a study of abnormalities of occlusion. Normal occlusion has been defined by Salzman (') as "the usual or accepted relationship for the species, of the teeth in the same jaw to each other, and to those in the opposing jaw when the teeth are approximated and the mandibular condyles are in rest or centric position in the glenoid fossae." The view of Le Roy Johnson (°) that it is a functional concept rather than an anatomical one has been borne in mind when describing the occlusion in New Guinea natives.

MATERIALS AND METHODS.

Plaster casts showing malocclusion were arranged according to Angle's classification (°), a formal definition of which is unnecessary here. Class 1 cases have been further subdivided in a manner somewhat similar to that of Dewey and Anderson ('). Their type v, mesial drifting of molars resulting from premature loss of teeth, has been omitted for two reasons: (i) young people almost always have a complete dentition; (ii) it did not seem justifiable in a consideration of abnormalities of occlusion to record conditions in old people, such as the drift of teeth caused by periodontitis or loss of adjacent teeth by caries.

RESULTS.

In addition to our own results, Table IV includes for comparison a series of figures from Wisconsin (188 white children examined and classified by Foster (°)). Allowance must be made, however, for the personal factor when comparing the Wisconsin and New Guinea figures.

TABLE IV.—CLASSIFICATION OF TYPES OF MALOCCLUSION OBSERVED IN NEW GUINEA NATIVES.

	Number of Subjects (% in brackets).			
	Natives of—			White Children of Wisconsin.
	Pātep.	Kavataria.	Koravagi.	
Normal	43 (54%)	11 (78%)	4 (21%)	96 (51%)
Class 1—				
Type i (bunched or crowded incisors).	4 (5%)	0 (0%)	3 (16%)	
Type ii (protrusion of upper incisors)	0 (0%)	0 (0%)	0 (0%)	
Type iii (one or more upper incisors locked behind lowers).	11 (14%)	0 (0%)	1 (5%)	
Type iv (molars and/or premolars malposed buccally or lingually).	3 (4%)	0 (0%)	1 (5%)	
Type v (deep overbite: upper incisors overlapping lower by half or more).	11 (14%)	0 (0%)	7 (37%)	
Miscellaneous (congenital abnormalities in tooth-size, etc.).	5 (6%)	3 (22%)	1 (5%)	
Class 1 (Totals)	34 (43%)	3 (22%)	13 (68%)	52 (28%)
Class 2—Division i	0 (0%)	0 (0%)	0 (0%)	
Division ii	2 (2%)	0 (0%)	2 (11%)	
Class 2 (Totals)	2 (2%)	0 (0%)	2 (11%)	34 (17%)
Class 3	1 (1%)	0 (0%)	0 (0%)	6 (4%)

DISCUSSION.

Because of the small number of cases in each class or division of a class a statistical analysis is of value in only some divisions of the classification adopted: however, the following comparisons can usefully be made.

1. In Table V the number of subjects with malocclusion (all types) is shown for (a) the New Guinea Group and (b) the Wisconsin Group.

TABLE V.

No. Subjects with—	Natives (New Guinea).	White Children (Wisconsin).
Normal occlusion	58 (52%)	96 (51%)
Malocclusion	54 (48%)	92 (49%)
Totals	112 (100%)	188 (100%)

The proportion of those with malocclusion is thus seen to be almost identical in the two groups (48 per cent and 49 per cent.).

2. In Table VI the number of subjects with Class 1 malocclusion is shown for the same two groups.

TABLE VI.

No. Subjects with—				Natives (New Guinea).	White Children (Wisconsin).
Class 1 malocclusion	...	...		50	52
Remainder of group	...	...		62	136
Totals	...	...	...	112	188

($\chi^2 = 8.01$)—significant.

There is a significantly greater proportion of subjects with Class 1 malocclusion in the population of the three New Guinea villages than in the children of Wisconsin (see Plate 3). However, the malocclusions observed in New Guinea were much less pronounced.

3. Table VII shows the figures for Class 2 malocclusion set out as for Class 1.

TABLE VII.

No. Subjects with—				Natives (New Guinea).	White Children (Wisconsin).
Class 2 malocclusion	...	...		4	34
Remainder of group	...	...		108	154
Totals	...	...	...	112	188

($\chi^2 = 13.6$)—significant.

Here again the difference in incidence is statistically significant, but in contrast to the incidence of Class 1 malocclusion that of Class 2 malocclusion is greater in the white children.

Of the four cases of Class 2 malocclusion (see Plate 4) observed in New Guinea none belonged to Division I. Thus it appears that some reputed causes of Class 2 malocclusion, viz., hypertrophied and infected adenoids and tonsils with their attendant symptoms, mouth-breathing and narrowing of the maxillary arch, do not exist as frequently in the New Guinea natives as they do in white peoples.

4. For Class 3 malocclusion the figures are shown in Table VIII.

TABLE VIII.

No. Subjects with—				Natives (New Guinea).	White Children (Wisconsin).
Class 3 malocclusion	...	...		1	6
Remainder of group	...	...		111	182
Totals	...	...	...	112	188

($\chi^2 = 1.5$)—not significant.

5. The number of subjects with a *deep anterior overbite* alone (that is, not associated with any other form of malocclusion) appears very large in Koravagi (36 per cent.). This is of importance because a deep overbite would traumatize the anterior periodontal tissues, unless it were accompanied by steep posterior cusp-inclination. That this compensating inclination was not generally present in Koravagi is shown in Section IV: Attrition (p. 232), where it is mentioned that in Koravagi the posterior teeth lose their cusps within 10-15 years of eruption. To illustrate the degrees of anterior overbite, the vertical relationship of upper and lower incisors, as shown by the plaster models, is set out in Table IX which indicates the presence and/or amount of overbite, independent of any other type of malocclusion.

TABLE IX.—VERTICAL RELATIONSHIP OF UPPER AND LOWER INCISORS.

No. Subjects with—	Pātep II.	Kavataria.	Koravagi.
1. Open bite	0	0	0
2. Edge-to-edge bite	1	2	2
3. Slight overbite	39	10	4
4. Moderate overbite	26	4	11
5. Deep overbite	9	0	5
	40	12	6
	35	4	16

The five possible positions are set out in Table IX which shows a difference between Kavataria and Koravagi in respect of the relative distribution of those subjects exhibiting edge-to-edge bite or slight overbite on the one hand and those with moderate or deep overbite on the other hand. Thus the respective percentages of edge-to-edge bite or slight overbite are 75 per cent. (12) and 27 per cent. (6) and of moderate or severe overbite are 25 per cent. (4) and 73 per cent. (16). Admittedly the figures on which the percentages are based are very small. On the assumption (at present not entirely justifiable) that this difference is not due to chance, it may be attributed either to hereditary or environmental factors. The two villages are racially distinct; the people of Koravagi are of the older and typical Papuan stock and the Trobriand Islanders are Melanesians.

The nature of the diet and the food-habits may be mentioned as two quite likely environmental influences. Of interest in this connection are the observations of Kirkpatrick (*) on the island of Manus. He reported that the incidence of (i) crowding of teeth and (ii) traumatic occlusion was significantly higher among the sago-eating population than among the taro-eating population. He also found that acute or subacute Vincent's infection and suppurative periodontitis occurred to a significantly greater extent among the sago-eaters. Thus, if we assume that the traumatic occlusion and periodontal infections mentioned by Kirkpatrick are the result of a deep anterior overbite (which is highly probable), then this condition is common to both of the sago-eating populations (on Manus and at Koravagi); and also it is seen to a greater extent in the sago-eating populations than among the taro-eaters of Manus, the sweet potato-eaters of Pātep II or the yam-and-fish-eaters of Kavataria.

6. Referring to Table IX it will be noted that no instance of an anterior open bite was seen in any of the New Guinea villages, neither where any cases of protruding upper incisors (Class 1, type ii) seen (Table IV). Nor were any cases seen which showed the extreme narrowing of the upper arch and severe crowding of anterior teeth which is sometimes seen in white

children. These conditions are frequently considered to be the results of habits such as thumb- and lip-sucking and tongue- or nail-biting, etc. It may then be concluded that either New Guinea children do not indulge in such habits or that they discard the habits early in life so that permanent deformity does not occur.

7. The proportion of persons exhibiting Class 1, type iv, malocclusion is high in Pātep II. The only likely explanation for this is that anterior deciduous teeth were retained too long or that the abnormality is an inherited one or that both causes may be operative.

SUMMARY AND CONCLUSIONS.

Malocclusion exists among New Guinea natives and its incidence (all types taken together) is almost the same as in a group of white children. The most common types seen were a deep anterior overbite in Koravagi and one or more upper incisors locked behind the lower incisors in Pātep II. Some of the types of malocclusion reputedly caused by (a) mouth-breathing and (b) thumb-sucking, etc., were not seen, so that apparently these habits and their causes do not exist or persist in New Guinea natives as frequently as in white children.

(For references see end of report.)

Section III. Developmental Aberrations.

INTRODUCTION.

The term "developmental aberration" includes for the purposes of this report supernumerary teeth, odontomes, diminutive or otherwise unusual crowns and congenital absence of teeth; for convenience of presentation pathological states, such as impaction, will also be discussed here.

MATERIALS AND METHODS.

The data were collected by making clinical and radiographical examinations. Before regarding the absence of a tooth as a congenital defect, account was taken of the possibility or likelihood that its absence was the result of caries or periodontal disease, and congenital absence was not accepted as established unless the following requirements were met:—

- (i) Failure to obtain a history of the presence at any time of a tooth at the site concerned;
- (ii) very slight or no bone-loss around the remaining teeth (radiographical evidence);
- (iii) absence of caries from the remaining teeth;
- (iv) absence of radiographical evidence of unerupted teeth at the site concerned.

RESULTS AND DISCUSSION.

The results are set out in Table X, which includes also figures for a group of 163 white students (Lilienthal (')). In Table XI Australian aborigines are compared with New Guinea natives.

TABLE X.—DEVELOPMENTAL ABERRATIONS OBSERVED IN NEW GUINEA NATIVES.

Abnormality.	Village of Patep II.		Village of Kavataria.		Village of Koravagi.		Group of 163 white medical and dental students examined by B. Lillenthal.
	No. examined in village, 136 (adults 87).		No. examined in village, 96 (adults 60).		No. examined in village, 100 (adults 62).		
	No. people with abnormality.	No. occurrences of abnormality.	No. people with abnormality.	No. occurrences of abnormality.	No. people with abnormality.	No. occurrences of abnormality.	
Odontomes	2	2	1	1	1	1	0
Supernumerary upper incisors (erupted)	2	2	0	0	1	1	0
Supernumerary bicuspids (unerupted)	0	0	1	4 (mandibular : 2 on each side).	0	0	3 (2 maxillary : 1 on each side, 1 mandibular).
Congenitally absent maxillary laterals	1	1	3	4	1	2	2
Congenitally absent bicuspids	1	2	1	1	0	0	0
Congenitally absent 2nd molars	2	2	1	1	0	0	0
Congenitally absent 3rd molars	8	12	1	2	0	0	28
Small or peg-shaped upper laterals	2	3	0	0	2	2	...
Small or peg-shaped upper 3rd molars	1	1	2	2	1	1	...
Impacted or malaligned 3rd molars	2	4	3	3	1	1	86
Impacted maxillary canines	1	2	0	0	0	0	5
Impacted maxillary bicuspids	0	0	1	1	0	0	...

Odontomes.—The three instances observed occurred in the upper anterior region in each case and consisted of a single mass of calcified tissue, in size not exceeding 10 mm. x 5 mm. (see Plate 5).

Supernumerary Teeth have been reported in many different races geographically and chronologically widely separated, for example in the skulls of Australian aborigines (²) and of American Indians (³). Details of these irregularities, as observed in New Guinea natives, are shown in Table X (see Plates 6, 7, 8).

Congenital Absence or Diminutive Form of one or more teeth was observed in 23 subjects. A difference between white subjects and New Guinea natives was noted in relation to the third molars: in the white subjects they were generally either all present or all absent, whereas in the natives generally only one or two were absent (see Plates 9-14).

Impaction and Malalignment.—Impaction of canines and third molars was more than ten times as frequent in white students as in New Guinea adults (33 per cent. of 163 and 3 per cent. of 209 respectively). Malalignment caused by the loss of adjacent or opposing teeth was observed but not recorded in detail.

Apical Rarefaction of the bone was seen in three subjects in relation to teeth with clinically normal crowns. This was probably due to trauma: a suggestion borne out by the history of one of the subjects.

TABLE XI.—DEVELOPMENTAL ABERRATIONS IN AUSTRALIAN ABORIGINES AND NEW GUINEA NATIVES.

Race.	No. subjects.	Odontomes.		Supernumerary teeth.		Congenitally absent teeth.		Diminutive forms of crowns.	
		No. subjects.	No. occurrences.	No. subjects.	No. occurrences.	No. subjects.	No. occurrences.	No. subjects.	No. occurrences.
Australian aborigines (Campbell) ...	600	1	1	9	9	9	15	...	...
New Guinea natives ...	209	4	4	4	7	16	27	7	10

SUMMARY AND CONCLUSIONS.

Developmental aberrations in native races are by no means as rare as is commonly supposed. If the frequency of such aberrations is in any way indicative of the relatively advanced position of the race anthropologically, New Guinea natives must be more advanced than Australian aborigines.

Furthermore, abnormalities such as impaction, usually caused by insufficient growth of the jaw bones, occurred much more rarely in New Guinea natives than in white Australian students.

(For references see end of report.)

Section IV. Attrition.

INTRODUCTION.

The attritional forces which are brought to bear on the occlusal and incisal surfaces of the teeth are of considerable importance because they have a close relationship to the health of the teeth and of their surrounding structures.

A. OCCLUSAL ATTRITION.

1. Effect on Tissues Surrounding the Teeth.

There is little doubt that each of the two extremes (i) no attrition at all, and (ii) excessive attrition, has equally undesirable effects on the tissues surrounding the teeth.

When food is over-refined, over-cooked and of soft consistency, the cusps of the posterior teeth and the incisal edges of the anterior teeth do not become worn down, even to a small degree. This is of little consequence in a young and healthy adult but in an older person it is essential that there should be lessened cusp-interference during lateral excursions of the mandible: otherwise breakdown and infection of the periodontal tissues takes place, because they cannot in old age withstand the same amount of lateral trauma during masticatory excursions as they could in youth.

On the other hand, if attrition is too rapid and too severe other pathological effects follow. Normally, as wear takes place on the occlusal surfaces of the teeth, secondary dentine is laid down in the corresponding part of the wall of the pulp chamber, so that, when attrition has reached that level, the pulp will have receded rootwards behind its protective layer of secondary dentine. But, when attrition is too rapid, the secondary dentine cannot be laid down quickly enough; hence, when the tooth is worn down to the level of the cornua of the pulp-chamber, the dental pulp is exposed. It then becomes infected and necrotic, and rarefying osteitis or an apical abscess and some of its sequelae develop in the alveolar bone. These pathological states would almost certainly be accompanied by severe pain.

Such excessive degrees of wear have been observed in certain surviving and pre-historic native races. Rabkin ⁽¹⁾ has seen it among pre-historic American Indian tribes, who presumably prepared their food in such a way that a lot of sand and grit was incorporated; Campbell ⁽²⁾ found evidence of it in 35 out of 47 skulls of aged Australian aborigines. However, just what intermediate degree of wear would be the ideal in old age is a somewhat contentious point.

Miller ⁽³⁾ and Box ⁽⁴⁾ seem to consider that the entire wearing away of the buccal cusps of the lower teeth and of the lingual cusps of the upper teeth would cause decreased efficiency of the masticatory apparatus (because of the flattened occlusal surfaces of the teeth), necessitating the use of greater force to produce the same degree of comminution of the food. They believe that the greater force required for mastication produces alveolar resorption and traumatic occlusion. However, many other observers, some on the basis of studies of native races, consider that such degrees of wear as will eliminate the cusps of the teeth are desirable and conducive to the health of the periodontal tissues. Among these are Gottlieb and Orban ⁽⁵⁾, Stein ⁽⁶⁾, Cameron ⁽⁷⁾, and Linghorne ⁽⁸⁾.

II. Effect on Caries-Susceptibility.

The occlusal surfaces of, for example, permanent molars usually present one or more pits or fissures which are difficult or impossible to clean (by natural or artificial methods), thus creating a suitable environment for the initiation of a carious lesion. If the diet and nature of the saliva are such as to produce a high susceptibility to dental caries of the dentition as a whole, the lesion rapidly increases in size and, unless restorative measures are undertaken, leads to the loss of the tooth regardless of whether attrition is taking place or not. On the other hand, when the caries-producing factors are somewhat less active and the lesion is progressing very slowly, if attrition takes place on the occlusal surface, it may conceivably "overtake" the carious process and "grind out" the pit and underlying carious dentine, leaving a smooth surface which is now caries immune because no longer subject to a local environment conducive to caries.

B. APPROXIMAL ATTRITION.

The results of attrition are seen not only on the occlusal and incisal surfaces but also on the approximal surfaces of the teeth.

I. Effect on Periodontal Tissues.

Black (⁹) states that approximal attrition frequently leads to pathological changes in the periodontal tissue, because the contact becomes loosened and food is forced between the teeth and onto the interdental gingivae.

II. Effect on Caries-Susceptibility.

In a child or young adult the most frequent type of contact is that where the approximating surfaces of the teeth are spheroidal and so are in contact only over a minimal area. This is usually considered to be the kind of contact which is least susceptible to dental caries; and in certain cases, when the teeth do not have this form, procedures such as discing (⁹: *loc. cit.*, vol. iv, p. 122) have been suggested to reduce the size of the contact-area and widen the embrasures to facilitate cleaning the tooth-surface.

As age advances, attrition takes place approximally and the areas of contact of the teeth become broader and flatter, which Black (⁹: *loc. cit.*, vol. iv, p. 121) maintains increases the susceptibility to dental caries. The suggested treatment is the placement of mesial and distal restorations in the teeth with contact-points similar to those seen in a young person.

MATERIALS AND METHODS.

The degrees of attrition were studied on the plaster models of the adults of the three villages. Broca's classification (¹⁰) of the degree of occlusal attrition was used. This contains four classes—

- (i) enamel worn, but without cusp-obliteration or exposure of dentine;
- (ii) cusps worn down and the dentine exposed;
- (iii) appreciable amount of the crown of the tooth worn away;
- (iv) most of the crown worn away and the area of attrition extended to the neck of the tooth.

The attrition was on the whole judged by the condition of the posterior teeth, as this classification describes the stages as they occur on the posterior teeth. Admittedly the personal factor cannot be eliminated from the assessment (on any such basis) of degrees of wear, but no better method of assessment is available.

RESULTS.

Table XII shows the different degrees of occlusal attrition observed in each age-group of the population in each village. It will be noted that (i) all natives more than 30 years of age showed attrition of the posterior teeth; (ii) the attrition seen in middle-aged and older people was frequently of degrees II and III, degrees which in our experience are rarely seen in white people living on a "civilised" diet. (See Plates 15 and 16.) There is a remote possibility that this is due to the fact that many white people have already lost their teeth by the time they reach middle life; (iii) no subjects were seen who showed pulp-exposure caused by extensive and too rapid attrition.

The amount of approximal attrition is difficult to assess; we have merely noted that it was frequently obvious in some old subjects (see Plates 16 and 18).

TABLE XII.—SUBJECTS IN DIFFERENT AGE-GROUPS CLASSIFIED ACCORDING TO DEGREE OF OCCLUSAL ATTRITION.

Age-group (years).	No. of subjects examined.	Degrees of Attrition.				
		None.	I (slight).	II (moderate).	III (moderately severe).	IV (severe).
Pātep II—						
16-29 ...	...	8	37	3	0	0
30-44 ...	...	0	11	9	0	0
45 and over ...	...	0	3	6	2	1
Totals ...	80	8	51	18	2	1
Kavataria—						
16-29 ...	...	0	3	1	0	0
30-44 ...	...	0	1	4	0	0
45 and over ...	...	0	0	1	2	0
Totals ...	12	0	4	6	2	0
Koravagi—						
16-29 ...	...	0	4	2	0	0
30-44 ...	...	0	0	5	6	0
45 and over ...	...	0	0	0	3	0
Totals ...	20	0	4	7	9	0

Campbell (²: *loc. cit.*, p. 66) has described a complex direction of wear on the molars of Australian aborigines, and this was particularly sought on the models of the New Guinea natives. Its chief feature is that, when the occlusal surfaces become worn, all the cusps of the teeth are not equally affected. On the lower first molar the buccal cusps, particularly the mesiobuccal, are worn more rapidly than the lingual cusps. On the corresponding maxillary molar the lingual cusps (especially the distolingual) become worn much more rapidly than do the buccal cusps. The third molars usually exhibit exactly the reverse direction of wear and the second molars show a fairly horizontal and intermediate direction of attrition.

This complex direction of wear occurred most frequently in the middle-aged and older natives of New Guinea; the best examples were seen in Kavataria and Koravagi.

Campbell believes this direction of wear is due to the fact that in the first molar region the upper arch is wider than the lower, but in the third molar region the upper arch is narrower than the lower. This is probably the case frequently in the New Guinea natives because many of the models show a cross bite of the third molars. However, third molars usually erupt in such a manner that the occlusal surface of the upper is definitely facing somewhat buccally and that of the lower in a corresponding direction lingually. Thus wear does not alter the angulation of the occlusal surface of this tooth: it rather retains it.

DISCUSSION.

1. For a discussion of the effect of occlusal attrition on the periodontal condition in these New Guinea natives see Section V: Periodontal Disease.

2. It appears highly probable that in Kavataria the carious process was sufficiently slow for the occlusal attrition to overtake it. The occlusal pits in the permanent molars of the children were much more frequently carious than were those of the adults, whose occlusal surfaces indeed were usually worn flat and smooth.

3. It is impossible to make a statement as to whether approximal attrition and periodontitis are causally related: both of them were almost universally present in older people. There were also, however, several other possible causes for the periodontitis observed.

4. Although some degree of approximal attrition appears to have taken place in almost all the adults (and some models of older people show it to have occurred to a very noticeable extent), it does not appear to have increased the susceptibility of these approximating surfaces to dental caries. The possible exception is the approximal caries initiated at the cemento-enamel junction of some of the older people of Pātep II.

On the other hand, there are reasons why approximal attrition may rather lessen the susceptibility of these surfaces to caries. In white people, when caries is seen approximally, it occurs usually just below the contact-point, which would seem to indicate that the contact-point itself is caries-immune. This is possible because (when hard food is eaten) the two teeth rubbing together are mutually self-cleansing. The more the two teeth rub together the greater will be the degree of immunity, and also, as attrition takes place, the greater will be the area of enamel protected by this immunity.

(For references, see end of report.)

Section V.—Periodontal Disease.

INTRODUCTION.

There are many and varied reports, often contradictory, of the periodontal conditions in uncivilised and primitive races living on their native diets. We saw no cases of acute Vincent's infection, although medical assistants in the areas visited said that it does occur in sporadic outbreaks. Nor were any subjects seen whose periodontal tissues presented the clinical signs usually associated with blood dyscrasias and endocrine disturbances. Generalised periodontitis, however, was commonly met.

Generalised Marginal Periodontitis.

In all three New Guinea villages visited we observed frequently a condition whose clinical features were similar to those of Gottlieb's "Schmutz-pyorrhoea" (¹). The same condition has also been described by Thoma under the title of "Generalised Marginal Periodontitis" (²). It appeared to be the same disease in each village, but present in different degrees. Although the clinical features were the same as those of the conditions mentioned above, at the present juncture we do not feel justified in accepting without reservation Gottlieb's and Thoma's opinions as to the aetiology of the condition.

METHODS OF EXAMINATION AND CLASSIFICATION.

Ordinary clinical methods were discarded as too subject to error (the personal factor). More reliable data were provided by radiography (bite-wings) and on the basis of bone-loss we have defined three degrees of the condition:

Degree 1: No loss of bone.

Degree 2: Loss of bone ranging from one or two small pockets (Plate 17) to a widespread and general loss (Plate 18). Those showing very slight loss of bone at the bifurcation of the roots of one or two molars were the upper limit of this degree of the disease.

Degree 3: Extensive general bone-loss, usually associated with exfoliation of the teeth and obvious loss of bone at the bifurcation of the roots of more than two molars. (Plates 19-24.)

In the classification we have included in each village all the adults for whom satisfactory radiograms were available, regardless of the clinical appearance of the gingivae. Thus degree 1 includes not only those with no periodontal disease but also those with grades of the disease which were insufficient to produce discernible bone-loss.

CLINICAL FEATURES.

Although, as mentioned above, the ordinary clinical examination is not to be regarded as providing the best basis for classifying degrees of severity, a short resume of the principal clinical features is included here for the sake of completeness.

(i) It was almost invariably associated with heavy deposits of both sub- and supra-gingival calculus. (ii) The degrees of inflammation varied: at times it was severe and in these cases the gingivae were swollen, soft, shining and haemorrhagic with rounded, everted, interdental papillae. In

other instances the gingivae were normal in colour and tone, but nevertheless showed extensive recession. (iii) The periodontal pockets were not restricted to any particular site and their depth varied. (iv) Recession of the gingival tissues occurred and in more advanced cases a considerable area of cementum was exposed. It is frequently stated that recession of the periodontal tissues is a normal physiological process associated with advancing age and in ideal cases compensates for the physiological attrition of the occlusal surfaces of the teeth. However, these natives commonly showed recession and bone-loss quite out of proportion to the amount of tooth-substance lost by attrition. The result of this was that the amount of tooth visible above the gum margin was greatly increased as the disease progressed. Thus the leverage of this extra-alveolar part of the tooth during masticatory movement is increased and further weakens the supporting tissues.

RESULTS.

The results are set out for each village separately, Tables XIII, XIV and XV are self-explanatory.

TABLE XIII.—NUMBER OF PERSONS SHOWING DEGREES OF PERIODONTITIS AT PÂTEP II.

Age-group (years).	Degrees of disease according to loss of bone.			Total number of persons.
	1. No loss.	2. Moderate loss.	3. Extensive loss.	
16-29	Male 12	Male 6	Male 0	43 (54%)
	Female 20	Female 5	Female 0	
30-44	Male 2	Male 4	Male 4	22 (27%)
	Female 3	Female 9	Female 0	
45 and over	Male 0	Male 4	Male 1	15 (19%)
	Female 1	Female 9	Female 0	
Total number of persons	38 (47%)	37 (46%)	5 (7%)	80 (100%)

TABLE XIV.—NUMBER OF PERSONS SHOWING DEGREES OF PERIODONTITIS AT KORAVAGI.

Age-group (years).	Degree of disease according to loss of bone.			Total number of persons.
	1. No loss.	2. Moderate loss.	3. Extensive loss.	
16-29	Male 3	Male 1	Male 1	16 (29%)
	Female 6	Female 3	Female 2	
30-44	Male 0	Male 7	Male 9	26 (47%)
	Female 3	Female 7	Female 0	
45 and over	Male 1	Male 5	Male 5	13 (24%)
	Female 0	Female 0	Female 2	
Total number of persons	13 (24%)	23 (42%)	19 (34%)	55 (100%)

TABLE XV.—NUMBER OF PERSONS SHOWING DEGREES OF PERIODONTITIS AT KAVATARIA.

Age-group (years).	Degree of disease according to loss of bone.			Total number of persons.
	1. No loss.	2. Moderate loss.	3. Extensive loss.	
16-29	Male 6	Male 2	Male 1	18 (34%)
	Female 8	Female 1	Female 0	
30-44	Male 0	Male 9	Male 5	25 (47%)
	Female 3	Female 3	Female 5	
45 and over	Male 0	Male 1	Male 8	10 (19%)
	Female 0	Female 0	Female 1	
Total number of persons	17 (32%)	16 (30%)	20 (38%)	53 (100%)

DISCUSSION.

It will be noticed that Tables XIII-XV exclude persons under 16 years of age. This is because the gingivae in the children were rarely other than healthy.

In Pātep II, Kavataria and Koravagi respectively, 53, 68, and 76 per cent. of the adult population exhibited loss of alveolar bone caused by periodontitis; the incidence of this disease is, therefore, very high. In middle and old age many of the population show stages of the diseases which would by modern standards undoubtedly be considered as detrimental to the health of the body as a whole.

The causes of such widespread and progressive disease are difficult to determine. Although the clinical manifestations were similar among the people of each village, the incidence and severity of the condition were less severe in Pātep II than in the other two villages. It is highly probable that the contributing causes may be different in each district.

The possible effects of certain factors, which have been mentioned by various workers as being causally related to periodontitis, are discussed below, paragraphs (a), (b), (c) (d) for all villages combined and (e), (f) for each village separately.

(a) *Lack of vitamin C.* As indicated in the biochemists' report, "all villages exhibited satisfactory ascorbic acid nutritional status with the possible exception of Kavataria."

(b) *Insufficient stimulation of gingival tissues, e.g.,* when the diet consists mainly of soft non-fibrous foods. The physical characteristics of food are difficult to define and assess on a quantitative basis; satisfactory data are not available.

(c) *Infection, e.g.,* by Vincent's organisms. No original data were collected.

(d) *Chemical irritation, e.g.,* that arising possibly from the chewing of betel nut. No original data were collected.

Village of Pātep II.

(e) *Mechanical Irritation.* The mouths of the women and children were usually clean and the teeth unstained. But in the men the approximal and lingual surfaces of the teeth were usually covered with a layer of adherent debris stained red-brown from chewing betel nut or smoking tobacco. The labial and buccal surfaces were kept clean by rubbing with sand.

(f) *Trauma during mastication.* Lack of occlusal attrition is believed by many observers to cause generalised periodontal disease in white races. However, in the people of Pātep II the amount of attrition appeared to have considerably reduced lateral trauma caused by cusp-interference and, in the case of some of the older people, there were indeed examples of perfectly "ground in" occlusion associated with the second degree of bone-loss (Plates 18 and 25).

Village of Kavataria.

(e) *Mechanical Irritation.* Darkly stained debris and large amounts of sub- and supra-gingival calculus were nearly always present, especially in the adults. Black teeth were considered an asset and some form of permanent paint had been applied to the teeth of many of the adults.

(f) *Trauma during mastication.* Anterior over-bite was minimal or absent in the models studied, and wear of the occlusal surfaces of the posterior teeth suggested that there could not have been any great amount of trauma during mastication. Hence this factor cannot be regarded as causing the periodontitis which was so frequently seen.

Village of Koravagi.

(e) *Mechanical Irritation.* The oral hygiene of the adults here was equally as unsatisfactory as in Kavataria. The use of lime as a co-masticatory of betel-nut (which was even more plentiful than in Kavataria and was chewed extensively by both men and women) may have been a contributing factor towards the large deposits of calculus which were frequently present.

(f) *Trauma during mastication.* Within about fifteen years of their eruption the posterior teeth were worn down to a nearly plane or even concave surface. However, fully balanced occlusion was only rarely attained, because of the very common deep anterior overbite, and trauma of the periodontal tissues of the anterior teeth must often have been severe. This may have caused the frequently observed loosening of lower anterior teeth. However, there were a few subjects aged between 35 and 50 years who had a balanced functional occlusion, but even these exhibited amounts of bone-loss which were assessed as degrees 2 and 3.

SUMMARY AND CONCLUSIONS.

The results of the nutritionists' observations exclude lack of vitamin C as a factor in the aetiology of the periodontal disease as observed in New Guinea.

Although malocclusion and/or lack of occlusal wear would intensify periodontal disease, nevertheless this latter condition existed in many subjects with a balanced functional occlusion and what should be an adequate amount of occlusal wear. A similar observation has been made by Fish (*).

It is practically certain that the amount of calculus and debris seen around the teeth would have been sufficient to cause irritation of the gingival tissues. As well as being a mechanical irritant and impinging on the gingival tissues, it would also tend to protect bacteria lodged between it and the gingiva.

Just what degree of fibrosity and toughness of food would be necessary to keep gingival tissues satisfactorily stimulated and the teeth free from calculus is unknown, but the clinical state of the teeth and supporting tissues made it obvious that the food-habits and practices of these natives were not satisfactory in this respect.

(For references see end of report.)

Section VI. Dental Caries.

INTRODUCTION.

There is a widespread belief that certain ways of life associated with civilisation and over-refinement of foodstuffs are the cause of ill-health in general and dental decay in particular; and that people living on native dietaries are relatively free from disease. Hence there is a tendency to regard the words "native diet" as synonymous with "ideal diet" and as implying *ipso facto* "freedom from dental caries." This view is held often without due consideration of the nature of any particular diet or methods of food-preparation and without proper realisation of how greatly "native diets" differ from one another.

We therefore welcomed the opportunity of making investigations into the dental conditions of New Guinea populations. As mentioned earlier, our principal object was to obtain data on certain aspects of dental caries and to this end the people of three villages were studied.

MATERIALS AND METHODS.

Subjects.—In each village as many of the people were examined as possible: in Pātep II 136 out of a total available population of 156; and in Koravagi and Kavataria about 100 each, which represented approximately one-third of the total population. Selection of subjects in the latter two places was based on the family unit; the members of every third household were examined. In Kavataria this plan worked well and the sample was a good cross-section of the population. In Koravagi we were able to examine only those who were willing to visit the camp. Data on children under the age of about one year have been omitted throughout.

Methods of (1) *clinical examination*, (2) *radiographical examination*, (3) *recording observations* and (4) *collecting samples of saliva for bacteriological examination*.

1. *Clinical Examination.*—The subjects were seated on a stool in the shade, but so placed that there was adequate light. All accessible tooth-surfaces were examined with the aid of Ash's No. 5 mirrors (plane) and sharp right-angle explorers ("Udimocolite" No. 6).

2. *Radiographical Examination.*—Five X-ray films were used, one on each side for posterior teeth (bitewings) and three for upper anteriors. Eastman Kodak radiatized films were used in Pātep II, and Ilford No. 5 in Kavataria and Koravagi. In order to get the best results with the somewhat inadequate apparatus it was necessary to give a long exposure. The use of five films in Pātep II meant that each individual was subjected to a total exposure of 76 seconds, which was considered the maximum consistent with safety. In Koravagi and Kavataria where the Ilford films were used, each subject received a total exposure of 34 seconds. Young children were not included as they could not remain motionless long enough. On the whole the procedure in Koravagi and Kavataria proved less satisfactory than that in Pātep II, probably because in Pātep the films had been in a tropical climate for a shorter period of time and therefore had not deteriorated.

After development at the Dental Hospital of Sydney by the staff of the X-ray Department, the films were examined and any previously undetected lesions were recorded. By no means all of the radiograms obtained were entirely satisfactory. The outline of the pulp chamber and the differentiation of enamel and dentine were usually fairly clear, but the detail was often insufficient to show whether there were small cavities in the approximal surfaces of the teeth.

3. *Recording the observations.*—The caries-incidence (Tables XVI-XXV inclusive) has been recorded on three distinct bases: (i) *people* with or without caries; (ii) *teeth* with or without caries; (iii) *tooth-surfaces* with or without caries.

The native people on the whole were unable to give accurate information about their ages and in Koravagi the village records were incomplete. The subjects, therefore, have been divided into what may be termed physiological age-groups, determined in the children by the eruption-time of their teeth and in adults by their general physical appearance:—

Group A: 12 or more deciduous teeth—approximate age-group, 1-5 years old.

Group B: 1 or more first permanent molars—approximate age-group, 6-10 years old.

Group C: 1 or more second permanent molars—approximate age-group, 11-15 years old.

Group 4: 1 or more third permanent molars and/or young adults up to approximately 29 years—approximate age-group, 16-29 years old.

Group E: Middle-aged adults—approximate age-group, 30-44 years old.

Group F: Old people—approximate age-group, 45 and over 45 years.

In those age-groups with mixed dentition figures are given for the deciduous and permanent teeth separately and for the deciduous and permanent teeth jointly. Hence children with mixed dentition will be represented in all three subdivisions. The "deciduous group" includes all the children with any deciduous teeth at all and the figures refer only to these deciduous teeth. The "permanent group" includes all those with any permanent teeth at all and the figures refer only to the permanent teeth.

The data compiled from the number of *surfaces* with or without caries might preferably have been presented in the manner described by Bodecker (1) for his modified Dental Caries Index, which is determined by adding to the total number of carious or filled surfaces in the mouth, three for each tooth extracted because of caries. However, when applied to native races and to all age-groups, it is often necessary to make assumptions concerning the causes of loss of teeth, and an index so calculated might possibly be misleading.

In his report, therefore, we have stated the number of surfaces observed to be carious as a percentage of the total number of tooth-surfaces in the mouth. The following are the main points in our calculation:—

(a) Permanent teeth were considered by us as by Bodecker to possess a total of 180 susceptible surfaces.

(b) Deciduous teeth were considered to possess a total of 108 susceptible surfaces, that is, 8 more than the figure given by Bodecker. The additional surfaces are:

(i) One on the occlusal aspect of each of the deciduous maxillary molars.

(ii) One on the buccal aspect of the lower 2nd deciduous molars as distinct from the gingival third of this aspect (there is almost invariably a caries-susceptible pit present on this surface).

(iii) Six, instead of five, surfaces on the lower 1st deciduous molars.

(c) Our calculations are based on conditions in the mouth at the time of examination:

$$\frac{\text{cariou surfaces present}}{\text{total surfaces present}} \times 100.$$

(d) For mixed dentitions three indices were calculated: one each for the deciduous and permanent teeth and one for the deciduous and permanent teeth jointly.

4. *Collection of samples of saliva for bacteriological purposes.*—For details, see Appendix I: Bacteriological Investigations (p. 262).

RESULTS.

A. *Characteristics of Lesions Recorded as Caries.*

1. As in civilised races, carious lesions occurred in anatomical pits and fissures and on the gingival third of the teeth.

2. It is usual, when examining the permanent teeth of white children, to consider as carious any pit or fissure into which the probe can be introduced to such a depth that it will remain fast. Pits of this nature were sometimes seen in the children of each village and were regarded as carious. This criterion must have been correct in Pātep II, because in the adults these occlusal and buccal pits were often grossly carious. On the other hand, in Kavataria and Koravagi in the older people the buccal pits were sometimes carious, but the occlusal surfaces of the molars were usually worn smooth and showed no caries. There are two possible explanations for this: (i) either the occlusal pits did not become actively carious and

were eventually "ground out" by the process of attrition; or (ii) the dental health of the two communities (Koravagi and Kavataria) is deteriorating and those who are children now will not in twenty years' time have such sound teeth as their parents have now.

3. The type of approximal cavity most frequently seen in young white people occurred very rarely in the principal groups of natives examined (but see Appendix II, p. 264). Approximal cavities did occur in the older people of Pâtep II, but from the radiographical evidence the site of the initial lesion appears to have been at the cemento-enamel junction rather than just below the contact point (see Plates 21, 25, 46).

4. In two subjects at Koravagi the molars showed lesions on approximal surfaces; the dentine was exposed and carious, but had an unusual appearance in the radiogram. The lesions seem to be similar to some described by Campbell (²) as occurring in the aborigines of Australia: he called it "erosion," on the assumption that the original process was one of erosion on which caries had been superimposed.

5. Carious lesions sometimes occurred at unusual sites on the teeth, e.g., cusps and marginal ridges of molars and the middle third of the labial surface of upper incisors. The character of lesions in the molars often suggested that the enamel of the cusp or ridge had been fractured and dislodged, exposing the dentine which was black, rough and leathery and therefore regarded as carious. The cavities on the middle third of the labial surface of upper incisors (similar to those which are seen, but only very rarely, in white races) may have begun in small hypoplastic pits, but except for their unusual position they certainly had all the appearances of a carious cavity.

6. Almost invariably exposed carious dentine was dark-brown, tough and leathery (even in children), rather than soft and pale, as is usual in white races.

B. Incidence and Distribution of Lesions Recorded as Caries.

1. *On the basis of persons with or without caries.*—Tables XVI-XVIII show for each village the distribution, according to age-group, of (a) caries-free persons; (b) persons free of evidence of caries but with retained roots; (c) persons with caries. It was considered to be fairer to segregate those subjects with retained roots, because of the impossibility of determining whether the missing crowns had ever been affected by caries or had been lost from other causes. Two subjects in Koravagi, who showed no evidence of caries but gave a history of extraction by Europeans, were also included in this group (b).

It seemed instructive to compare on the basis of percentage of caries-free persons, the incidence of caries in the total populations of each of the three villages with that for some other native races and for white people. Table XIX shows these figures, but it should be borne in mind that they have not necessarily been derived from populations with comparable age-distributions.

2. *On the basis of teeth with or without caries.*—In many respects the dental health of a community is more clearly indicated by figures giving the number of teeth both carious and sound as distinct from numbers of persons with or without caries. Such figures for the New Guinea villages

are shown in tables XXII-XII and can be compared with those of (i) Cunningham (⁸), who in his report of the work of the Cambridge Dental Clinic showed that 52 per cent. of the teeth of the children examined were carious, and of (ii) Campbell (²: *loc. cit.*, p. 75), who showed that for Australian aborigines (all ages) of 10,561 teeth examined 167 (or 1.58 per cent.) were carious.

3. *On the basis of tooth surfaces with or without caries.*—Tables XXIII-XXV give an index of dental caries calculated on the basis of the formula $\frac{\text{carious surfaces present}}{\text{total surfaces present}} \times 100$; this figure was worked out for each individual. The tables also show the mean and median for each age-group, and the distribution of the individual percentages. Percentages were not calculated for subjects with some roots present but otherwise caries-free mouths.

It should be noted that in each village the individual percentages are nearly all below 5 and that only a scattered minority falls within the range of higher values. In Table XXXIII the figures for three New Guinea groups are compared with those for two white populations.

The figures for New Zealand (¹⁴) and Australia (Sydney) (⁶) include teeth lost because of caries. Those for New Guinea do not include such teeth; however, as may be noted in Tables XXIX-XXXI inclusive, there were only 8 teeth missing amongst the 121 New Guinea children examined, so that the figures represent the relative incidence with reasonable accuracy.

DISCUSSION OF INCIDENCE AND DISTRIBUTION OF LESIONS RECORDED AS CARIES.

(a) *Comparison of the three villages each considered as a unit.*—From Tables XVI-XXV it appears that irrespective of the basis for assessment of the severity and extent of the carious process (whether as *persons* with or without caries, or *teeth* with or without caries or *surfaces* with or without caries) the disease is most prevalent in Pātep II, less so in Kavataria and least in Koravagi (Table XXVI).

Statistical analysis of the figures on the basis of people with or without caries shows that the difference between Pātep and Koravagi is significant.

(b) *Comparison of the different incidences of caries in the different age groups in each of the three villages.*—On whatever basis the incidence is determined (persons or teeth or surfaces) in Pātep II it increases with age. On the other hand, in Kavataria the children seem to suffer from dental caries far more than do the adults. In Koravagi the intensity of the carious process seems to be about the same for all age-groups. Table XXVII shows these different distributions on the basis of percentage of carious teeth.

(c) *Comparison of the different incidence of caries in deciduous and permanent teeth.*—The difference in the degree to which deciduous and permanent teeth are affected in any one village can best be shown statistically when *numbers of persons* rather than of teeth are compared.

A system similar to that used for subdivision within a group of children who have mixed dentition can also be applied in an analysis of a whole population to show which dentition on the whole is the more subject to

caries. In the analysis which follows of (i) people with deciduous, and (ii) people with permanent teeth, the two classes are built up in the following way. The "*deciduous group*" contains all the children with any deciduous teeth at all and is then subdivided into two groups, children who had or who did not have caries of their deciduous teeth. The "*permanent group*" contains all people with any permanent teeth at all (except those caries-free persons with retained roots). They have been similarly subdivided on the basis of those with, and those without caries of their permanent teeth. Thus, if the number of persons in each group (deciduous and permanent) were added together, the total would necessarily be greater than the total number examined in the village.

(1) Within each village: At Pātep II the number of persons who had caries was significantly higher among those with permanent teeth than it was among those with deciduous teeth, that is, more people had caries of the permanent teeth. When similar comparisons are made for Kavataria significantly more people had caries of the deciduous teeth. In Koravagi there was no significant difference.

(2) Between the villages: When the populations have been divided into those with deciduous and those with permanent teeth, it becomes possible to compare the number of persons with or without caries in each village on three distinct bases—

- (i) the whole population (as has been done already, p. 243);
- (ii) that portion of the whole population with any permanent teeth;
- (iii) that portion of the whole population with any deciduous teeth.

Analysing and comparing the figures for "permanent groups" only, it is seen that far more of these people suffer from caries in Pātep II than in Kavataria or Koravagi. In respect to the children with any deciduous teeth more of them suffer from caries in Kavataria than in Pātep II.

Thus tabulation of the incidence (people with or without caries) on these three bases (i) the whole population (with or without caries); (ii) that portion of the whole with any permanent teeth; (iii) that portion of the whole with any deciduous teeth, reveals the "order of merit" shown in Table XXVIII. It should be noted that the term "bad" is used only for comparison between the three villages; by comparison with those of civilised peoples the teeth of the New Guinea people are good.

ODONTOCLASIA.

The condition known as odontoclasia has been described as occurring on two tropical islands: on Hawaii by Jones *et al.* (9, 10) and on Manus by Kirkpatrick (4). According to these authors its main features appear to be those described below.

1. *Clinical picture of affected dentine.*—Both writers describe two distinct types of the disease, distinguished by the way in which the dentine is affected. In one type the dentine is softened, rough and carious in appearance, in the other type it is hard and eburnated and the teeth have sometimes been worn down to their gingival margins, despite the fact that the subjects are children.

2. *Location of lesions.*—"It occurs on all surfaces of the teeth including those which are normally immune to caries; and progresses over the surfaces in broad lines rather than by boring into pits and fissures." It attacks especially the middle third of the incisors.

3. *Incidence.*—It seems to have been described only on these two tropical islands and "is confined almost exclusively to the deciduous teeth." Kirkpatrick states that its incidence is different in districts where the incidence of typical caries is the same.

4. The *aetiology* is undecided. Kirkpatrick considers the cases he observed may be due to the inability of the mothers to supply sufficient calcium and phosphorus for the foetus. Jones *et. al.* blame mainly the increased consumption of imported grain-foods by the native Hawaiians. But they conclude: "it is probably an exaggerated form of caries, the underlying causes appear to be the same."

We believe we have seen an essentially similar disease, fairly prevalent in Kavataria but also occurring occasionally in both Pātep II and Koravagi. Its principal features are:—

(i) *Clinical picture of affected dentine.*—In Kavataria and Koravagi the lesions were of the "carios"-dentine type. In Pātep II they were of the hard, smooth eburnated-dentine type and on first appearance the condition seemed to be due to an edge-to-edge bite, the crowns of the upper and lower anterior teeth being "worn down" to the gingival margin. On further examination it was seen that, with the posterior teeth in occlusion, there was a considerable space between the incisal "surfaces" of the anterior teeth. These surfaces were smooth and slightly convex antero-posteriorly; the dentine was hard and stained a deep brown with a lighter area representing secondary dentine in the centre. Because of the well-formed secondary dentine and hardness of the incisal "surface" the teeth did not appear to have been attacked by caries or to have been broken by injury; rather did they look as if they had been subjected to intensive attrition.

(ii) *Location of lesions.*—In Kavataria and Koravagi lesions occurred in unusual sites such as the cusps and marginal ridges of teeth and the middle third of the labial (and occasionally also the lingual) surface of the incisors.

(iii) *Incidence of lesions* (in Kavataria and Koravagi) in which the affected dentine had the characteristics of caries was much higher than was that of caries of the permanent teeth.

(iv) *Aetiology.*—On the island (Kiriwina) on which the condition seemed commonest imported grain-foods were not eaten at all and the natives were at that time living on locally produced foods. However, it was only two years since the end of the war, during three years of which 70,000 servicemen are said to have visited the island and almost certainly gave to the natives some of their candies and other items of diet, for which the natives in our experience showed a great liking.

However, to simplify the presentation of the data, we have not described the disease separately as such, but the lesions presenting "carios"-looking dentine have been called dental caries and the others showing the eburnated

dentine have been placed in a separate class. The following are additional reasons for this mode of presentation of the data:—

- (a) It seems strange that one disease should be able to produce in the dentine two such different effects, unless one were a later stage of the other. If this is the case, then in any district where the disease is prevalent one might expect to see both stages and also some which are intermediate. Yet in our experience the two appearances occurred separately in entirely different districts: furthermore, intermediate stages were not seen.
- (b) Although it is fairly uncommon to find in civilised children carious lesions on *e.g.*, the middle third of the labial surfaces of incisors, when they do occur, the condition is described as rampant dental caries.
- (c) The aetiology is undecided and appears to be different in each island.

OTHER CONSIDERATIONS RELATIVE TO DENTAL CARIES.

A. Missing teeth and the probable cause.—(a) Removal by the natives themselves: as far as we were able to ascertain, the natives living in the areas visited do not indulge in any religious practices involving tooth-mutilation or extraction; nor do they, as far as is known, remove their teeth to relieve pain except when periodontal disease has weakened the bony support and the tooth becomes very loose.

(b) Removal by Europeans: only in two instances did we obtain a history of extractions by Europeans. In both the subjects were inhabitants of Korovagi and had had the extractions performed during some former period of indentured labour service. The people of Pātep II had had little contact with white people and their geographical position makes it unlikely that they had ever received this service. Kavataria on the other hand was only a mile away from the native hospital at Losuia, although hospital records showed that extractions were almost always for natives from villages farther inland than Kavataria.

(c) Removal for other reasons: in evaluating likely reasons for the absence of a tooth or its crown the following possibilities were considered:—Caries, periodontal disease, trauma, retarded eruption and congenital absence. Roots and missing teeth were placed in one or other category after consideration of—

- (1) the state of remaining teeth as regards caries;
- (2) the condition of the periodontal tissues and firmness or otherwise of the remaining teeth;
- (3) the history given by the subject, although this was usually a matter of signs and broken phrases.

It is comparatively easy to understand how a tooth can be exfoliated when its bony support has disappeared (see Plates 22, 23, 24). That the entire tooth can be destroyed by a carious process alone is a little harder to understand, but some of the radiograms present evidence which indicates that this can and does occur (see Plates 26, 27, 28).

Tables XXIX-XXXI give the number of missing teeth in each age-group and the probable cause thereof and show the following trends:—

- (i) the mean number of missing teeth per head of population (all causes) is 2.2 in Pātep II, 2.3 in Kavataria and 0.63 in Koravagi. However, the lower number of missing teeth in Koravagi may be partly due to the fact that very few of the oldest subjects presented themselves for examination.
- (ii) Tooth-loss increases with age, irrespective of the cause in all three villages. In each village the number of missing teeth in the group of young adults (aged 16-29 years) is somewhat higher than it would be if the figure included only pathological and traumatic causes, because some of these subjects had unerupted third molars.
- (iii) The relatively large number of teeth which seemed to have been lost by caries in Pātep II is indicated by the carious condition of many of the remaining teeth.
- (iv) Although in Kavataria caries or odontoclasia was very prevalent in deciduous teeth, it obviously did not cause premature loss of such teeth. Acute periapical conditions of affected deciduous teeth were very rarely observed.

B. *Frequency of attack of individual teeth by caries.*—Why some teeth should be more prone than others to attack is a question which is frequently asked. For white populations several observers (^{11,12}) have pointed out that caries frequently occurs to an equal degree and with symmetrical distribution on both sides of the mouth. Some have pointed to a relative immunity possessed by the upper posterior teeth as compared to their lower antagonists (¹³), others have found the reverse (¹²).

Table XXXII shows the frequency with which the individual teeth were attacked by caries in the young and middle-aged adults (approx. age-group 16-44 years) of Pātep II. (It does not record the number of lesions seen on each tooth but rather the number of teeth that have been attacked by caries. Roots and teeth presumed destroyed by caries are also included.) Upper incisors were affected more than lower, and the lower molars were affected slightly more than the upper. In each quadrant the third molar was the most frequently affected tooth.

SUMMARY AND CONCLUSIONS.

Dental caries exists in each of the three groups of New Guinea natives which were studied.

Its incidence is, however, much lower than that usually observed among most "civilised" peoples.

The incidence of the disease is different in each of the three villages. It was lowest among the inhabitants of Koravagi (sago-staple diet), next lowest among those of Kavataria (yams and fish), and greatest among those of Pātep II (sweet potato).

The incidence of the disease is sometimes different in the two dentitions. In Pātep II the incidence of caries of the deciduous teeth is quite low, while that of the permanent teeth is considerably higher. On the other hand in Kavataria this relationship is reversed.

The incidence of caries of the approximal surfaces of the teeth is very much lower in New Guinea natives than in civilised peoples. The incidence of caries of pits and fissures is also lower in New Guinea natives, but the difference between native and civilised peoples is smaller in relation to caries of pits and fissures than in relation to caries of the approximal surfaces.

Differences in the characteristics (*e.g.*, age-distribution, clinical features and surface-incidence) of lesions classified as caries suggest (*a*) that the disease manifests itself in a number of different forms and (*b*) that differences in the form of the disease exist not only as between native and civilised peoples but also as between groups of native peoples exposed to dissimilar environments.

It is very desirable, therefore, that we should attempt both to define dental caries more satisfactorily and to describe more accurately the criteria (clinical, histopathological, chemical, etc.) necessary for its certain recognition.

The condition named "Odontoclasia," which is described as occurring in Hawaii and Manus, was prevalent in Kavataria and seen occasionally in Pātep II and Koravagi.

TABLE XVI (A).—PERCENTAGE OF CARIES-FREE SUBJECTS IN PATEP II.

Approx. Age-Group (Years).	Number of Subjects.				Percentage Subjects Caries-free.
	Examined.	Caries-free.	With Caries.	With Roots Present; Other teeth Caries-free.	
1-5 (subjects with deciduous teeth only)	23	18	5	0	78
6-10 (subjects with 1 or more 1st permanent molars)	14	8	6	0	57
11-15 (subjects with 1 or more 2nd permanent molars)	12	9	3	0	75
16-29	46	19	24	3	41
30-44	23	6	14	3	26
45 and over	18	1	15	2	7
Totals	136	61	67	8	46

TABLE XVI (B).—DATA FOR SUBJECTS WITH MIXED DENTITIONS.

Approx. Age Group (Years).	Subjects With—	Number of Subjects.			Percentage Subjects Caries-free.
		Examined.	Caries-free.	With Caries.	
6-10	Deciduous teeth ...	14	10	4	71
	Permanent teeth ...	14	10	4	71

TABLE XVII (A).—PERCENTAGE OF CARIES-FREE SUBJECTS
IN KAVATARIA.

Approx. Age-Group (Years).	Number of Subjects.				Percentage Subjects Caries-free.
	Examined.	Caries-free.	With Caries.	With Roots present; Other Teeth Caries-free.	
1-5 (subjects with decid- uous teeth only)	8	3	5	0	38
6-10 (subjects with 1 or more 1st permanent molars)	13	2	11	0	15
11-15 (subjects with 1 or more 2nd permanent molars)	13	4	9	0	30
16-29	19	15	4	0	79
30-44	26	21	4	1	80
45 and over	15	7	6	2	47
Totals	94	52	39	3	55

TABLE XVII (B).—DATA FOR SUBJECTS WITH MIXED DENTITIONS.

Approx. Age-Group (Years).	Subjects With—	Number of Subjects.			Percentage Subjects Caries-free.
		Examined.	Caries-free.	With Caries.	
6-10	Deciduous teeth ...	12	3	9	25
	Permanent teeth ...	13	7	6	54
11-15	Deciduous teeth ...	3	2	1	66
	Permanent teeth ...	13	5	8	40

TABLE XVIII (A).—PERCENTAGE OF CARIES-FREE SUBJECTS IN KORAVAGI.

Approx. Age-Group (Years).	Number of Subjects.				Percentage Subjects Caries-free.
	Examined.	Caries-free.	With Caries.	With Roots Present; Other Teeth Caries-free.	
1-5 (subjects with deciduous teeth only) ...	9	6	3	0	66
6-10 (subjects with 1 or more 1st permanent molars) ...	19	11	8	0	58
11-15 (subjects with 1 or more 2nd permanent molars) ...	10	7	3	0	70
16-29 ...	17	13	4	0	76
30-44 ...	31	21	10	0	68
45 and over ...	14	9	2	3	64
Totals ...	100	67	30	3	67

TABLE XVIII (B).—DATA FOR SUBJECTS WITH MIXED DENTITIONS.

Approx. Age-Group (Years).	Subjects With—	Number of Subjects.			Percentage Subjects Caries-free.
		Examined.	Caries-free.	With Caries.	
6-10 ...	Deciduous teeth ...	18	10	8	56
	Permanent teeth ...	19	18	1	95

TABLE XIX.—PERCENTAGE OF CARIES-FREE SUBJECTS IN DIFFERENT RACES.

Observer.	Approx. Age-Group.	Skulls or Living Subjects.	Geographical Location.	Number Observed.	Percentage Subjects Caries-free.
Turner (2) ...	Mixed ...	Skulls (ancient)	Egypt ...	104	60
Campbell (2) ...	Mixed ...	Skulls ...	Australian aboriginals.	583	86
Kirkpatrick (4) ...	Mixed ...	Living subjects	Manus (Admiralty Is.).	1,976	97.5
Colyer (5) ...	Adult males.	Living subjects	Central Africa ...	700	89
Cameron (6) ...	Children— 1-7 yrs.	Living subjects	Australia (white)...	639	15
	8-12 yrs.	Living subjects	Australia (white)...	1,082	0
Schleswig-Holstein (7) Dent. Assn.	School- children.	Living subjects	Northern Germany	19,725	5
Present writers ...	All age groups.	Living subjects	Pâtep II ...	136	45
			Kavataria ...	94	55
			Korovagi ...	100	67

TABLE XX (A).—PERCENTAGE OF CARIOUS TEETH AMONG NATIVES OF PÂTEP II.

Approx. Age-Group (Years).	Total No. Subjects Examined.	Number of Teeth.		Percentage Carious Teeth.
		Standing.	Carious.	
1-5 (subjects with deciduous teeth only)	23	460	12	2.5
6-10 (subjects with 1 or more 1st permanent molars)	14	333	22	6.5
11-15 (subjects with 1 or more 2nd permanent molars)	12	332	9	2.5
16-29	46	1,404	70	5.0
30-44	23	675	57	8.5
45 and over	18	400	58	14.5
Totals	136	3,604	228	6.3

TABLE XX (B).—DATA FOR SUBJECTS WITH MIXED DENTITIONS.

Approx. Age-Group (Years).	Subjects With—	Total No. Subjects.	Number of Teeth.		Percentage Carious Teeth.
			Standing.	Carious.	
6-10	Deciduous teeth ...	14	177	13	7
	Permanent teeth ...	14	157	9	6

TABLE XXI (A).—PERCENTAGE OF CARIOUS TEETH AMONG THE NATIVES OF KAVATARIA.

Approx. Age-Group (Years).	Total No. Subjects Examined.	Number of Teeth.		Percentage Carious Teeth.
		Standing.	Carious.	
1-5 (subjects with deciduous teeth only)...	8	159	32	20
6-10 (subjects with 1 or more 1st permanent molars)	13	307	47	15.5
11-15 (subjects with 1 or more 2nd permanent molars)	13	357	18	5
16-29	19	602	5	0.8
30-44	26	804	5	0.6
45 and over	15	301	6	2
Totals	94	2,530	113	4.5

TABLE XXI (B).—DATA FOR SUBJECTS WITH MIXED DENTITIONS.

Approx. Age-Group (Years).	Subjects With—	Total No. Subjects.	Number of Teeth.		Percentage Cari-ous Teeth.
			Standing.	Cari-ous.	
6-10	Deciduous teeth ...	12	159	37	23
	Permanent teeth ...	13	148	10	7
11-15	Deciduous teeth ...	3	3	1	33
	Permanent teeth ...	13	354	7	5

TABLE XXII (A).—PERCENTAGE OF CARIOUS TEETH AMONG NATIVES OF KORAVAGL.

Approx. Age-Group (Years).	Total No. Subjects Examined.	Number of Teeth.		Percentage Cari-ous Teeth.
		Standing.	Cari-ous.	
1-5 (subjects with deciduous teeth only)	9	164	6	3.0
6-10 (subjects with 1 or more 1st permanent molars)	19	456	30	6.6
11-15 (subjects with 1 or more 2nd permanent molars)	10	276	8	3.0
16-29	17	524	10	2.0
30-44	31	982	18	1.8
45 and over	14	416	3	0.75
Totals	100	2,818	75	2.66

TABLE XXII (B).—DATA FOR SUBJECTS WITH MIXED DENTITIONS.

Approx. Age-Group (Years).	Subjects With—	Total No. Subjects Examined.	Number of Teeth.		Percentage Cari-ous Teeth.
			Standing.	Cari-ous.	
6-10	Deciduous teeth ...	18	244	28	11
	Permanent teeth ...	19	209	3	1

TABLE XXIII (A).—PERCENTAGE OF CARIOUS TOOTH-SURFACES AMONG THE NATIVES OF PATEP II.

Approx. Age-Group (Years).	Total No. Subjects.	*Percentage Carious Surfaces.		Distribution of Population according to Percentage of Carious Surfaces.				
		Mean.	Median.	0-4%	5-9%	10-14%	15-19%	20% and over.
1-5 (subjects with deciduous teeth only)	23	0.89	0	21	2	0	0	0
6-10 (subjects with 1 or more 1st permanent molars)	14	1.70	0	12	1	1	0	0
11-15 (subjects with 1 or more 2nd permanent molars)	12	0.64	0	12	0	0	0	0
16-29	43	1.35	0.60	41	1	1	0	0
30-44	20	2.55	1.68	16	4	0	0	0
45 and over	16	4.78	3.94	11	3	1	1	0
Totals	128	1.86	0.60	113	11	3	1	0

* Percentages were not calculated for subjects who had some roots present but were otherwise caries-free.

TABLE XXIII (B).—DATA FOR SUBJECTS WITH MIXED DENTITION.

Approx. Age-Group (Years).	Subjects With—	Total No. Subjects Examined.	Percentage Carious Surfaces.		Distribution of Population according to Percentage of Carious Surfaces.				
			Mean.	Median.	0-4%	5-9%	10-14%	15-19%	20% and over.
6-10 ...	Deciduous teeth ...	14	2.27	0	11	1	2	0	0
	Permanent teeth ...	14	1.29	0	13	1	0	0	0

TABLE XXIV (A).—PERCENTAGE OF CARIOUS TOOTH-SURFACES AMONG THE NATIVES OF KAVATARIA.

Approx. Age-Group (Years).	Total No. Subjects.	*Percentage Carious Surfaces.		Distribution of Population according to Percentage of Carious Surfaces.				
		Mean.	Median.	0-4%	5-9%	10-14%	15-19%	20% and more.
1-5 (subjects with deciduous teeth only)	8	5.56	1.40	5	1	0	2	0
6-10 (subjects with 1 or more 1st permanent molars)	13	4.97	2.98	9	3	0	1	0
11-15 (subjects with 1 or more 2nd permanent molars)	13	1.23	0.69	13	0	0	0	0
16-29	19	0.15	0	19	0	0	0	0
30-44	25	0.21	0	25	0	0	0	0
45 and over	13	0.58	0	13	0	0	0	0
Total	91	1.424	0	84	4	0	3	0

* Percentages were not calculated for subjects who had some roots present but were otherwise caries-free.

TABLE XXIV (B).—DATA FOR SUBJECTS WITH MIXED DENTITION.

Approx. Age-Group (Years).	Subjects With—	Total No. Subjects Examined.	Percentage Carious Surfaces.		Distribution of Population according to Percentage of Carious Surfaces.				
			Mean.	Median.	0-4%	5-9%	10-14%	15-19%	20% and over.
6-10 ...	Deciduous teeth ...	12	7.37	2.40	8	0	2	0	2
	Permanent teeth ...	13	1.75	0	11	2	0	0	0
11-15 ...	Deciduous teeth ...	3	6.67	0	2	0	0	0	0
	Permanent teeth ...	13	1.19	0.64	13	0	0	0	0

TABLE XXV (A). PERCENTAGES OF CARIOUS TOOTH-SURFACES AMONG THE NATIVES OF KORAVAGI.

Approx. Age-Group (Years).	Total No. Subjects.	*Percentage Carious Surfaces.		Distribution of Population according to Percentage of Carious Surfaces.				
		Mean.	Median.	0-4%	5-9%	10-14%	15-19%	20% and over.
1-5 (subjects with deciduous teeth only) ...	9	0.76	0	9	0	0	0	0
6-10 (subjects with 1 or more 1st permanent molars) ...	19	1.97	0	17	1	1	0	0
11-15 (subjects with 1 or more 2nd permanent molars) ...	10	0.64	0	10	0	0	0	0
16-29 ...	17	0.34	0	17	0	0	0	0
30-44 ...	31	0.53	0	31	0	0	0	0
45 and over ...	11	0.22	0	11	0	0	0	0
Totals ...	97	0.75	0	95	1	1	0	0

* Percentages were not calculated for subjects who had some roots present but were otherwise caries-free.

TABLE XXV (B).—DATA OF SUBJECTS WITH MIXED DENTITION.

Approx. Age-Group (Years).	Subjects With—	Total No. Subjects Examined.	Percentage Carious Surfaces.		Distribution of Population according to Percentage of Carious Surfaces.				
			Mean.	Median.	0-4%	5-9%	10-14%	15-19%	20% and over.
6-10	Deciduous teeth ...	18	3.13	0	15	2	0	0	0
	Permanent teeth ...	19	0.42	0	18	1	0	0	0

TABLE XXVI.—COMPARISON OF THE INCIDENCE OF CARIES IN THE THREE VILLAGES EACH CONSIDERED AS A UNIT AND IN A GROUP OF WHITE CHILDREN (1-12 YEARS).

Location.	Percentage People with Caries.	Percentage Teeth Carious.	Mean Percentage Surfaces Carious.
Pātep II ...	52	6.5	1.86
Kavataria ...	43	4.5	1.42
Koravagi ...	31	2.75	0.75
Sydney, N.S.W. ...	90	39.13	13.42

TABLE XXVII.—PERCENTAGES OF CARIOUS TEETH IN THE DIFFERENT AGE-GROUPS IN EACH VILLAGE (Numbers are given in Tables XVI-XXV).

Approx. Age-Group (Years).	Percentages of Carious Teeth.		
	Pātep II.	Kavataria.	Koravagi.
1-5... ..	2.5	20.0	3.0
6-10	6.5	15.5	6.6
11-15	2.5	5.0	3.0
16-29	5.0	0.8	2.0
30-44	8.5	0.6	1.8
45 and over ...	14.0	2.0	0.75
Totals ...	6.5	4.5	2.75

TABLE XXVIII.—CARIES INCIDENCE (PEOPLE WITH OR WITHOUT CARIES) EXPRESSED AS AN "ORDER OF MERIT."

Village.	All Teeth.	"Permanent" Group.	"Deciduous" Group.
Pātep II ...	4 (bad)	5 (very bad)	1 (very good)
Kavataria ...	3 (moderate)	1 (very good)	5 (very bad)
Koravagi ...	2 (good)	2 (good)	3 (moderate)

Note.—The terms "bad," "moderate," "good" are used only for comparison between the three villages, because in comparison with those of civilised peoples the teeth of the natives are good.

TABLE XXIX.—PATEP II—MISSING TEETH—CLASSIFICATION OF PROBABLE CAUSES.

Approx. Age-Group (Years).	Total No. Subjects Examined.	No. Teeth Standing.	Total No. Missing Teeth + Roots.	No. Missing Teeth or Roots per Person.	Number of Teeth Missing and Probable Cause.						Number of Roots and Probable Cause.			
					Caries.	Perio- dontitis.	Trauma.	Un- erupted.	Con- genitally Absent.	Un- known.	Caries.	Trauma.	Un- known.	
1-5 (subjects with deciduous teeth only)...	23	460	0	0	0	0	0	0	0	0	0	0	0	0
6-10 (subjects with 1 or more 1st permanent molars) ...	14	333	1	0.7	0	0	0	0	0	0	1	0	0	0
11-15 (subjects with 1 or more 2nd permanent molars) ...	12	332	2	1.6	0	0	0	0	2	0	0	0	0	0
16-29... ..	46	1,404	67	1.2	3	0	0	15	14	7	24	4	0	0
30-44... ..	23	675	61	2.6	22	5	1	1	2	3	20	6	0	0
45 and over	18	400	177	9.0	48	5	0	0	0	3	121	0	0	0
Totals	136	3,604	308	2.2	73	10	1	16	18	13	166	10	0	0

Teeth presumed unerupted are excluded from the first three age-groups.

TABLE XXX.—KAVATARIA—MISSING TEETH—CLASSIFICATION OF PROBABLE CAUSES.

Approx. Age-Group (Years).	Total No. Subjects Examined.	No. Teeth Standing.	Total No. Missing Teeth + Roots.	No. Missing Teeth or Roots per Person.	Number of Teeth Missing and Probable Cause.					Number of Roots and Probable Cause.			
					Caries.	Perio- dontitis.	Trauma.	Un- erupted.	Con- genitally Absent.	Un- known.	Caries.	Trauma.	Un- known.
1-5 (subjects with deciduous teeth only)...	8	159	1	0.12	0	0	0	0	0	0	1	0	0
6-10 (subjects with 1 or more 1st permanent molars) ...	13	307	0	0	0	0	0	0	0	0	0	0	0
11-15 (subjects with 1 or more 2nd permanent molars) ...	13	357	2	0.15	1	0	0	0	1	0	0	0	0
16-29 ...	19	602	6	0.31	0	0	0	5	0	1	0	0	0
30-44 ...	26	804	28	1.07	0	5	2	0	6	13	2	0	0
45 and over ...	15	301	179	12.0	2	45	0	0	1	122	5	0	4
Totals ...	94	2,530	216	2.3	3	50	2	5	8	136	8	0	4

Teeth presumed unerupted are excluded from the first three age-groups.

TABLE XXXI.—KORAVAGI—MISSING TEETH—CLASSIFICATION OF PROBABLE CAUSES.

Approx. Age-Group (Years).	Total No. Subjects Examined.	No. Teeth Standing.	Total No. Missing Teeth + Roots.	No. Missing Teeth or Roots per Person.	Number of Teeth Missing and Probable Cause.						Number of Roots and Probable Cause.		
					Caries.	Periodontitis.	Trauma.	Un-erupted.	Con-genitally Absent.	Un-known.	Caries.	Trauma.	Un-known.
1-5 (subjects with deciduous teeth only)...	9	164	0	0	0	0	0	0	0	0	0	0	0
6-10 (subjects with 1 or more 1st permanent molars) ...	19	456	2	0.1	2	0	0	0	0	0	0	0	0
11-15 (subjects with 1 or more 2nd permanent molars) ...	10	276	0	0	0	0	0	0	0	0	0	0	0
16-29... ..	17	524	19	1.1	0	2	2	9	2	4	0	0	0
30-44... ..	31	982	10	0.3	1	2	2	5	0	0	0	0	0
45 and over ...	14	416	32	2.3	4	23	5	0	0	0	1	0	0
Totals ...	100	2,818	63	0.63	7	27	9	14	2	4	1	0	0

Teeth presumed unerupted are excluded from the first three age-groups.

TABLE XXXII.—PĀTEP II—SUBJECTS AGED 16-44 YEARS—FREQUENCY OF ATTACK OF INDIVIDUAL TEETH BY CARIES (roots and teeth presumed destroyed by caries included).

Left.	Upper	15	11	6	2	0	0	6	11	5	5	2	1	1	3	10	19	Right.
	Lower	18	11	10	1	2	0	2	1	1	2	0	2	2	13	21	20	
		3rd molar	2nd molar	1st molar	2nd bicuspid	1st bicuspid	canine	lateral incisor	central incisor	central incisor	lateral incisor	canine	1st bicuspid	2nd bicuspid	1st molar	2nd molar	3rd molar	

TABLE XXXIII.—CARIES INDEX FOR EACH POPULATION (based on percentage of carious surfaces).

Approx. Age-Group (Years).			Location.				
			Pātep II.	Kavatania.	Koravagi.	New Zealand.	Australia (Sydney).
1-5	...	...	0.87	5.56	0.76	...	10.70
6-10	...	...	1.70	4.97	1.97	...	16.37
11-15	...	...	0.64	1.23	0.64	...	...
7-16	...	...	...	...	...	23.9	...

Section VII. Possible Relationships Between Diet, Nutrition and Disease.

When the dietary, medical and biochemical data secured by the survey party are considered in relation to the dental data, it seems permissible to make the following observations on some aspects of diet and nutrition commonly held to exert an influence on the initiation and progress of dental disease.

(1) The main difference between the general diet of the New Guinea people as a whole and white people in urbanised societies lies in the complete absence of soft, sweet food made from refined (denatured) ingredients, (*e.g.*, white flour and sugar).

(2) A second difference seems to be that the natives' natural foods are consumed in a fresher state than are many similar foods eaten by white people (*e.g.*, green vegetable).

(3) A third difference lies in the fact that human milk is the only milk available to the indigenous population.

(4) A native child is breast-fed for a longer period (12-18 months) than is the white child.

(5) Despite this, there seems to be a deficient intake of calcium in the post-weaning period of early childhood.

(6) The average calcium-intake for the population seems to be low by our standards (N.R.C., U.S.A.), yet only a few cases of mild rickets were observed (radiological evidence).

(7) (a) On the basis of a computed average daily requirement of ascorbic acid (pregnancy and lactation periods excluded), the peoples of Pātep II and Kavataria were receiving five times and three times respectively the amount needed to maintain health.

(b) On the basis of a minimal plasma ascorbic acid concentration of 0.4 mgm. per 100 ml. required for the maintenance of adequate nutrition, that of the peoples of Pātep II and Korovagi should have been satisfactory and that of the people of Kavataria on the borderline.

(8) Similarly the thiamin intake for Pātep II and Kavataria is approximately twice the required (computed) amount.

(9) On the assumption that the absence of evidence of rickets is evidence in favour of an adequate intake of calcium and of vitamin D and in the light of paragraph 5 above, it appears that the intake of vitamin D is certainly not deficient.

(10) The general nutrition was least satisfactory in Koravagi and most satisfactory in Pātep II and Kavataria; yet the incidence of caries was greatest in Pātep II and lowest in Koravagi.

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Appendix I.

BACTERIOLOGICAL INVESTIGATIONS.

Introduction.

The aetiology of dental caries cannot be discussed completely without reference to possible bacteriological factors. Even those who support the view that such factors as diet, nutrition, heredity, etc., are dominant in the aetiology are now probably prepared to admit, if somewhat grudgingly, the possibility that micro-organisms play a part. We ourselves see no reason for precipitately abandoning the traditional viewpoint commonly attributed to Miller, and it was largely to determine whether the oral conditions would support or refute this hypothesis that our investigations in New Guinea were undertaken.

Of the bacteria most commonly implicated the *Lactobacillus* has received greatest attention. The general aim of our investigations was, therefore, to determine the presence or absence of lactobacilli in the mouths of New Guinea natives and to correlate, where possible, such presence or absence of lactobacilli with the presence or absence of dental caries. (It had originally been intended to widen the observations in order to observe whether pathogens such as *Staphylococcus pyogenes* and *Streptococcus pyogenes* were common in the mouth and pharynx of the natives, but circumstances prevented this extension.)

Frequently associated with *Lactobacillus* are various "yeast-like organisms," mainly *Monilia*. These, too, we sought to detect and study. Recently another group of organisms, gram-negative rods such as *Aerobacter aerogenes*, has been studied (Kesel⁽¹⁾), and it has been suggested that they inhibit the growth of lactobacilli and the conversion of glucose to acid. It was decided, therefore, to search also for organisms of this type.

To sum up, we planned to study the incidence of (1) lactobacilli; (2) "Yeast-like organisms"; (2) organisms of the *Aerobacter aerogenes* type.

Subjects, Materials and Methods.

The *subjects* were drawn from the inhabitants of the three New Guinea villages already mentioned and were the same groups as were studied clinically for dental caries, etc. European members of the survey party were used for control observations.

Materials. As it was not possible to take to New Guinea a complete bacteriological laboratory, tomato-peptone agar (for the isolation of *Lactobacillus* and *Monilia*) was prepared in bulk at the Institute in Sydney and shipped to New Guinea. McConkey's medium and desoxycholate medium (both for the isolation of gram-negative rods: *Bacterium*) were carried in the dried form and reconstituted as required at the various stations. For preservation and transport of cultures from New Guinea to the Institute small bottles of Robertson's cooked-meat medium were prepared in the Institute.

The major pieces of apparatus were a kerosene-heated autoclave, a kerosene-heated incubator and a kerosene-operated refrigerator. In addition, we took the usual subsidiary supplies of petri-dishes, flasks, test tubes, stains, microscope, etc.

Methods. The investigation was conducted along lines essentially similar to those followed in similar investigations in America and elsewhere. The main points are these: The subject was asked to chew a piece of paraffin wax for five minutes and to eject the saliva into a suitable vessel. The sample of saliva was stood aside while the clinical examination was carried out and the bacteriological specimens from the previous samples of saliva were attended to. The samples of saliva were invariably collected between 8 and 9.30 a.m. and plated out as soon as possible but rarely before they had stood for three to eight hours. When stood for the longer periods they were placed in the refrigerator. According to common practice, dilutions of saliva were prepared in broth and measured quantities of these distributed over (a) three tomato-peptone agar plates; (b) one McConkey's agar plate and (c) one desoxycholate agar plate. The plates were incubated at 37°C. for a maximum of 72 hours. As a rule the two bile-containing media were examined at 24-48 hours and the tomato-peptone agar at 72 hours. The numbers of the different kinds of colonies deemed to be of interest were selected and picked into cooked meat medium (bottles). These were incubated overnight and then stored in a refrigerator at approximately 4°C. From the same or similar colonies films were prepared for microscopic study. Films were made also from the whole saliva. All films were allowed to dry, fixed by heat and wrapped and stored for transport to the Institute. It proved impossible in the time available to make any microscopic examinations at the various stations.

Results.

Approximately 750 pure cultures were isolated and brought back for study in the Institute. Considerable time will be required before this large number of cultures can be identified. However, sufficient data have become available to justify tentative conclusions that lactobacilli do occur in the mouth of New Guinea natives and that some of these strains possess the power of lowering the pH of glucose broth to levels between 4.0 and 5.0; that *Monilia* likewise occurs in the mouth of New Guinea natives and that gram-negative rods of the genus *Bacterium* are also present.

Discussion and Conclusions.

As the results are so incomplete, it is impossible to attempt any discussion. Likewise nothing can be said about any relationship between dental caries and the oral flora of these people. Little more can be done at this juncture than to state our opinion that the oral flora of the subjects examined includes *Lactobacillus* and *Monilia*.

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Appendix II.

OBSERVATIONS ON THE TEETH OF SOME NATIVES IN THE BUANG MOUNTAINS IN NEW GUINEA.

This appendix covers some observations made by one of us (D.A.C.) while with a section of the party proceeding on foot from Pātep II to Busama, south of Lae at the head of the Huon Gulf.

The European Medical Assistant at Mumeng and visiting natives had reported to us that a large number of people in the Mapos group of villages were affected by dental caries, more so than those in Pātep II. As the route to the coast passed through these villages, the opportunity to investigate the reports was taken.

The villages visited were Mapos, Siouga, Bulantim and Wagau, all in the Buang Mountains on the southern side of the Snake River. About twenty-five men and twenty-five women from the throng of natives who greeted the party at each place were examined. As time was limited, the examination was rather hurried and was made only to determine whether or not there were large numbers of natives with caries. The inspection was made with mirror and probe and it is certain that some small cavities were overlooked. In table XXXIV figures are recorded of the carious and missing teeth only; the number of tooth-surfaces affected was not noted. The first three columns in the table show the number examined in each age-group, the number of natives with caries and the total number of decayed and missing teeth. The ages of the natives were roughly estimated as no records were available.

Of the 190 subjects inspected, 149 (78 per cent.) had one or more missing or carious teeth and the average number of missing and carious teeth for all ages was 5.9 per individual. The corresponding figures for Pātep II are: 136 subjects; 75 (55.2 per cent.) subjects with caries; 3.8 missing or carious teeth per person.

The general impression was that the gingival and periodontal conditions were about the same as at Pātep II and that those teeth actually missing had been lost through caries. The teeth had been attacked in all the three usual sites, approximal, occlusal and gingival. It was not possible in the time available to seek reasons for the high incidence of caries in this group of villages (78.4 per cent.) as compared with that of Pātep II (55.2 per cent.). However, it was noted that the natives had very little contact with Europeans and that their staple food was yam.

This report is based on a very incomplete examination of the teeth of a relatively small group of natives; nevertheless, it is certain that in this group of villages the incidence of dental caries is higher than in the three principal villages visited.

TABLE XXXIV.—THE AGE AND SEX DISTRIBUTION OF PERSONS WITH CARIES IN THE MAPOS GROUP OF VILLAGES.

Age Group (Years).	Total No. Subjects.	No. Persons with Caries.	Total No. Carious and Missing Teeth.	VILLAGES.							
				Slouga.		Mapos.		Bulantim and Lamalem.		Wagu.	
				Male.	Female.	Male.	Female.	Male.	Female.		Male.	Female.
0-5 ...	13	9	41	3	0	0, 0, 2, 5	2, 2	0	0, 0, 0, 3, 4, 8	4, 5	7, 11
6-10 ...	39	29	127	1, 3, 4	3, 5, 7	1, 2, 5, 9	0, 0, 2, 4, 4, 6	0, 0, 0, 0, 3, 4, 8	0, 1, 2, 3, 4, 4,	0, 0, 7, 8, 9	
1-15 ...	48	35	197	2, 2, 4, 4, 5, 8	0, 2, 4, 4, 5, 6, 12	2, 3, 12, 20, 22	0, 2, 4, 5, 7, 9	0, 0, 0, 0, 1, 4,	0, 0, 3, 3, 4	0, 4, 8	
6-20 ...	24	16	99	...	3, 4, 4	3, 4, 8, 10, 13	0, 9	...	0, 0, 1, 3, 14	0, 2	
1-25 ...	22	17	155	0	6, 7, 10, 15	2, 28	0, 15, 12	1, 6	0, 0, 3, 4	4, 3	
6-30 ...	20	20	222	5, 9, 10, 11	8, 11, 18, 22	20, 25	7, 30	2, 3, 3	...	4, 18	
1-35 ...	11	11	88	1, 3, 7, 11, 18	16	...	2	1, 12	...	1	
6-40 ...	6	5	53	0, 12, 16	...	...	18	...	6	2, 25	
1-45 ...	4	4	75	...	...	...	...	...	26	...	
6-50 ...	1	1	30	...	...	...	...	...	30	...	
1-55 ...	1	1	30	...	...	...	...	...	30	...	
6-60 ...	1	1	16	...	...	16	...	...	...	...	
Totals	190	149	1,133	...	...	...	...	...	...	...	

Appendix III.

A SHORT NOTE ON THE FLUORINE CONTENT OF SELECTED WATERS.

BY

PAMELA B. JONES.

Results of the analyses of seven samples of potable waters from five villages in the Territories of Papua-New Guinea. Samples of drinking water were collected from five villages and analysed for their content of fluorine, calcium, magnesium and for their permanent hardness. The results are shown in table XXXV.

TABLE XXXV.—ANALYSES OF SAMPLES OF POTABLE WATERS FROM FIVE VILLAGES.

Village.	Source.	Month of Collection.	Fluorine. p.p.m.	Calcium. p.p.m.	Magnesium. p.p.m.	Hardness as CaCO ₃ . p.p.m.
Boytalu	Spring	October	0.55	73.5	0.0	240
Busama	Spring	August	0.55	6.0	1.0	50
Kavataria	Spring	September	0.45	77.2	32.6	340
Koravagi	Well from River Purari	October	0.20	4.5	4.4	60
Pātep II	Mountain stream	August	0.40	10.2	4.0	90
Pātep II	Mountain stream	August	0.30	11.8	4.0	90

It is now well known that an inverse correlation exists between the fluorine content of the domestic water and the incidence of dental caries. Dean and his associates (^{1,2}) have shown this relationship for drinking water with a fluorine content ranging from 0.0—3.1 p.p.m. Attempts to correlate the incidence of caries in these villages with the fluorine content of the drinking water were made. On the basis of the percentage of carious teeth per village the results for the three villages are shown in table XXXVI.

TABLE XXXVI.—CORRELATION OF THE INCIDENCE OF CARIES WITH THE FLUORINE CONTENT OF DRINKING WATER.

Village.	Fluorine. p.p.m.	Percentage Carious Teeth per Village.
Pātep II	0.35	6.50
Kavataria	0.45	4.50
Koravagi	0.20	2.75

However, since no records of the missing teeth existed and since no control of variables, such as age, sex, diet, race and climate, was possible, no satisfactory correlation could be made. Notwithstanding the lack of significant correlation between the incidence of caries and the fluorine in the drinking water, these fluorine figures are of interest in that the average figure (0.40 p.p.m.: 6 samples) is distinctly higher than the average figure (0.20 p.p.m.) for a series of waters (127 samples) from New South Wales. Admittedly the number of New Guinea waters analysed is small, but the results indicate that it might be of value to extend the survey to include a greater number of water-supplies.

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¹Dean, H. T., Jay, P., Arnold, F. A. and Elvove, E.: 1941. Domestic Water and Dental Caries. II. A Study of 2832 White Children aged 12-14 Years of Eight Suburban Chicago Communities including *L. acidophilus* Studies of 1,761 Children. U.S. Pub. Hlth. Rpts. **56**, 761.

²Dean, H. T., Arnold, F. A. and Elvove, E.: 1942. Domestic Water and Dental Caries. V. Additional Studies of Relation of Fluoride Domestic Waters to Dental Caries Experience in 4,425 White Children aged 12-14 Years of Thirteen Cities in Four States. U.S. Pub. Hlth. Rpts. **57**, 1155.

TABLE XXV—ANALYSIS OF SAMPLES OF POTABLE WATER FROM FIVE VILLAGES

Village	Source	Amount of Sample, Gallons	Fluoride, p.p.m.	Calcium, p.p.m.	Hardness as CaCO ₃ , p.p.m.
Forest II	Well	100	0.25	100	100
Forest I	Well	100	0.25	100	100
Forest III	Well	100	0.25	100	100
Forest IV	Well	100	0.25	100	100
Forest V	Well	100	0.25	100	100

It is now well known that an inverse correlation exists between the fluoride content of the domestic water and the incidence of dental caries. Dean and his associates (1,2) have shown this relationship for drinking water with a fluoride content ranging from 0.5 to 1.0 p.p.m. Attempts to correlate the incidence of caries in these villages with the fluoride content of the drinking water were made. On the basis of the percentage of caries teeth per village the results for the five villages are shown in Table XXVI.

TABLE XXVI—CORRELATION OF THE INCIDENCE OF CARIES WITH THE FLUORIDE CONTENT OF DRINKING WATER

Village	Fluoride, p.p.m.	Percentage Caries Teeth per Village
Forest II	0.25	0.50
Forest I	0.25	4.50
Forest III	0.25	5.75

However, since no records of the drinking water existed and since no record of caries teeth was kept, it was not possible to establish a correlation between the incidence of caries and the fluoride content of the drinking water. These fluoride levels are of interest in that the average level (0.25 p.p.m.) is slightly higher than the average level (0.10 p.p.m.) for a series of caries (197 samples) from New South Wales. Admittedly the number of caries teeth analyzed is small, but the results indicate that it might be of value to extend the survey to include a greater number of water supplies.

PART 9.

NEW GUINEA AND PAPUAN FOOD COMPOSITION TABLES.

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1. Introduction.

2. Classification of Foodstuffs.

3. Collection and Analysis of New Guinea and Papuan Foods.

4. Standards adopted in Tables.

5. Food Composition Tables.

(1) Cereals, Starchy Roots and Fruits, etc

(2) Vegetables.

(3) Oil Seeds and Nuts.

(4) Fruits and Flowers.

(5) Stems.

(6) Fungi.

(7) Animal Products.

(8) References.

1. Introduction.

The tables were compiled for the calculation of the dietary levels of the surveyed New Guinea and Papuan villages. These tables consist of values obtained from foodstuffs collected in New Guinea, supplemented where necessary from other sources which are indicated in the tables.

It will be noted that the values for most collected foods were calculated from one sample. This was unavoidable, because of two factors: (1) an attempt was made to collect one sample at least of each foodstuff consumed; and, (2) the foodstuffs were difficult to procure at times, the natives being unreliable suppliers. However, it was thought preferable to use the values so obtained than the equivalents from other countries. Thus, the values given are only provisional and to become satisfactory need to be expanded and modified by further analyses.

2. Classification of Foodstuffs.

The following classification of the foodstuffs was used in the tables.

1. Cereals and Starchy Roots, Fruits, etc.
2. Vegetables.
 - (a) Leafy (Kumus).
 - (b) Legumes.
 - (c) Other.
3. Oil Seeds and Nuts.
4. Fruits.
5. Stems.
6. Fungi.
7. Animal Products.
 - (a) Fish and Fish Products (including Molluscs and Crustacea).
 - (b) Insects.
 - (c) Meat and Meat Products.

3. Collection and Analysis of New Guinea and Papuan Foods.

The following procedures were adopted in the treatment of the foodstuffs for and during analysis.

(a) *Collection and Drying.* The foods were collected and given a preliminary drying (at a temperature not exceeding 70°C.) to render them suitable for despatch, by air, to Australia. Only edible portions were dried and despatched, a small amount of toluene being used as a preservative.

(b) *Analysis.* The following methods were used in the analysis of the foodstuffs.

Residual Moisture (after preliminary drying). The toluene distillation method was used (¹).

Protein. A macro-Kjeldahl method, with selenium as catalyst was used.

Fat. The method was based on that of Von Lieberman and SzeKely described by McCance and Shipp (⁴).

Available Carbohydrate. The glucose was estimated, after the hydrolysis of the starch using the method of Lane and Eynon (³).

Crude Fibre. As specified by the Analytical Methods Committee (1943) (²).

Calcium. The "wet ash" method according to Piper (⁵).

Ash. Direct dry ashing in muffle furnace up to 750°C.

Ascorbic Acid. These analyses were carried out on fresh samples in the field using the 2:6 dichlorophenolindophenol as described by Harris and Olliver (⁶). Instead of grinding with sand, three minutes maceration in a Waring Blendor was substituted.

4. Standards Adopted in Tables.

(a) *Nomenclature.* Wherever possible a common name, either English or Pidgin English as well as a scientific name is given. However, sometimes neither a specific English or Pidgin English name was available and only the native name (designated (N.N.) in the tables) with scientific name could be given.

(b) The sign § is used wherever a value was so low as to be negligible.

(c) *Calories.* The calorific values of the foodstuffs were calculated as follows:—

(i) *Protein.*

Vegetables, 2.90 cal./gm.

Fruits, 3.15 cal./gm.

Nuts, 3.20 cal./gm.

Animal Products, 4.25 cal./gm.

(ii) *Fat.*

Plant Products, 8.35 cal./gm.

Animal Products, 9.00 cal./gm.

(iii) *Carbohydrate.*

Carbohydrate is expressed in two ways in the tables, as "available carbohydrate" and as "carbohydrate by difference." D.C. ("carbohydrate by difference") was obtained by subtracting the percentage of water, protein, fat, ash and fibre from 100; A.C. (available carbohydrate) is expressed as grams of starch found by analysis. In the case of nuts, however, the fibre was included in the carbohydrate by difference. The mean of the available and by difference carbohydrates was then taken and the value of 4.22 cal./gm. used with the exception of nuts for which a value of 4.0 cal./gm. was used. Where the available carbohydrate is not given the carbohydrate by difference was ascribed a value of 4.0 cal./gm.

Where food values have been obtained from other sources the calorie values as given in the source have been used and the carbohydrate values placed under "D.C."

(d) *Calcium*. The calcium figures shown in the tables are as found by analysis and take no account of availability. However, in view of the number of these foods with high calcium contents and of the knowledge that the presence of oxalates interferes with calcium retention in animals (for instance see Fairbanks and Mitchell (⁷)) several oxalate determinations were carried out by the method described by Hoover and Karunaratnam (⁸). The results are set out together with the corresponding calcium contents in the table below. It will be seen that in no instance does the oxalic acid concentration exceed or equal the calcium concentration (compared on a millequivalent basis).

CALCIUM AND OXALATE CONTENTS OF SOME NEW GUINEA AND PAPUAN FOODS.

Botanical Name and Part of Plant.	Pidgin English or Common Name.	Calcium.	Oxalic Acid.
		m.e.g./100 gm.	m.e.g./100 gm.
<i>Hibiscus abelmoschus</i> (leaf) ...	Aibika ...	29.0	11.0
<i>Dammaropsis</i> sp. (leaf) ...	.....	10.0	2.1
<i>Dryopteris</i> sp. (leaf) ...	Kumu ...	18.5	2.4
—(leaf) ...	Kumu ...	21.3	9.4
<i>Colocasia antiquorum</i> (leaf) ...	Lip Taro ...	17.2	9.1
<i>Colocasia antiquorum</i> (leaf) ...	Taro ...	10.0	6.2
<i>Gnetum gnemon</i> (leaf) ...	Tulip ...	12.4	5.1
<i>Morus species</i> (leaf) ...	.....	14.5	10.8

However, until direct experimental work is carried out on human subjects to determine effects of dietary oxalate on calcium metabolism these figures are of no value in assessing the availability of the calcium in the foodstuffs.

Thiamin and Riboflavin. No thiamin analyses were carried out on the foods collected in New Guinea, since extensive destruction of thiamin occurred during drying. (However, this was not the case with pure thiamin solutions at pHs of 3.7 and 6.8). No satisfactory alternative method for despatch of samples, without alteration of thiamin content has been found. The thiamin values shown in the tables were selected from the sources as indicated.

No riboflavin figures are quoted because of known disagreements between workers on European foodstuffs. At the moment, accurate figures are available for only a few foodstuffs.

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION.

(1) *Cereals, Starchy Roots and Fruits, etc.*

Serial No.	Pidgir English or Native Name.	Scientific Name.	Water Content. gm.	Protein. gm.	Fat. gm.	Carbohydrate.		Cal-ories.	Crude Fibre. gm.	Ash. mgm.	Cal-cium. mgm.	Thiamin. mgm.	Ascorbic Acid. mgm.	Source of Values.	Number of Samples Analysed.
						D.C.	A.C.								
						gm.	gm.								
1	Kasien (N.N.)	...	83.8	0.5	0	12.6	12.3	57	1.6	490	23	...	...	9	1*
2	Bananas— (a) Green ... (b) Mau (or ripe) ...	<i>Dioscorea acroidea</i> ... <i>Musa sapientis</i> ... <i>Musa sapientis</i> ...	61.7 75 12	1.3 1.1 10	0 0 4.5	34.6 22.7 67	30.8 19.7 ...	142 93.7 349	1.6 0.3 ...	800 900 ...	8 8 12	0.05 (†) 0.05 (†) 0.33	31.3 (†) 19.9 (†) 0	9 9 11	6 5 ...
3	Corn ...	<i>Zea mays</i> ...	67.3	0.9	0	31.2	29.8	150	0.5	1,000	15	0.13 (†)	31.3†	9	3
4	Kau Kau ...	<i>Ipomoea batatas</i> ...	60	0.7	0	32	...	131	...	...	25	0.02	30	11	...
5	Manioc or Tapioca ...	<i>Manihot utilissima</i> ...	10	5.5	2.2	81.3	...	346	...	...	...	0.3	0	10	...
6	Rice, Brown ...	<i>Oryza sativa</i> ...	16.9	0.1	0	82.7	82.7	349	0.1	200	10	0	0	9	1
7	Sago (Sak Sak) ...	<i>Metrostylon rumphii</i> ...	63.9	1.4	0	33.8	33	145	0.6	1,100	39	0.1 (†)	6.2	9	4
8	Taro ...	<i>Colocasia</i> and <i>Allocasia</i> spp.	70.7	1.9	0	24.4	24.2	107	2.3	0.7	10	0.1 (†)	5.6	9	4
9	Yam or Taitu ...	<i>Dioscorea</i> spp.	...	...	...	...	...	...	...	...	...	...	...	...	...

* Single sample for analysis consisted of five varieties from one locality.

† The ascorbic acid values varied greatly, the values shown are the mean of 11 analysis each.

‡ Mean of 10 values.

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION—continued.

(2) Vegetables.

Serial No.	Pidgin English or Native Name.	Scientific Name.	Water Content. gm.	Protein. gm.	Fat. gm.	Carbohydrate.			Cal-ories.	Crude Fibre. gm.	Ash. mgm.	Cal-cium. mgm.	Thiamin. mgm.	Ascorbic Acid. mgm.	Source of Values.	Number of Samples Analysed.
						D.C.	A.C.	gm.								
10	(a) Leafy (Kumu)—Leaves— High carotene dark green. Low carotene light green.	..... .....	85 90	4 3	0.4 0.2	...	...	6 3	44 26	...	...	210 85	0.15 0.10	100 50	11 11	...
11	Aibika	<i>Hibiscus abelmoschus</i> .	82.7	5.7	...	6.8	...	...	45	1.8	2,360	580	0.15 (11)	118† 53.6	9	2
12	Barop (NN)	—(<i>pteridophyta</i>)	90.4	2.8	...	3.2	...	...	22	2.1	1,510	18	0.15 (11)	7	9	1
13	Barua	<i>Morus</i> spp.	78.2	2.9	...	...	...	12	57	4.5	...	300	0.15 (11)	48.8	9	1
14	Guantri (NN)	<i>Alsephila</i> spp.	81	5.5	...	6.3	...	...	43	7	140	...	0.15 (11)	25.5	9	1
15	Gusung (NN)	<i>Dryopteris</i> spp.	84.7	3.4	...	9.9	...	...	52	...	1,260	370	0.10 (11)	56.1	9	1
16	Gwen (NN)	—(<i>Cruciferae</i>)	86.3	4.4	...	6.8	...	...	40	...	2,570	...	0.15 (11)	56.2	9	1
17	Lip Blango (N.N.)	<i>Dryopteris</i> spp.	77.5	5.5	0.2	9.9	...	...	59	7	...	49	0.15 (11)	47.2	9	1
18	Lip-pumpkin	<i>Cucurbita maxima</i>	90	3.8	...	3.5	...	...	26	1.6	1,120	80	0.15 (11)	18	9	1
19	Lip taro	<i>Colocasia and-quorum</i> .	84.6	4.1	...	7.4	...	...	43	2.4	1,516	310	0.15 (11)	15.8	9	3
20	Putuhu (N.N.)	<i>Danmariopsis</i> sp.	85.5	2.2	...	7.4	...	...	38	3.4	1,260	200	0.10 (11)	5.1	9	1
21	Tulip	<i>Gadum gnemon</i>	75.6	6.4	...	...	...	...	1	10	1,745	240	0.10 (11)	390	9	2
22	Vena (N.N.)	<i>Amaranthus tricolor</i>	90	4.2	...	4.2	...	...	29	...	1,560	...	0.15 (11)	27.5	9	1
23	(b) Legumes— Beans, all eaten green in food.	.....	90	2	0	5.5	...	...	30	...	...	64	0.08	20	11	...
24	Bln opis (N.N.)	<i>Psophocarpus tetragonobulus</i> .	79	8.1	3.9	8.1	...	...	97	...	...	...	0.008	37 (†)	11*	...

* These values were taken from (11) Nos. 86 and 87 for green leaves on which no analyses were carried out.

† These ascorbic acid values were obtained at Busama and Kaiapit respectively as means of several analyses. The former value was used for Busama and Patep, the latter for Kaiapit.

‡ Assuming a moisture content of 79 per cent. (green peas), these values were obtained from Platt No. 45 (11) by calculation.

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION—continued.

(2) Vegetables—continued.

Serial No.	Pidgin English or Native Name.	Scientific Name.	Water Content. gm.	Protein. gm.	Fat. gm.	Carbohydrate.			Crude Fibre. gm.	Ash. mgm.	Calcium. mgm.	Thiamin. mgm.	Ascorbic Acid. mgm.	Source of Values.	Number of Samples Analysed.
						D.C.	A.C.	gm.							
25	(c) Other— Cucumber ... shoots Kru (growing of)	<i>Cucumis sativa</i> var.	96	0.6	0	...	2.4	11	...	...	23	0.045	10	10	...
26	1. Grass ...	<i>Panicum palmarum</i>	92*	1.6	0	5.2	...	25	1.2	...	7	...	8.2	9	1
27	2. — ...	<i>Archentia phoenix</i> ...	92	1.9	0	3.2	3	19	1.9	1,000	550	...	14	9	1
28	3. Sak sak ...	<i>Metroxylon rhumphii</i>	92.3	1.6	0	...	1.3	...	0.9	...	7	...	15.7	9	1
29	Pumpkin ...	<i>Cucurbita maxima</i>	88	1.5	0	...	9.9	44	...	...	20	0.04 (11)	10	10	...
30	Taro stalks ...	<i>C. moschata</i> , <i>Colocasia anti-</i> <i>quorum</i> .	93	0.5	0	3.9	...	19	1.6	500	218	...	214	9	1
31	Taro and shootst	<i>Colocasia anti-</i> <i>quorum</i> .	74.8	1.5	0	23.8	23.4	104	...	930	180	0.12†	...	9	1
32	Tomato ...	<i>Lycopersicon</i> <i>esculentum</i> .	930	0.9	0	...	5.3	22	...	...	130	0.06	22	10	...

† This value taken as for Bamboo Shoots—Rosedale (12).

‡ Young sprout taro plants—the swollen stem and stalk eaten. Thiamin value calculated from No. 86 in (11) and from page 21 in (10).

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION—continued.

(3) Oil Seeds and Nuts.

Serial No.	Pidgin English or Native Name.	Scientific Name.	Water Content. gm.	Protein. gm.	Fat. gm.	Carbohydrate.		Calories.	Crude Fibre. gm.	Ash. mgm.	Calcium. mgm.	Thiamin. mgm.	Ascorbic Acid. mgm.	Source of Values.	Number of Samples Analysed.
						D.C. gm.	A.C. gm.								
33	Breadfruit ... Coconut—	<i>Artocarpus nobilis</i> ...	69 (12)	4.3	0.3 (13)	...	23.1	110	5.41	1,400	2	...	...	9	1
	(a) Green (Kulau)—	<i>Cocos nucifera</i> —													
34	Water ...	.....	94.8	0.2	0.4	3.6	...	18.1	...	640	30	...	...	14	...
35	Meat ...	.....	92.8	0.7	1	4.8	...	30.7	...	715	...	...	...	14	...
	(b) Ripe (dry)—														
36	Water ...	.....	92.7	0.4	1.5	4.6	...	32	...	800	20	...	24	14	...
37	Meat ...	.....	36	4.7	53.4	5.1	4.8	479	...	787	24	0.13 (14)	...	9	1
38	Fibre* ...	.....	58	2.3	34	5.3	4.8	301	...	433	10	0.05 (14)	...	9	1
39	.....	<i>Triploid endosperm</i>	84.6	3.4	3.4	7.1	5.34	70.9	2.01	1,500	68	...	0	9	1
40	Tatagum seeds (N.N.)†	— <i>Cucurbitaceae</i> ...	13	26	50	10	...	594	...	...	60	...	...	11	...

* "Fibre" refers to the discarded "coconut meat" after squeezing by hand, after addition of water. The contents of the "coconut milk," the squeezed-out fluid can be calculated by difference between "meat" and "fibre."

† A tree-climbing cucurbita, with fruit about 6-inch diameter, with yellow flesh, and dark green slimy centre. Containing seeds taken as pumpkin seeds (11).

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION—continued.

(4) Fruits and Flowers.

Serial No.	Pidgin English or Native Name.	Scientific Name.	Water Content.		Protein.	Fat.	Carbohydrate.			Crude Fibre.	Ash.	Cal-cium.	Thiamin.	Ascorbic Acid.	Source of Values.	Number of Samples Analysed.
			gm.	gm.	gm.	gm.	D.C.	A.C.	gm.							
41	Banana flower	<i>Musa sapientis</i>	90	0.2	1	0.2	5	...	26	2	1,200	30	...	13 (*)	13	...
42	Figs	<i>Ficus sp.</i>	80	0.2	1.3	0.2	17.8	...	70	...	...	34.2	0.057	2	10	...
43	Gikku (N.N.)	...	80.2	...	0.4	...	18.9	6.8	54.8	...	540	50	...	...	9	...
44	Tulip (fruit)	<i>Gnetum gnemon</i>	81	...	3.3	...	9	4.4	40.6	5.7	1,060	53	...	148	9	...
45	Maa'arii (N.N.)	<i>Eugenia malaccensis</i>	92.6	...	0.4	...	3.6	1.3	12.8	1.5	640	0	...	3.1	9	...
46	Maa'puvaki (N.N.)	<i>Garcinea spp.</i>	90.2	...	0.6	...	6.8	2.9	23.2	1.8	610	5	...	5.3	...	...
47	Maa'uni	<i>Myristica spp.</i>	90	...	0.4	...	7.3	1.7	20.3	1.9	410	58	...	6.0	...	...
48	Pawpaw—	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
49	Ripe	<i>Carica papaya</i>	87	0	0.5	0	12.1	...	45	...	...	20	0.045	80	10	...
50	Half ripe*	<i>Carica papaya</i>	87	0	0.5	0	12.1	...	45	...	...	20	0.045	29 (13)	10	...
51	Pit pit	<i>Saccharum robustum</i>	89	...	4.1	...	6.9	6.2	38.4	0.7	21	10	...	21	9	...
52	Tatagum† flesh	<i>Cucurbitaceae</i>	88	0	1.5	0	99	...	44	...	...	20	...	52 (*)	10	...
53	Tomato	<i>Lycopersicon esculentum</i>	93	0	0.9	0	5.3	...	22	...	...	13	0.06	22	10	...
54	Watermelon	<i>Citrullus vulgaris Schrau.</i>	95	0	0.6	0	4.1	...	17	...	...	3	56	8	10	...

* Only ascorbic acid values were available for this product, the remainder of the constituents were assumed the same as ripe paw paw.
 Taken from Osmond (10). "Pumpkin and Hubbard squash"—*Cucurbita* spp.

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION—continued.

(5) *Stems.*

Serial No.	Pidgin English or Native Name.	Scientific Name.	Water Content. gm.	Protein. gm.	Fat. gm.	Carbohydrate.		Cal- ories.	Crude Fibre. gm.	Ash. mgm.	Cal- cium. mgm.	Thiamin. mgm.	Ascorbic Acid. mgm.	Source of Values.	Number of Samples Analysed.
						D.C. gm.	A.C. gm.								
54	Sugar cane*	<i>Saccharum officinarum</i> Linn.	82	0.4	§	14	...	58	10-15	...	10	§	§	11	...

(6) *Fungi.*

55	Taringa ...	<i>Agaricus</i> spp. and <i>Auricularia</i> spp.	93.7	1.2	0.3 (11)	4.8	...	23	...	83	4	0-12 (11)	9.3	9	2
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* Commonly chewed to extract the juice; the material ejected after chewing includes saliva and therefore cannot be used as a basis for calculating the edible portion. (Quoted from Platt (11)).

NUTRITIVE VALUE OF 100 GM. OF UNCOOKED EDIBLE PORTION—continued.

(7) Animal Products.

Serial No.	Pidgin English or Native Name.	Scientific Name.	Water Content, gm.	Protein, gm.	Fat, gm.	Carbohydrate.		Cal-ories, gm.	Crude Fibre, gm.	Ash, mgm.	Cal-cium, mgm.	Thiamin, mgm.	Ascorbic Acid, mgm.	Source of Values.	Number of Samples Analyzed.
						D.C, gm.	A.C, gm.								
(a) Fish and Fish Products—															
56	Crabs ...	.....	73	20	4	1.3	...	126	...	...	45	...	0	10	...
57	Fish—	.....	68.9	18.2	11.5	0	...	181	...	...	37	0.06	0	10	...
58	(i) Fatty ...	.....	77.6	18.3	2.8	0	...	103	...	...	34	0.06	0	10	...
	(ii) Non-fatty (e.g. tuna).	.....						82	...	...	70	...	0	10	...
59	Oysters ...	.....	80	12.8	1.4	4.0	...	105	...	3,130	640	0.02	0	13	...
60	Vaya *	.....	77	22	0.8	0.2	...								...
(b) Insects—															
61	Sago grub ...	Family <i>cerambyidae</i>	70.5	6.1	13.1	9	...	181	...	1,250	8	...	0	9	1
(c) Meat and Meat Products—															
62	Bully beef ...	.....	61.8	24.2	12.5	0	...	215	...	1.8	...	0.031	...	16	...
63	Pigt ...	.....	58.5	15.0	25.3	0	...	292	...	...	10	1	0	10	...

* From Nicholls (13) page 198—Fish (dried sprats) with a water content of 12 per cent. were reconstituted to fish with a water value of 77 per cent.

† These values are for pork from Osmond (10). No figures are available for whole pig—including the gut.

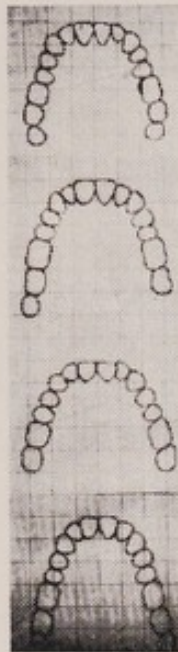
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- (³) As described in "Clowes and Coleman's Quantitative Analysis," 14th Ed. (1938), p. 435.
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- (⁷) Fairbanks, B. W. and Mitchell, H. H. J., Nutrition, 16 (1938), 79.
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- (⁹) Analysis conducted at Australian Institute of Anatomy. Canberra, by methods described in text.
- (¹⁰) Osmond, A. "Tables of Composition of Australian Foods" (1946), N.H. and M.R.C. Special Report, Series No. 2.
- (¹¹) Platt, B. S. "Tables of Representative Values of Foods Commonly Used in Tropical Countries. 1945. Med. Res. Coun. Spec. Rep. Series. No. 253. (H.M. Stationery Office).
- (¹²) Rosedale, J. L., "Chemical Analysis of Malayan Foods" (1931), Singapore.
- (¹³) Nicholls, L. 1945. Tropical Nutrition and Dietetics (Balliere, Tindall and Cox).
- (¹⁴) Miller, C. D. Food Values of Bread Fruit, Taro Leaves, Coconut and Sugar Cane. (1929), Bulletin 64, Bernice P., Bishop Museum. Honolulu.
- (¹⁵) Munsell, H. Food Research, 10 (1945), 42.
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PLATES.

1-28, illustrating Part 8, Observations on Dental Conditions
among Native Peoples in Papua-New Guinea.

29-43, selected photographs illustrating important aspects
of the Nutrition Survey.



SOME OF THE ARCH-FORMS OBSERVED IN PÁTEP II.

ANTERIOR SEGMENT.
I. Straight.

POSTERIOR SEGMENT.
Rounded.

ANTERIOR SEGMENT.
II. Straight.

POSTERIOR SEGMENT.
Straight.

ANTERIOR SEGMENT.
III. Straight.

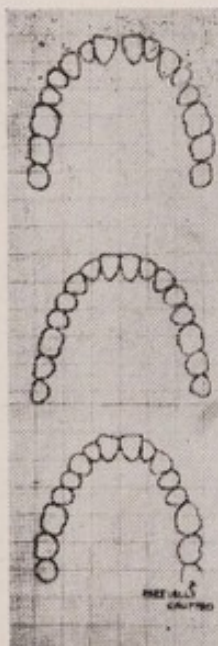
POSTERIOR SEGMENT.
Straight
(and widely diverging).

ANTERIOR SEGMENT.
IV. Tapering.

POSTERIOR SEGMENT.
Straight.

PLATE 1.

Photograph of tracings
which were made on
squared centimetre
paper.



SOME OF THE ARCH-FORMS OBSERVED IN KAVATARIA.

ANTERIOR SEGMENT.
V. Rounded.

POSTERIOR SEGMENT.
Rounded.

ANTERIOR SEGMENT.
VI. Rounded.

POSTERIOR SEGMENT
Straight.

ANTERIOR SEGMENT.
VII. Tapering.

POSTERIOR SEGMENT.
Rounded.

PLATE 2.

Photograph of tracings
which were made on
squared centimetre
paper.

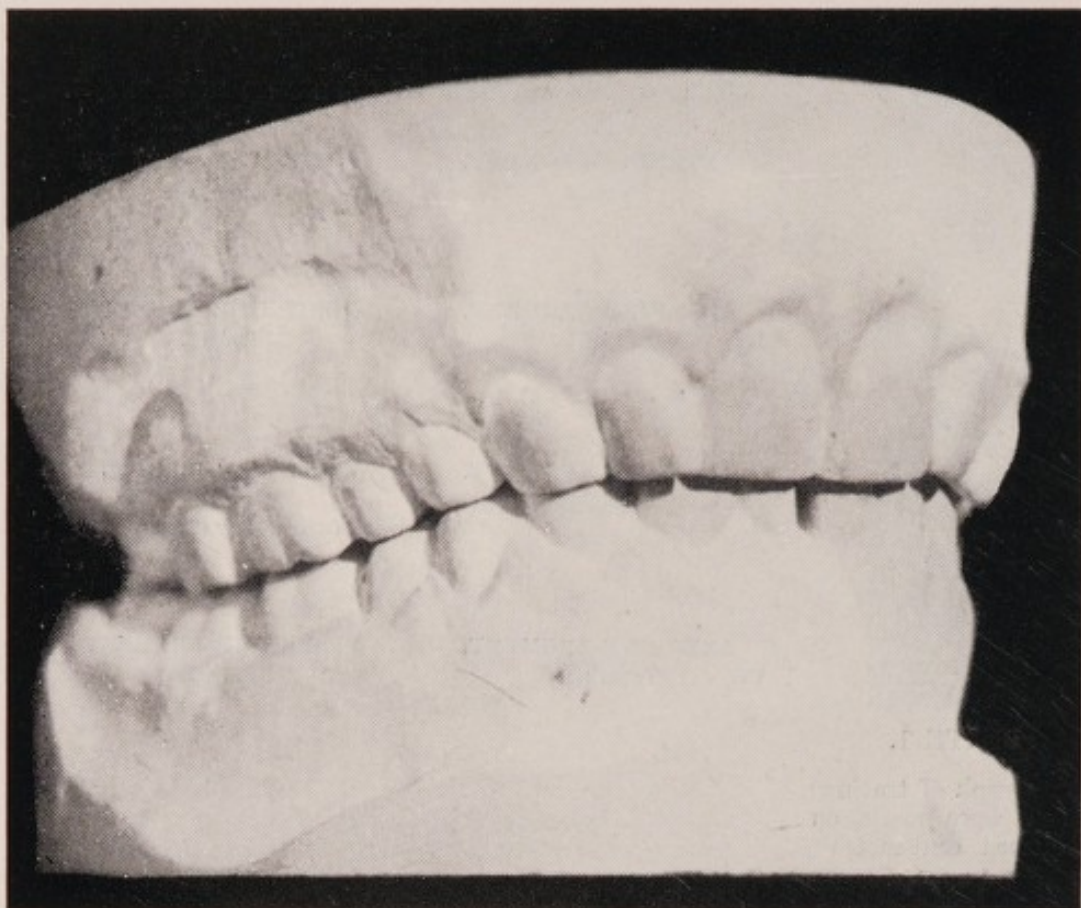


PLATE 3.

Case of Class II, division ii, malocclusion (from Koravagi).

t

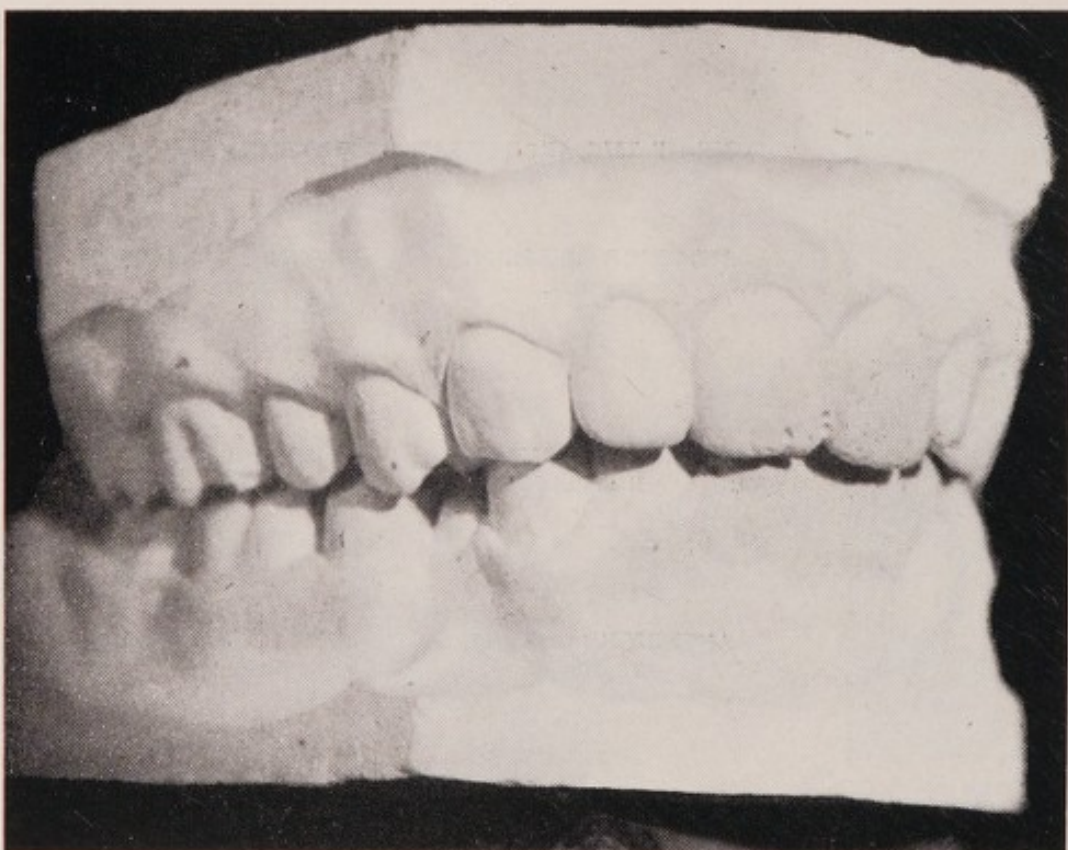


PLATE 4.

Case of Class I malocclusion, showing lower premolar malposed lingually and a deep anterior overbite (from Koravagi).



PLATE 5.

Odontoma, upper anterior region (from Pātep II).

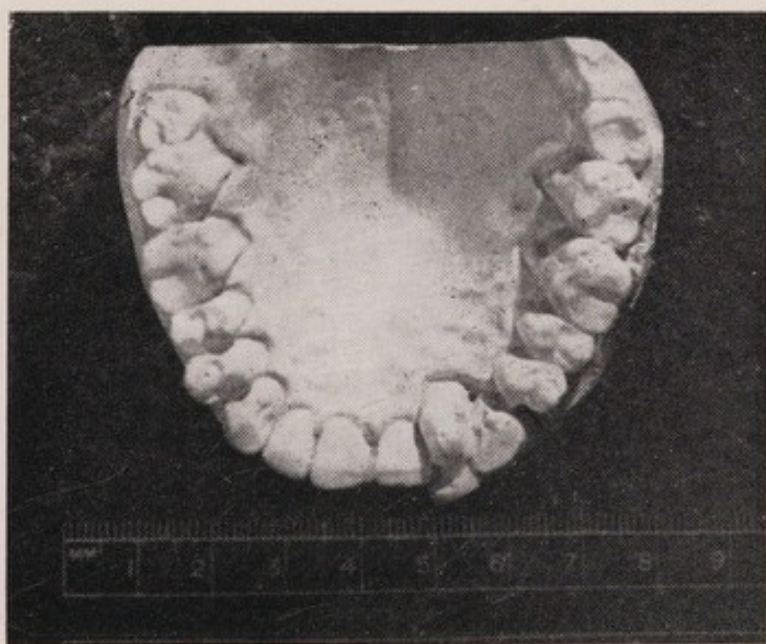


PLATE 6.

Supernumerary upper, right lateral incisor (from Koravagi).



PLATE 7.

Two supernumerary lower left bicuspid. Subject No. 49 from Kavataria.



PLATE 8.

Two supernumerary lower right bicuspid. Subject No. 49 from Kavataria.



PLATE 9.

Photograph of radiogram of upper, left incisor region. Subject No. 17 (Pātep II), who showed congenital absence of upper left lateral incisor.

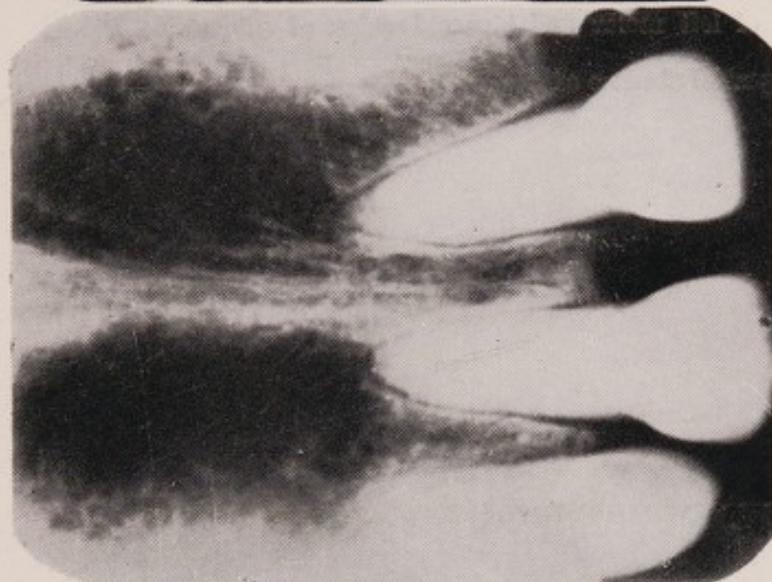


PLATE 10.

Photograph of radiogram of upper central incisor region of subject No. 17 in Pātep II, who showed congenital absence of upper right and left lateral incisor.



PLATE 11.

Photograph of radiogram of upper, right incisor region. Subject No. 17 (Pātep II), showing congenital absence of upper right, lateral incisor.

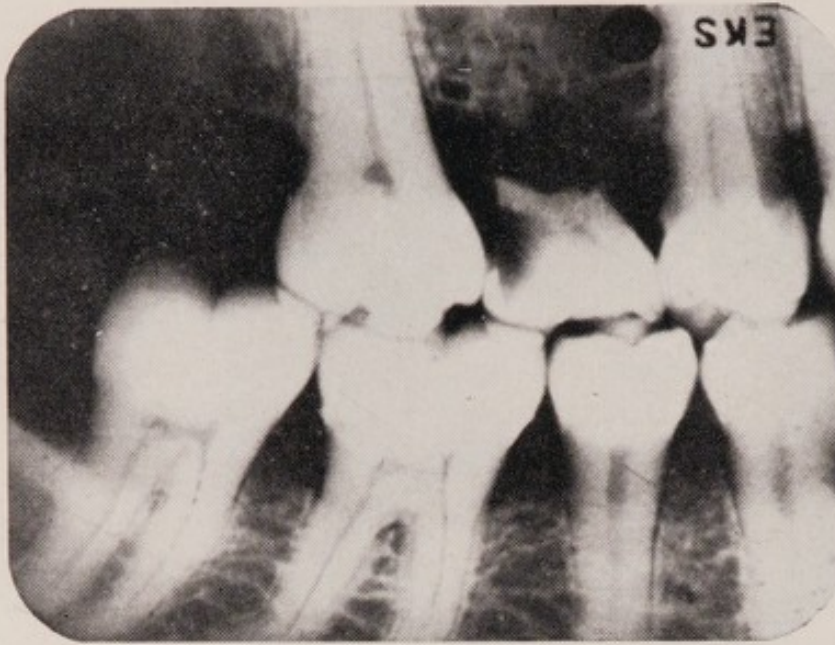


PLATE 12.

Photograph of radiogram of left molar and bicuspid region of subject No. 106 in Pātep II, who showed congenital absence of

left	8, 7,	5	|	5,	8	right
side	8		|		8	side

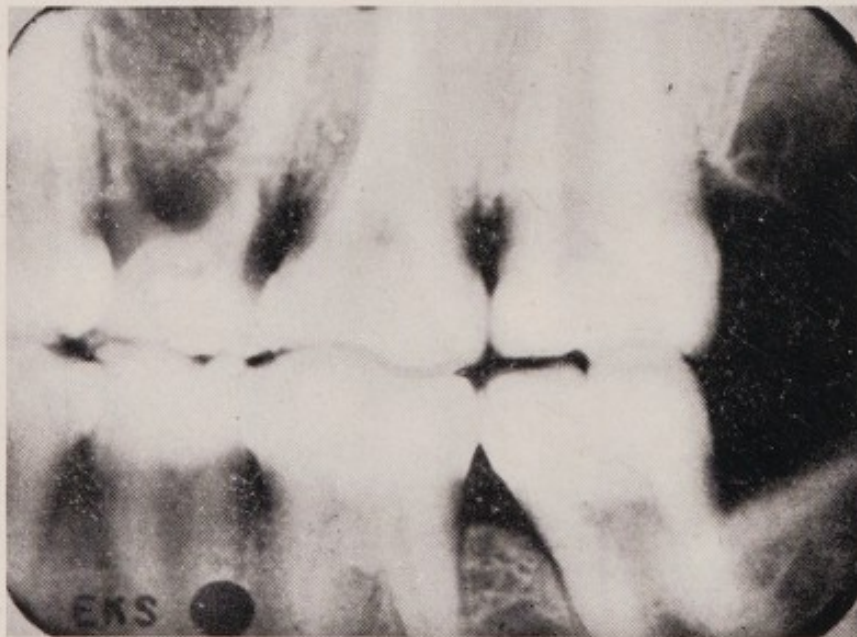


PLATE 13.

Photograph of radiogram of right molar and premolar region of subject No. 106 in Pātep II, who showed congenital absence of

left	8, 7,	5	|	5,	8	right
side	8		|		8	side



PLATE 14.

Photograph of radiogram of right, molar region showing congenital absence of lower right third molar. Subject No. 125 (Patep II).



PLATE 15.

Occlusal attrition as shown on mandibular teeth. Note loss of mesio-buccal cusps of lower first molars. (From Koravagi.)



PLATE 16.

Occlusal and approximal attrition as shown on maxillary teeth of subject at Pâtep II.



PLATE 17.

Bone-loss of Degree 2. Small pocket distal of upper left first molar Subject No. 32 (Kavataria).



PLATE 18.

Bone-loss of Degree 2. Subject No. 124 from Pátep II. Note attrition, both occlusal and approximal.



PLATE 19.

Lower limit of degree 3
bone-loss. Subject No. 1
(Kavataria).

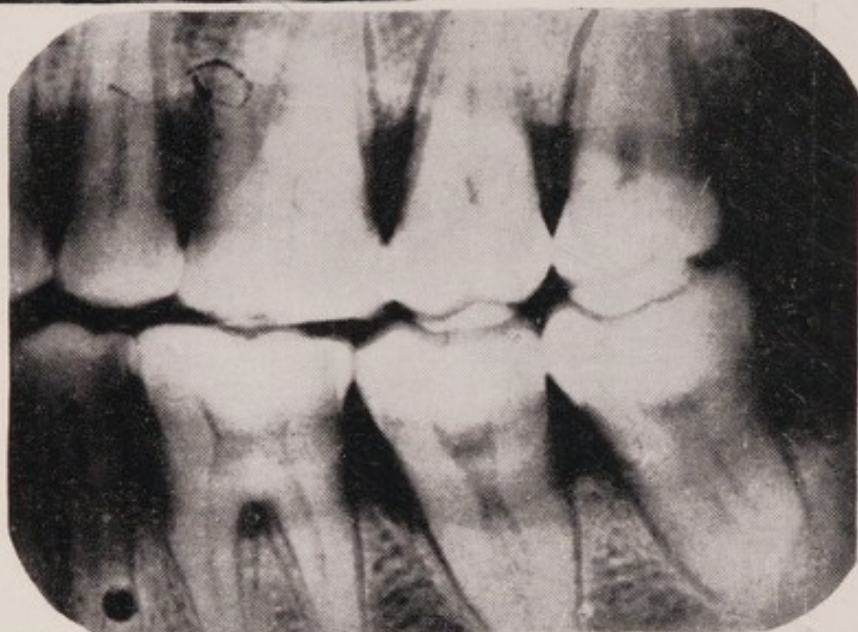


PLATE 20.

Lower limit of degree 3,
bone-loss. Subject No. 9
(Kavataria).



PLATE 21.

Bone-loss of degree 3.
Subject No. 74 (Pātep II).

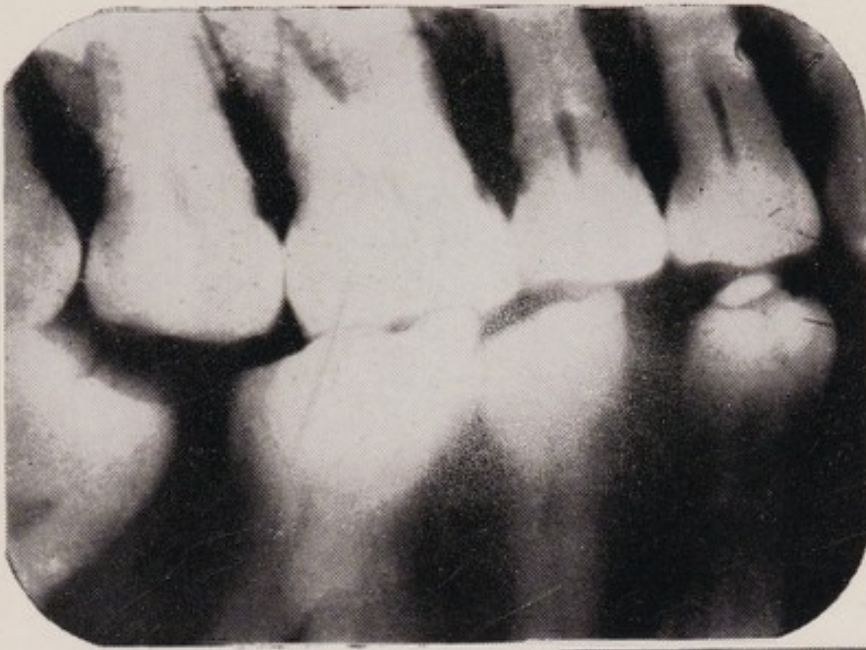


PLATE 22.
Bone-loss of degree 3.
Subject No. 35 (Kavataria).

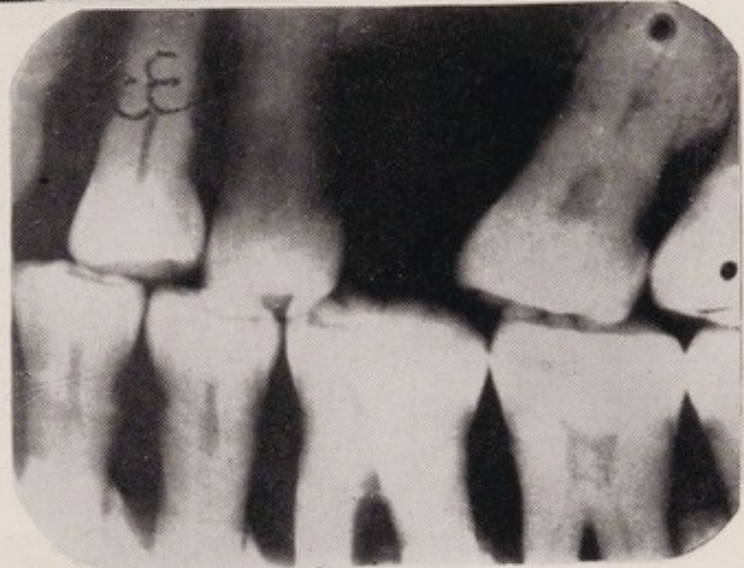


PLATE 23.
Bone-loss of degree 3.
Subject No. 35 (Kavataria).



PLATE 24.
Bone-loss of degree 3.
Subject No. 35 (Kavataria).

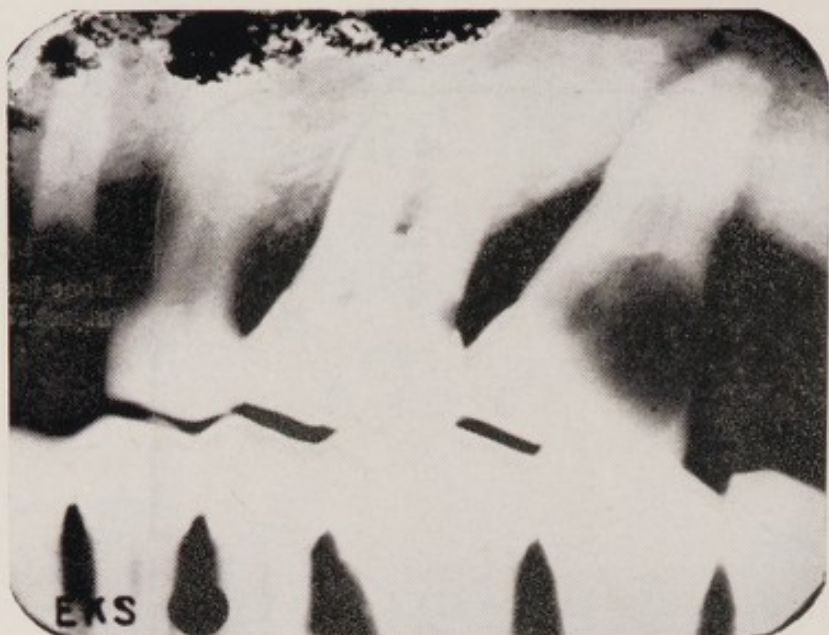


PLATE 25.

Bone-loss of degree 2. Note occlusal attrition.



PLATE 26.

Showing carious lesions which appear to have commenced at the cemento-enamel junction.



PLATE 27.
Showing root fragment being exfoliated.



PLATE 28.
Root fragments being exfoliated.

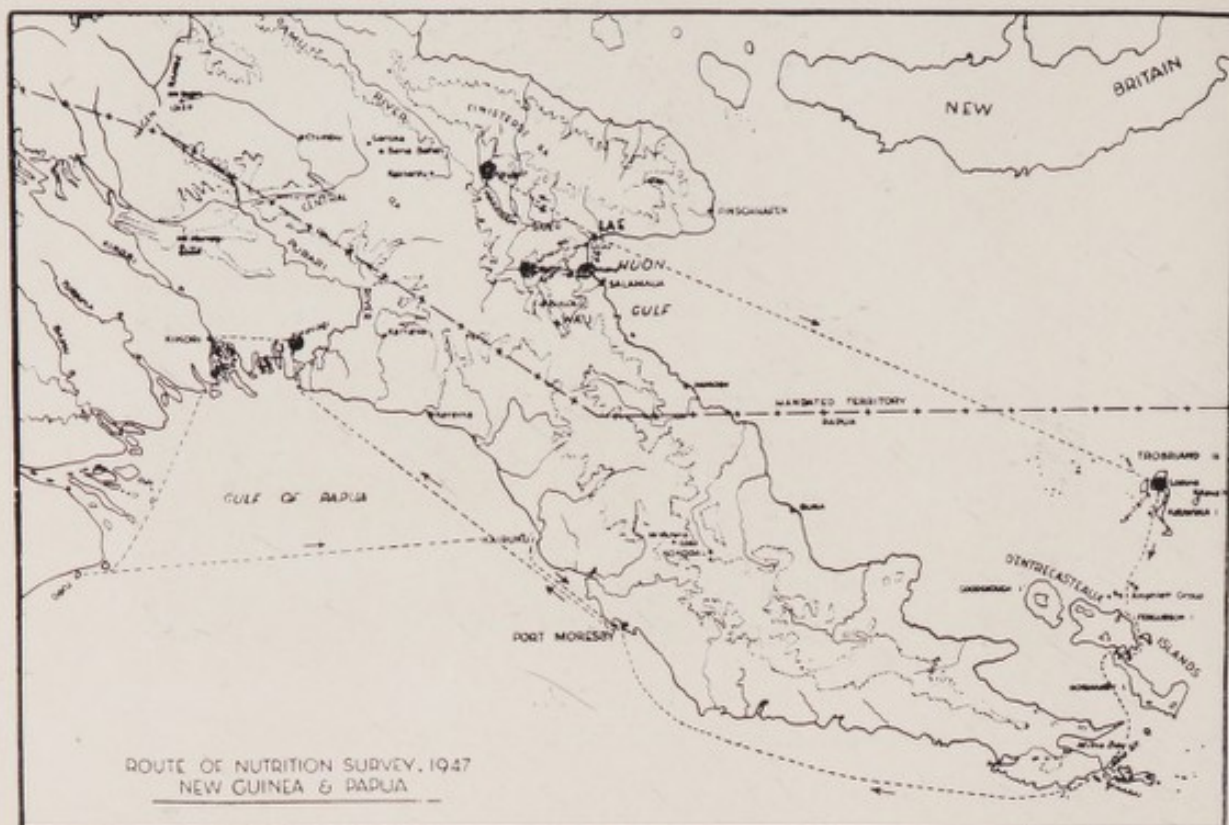


PLATE 29.

The expedition spent approximately one month in each of five villages. The food pattern of each village was based on a different staple food as follows:—

Busama—Taro. Kaiapit—Banana and Sweet Potato. Patep—Sweet Potato and Taro.
Kavitaria—Yam. Koravagi—Sago.



PLATE 30.

Burning off cleared garden land in the Trobriands for planting of yams. On the left is seen the nature of the secondary forest from which the garden is cut. Some saplings are left standing as support for the yam vines.

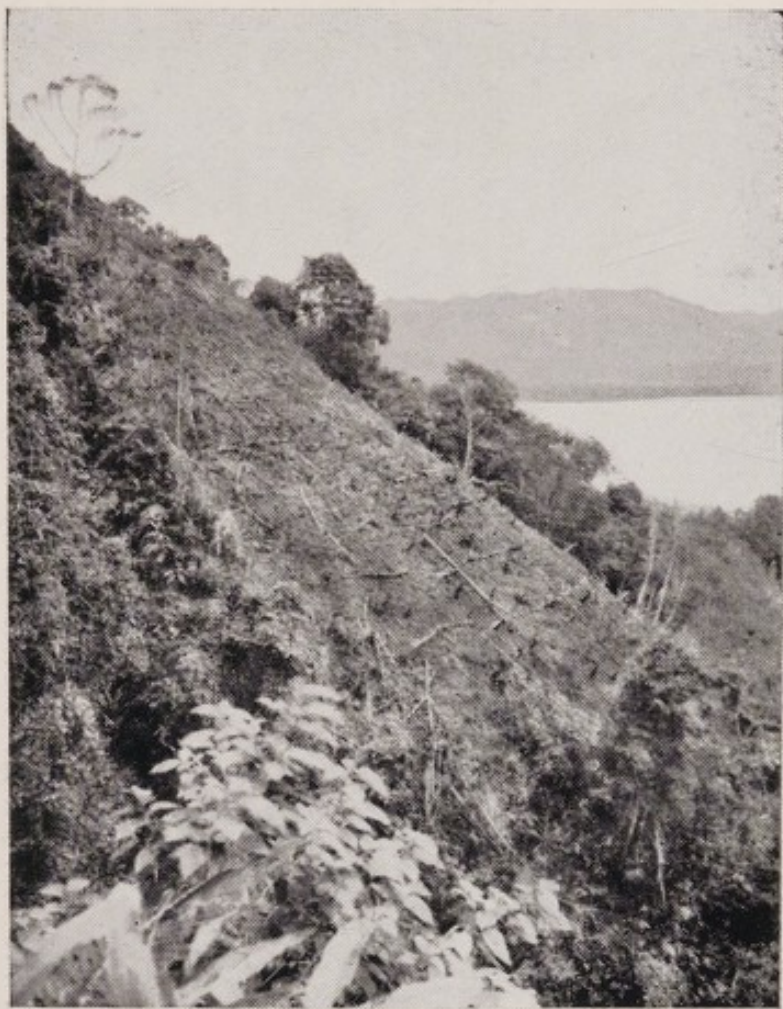


PLATE 31.

A recently p'anted hillside taro garden at Busama, showing the use of logs for soil retention. The character of the surrounding "Bush Fallow" or secondary forest is apparent.

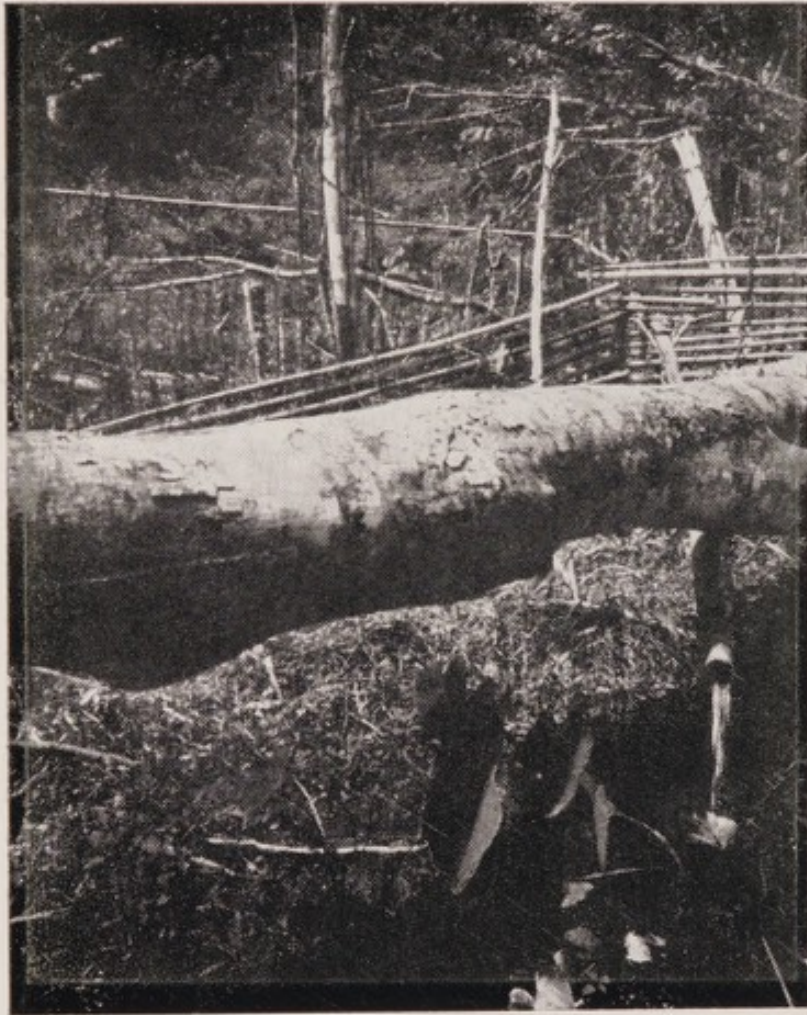


PLATE 32.

Taro irrigation with bamboo piping—Patep Area. The natives in the Patep area are a localised group who apparently are unique in this part of New Guinea in having evolved methods of irrigating taro. Two methods of conducting the water are practised: bamboo piping, and channels dug in the hillsides. The former was the only method seen in operation during the survey. It appeared to be ingenious and highly effective.



PLATE 33.

Characteristic riverside garden patch near Koravagi, Purari Delta, containing taro (*Colocasia antiquorum*), banana (*Musa sapientis*), and wild sugar (*Saccharum robustum*). Young palms of sago (*Metroxylon rumphii*) at rear, and backed by evergreen swamp forest. Note several palms of nipa (*Nipa fruticans*) at water's edge on left. Nipa and mangrove line the banks of the waterways of the Delta area.



PLATE 34.

A Yam-house in the Trobriand Islands. Yams (*Dioscorea* sp.) are grown in areas of New Guinea which possess a well-drained soil of high mineral fertility. The crop is seasonal and is stored up to five months in yam-houses of which this is an example. Great care is taken not to bruise the yams and the store house is constructed to allow free circulation of air, and protection from weather. Yams provide one of the few examples of vegetable foods which can be stored for comparatively long periods. Before World War II considerable quantities of yams from the Trobriand Islands moved in trade to the goldfields of the Louisiade Archipelago.

PLATE 35.

Nutritionist Miss Doreen Langley examines a stock of smoked possums (*Phalanger maculatus*) (Pidgin English: Kapul); they are singed, cleaned, partly cooked and then smoked by suspending in the dwellings over the fire. One of the few examples of storage of food of an animal origin seen in New Guinea.





PLATE 36.

Pig butchering—Kaiapit. The eating of domestic pigs is mainly reserved for festive occasions. However at any time should a wild pig be trapped or speared it is eaten. Because the natives have no methods of preserving pig-meat it must be consumed shortly after it is killed, and for this it is necessary that communal groups take part. At Kaiapit the carcass was expertly butchered and the joints boiled in pots. There was no waste: even the blood was collected and the intestines too were eaten after being washed in the river.

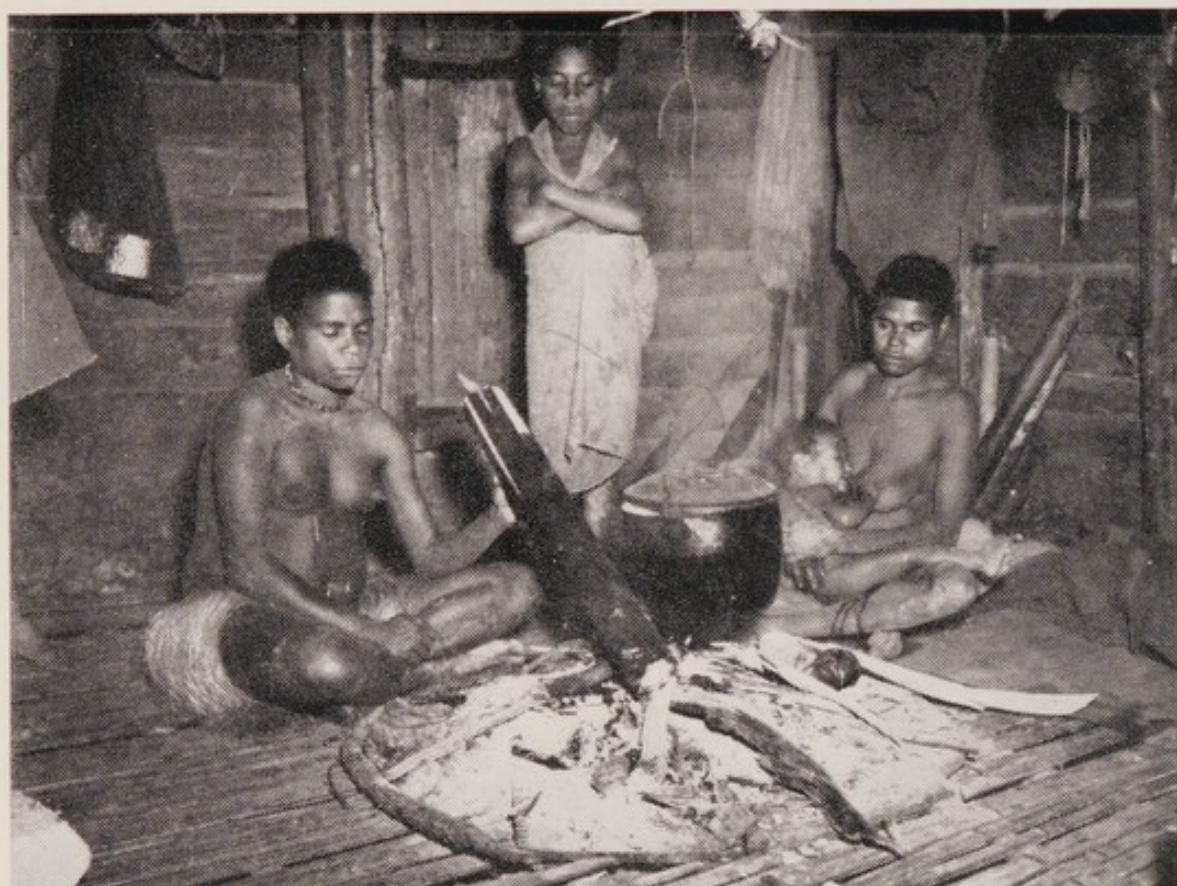


PLATE 37.

Two types of cooking utensils—Patep. In general in New Guinea cooking methods were good: cooking-times were not unduly prolonged and lids (usually large leaves) were used to cover cooking pots. In Patep frequent use was made of bamboo tubes which contained a small quantity of water together with the "spinach", mushrooms, pit-pit or other foods to be cooked. Grass was stuffed in the open end of the tube to prevent the escape of steam. The effect was to steam cook the foodstuffs and the result was a very palatable dish of which the minimum nutritive losses had occurred during cooking.



PLATE 38.

Branch and mature fruit of *Gnetum gnemon*, a small tree of the family *Gnetaceae*, widely used in Papua and New Guinea.

Pidgin name Tulip

Motu Kemu

The young leaves are eaten as spinach, while the nut contained in the mature fruit is eaten raw, or in soups, being very palatable when boiled. The nut finds considerable sale in native bazaars in Malaya and other areas of S.E. Asia.



PLATE 39.

Agricultural officer L. A. Bridgland examines a native spinach plant (*Amarantus tricolor*) in the Pātep area. This is one example of a great variety of leafy green foods which make an important contribution to the New Guinea diet.



PLATE 40.

Fish-yam trade, Trobriand Islands. In many parts of New Guinea there is little or no trade in foodstuffs, but in the Trobriand Islands there is an important and well-developed barter trade between the inland villagers who grow more yams than they require and the coastal villagers who have a surplus of fish. The picture shows inland natives with their baskets of yams awaiting the arrival of the fishing fleet.



PLATE 41.

Copra production. This is an example of native enterprise in the Trobriand Islands. There, owing to the forethought of previous administrators, the natives have a surplus of coconuts growing in and around the village. The fallen nuts are collected, husked, split open, and the meat smoke-dried over a fire as is shown. After being removed from the nut the coconut meat is bagged and sold to local traders for cash. The money obtained is used for the purchase of knives, axes, tobacco, trade cloth, sailcloth, rope, soap, diving goggles, fishing lines and hooks, razor blades, mirrors, cooking utensils, matches, etc.

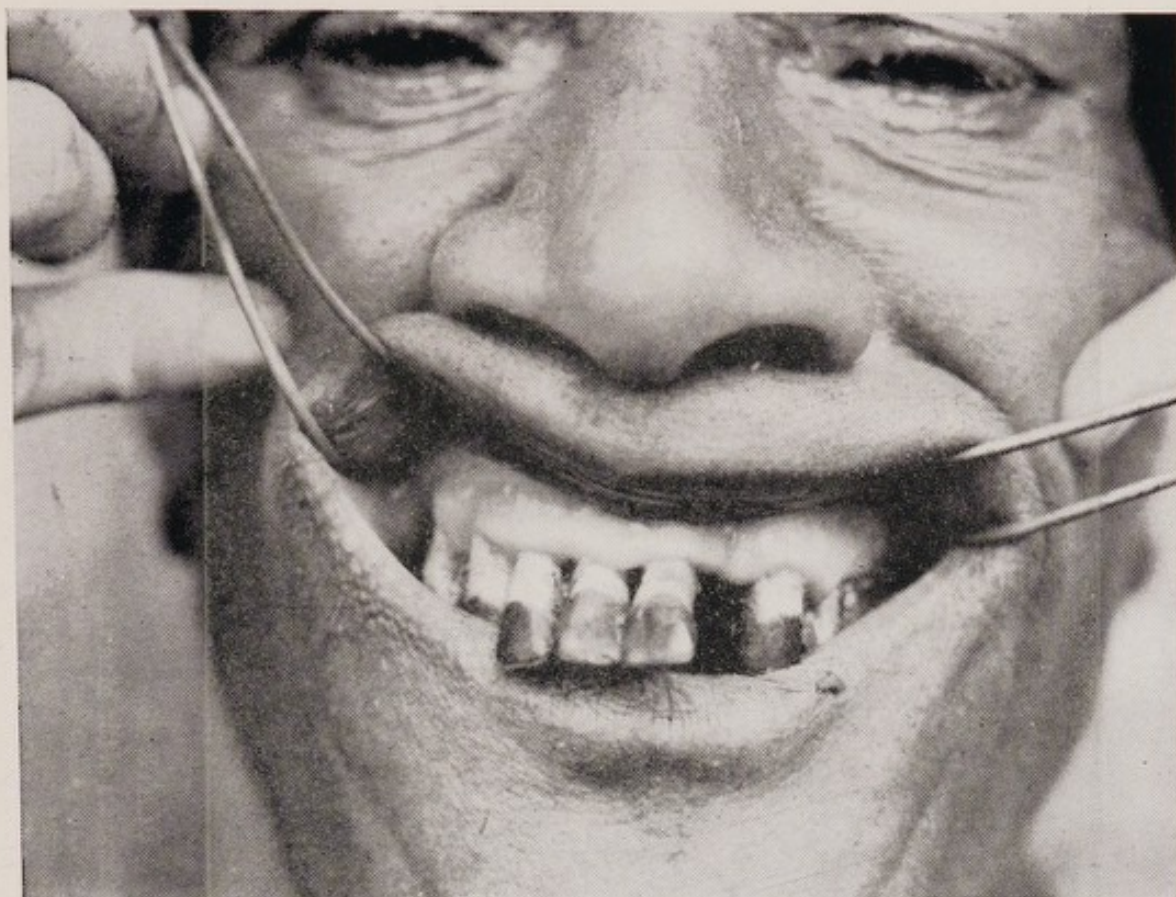


PLATE 42.

An advanced state of periodontitis commonly seen in New Guinea natives over the age of forty years. It is probably due to the accumulation of calculus and debris around the teeth. This protects bacteria which cause irritation of the gingival tissues.

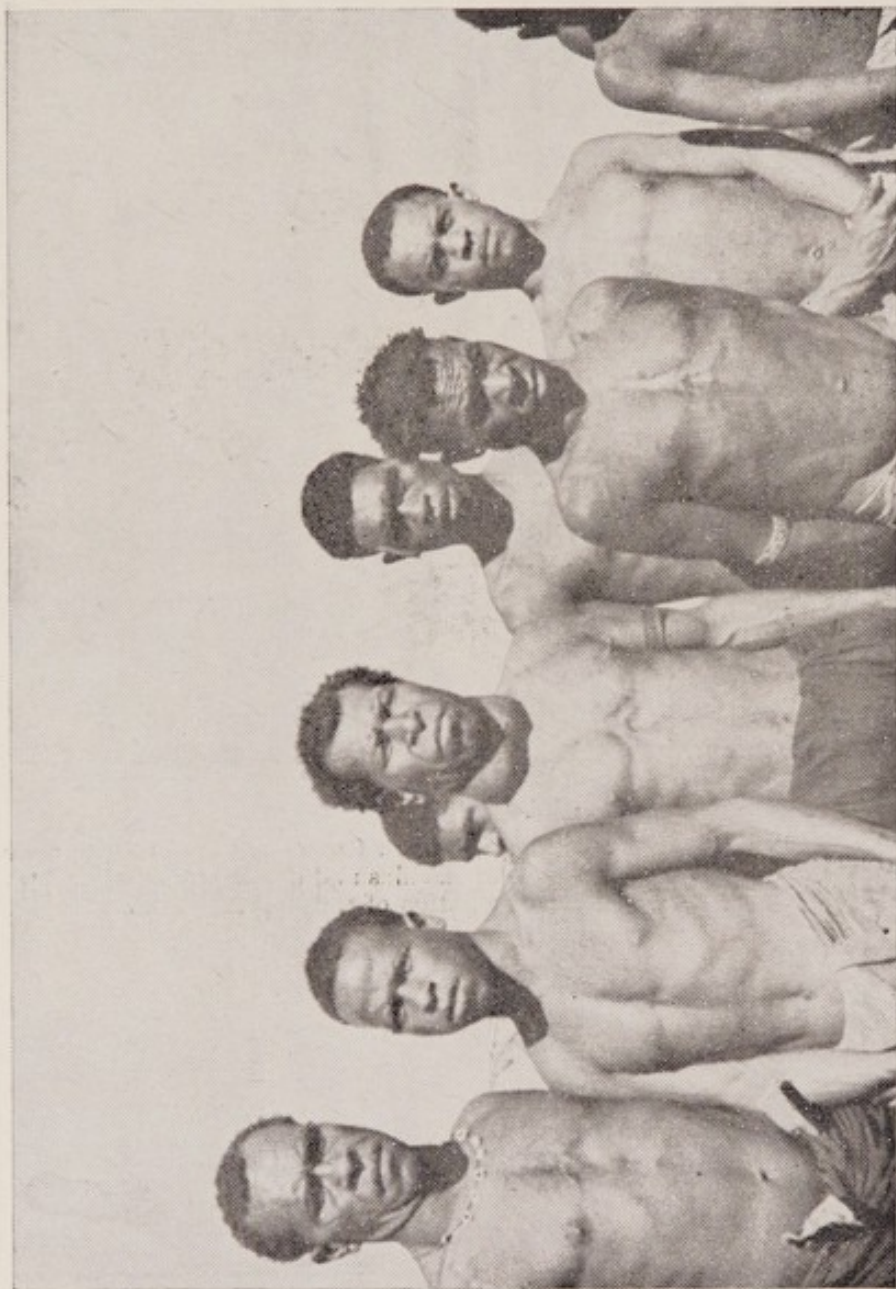


PLATE 43.

A group of natives from a village in the headwaters of the Maniang, a tributary of the Markham River. Every individual of 40 natives examined in this group had definite hypertrophy of the thyroid gland which in some cases was gross.



