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Report on the Gilbert Islands: Some aspects of human ecology

by

René L. A. Catala

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PREFACE

René L. A. Catala, the author of this report, obtained his doctor's degree at the University of Paris. He is a graduate of the "Institut de France" and of the "Ecole Coloniale du Havre".

The major part of his career was spent in Madagascar where he established coffee plantations and, later on, a private station for biological and morphological research. His work dealt in particular with the experimental variations of lepidoptera and the biology of river-fish. As a correspondent of the National Museum for Natural History in Paris, he carried out extensive scientific research in Madagascar.

In 1944 Dr. Catala submitted to the Overseas Office for Scientific Research in Paris, a project for the establishment of a French Institute of Oceania in New Caledonia. Official negotiations, which he conducted himself in the United States of America, resulted in the assignment of buildings and equipment to that organization, on the basis of the Washington Agreements of May 1946. At the newly created research centre, Dr. Catala, after having been in charge of the setting up of the I.F.O. services and the various research branches, undertook the study of coffee plantations in New Caledonia and coconut groves in the New Hebrides. After he was appointed head of the ecological laboratory, he specialized in the study of coral islands.

Because of his special knowledge of ecology and his long experience of tropical crops, Dr. Catala was entrusted by the South Pacific Commission with the survey which forms the subject of this report.

The present report had its beginning in a research study carried out by Dr. Catala in 1951. The report of this study forwarded to the South Pacific Commission in French in 1952 was too extensive and detailed to permit publication. Technical experts of the Secretariat of the Commission have extracted the most essential contributions of the research and put them into suitable length for readers interested in Atolls. The final manuscript has been approved by Dr. Catala.

During the intervening time since the original study was made, there have been numerous contributions to research on Atolls, but the report which is presented here has much current value. The entire subject of Atolls is so extensive that the valuable original work of Dr. Catala will have much interest and worth to present-day readers.

Mr. Harold J. Coolidge, Executive Director of the Pacific Science Board, and a Member of the Research Council of the South Pacific Commission,

has been of material assistance in obtaining publication of Dr. Catala's report in the well-known Atoll Research Bulletin, to which the South Pacific Commission has contributed some financial support.

Ralph Clairon Bedell
Secretary-General

South Pacific Commission
Noumea, New Caledonia.

Editor's Note:

Because of discrepancies between the English manuscript as received and some of the original data, specimens, and the original French manuscript, as well as reidentifications of some of the material, it seemed desirable to edit the manuscript rather carefully. Miss Marie-Helene Sachet, assistant editor, has undertaken, with the author's permission, to do this, and has rather extensively retranslated and rewritten large parts of the manuscript. However, it was impossible to spend more time to give more uniformity to the style, and to reconcile throughout English versus American spellings and turns of phrase. No attempt was made to avoid using both English and metric systems of weights and measures. The aim was to make the report as intelligible and correct as possible. The arrangement, division into chapters, and reference to illustrations have been changed, also, from the English version as submitted for publication. A few bibliographic references have been added.---Ed.

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INTRODUCTION

This report concludes the survey assigned to my wife and me by the South Pacific Commission in connection with Project E.6, under the general direction of Dr. H. G. MacMillan, Executive Officer for Economic Development.

The survey covered a period of six months of field work in the islands of the Gilbert Group, from 6 March to 30 August 1951.

The approved objectives were, "firstly, to study and assess the physical environment, particularly the soil, water, and climatological relations; the vegetation in its economic or other relationship; the production of the sea; in a word, the 'ecology' of this representative area. A second objective was the improvement of the human ecology of the area, by discovering ways and means of increasing the quantity and variety of subsistence and commercial crops, and of achieving greater unit production by improved fertility and method; the improvement of domestic animals; and the improvement of fisheries and other products of the sea."

We were favoured in that we arrived in the Gilbert Islands after two years of severe droughts and just before the beginning of a period of very abundant rains. We were thus able during the first stage of our visit to study the effects of drought and, a few months later, those of almost daily rain.

We were fortunate enough to be able to visit almost all the islands in the Group except Kuria, Maiana, Nonouti, Tabiteuea and Tamana. But these gaps, however regrettable, were compensated by the knowledge we gained of neighbouring islands, with identical or very similar general conditions. We may consider ourselves lucky to have had an opportunity of visiting eleven islands within a few months, in view of the often considerable distances between the various island groups and of the very small number of ships plying between them. Our visit to some of these islands was very short, but nearly always long enough to form a good comparative picture in relation to those on which we stayed longer; Abemama, Nikunau and, of course, Tarawa, where we established our headquarters, and lived in two localities, at Bairiki and Bikenibeu respectively.

Although we made the most of this six months' visit and recorded as many observations as we were able to, a most interesting, if not essential, section does not appear in this report, namely, the ecology of coral reefs and lagoon waters, of which it was impossible to make a real study for lack of adequate equipment, boat and fishing gear.

However, there were valuable compensations for these deficiencies, and it gives us great pleasure to mention here the unceasing assistance extended by the administrative authorities of the Gilbert Islands, under the distinguished direction of the Acting Resident Commissioner, Mr. Ph. Keegan. The Resident and his staff took a continued interest in our survey, its

objectives and implementation, and thanks to their unfailing kindness, we found upon our arrival many more facilities and much better accommodation than we could have expected. We were able to visit a number of territories, sometimes being invited by the Resident to accompany him on his official visits, sometimes taking advantage of very fortunate "coincidences" in shipping movements - not always due to chance. Records likely to be of interest in connection with our survey were made available to us in the spirit of cooperation displayed by everyone who could, from personal experience, supply us with information. Finally, we were able to hold frequent meetings which always helped in elucidating problems or advancing the implementation of the project.

We must also mention the valuable information supplied by the Tarawa health authorities, by Captain Brown, mv. "Tungaru", by Captain Reiher, landowner in Abemama, and by several missionaries who either had spent their whole lives in the Group and were thus well informed on a number of subjects, or who had long studied every aspect of life in these low islands. Father Sabatier, Father Zufrey and others were mines of information.

Great benefit was also derived from our conversations with school teachers and other native civil servants and from the cooperation of a few natives; some of an older generation who still have much useful knowledge on their country, and others who have adhered to their traditions through keeping in close contact with their environment.

Our colleague, Mr. R. Mason, an officer of the Fiji Department of Agriculture, for his part concentrated his activities on a limited area of Tarawa Atoll. Considering the short time he spent in the Group, his observations were recorded in a very comprehensive, well-illustrated report.

Neither must we omit to pay tribute to our friend, Monsieur J. Barrau who paid us a short visit. By his knowledge of soils, his ability as an observer, and his critical sense, he made a most valuable voluntary contribution to our survey.

Acknowledgement should also be made of the very valuable assistance given by various individuals and institutions in identifying specimens. The following specimens were sent to the Australian Museum, Sydney, for identification: Fish to Mr. Gilbert P. Whitley, crustaceans to Mr. F. McNeill, molluscs to Miss Joyce Allan, other marine specimens to Miss Elizabeth Pope, a few insects to Mr. A. Musgrave.

The plants were identified in a preliminary way by Professor A. Guillaumin of the National Museum, Paris, and by Dr. Marcel Bauman of the Botanical Museum, University of Zurich. Sea-weeds were sent to Mrs. Valerie May (Jones) of the Sydney Botanical Gardens. Algae from fish ponds (Cyanophyceae) were sent to Dr. Drouet of the Chicago Natural History Museum.* Macromycetes and micromycetes, mosses, lichens and land algae were sent to Professor R. Heim of the National Museum, Paris. Lepidoptera were sent to Monsieur Pierre Viette of the National Museum, Paris. A consignment of insects belonging to various groups was sent to the Bishop Museum

*See Appendix I, p. 187.

in Honolulu and preliminary lists of identifications were received from the following specialists: Miss Amy Suehiro, Mr. R. H. van Zwaluwenburg, Dr. D. Elmo Hardy, Dr. O. H. Swezey, Mr. E. H. Bryan, Jr. Finally, some plankton specimens were sent to Professor Monod, Head of the "Institut Francais d'Afrique Noire", Dakar.

Unforeseen contingencies and long delays in shipping which were beyond our control involved a considerable delay in the delivery to various specialists of several cases of specimens; the corresponding identifications will be accordingly delayed. An addendum to the present report will probably be necessary. Except for specimens known to us beyond any possibility of doubt, this report will often show, after the names indicated, the genus or family only.

All local names were checked several times and, apart from a few mentioned as doubtful, even in native circles, they may be considered accurate.

It should be noted that the collections made in a variety of fields by American experts of the Pacific Science Board working in Onotoa*, cannot fail, in due time, to add valuable complementary data to our more general inventory.

It will be readily understood that, for our part, we concentrated mainly on specimens of economic value, having a direct bearing on the survey assigned to us.

In conclusion may the author also be allowed to pay tribute to the invaluable assistance given by his wife, who constantly helped in all spheres of this survey.

René L. A. Catala

Noumea, New Caledonia
June, 1952.

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*See Atoll Research Bulletins nos. 12, 13, 28, 47 and 57.

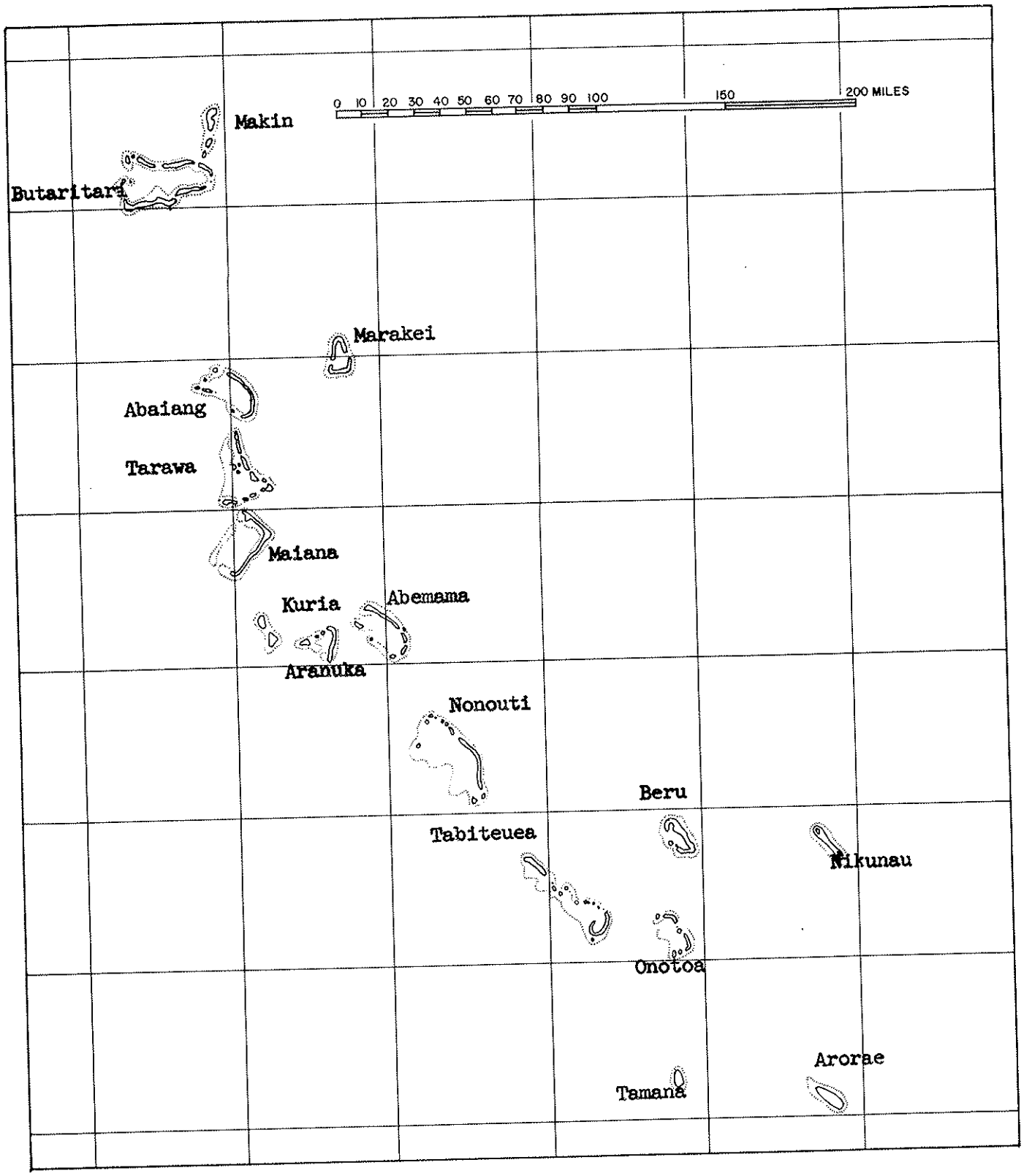


Fig. 1 - The Gilbert Islands

CHAPTER 1

PHYSICAL AND CLIMATIC CHARACTERISTICS

Formerly known as the Kingsmill Group, the Gilbert Group straddles the Equator and extends over 400 miles from the island of Arorae in the south to the island of Little Makin in the north-west (Fig. 1). It constitutes the central link in a long chain of islands stretching from the Marshall Group in the north to the Ellice Group in the south.

The Group lies between 3°30 latitude north and 2°45 latitude south and between 172°30 and 177° longitudes east. It may be divided into eleven atolls and five reef islands. (The atoll is a chain of small islands set around a lagoon, while the reef island has no lagoon and is washed on all sides by the ocean. However, both were formed by coral growths on a pedestal of submarine peaks. These islands are very low, rarely exceeding 3 meters above the average tide level.) Figures 2 and 3 show some of the essential differences between atolls and reef islands.

The Gilbert Islands may be divided into three groups:

North - Little Makin - Butaritari

Centre - Marakei - Abaiang - Tarawa - Maiana - Abemama - Kuria - Aranuka

South - Nonouti - Tabiteuea - Beru - Nikunau - Onotoa - Tamana - Arorae

These sixteen atolls and islands represent a land surface of 114 square miles, distributed as follows (Pusinelli, 1947):

Name of Island		Sq. Mile	Population density per sq. mile	
				1947
Little Makin		2.80		345.6
Butaritari		4.50		405.1
Marakei		3.94		437.4
Abaiang		11.06		255.4
Tarawa		7.73		453.5
Maiana		10.39		137.2
Abemama		6.57		178.7
Kuria		4.98		63.3
Aranuka		5.97		61.3
Nonouti		9.82		203.9
Tabiteuea		19.00		199.2
Beru		8.15		273.8
Nikunau		7.00		227.4
Onotoa		5.21		283.1
Tamana		2.00		441.5
Arorae		5.00		317.6
	Total	114.12	Average	243.9

General Characteristics

In the atoll type of island, the belt of land is usually not continuous but is often broken up into a number of fragments forming various geometrical patterns. Between these fragments, sometimes reduced to a very narrow strip of land, are depressions through which at high tide the ocean and lagoon waters meet.

At low tide one may walk across these hollows to reach the next island. However, in a few places where the water remains too deep, a rough bridge connects the islands. The number of these small islands is sometimes quite considerable. Tabiteuea Atoll, the largest of all, exhibits no fewer than sixty, extending over a distance of 30 miles, which appears all the greater because of the narrowness of most of the islands.

As for lagoons proper, their depth is not uniform. For instance, Tarawa lagoon is from 5 to 20 fathoms deep, while the soundings of Butaritari show depths down to 55 fathoms.

On the ocean side, the belt of land is bordered by a flat of coral debris cemented together and ranging in width from 400 to 600 yards. This flat has a barely noticeable incline. No living corals are usually to be found on it. The algal vegetation is represented only by low or encrusting forms, the only genera showing conspicuous development being Turbinaria and Halimeda. At the back of this platform, the slope is abruptly increased by one or two steps of masses cemented by calcareous algae, rising up to the beach which forms a ramp. The land plants start growing at the upper level on the ramp.

On the lagoon side, the gradient of the beach is less accentuated. Sometimes, it is only the beginning of a large flat made up of coral debris or merely of pure sand. Colonies of various sea plants are found in denser, more numerous clumps as the length of exposure to sunlight decreases. In most of the shallow depressions between the islets Thalassia is commonest of these.

The presence of vast sand areas should also be noted; their higher level causes them to be out of the water too long for any marine vegetation to survive. Instead, stands of mangrove have established themselves there adjacent to, and just below the Pemphis belt.

On the reef islands is a ridge on the side exposed to the prevailing winds, higher than the general level. Some of these islands such as Nikunau have inland ponds or lakes (Fig. 3).

Climate

The Gilbert Islands, mostly situated in the dry belt of the Central Pacific, are subject to an equatorial oceanic climate (de Martonne, 1948) chiefly characterised by a high yearly average temperature of 28° C. with a low yearly range of variation.

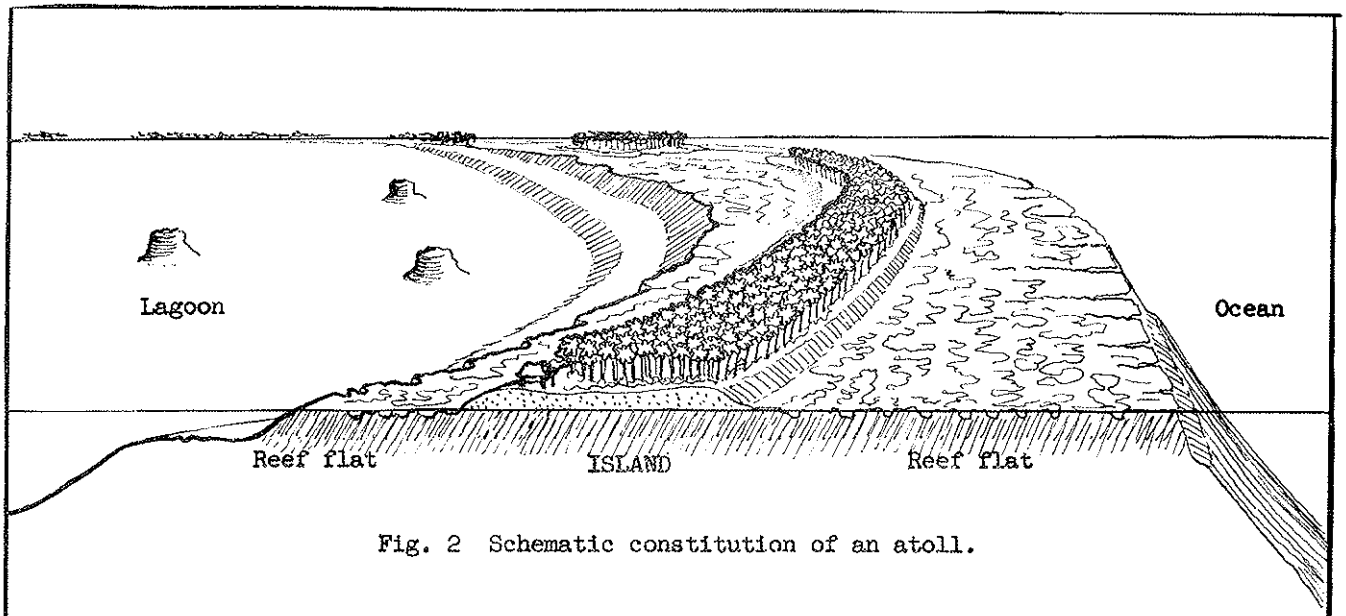


Fig. 2 Schematic constitution of an atoll.

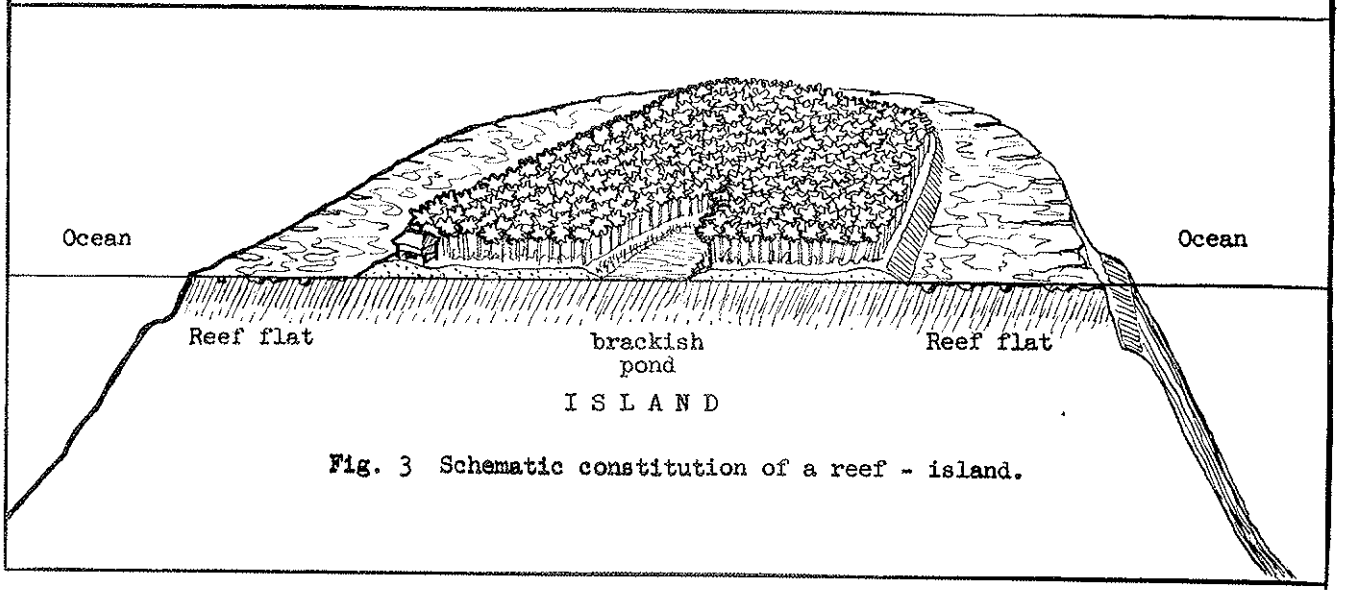


Fig. 3 Schematic constitution of a reef - island.

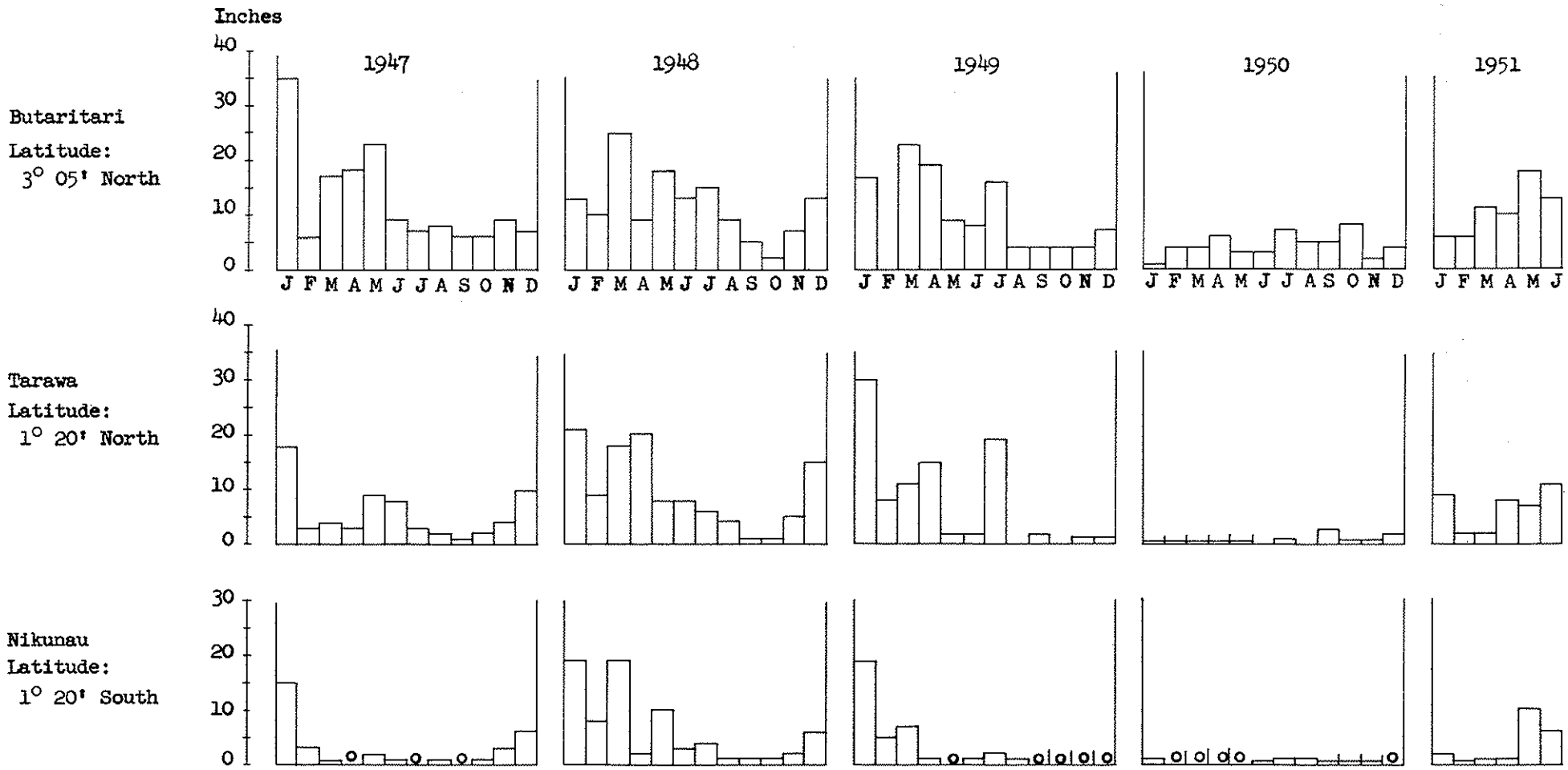
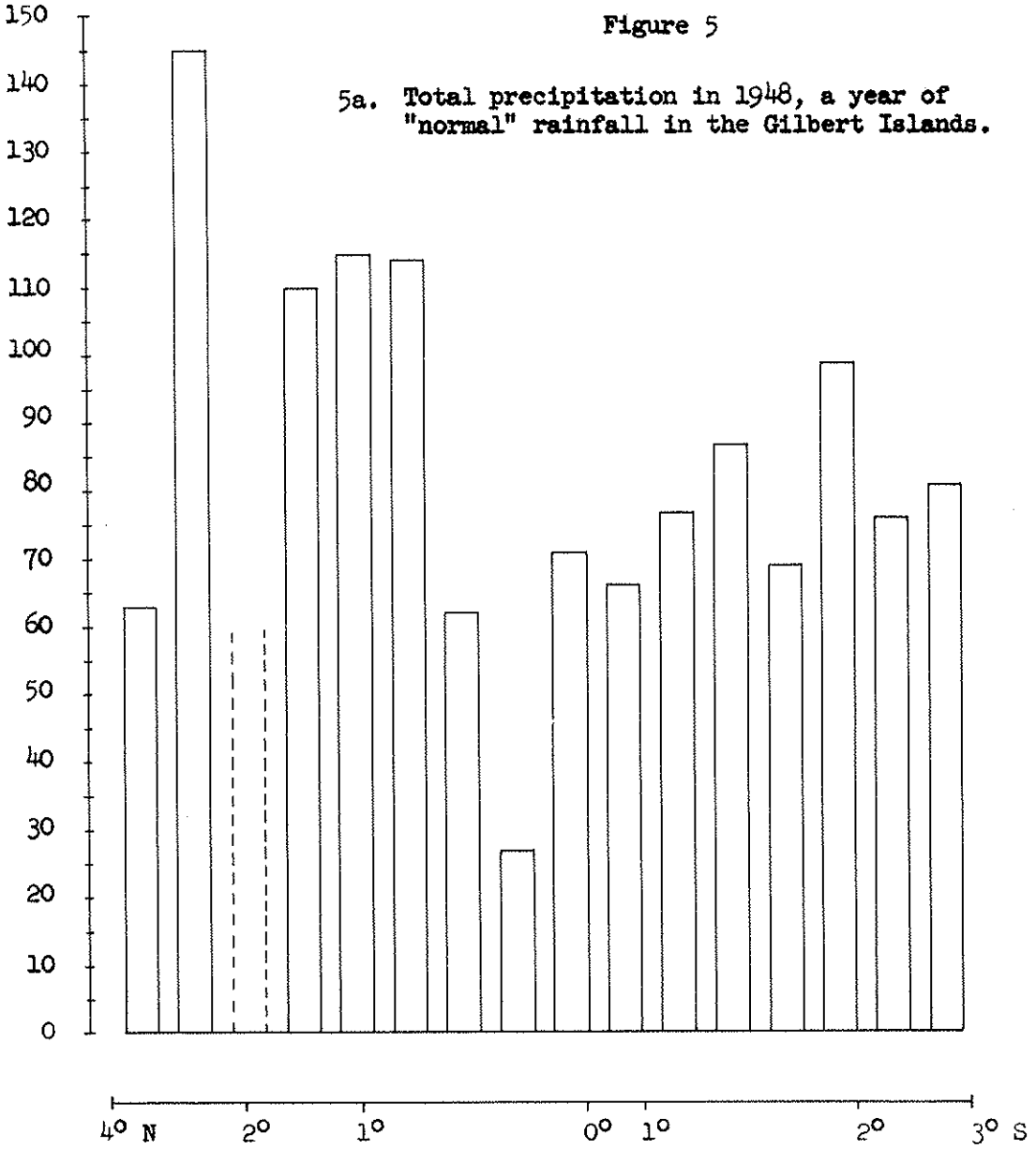


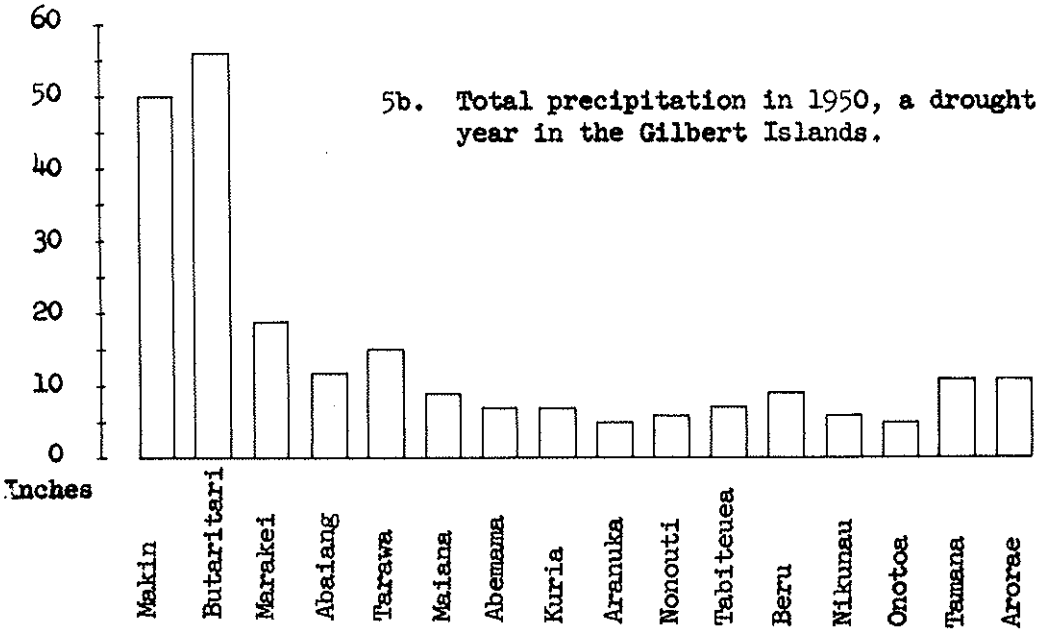
Fig. 4 Comparative diagrams of monthly rainfall on 3 islands - North, Centre and South - over a period of $4\frac{1}{2}$ years.

Figure 5

5a. Total precipitation in 1948, a year of "normal" rainfall in the Gilbert Islands.



5b. Total precipitation in 1950, a drought year in the Gilbert Islands.



As for the rainfall, the attached graphs will show how it varies between the groups in the North, Central and South Islands (Fig. 4). One of the most important ecological factors in the Gilbert Islands is drought. These islands are periodically affected by it. There was a two-year drought in 1917-1919, a three-year drought in 1937-1939, and another which lasted a year and a half in 1949-1951. These periods of drought particularly affect the south islands. Comparative statistics in Figure 4 show the monthly rainfall of one island of each group over a period of 4½ years, comparing periods of normal rainfall with periods of drought which occurred from August, 1949 to December, 1950. In this connection, it is interesting to consider variation of the aridity index between these three islands chosen as examples for the compilation of rainfall diagrams.

Island	Aridity Index
Butaritari (North)	119
Tarawa (Centre)	78
Nikunau (South)	43.3

The index was computed on the de Martonne formula:

$$I \qquad \frac{P}{10 + T}$$

P being the monthly rainfall average in millimetres and T the mean temperature in degrees centigrade.

The averages used to compute the above index were calculated over 4½ years (January, 1947 to July, 1951), from the records very kindly supplied by the Resident Commissioner in Tarawa.

In order to give a more precise idea of the seriousness of some droughts, we record here the case of Abemama atoll which, while not located in the most deprived area, had a rainfall of only 6 inches from April, 1924 to May, 1925. This gives 4 as the aridity index for that year while, according to de Martonne, an aridity index of 20 or less indicates drought.

However, if we consider the various rainfall tables in detail we shall note that however intense and prolonged the droughts may be, they are not absolute. Figure 5 shows the precipitation totals for all the islands of the Group during the year 1948, in which the rains were well distributed, compared with those for 1950, corresponding to a serious drought. However small the rainfall, it is used by the coconut palm.

Sabatier (1939) writes: "a shower which would be sufficient to water a European garden is only a drop of water on a red hot iron here. The recorder has something in his rain gauge - he can add up figures, but the coconut roots have had no moisture....". We are not of this opinion. The coconut, with its surface roots, makes use of the smallest shower, and if these showers only washed off the salt deposited on the leaves by the spray, even this would benefit the palm.

CHAPTER 2

THE SOILS

It was not intended that this work should include a detailed pedological investigation of the soils of the Gilbert Islands. The soils will, therefore, be studied chiefly as main factors in the agricultural ecology of these coral islands and atolls; in other words, we shall attempt to determine their general characteristics and especially their relationship with cultivated plants.

Our task in this field was made easier by the interesting preliminary report on the soils of Arno (Marshall Islands), by Earl J. Stone Jr. (1951a, 1951b), which was kindly made available by the Pacific Science Board. We have thus been able to compare our findings and those of our co-worker, Mr. R. Mason, with those of this distinguished expert.

The importance of the edaphic factor in the ecology of coral islands and atolls is well known. Both islands and atolls are composed of a comparatively thin layer of sand of coral origin resting on the reef platform. Two main components are therefore to be found in their soils, giving them their salient features (a) coral, (b) organic matter, deposited by vegetation.

The distinctions which can be established among these soils will then be based on qualitative differences (e.g. the variable fineness of the coral components) or on quantitative differences (e.g. the organic matter content). Generally the soils of the Gilbert Islands belong to a type of which the salient features are:

(i) A superficial horizon (A) consisting of organic matter and lime sand, of variable depth, ranging in colour from brown to grey, changing gradually to:

(ii) An underlying horizon (C), the original layer from which the soil structure was built, made of lime sand - pinkish white or yellowish in colour.

The profiles shown in Figure 6 and plate Ia and b are typical of the Gilbert Islands soils and correspond to the description given above.

Profile 2 shows a buried organic layer which seems to represent a primary A horizon covered by a superficial deposit of sand over which a new deposit of organic matter has settled. This sand deposit may be due to physical causes (such as storms) or, more often, to human causes (e.g. excavated material from cultivation pits).

As for profile 3, which is typical of reef islands, its main features are:

(i) The thinness of the soil which rests on a rocky platform very close to the surface,

(ii) The coarseness of the coral constituents (gravel) which are its main components.

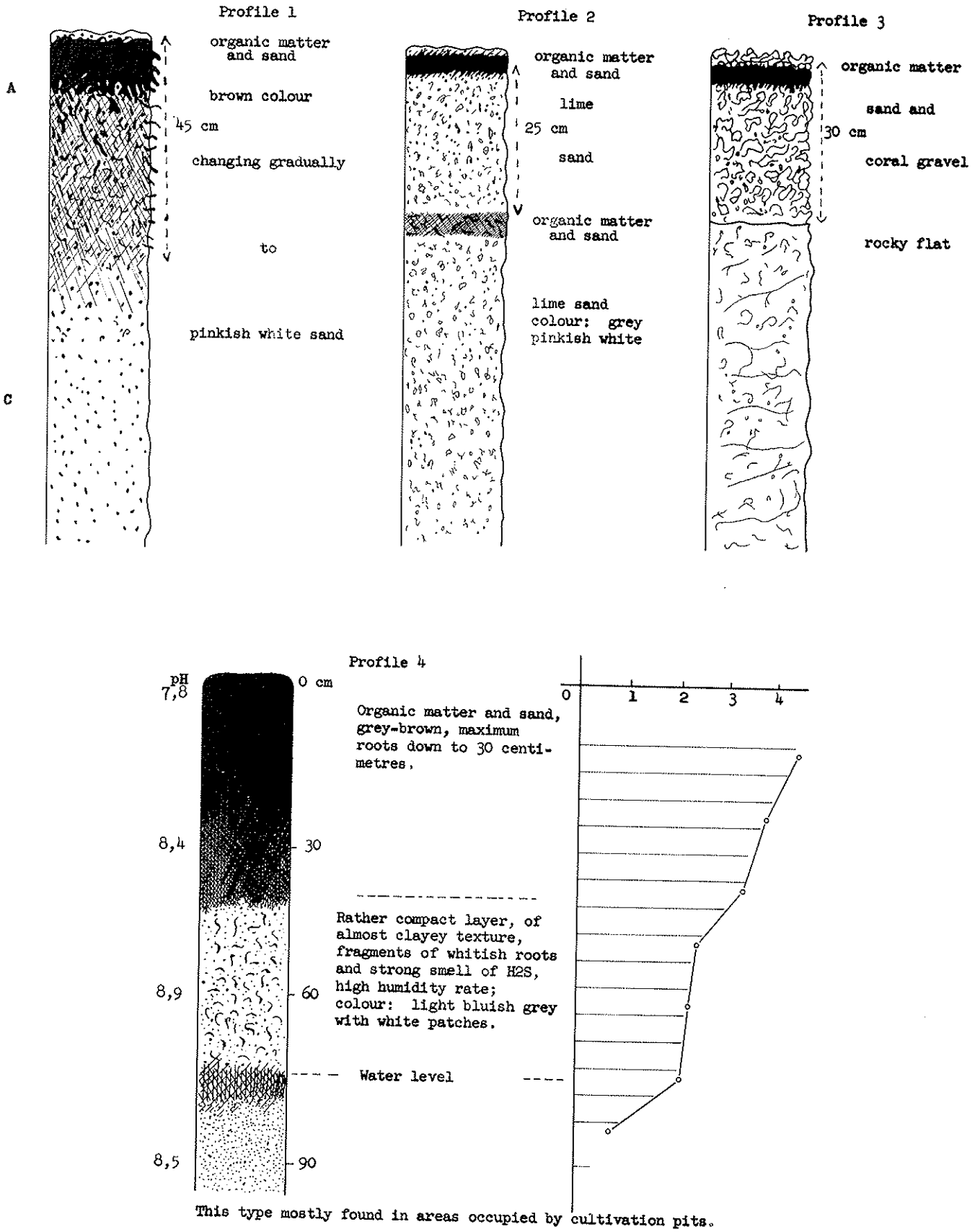
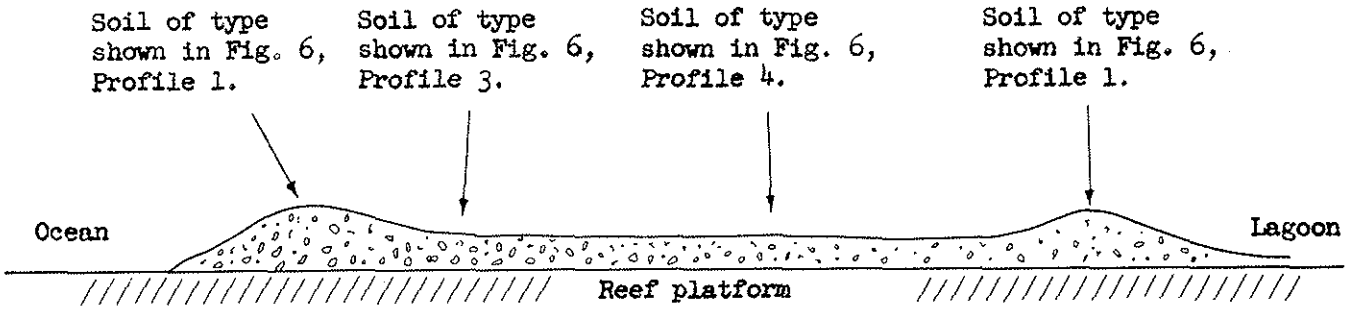
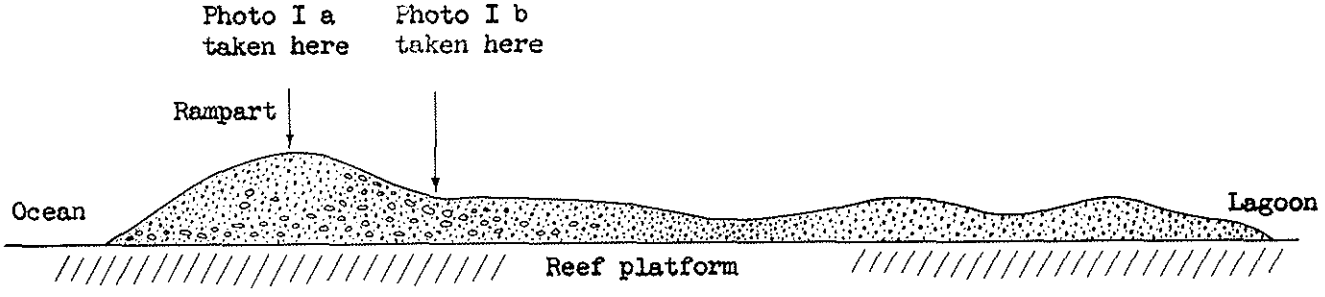


Fig. 6 A few typical profiles of Gilbert Islands soils.

Fig. 7 Cross-sections of Bikenibeu Islet, Tarawa Atoll.

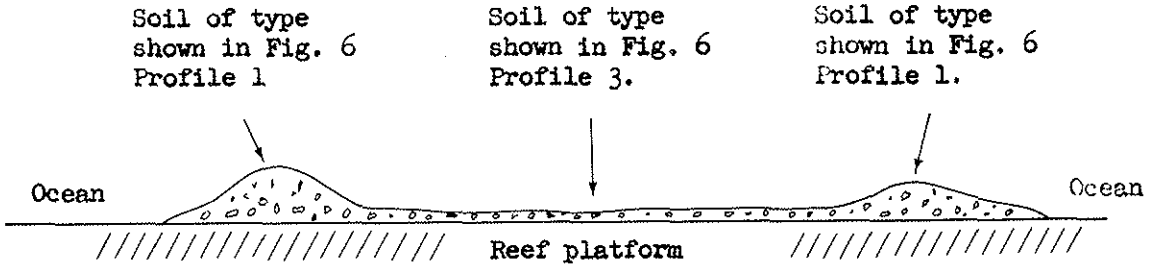


7a. Showing location of soil profiles.



7b. Showing location of photos.

Fig. 8 Cross-section of Arorae Reef Island.



Soils of this type are not confined to reef islands. They may also be found on atoll islets, on the rampart behind the beach on the ocean side (see Pl. Ia and Fig. 7b, Bikenibeu Islet, Tarawa). Fig. 6 includes another profile (4) corresponding to the centre of the same islet and which will be described in greater detail.

The pH values indicated in Fig. 6 (profile 4) were measured by a colorimetric method(1), in distilled water, from undried samples immediately after taking them. The pH of the compact layer, measured by the same method after drying, was only 8.2 as against 8.9 when fresh. This difference may be explained by the oxidation of sulphides. It should be added that when a soil of this type is scooped out until this water-logged layer is reached, a strong odour of H_2S, similar to that of the grey mud of cultivation pits, is given off.

The water level is found immediately below this layer. The natives of Bikenibeu also told us that when digging a pit for their "babai", encountering this same layer meant unfailingly that their work was drawing to an end, and they stopped on reaching the underlying sand horizon. The layer may be less compact and thinner than shown in Fig. 6 and Plate Ic.

A fresh sample of this layer was put through a test for determination of phosphorus content (Lamotte method). Whereas at a depth of 10 cm (4 inches) in the superficial horizon, a value of over 200 lbs/acre was obtained, the figure fell to 50 lbs/acre at a depth of 60 cm (24 inches) in this particular layer. However unreliable the method used, it is thought useful to mention the fact here. This type of soil should be compared with the "Arno Loamy Sand", which is put to the same use (cultivation pits) and which was described by Stone (op. cit.).

The cause of the differentiation between this layer and the rest of the superficial horizon might be found in phenomena similar to those occurring in fetid muds, the geologist's "faulschlamm". These phenomena possibly involve the alteration "in situ" of the organic matter and the coral sands in the lower layer of horizon A, saturated with fresh or slightly brackish water. Such anaerobic processes result in releases of gas, H_2S in the case of this soil, as in fetid muds of marine origin (Catala, 1950). It should be recalled that the reduction of sulphates in the modified coral components is possibly due (Baas Becking) to the action of Microspira desulfuricans. The slightly bluish colour of this layer may thus be explained by the occurrence of sulphides. Further, its physico-chemical nature is similar to that of the organo-calcareous muds to be found at the bottom of Gilbertese cultivation pits.

It seems therefore that the Gilbert soils examined by us are "AC soils", e.g. exempt from an illuvial (B) horizon, and we are in agreement here with Mr. Stone's conclusions as regards the soils of Arno Atoll.

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(1) The equipment used was: For the general determination of pH, the universal BDH indicator; for the measurement of pH over 8, thymol blue; using in both cases a "Lovibond" comparator with standard colour discs.

The distribution of these various types of soil on a coral atoll or on a reef island is summarized in Figures 7 and 8. It should be specified, however, that this is only a schematic representation. In the same spirit of schematization, these soils could be roughly classified as follows:

	Comparative Quality	Condition and yield of coconut plantations
Soil belonging to the type illustrated as profile 4, fig. 6	Good	Very dense Good yield
Soil type profile 1, fig. 6	Medium	Thinner plantation Medium yield
Soil type profile 3, fig. 6	Poor	Poor yield

These estimates of quality are of course only made by comparison within atoll environments.

Appreciable differences in quality may exist between soils belonging to any one of the types described above. While the type of soil shown in Fig. 6, profile 4 is generally of good quality, this particular profile is not good because of the compactness and depth of the lower layer of horizon A. Other formations of the same type on the same island are considered by the natives as being the best site for their cultivation pits as well as for a satisfactory yield from coconut palms.

For soils, the Gilbertese natives have a specific vocabulary of which a few examples from Tarawa Atoll are given below:

Te batano	layer of almost clayey consistency
Te nari	hard layer, impenetrable to roots
Te kara	coral fragments
Te tano	C horizon sand
Te iarauri Te ianuri Te bon	humus layer under Te uri (Guettarda speciosa)
Te mweang	decaying plant fragments
Te ribu Te riburibu	sulphur-smelling mud

To complete this outline, the results of analyses carried out on 29 samples from 10 distinct sites, by the laboratory of the Department of Agriculture at Suva, are set out in Table I. Mr. Cassidy, Director of this laboratory, kindly supplied these results with the following comments.

TABLE I

Analysis of typical atoll soils of certain Gilbert Islands taken at various depths, showing the color, the H-ion concentration measured by the Kühn method, calculated percentages of Calcium carbonate, Nitrogen, Chloride, and the water holding capacity at the saturation point as percentage of dry weight.

Soil Source	Depth in Cm.	Color	pH	$CaCO_3$ %	Nitrogen %	Chloride %	Water-Holding Capacity - %
Bikenibeu Tarawa	0 - 6.0	Dark brown	8.0	46	0.194	0.012	104
	6.0 -15.0	Grey	8.0	75	0.034	0.028	64
	15.0 ?	Grey brown	8.0	95	0.032	0.031	44
Reiher Abemama I	0 - 2.5	Grey brown	7.8	87	0.104	0.038	80
	2.5 -30.0	Light brown	7.3	68	0.015	0.008	53
	30.0 -40.0	Light grey	8.0	86		0.019	64
	58.0 -76.0	Light grey	7.3	64		0.011	48
Abemama Ra II	0 -25.0	Brown	7.3	63	0.522	0.120	83
	25.0 -70.0	Grey	8.0	81	0.014	0.072	43
	70.0 -80.0	Greyish white	8.0	84	0.010	0.012	46
Abemama Bike III	0 - 2.0	Brown	8.0	55	0.379	0.049	56
	2.0 -30.0	Light brown	8.0	71	0.124	0.034	42
	30.0 -60.0	Brownish white	7.8	77		0.012	35
Abemama Makin IV	0 - 8.0	Dark grey	8.0	54	0.142	0.134	90
	8.0 -15.0	Brown	8.0	90	0.222	0.311	73
	15.0 -20.0	Grey	8.0	79		0.006	56
	20.0 -30.0	Greyish white	7.8	83		0.029	65
Abemama Manoku V	0 - 6.0	Grey	8.0	79	0.085	0.009	52
	20.0 -40.0	Brownish white	8.0	91		0.007	43
Abemama Makin	*	Brown	8.0	55	0.391	0.150	136
	**	Grey brown	8.0	64	0.013	0.121	93
Abemama Makin III 3	*	Grey	8.0	58	0.393	0.450	83

Note: * Pits.
** Pits, banana culture.

TABLE I (continued)

Soil Source	Depth in Cm.	Color	pH	$CaCO_3$ %	Nitrogen %	Chloride %	Water-Holding Capacity - %
Little Makin A	0 - 5.0	Brown grey	8.0	63	0.129	0.012	94
	5.0 - 20.0	Grey brown	8.0	86	0.073	0.008	53
	20.0 - 30.0	Grey brown	8.0	72	0.099	0.015	51
	30.0 - 70.0	Grey	7.3	74		0.016	48
Rawannawi Marakei B	0 - 8.0	Grey brown	8.0	82	0.128	0.016	56
	8.0 - 35.0	Grey	8.0	87	0.039	0.015	44
	35.0 - 80.0	Grey	8.0	81		0.007	39

"Twenty-nine samples representing ten sites and eight soil profiles were submitted. Determinations were made of pH, calcium carbonate, total nitrogen, salinity (chloride) and water holding capacity at saturation.

"Because of lack of staff (more especially as some investigational work would be needed to establish methods for these highly coraline soils) no determinations of available nutrients could be attempted.

"The results are tabulated in Table I. It is notable that calcium carbonate, in all but one instance, exceeds 50% and in the lower layers it may exceed 90%.

"The material in the lower layers is only slightly off-white in colour and consists of coral fragments with minor amounts of small spiral (or occasionally bivalve) shells. The particle-size range is generally 1 - 5 mm.

"Layers nearer the surface have grey or brown colours and fewer coarse particles.

"The surface (Ao) layer is a grey brown to dark brown peaty material showing much undecomposed plant remains; it appears to be normally about 2 inches thick but in one case it was 10 inches thick.

"Water-holding capacity is important in these soils as the Gilbert Islands are subject to dry spells, and it is a little unexpected to find that even the coarse samples have a water capacity equal to, or better than, that of pure sand (0.5 - 1.0 mm) or even than many sandy soils, which hold only about 35% of their weight before run-off occurs.

"The explanation is clearly to be found in the many interstices of the coral fragments and shells. Total nitrogen is quite good in the surface layers but tends to be rather low for the whole profile.

"Salinity will naturally be a function of the amount of leaching by rainfall prior to sampling, but the present values (obtained presumably after rain following a dry period), and the general physiography of the islands, coupled with the available description of the vegetation, suggest that salinity is likely to be one main factor in plant production.

"The analyses for Abemama Makin III 3 indicate that the salinity of the latter soil (which was the soil applied around banana palms) was probably the cause of the poor growth and even complete failure reported in the former case for bananas growing in the soil pits."

Since analyses for available nutrients could not be undertaken we have no specific results available for phosphorus and potash. Although they can give but a rought estimate, the numerous tests carried out on Gilbertese soils with the "Lamotte set", indicated an appreciable content of soluble P_2O_5 and K_2O, confirmed by the results obtained by Mr. Stone for similar soils in Arno.

There remain the trace elements, the importance of which appears undeniable. Detailed research in this direction might be undertaken. Iron is of vital importance to cultivated plants on the atolls. The excess of $CaCO_3$ in these soils is frequently the cause of trophic disturbance, more often called "chlorosis".

The main factors governing the growth of cultivated plants in Gilbert soils are fresh water, organic matter, and iron. The causes of failure which we have been able to ascertain were the difficulty, for roots, in reaching the underground fresh-water level; or the salinity of this water level; or the lack of organic matter in the soil; or chlorosis; or the combination of several of these limiting factors. To these should be added, in the case of certain plants, the asphyxiation of the roots in badly-drained soils.

Fresh Water

It is known that fresh water exists in these soils in the form of a "lens", hydro-statically balanced on the surface of the salt-water level (Ghyben-Herzberg principle). The surface of this lens is at variable depths according to the height of the islands, and it is this level which has to be reached for village wells and cultivation pits.

Theoretically the salinity of ground water gradually decreases from the beach on the ocean side, and from the beach on the lagoon side to the centre of the island. Nevertheless, fresh or almost fresh water points may be found near the lagoon or near the ocean. Figure 9 gives the results of some of our observations on the salinity of underground water on Bikenibeu island, Tarawa Atoll. Eight wells were dug from one side of the island to the other, from which water samples were taken. The salinity of these samples was assessed by the practical and quick method indicated by Doak C. Cox (1951). The distribution of salinity is obviously related to the distribution of the vegetation. In Bikenibeu, for instance, the latter is as follows:

Ocean side: Scaevola, Messerschmidia and a few Pandanus

Central area: Guettarda, Pandanus

Lagoon side: Pemphis, Rhizophora and a few Pandanus

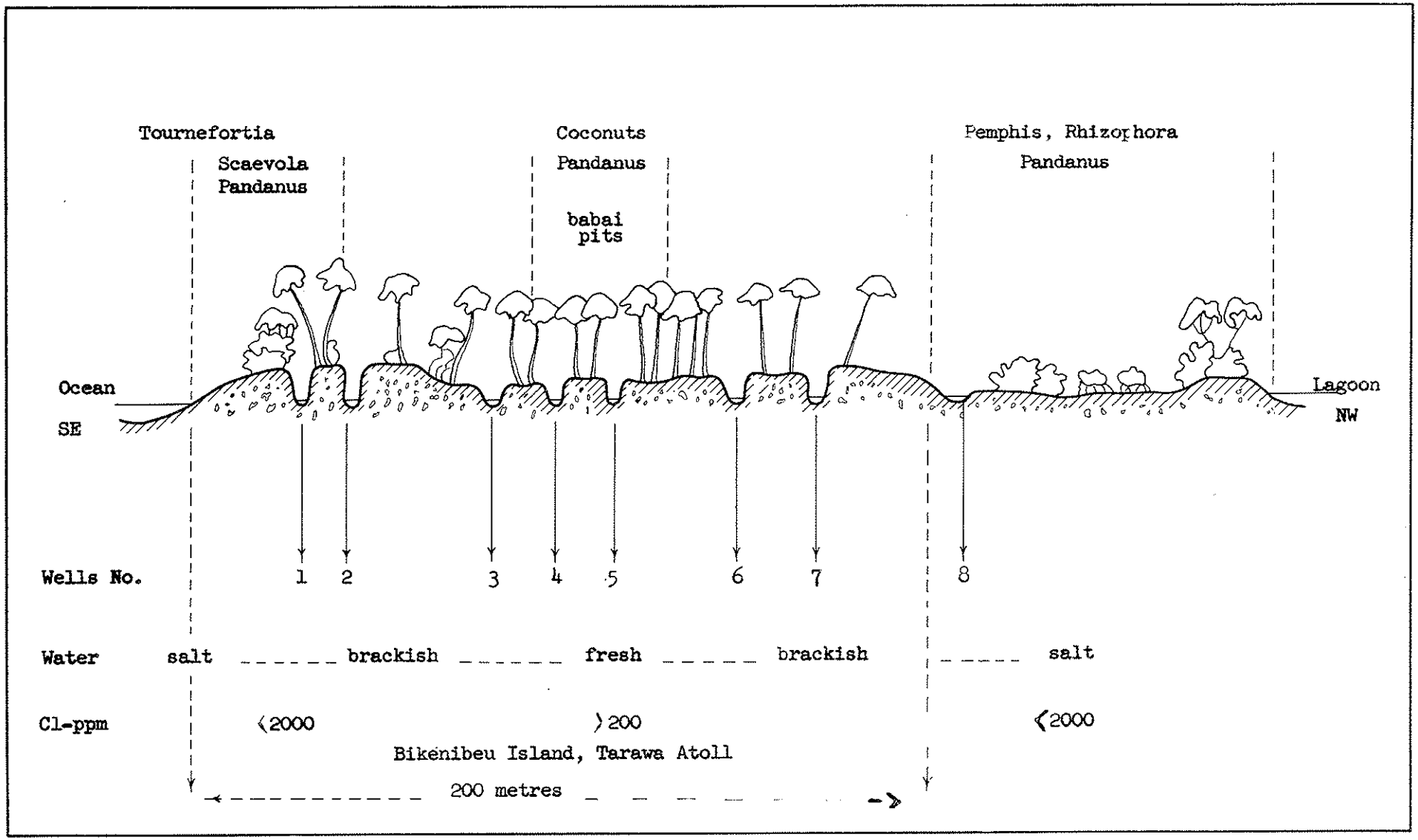
These three areas have also differing values from the agricultural point of view, as mentioned earlier:

Sparsely planted coconut palms on the rampart, on the ocean side - medium quality soil;

dense coconut palm plantations in the central area - good quality soil;

sparsely planted coconut palms on the lagoon side - medium quality soil.

Figure 9


Tournefortia
Scaevola
Pandanus
Coconuts
Pandanus
babai
pits
Pemphis, Rhizophora
Pandanus
Ocean
SE
Lagoon
NW
Wells No.
1
2
3
4
5
6
7
8
Water
salt
brackish
fresh
brackish
salt
Cl-ppm
〈2000
〉200
〈2000
Bikenibeu Island, Tarawa Atoll
200 metres

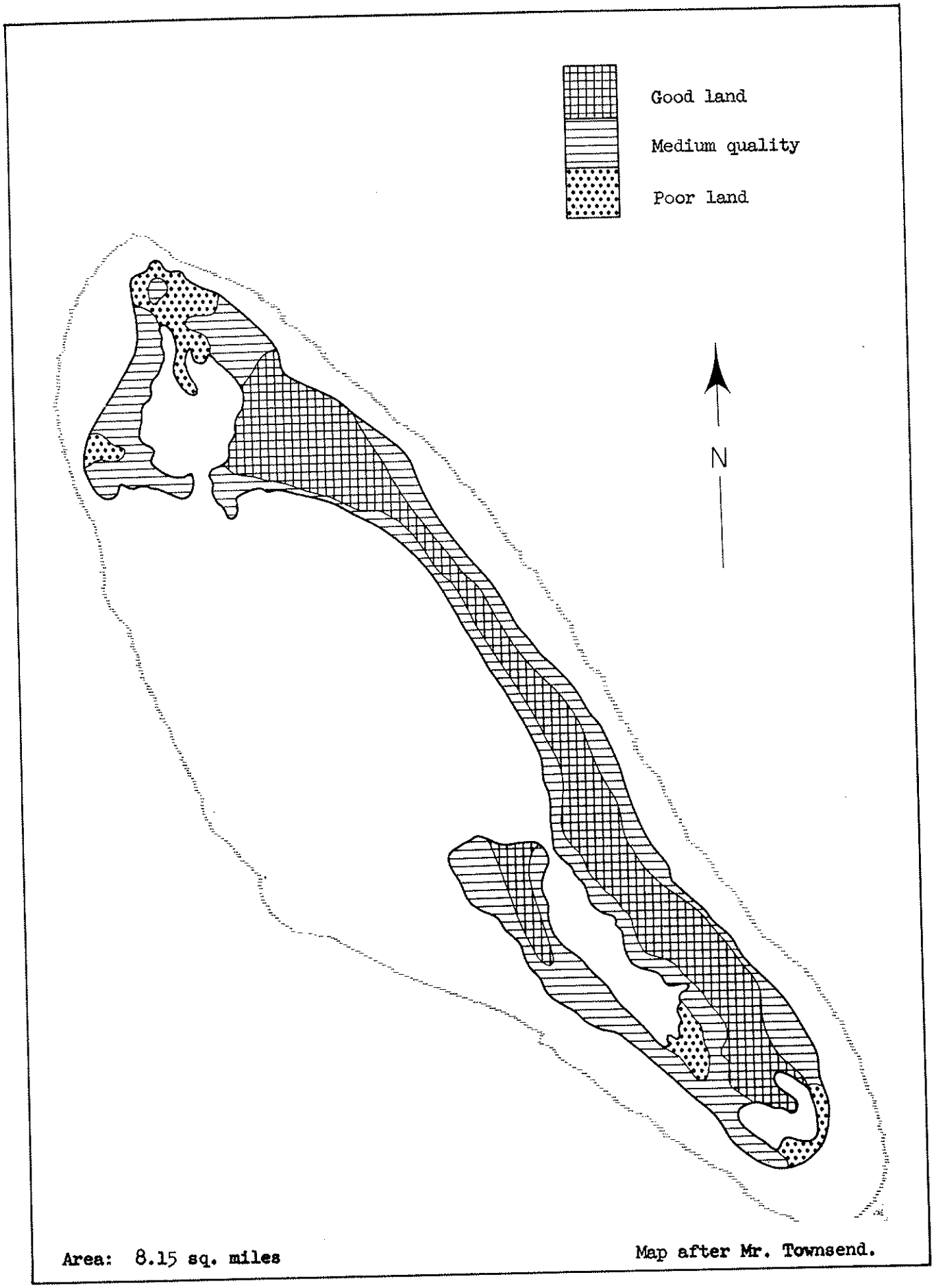


Fig. 10 Land classification, Beru Atoll.

The accompanying map (Fig. 10) made by Mr. Townsend for Beru Atoll, confirms the validity of this classification.

On reef islands the situation is different. The rocky platform is apparent at or very near the surface in the central area, where, furthermore, the soil is mainly made up of coarse components, coral gravel. But one cannot generalize. If we consider the particular case of islands such as Nikunau, with central brackish ponds, the qualities of coconut plantations in time of drought are distributed as shown in Figure 11. The proximity of the brackish ponds may provide sufficient water for the coconut palms. We were able to observe a similar phenomenon on Arorae, where coconut palms were stronger at one end of the island because they were planted near a swamp with a little stagnant brackish water.

The difficulties which roots may find in reaching the underground water level are due to the occurrence, at a variable depth, of a more or less hard layer which prevents their penetration. It is doubtful whether this would be a "hardpan" in the proper pedological sense. In fact, we have seen in most cases on reef islands, a rocky platform - a sort of coral "breccia" - which appears to be the reef platform upon which the island was built up. Alternatively, sometimes there are layers of cemented sand or gravel in the underlying C horizon, in most soils. From a certain depth, the sand grains or pebbles may be literally stuck together. This aggregation impedes the growth of the roots only if it occurs at a level near the surface. More often, the level of such layers is sufficiently deep, sometimes even deeper than the water level, and in these cases the roots easily get their water supply, capillarity even helping the water to rise.

On the Gilbert Islands we have never seen a hardpan originating from an illuviation and which might have been compared, because of such origin, with a "Caliche" or "Ortstein".

Thin salt crusts can, however, be found on the surface of certain open areas during droughts. Such phenomena are neither general nor frequent enough to have any real practical importance.

Mention should also be made of the case of phosphate "rocks" found on some islands, at a shallow depth (10-20 cm) often under a horizon with a high content of organic matter, in particular Guettarda humus. They appear to be built up by shell or coral debris bound with a phosphatic cement, possibly due to the leaching of surface guano. The brown-red colour of these very localised formations, for instance on Bikenibeu, Tarawa Atoll, is quite characteristic.

Finally, in the case of profile 4, Fig. 6, the grey compact layer may impede the penetration of roots. However, at the time when this profile was studied, this layer did not appear to be an obstacle to their water supply, owing to capillary action.

These difficulties of root penetration are of real importance chiefly during droughts, when roots are literally "chasing" water. Indeed, it is common to see in certain soils a succession of penetration levels corresponding

with the variations of sub-soil water level. When the rains occur the existence of a more or less waterproof layer may enable a temporary reserve to be built up. This is often sufficient for the roots; in fact, it is sometimes even harmful.

As for the water capacity of Gilbertese soils, Mr. Cassidy has very rightly observed that it is higher than could be expected, because of the many interstices of the coral fragments and shells which make up most of these soils. A special case is that of the reef islands, where, while the yield of coconut plantations will vary according to the rainfall of the season under investigation, during a drought period the coconut palms around the central ponds will be in better condition than those along the shore. During periods of abundant rain the situation is reversed.

It should be mentioned that the freshness of the water may, under the influence of various drought factors, give way to sufficient salinity to make the water undrinkable or noxious to cultivated plants. A radical change of this kind has often compelled natives to move their villages. (Eita, for instance, on Tarawa Atoll.)

Organic Matter

Organic matter is of capital importance in this hypercalcareous environment. .This is so true that, with the exception of the coconut palm which in the Gilbert Islands cannot be rightly considered a cultivated plant, agriculture in these islands is in fact "pot-cultivation".

How else could the babai pits be described, with their baskets woven around the plants, carefully and regularly filled up with vegetable mould gathered under the Guettarda or other species providing a good supply of humus, with leaves of Artocarpus, Sida, and other plants? This also is the case for banana pits and the holes where breadfruit trees are planted. And if the coconut palms in the villages give a good yield it is due for the main part to man and his refuse. The fact that European vegetables may be grown in the soil of cultivation pits as we observed in the Gilberts and as Stone reported on Arno, is mainly due, we believe, to the organic matter content.

In light and calcareous soils the decomposition of organic matter by oxidation is particularly rapid. Unfortunately the present sources of organic matter, without which there can be no agriculture, are only dead leaves and humus, which are found in comparatively limited quantities. In this connection, it should be mentioned that the Gilbertese habit of defecating in the sea, while satisfactory from the point of view of hygiene, is one of the causes of the impoverishment of these atolls and islands. One man produces an average of 486 kg. excreta per year, containing 27.6% of organic matter. An investigation should be made on the extent to which human excreta could be utilised to meet this essential need of Gilbertese agriculture for organic matter.

Utilization of human excreta as an organic fertilizer would require its collection and preparation without danger of polluting the water used for

drinking purposes; the destruction of the pathogenic germs it contains, before utilization; and its protection from flies in the manure pits used and the prevention of the multiplication of these pests.

All these are conditions which appear rather difficult of achievement in the Gilbert Islands as long as techniques for using human manure with the necessary hygienic guarantees are unknown. The use of part of the excreta mixed with compost could, however, be contemplated. The setting up of "collective compost pits", away from villages (on the rampart on the ocean side for instance) would then have to be considered. These pits could be made of a lime mortar platform with low walls, the effluent going to the sea.

The composts would be made of layers of plant fragments on which would be spread a moderate quantity of excreta collected in covered pails used in the village. The fermentation of the whole at a high temperature (55° C for several days) could eliminate part of the noxious elements in the compost.

In the coconut groves, too thorough cleaning of the ground, tending to keep it free of all fallen palm leaves would in our opinion be a mistake.

In addition to the physical usefulness of this careless "mulching", which reduces evaporation, the plant fragments strewn on the soil under the coconut palms are a considerable source of organic matter and fertilising elements, although their decomposition is sometimes slow.(1)

Also, the trees capable of providing natural humus should be protected, particularly Guettarda speciosa, the most frequent source of mould essential for growing "babai" (Cyrtosperma).

As for green manures, continuous experiments should be undertaken to discover herbaceous legumes which could be grown in the Gilbert coconut groves. The few experiments we made in this field in Bikenibeu during our too short stay in the Gilberts did not meet with great success. However, it might be possible to use some self-sown legumes growing on the coral sand beaches in other islands of the Pacific. The absence of nodules on the roots of young plants of legumes introduced by us, led us to think that the seeds might require inoculation with cultures of symbiotic bacteria.

Iron

On calcareous soils, chlorosis is a frequent occurrence. But in some islands, the native custom of placing fragments of rusty ironware in the holes prepared for their Artocarpus and other cultivated trees is sufficient to prevent it. If a more efficient control of chlorosis were necessary, the spreading of iron salts (e.g., sulphate) on the soil could be contemplated.

Fertilizers and Trace Elements

The deficiency in nitrogen which may be found in the soils of these islands could be corrected by organic manuring (see above).

(1) Nitrogen and mineral substances represent 8.5% of the dry weight of dead coconut leaves (Copeland).

As for phosphorus and potash, as far as could be judged from the observations and numerous tests made, deficiencies appear to be infrequent. Thus it seems that, if the organic matter content of these soils is sufficient, from the chemical point of view they can provide acceptable conditions for cultivated plants suitable for this environment.

In any case, before contemplating the use of chemicals, available local fertilizer sources should be considered, such as:

(a) Fish and fish debris, which decay very rapidly in the soil. The average composition of fish meal is as follows:

% Organic Nitrogen	4 - 10
Phosphorus pentoxide	5 - 6
Potash	0.5 - 1

However, it is problematic whether the native, who fishes only to provide himself with food, would do so also to fertilise his crops.

(b) Algae, including those of the fish ponds, which could be used after having been washed by rain.

(c) Ashes from coconut husks which contain about 30% potash.

(d) Phosphate "rocks" found here and there on some islets.

To sum up, the main features of the soils in the Gilbert coral islands and atolls are:

1. An excessive calcium carbonate content which results in:

(a) A high pH in the superficial horizon, often close to 8 and sometimes even higher;

(b) A quick destruction of organic matter;

(c) Trophic disturbances, chlorosis, affecting many cultivated plants.

2. A large sandy, gravel, or rocky fraction, comprising the greater part of the soil, composed of coral and shell debris, which owing to its porosity, is characterised by a water-holding capacity relatively high for such coarse components.

3. The existence of fresh water in the shape of very localised "lenses" hydrostatically balanced on the surface of the brackish water resulting from the infiltration of salt water.

These characteristics result in a very special method of soil utilisation which will be briefly studied later on.

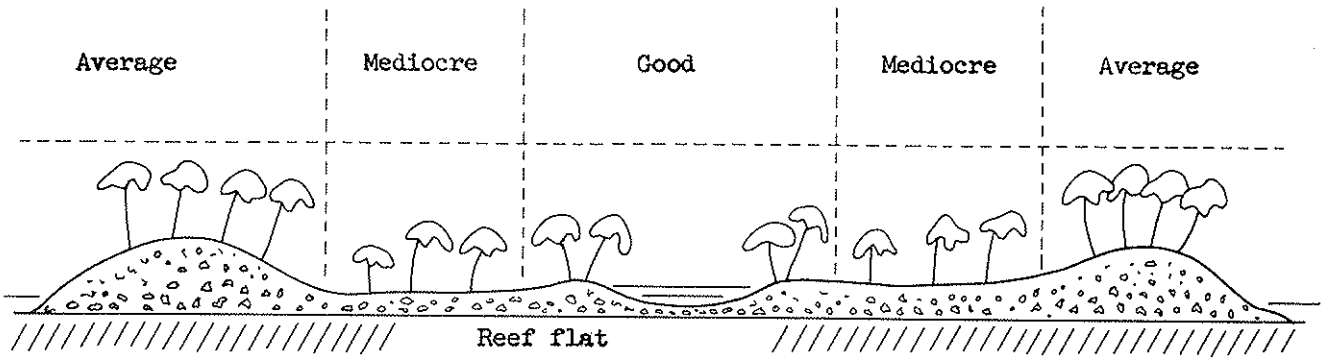


Fig. 11 Relative value of coconut groves in drought season on the Reef Island Nikunau.

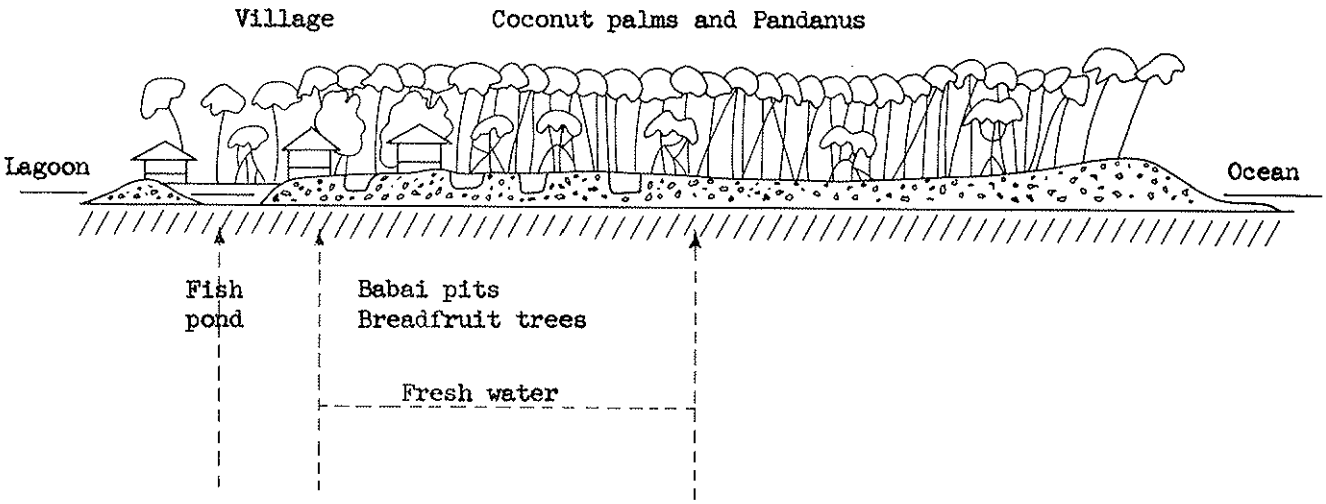


Fig. 12 Cross-section of atoll islet showing typical location of main economic plants.

From the pedological point of view, the soils on the atolls and coral islands considered are either lithosols or regosols, i.e. they are characterised by an indistinct differentiation of horizons, which are sometimes almost non-existent, and a prevailing rocky (lithosol) or sandy part (regosol) (see identical findings by Mr. Stone on Arno).

There are two food plants which are naturally adapted to the poor conditions of coral islands. These are the pandanus and coconut palm. For his other food plants (babai, breadfruit tree, banana) the Gilbert Island native practically has to make the soil in which they are to grow justifying our description of agriculture in these islands as "pot cultivation". Details of cultivation of these will be considered farther on in the appropriate chapters.

Thus, while the greater part of the land area can be used for the pandanus and coconut palm, owing to their adaptation to the particular conditions of atoll or coral islands, other crops depend entirely on fresh water, just as does man whose villages will be grouped where it is to be found.

The sketch in Figure 12 shows roughly the distribution of the various methods of soil utilization on a coral atoll.

Land Classification

The preceding section gave a rough classification of Gilbertese lands, based chiefly on the density of productivity of coconut plantations; these are practical criteria which we found convenient during our investigation.

It seems possible, however, to suggest here the following system of classification according to criteria which we have selected, viz:

(a) Depth of the soil in the superficial horizon, and its organic matter content.

(b) Nature of the coral components (sand, gravel, etc.) which make up the soil structure.

(c) Nature of the sub-soil water (fresh, brackish, salt).

In terms of these criteria, good quality land may be a deep soil with a well-developed "A" horizon rich in organic matter, parent material for the greater part of sand, ground water fresh to slightly brackish; medium quality land may be a deep soil with an "A" horizon of medium development, and a moderate supply of organic matter, the parent material sand and gravel, ground water slightly brackish to brackish; poor quality land may be a thin soil layer resting on a rocky platform near the surface where it may show in places, the composition of the soil being for the most part gravel or coarse sand, poor in organic matter, ground water brackish to salt.

Good quality land will be used for cultivation pits or will bear coconut groves with a good yield. Medium quality land will allow of the cultivation of the coconut palm with a reasonable yield. Poor quality land will be unfit for any useful crop. An illustration of the possibilities of the application of this classification is given in Figures 9 and 10.

CHAPTER 3

THE PEOPLE

This is not the place for a detailed account of the Gilbertese people. It will be enough to recall that it is the final result of many migrations, the history of which is still far from certain. The Archipelago is on the edge of three great divisions, Micronesia, Polynesia and Melanesia, and it is considered that the Gilbertese form a bridge between these various races, but that their affinities bring them nearer to the Micronesian stock. In short, the present population of the Gilbert Islands is the result of a real inter-mixing of populations of extremely varied origins, which is well reflected in the many different types and complexions found.

Administrative Organization

The greater part of the administration of the Gilbert Islands is based on an organization in which the natives play an important part. Each island has its native government under the supervision of a trained visiting administrator. This administrator does not deal directly with legal matters, which are handled by the native courts before being submitted for revision to the Resident Commissioner. Each of the local governments discharges its duties under the direction of a native magistrate who presides over the court composed of a council of elders (Kaubure). Each village elects one or more Kaubure according to the size of its population. The magistrate is assisted by a few subordinate officials, chief Kaubure, "scribes", etc.

This system of local government in the hands of natives with European supervision has proved excellent, since the administration has relied, according to the region, either on the descendants of former chieftains' families or, in the southern islands, on men selected for their character, who form the assembly of "Old Men".

It should be noted that natives who have been educated either in Suva or locally are eligible for administrative, medical or teaching posts. A few selected natives may even, as was recently the case, reach the higher rank of Assistant Administrative Officer. It should also be mentioned that two of the three missions receive subsidies from the Government for the schools founded and operated by them.

Demography

It would seem that the Gilbert Islands, where the soil is so poor, and which suffer from recurrent severe droughts, should have a small population. We observe, on the contrary, a very high demographic density. The population of the sixteen islands of the Group amounted at the time of the 1947 census to 27,824, or an average density of 243.9 per square mile. This figure is just given as an average and does not claim to have any great demonstrative value as, in fact, the density varies considerably as between one island and another. Thus Tamana has 441.5 per square mile while Aranuka has only 61.3

TABLE II

Population Statistics 1950 Gilbert Islands.

	Approximate population on 12-31-50						Marriages			Births						Age at Death					
	Natives		Europeans		Asiatics					Natives		Europeans		Asiatics							
	Men	Women	M	W	M	W	Natives	Europeans	Asiatics	M	W	M	W	M	W	Less than 1 yr.	1 yr.	2 to 9	10 and more	Europeans	Asiatics
Makin	486	420	1	-	1	-	11	-	-	36	22	-	-	-	-	4	2	2	13	-	-
Butaritari	1774	730	2	2	1	1	14	-	-	31	42	-	-	-	-	3	9	3	31	-	-
Marakei	727	806	1	2	-	-	7	-	-	34	32	-	-	-	-	11	6	5	18	-	-
Abaiang	1319	1137	4	7	-	-	25	-	-	18	25	-	-	-	-	2	1	4	34	-	-
Tarawa	1956	1746	39	43	4	2	42	-	-	45	32	1	-	-	-	7	7	7	50	-	-
Maiana	657	580	1	-	-	-	10	-	-	16	17	-	-	-	-	3	2	1	14	-	-
Abemama	687	794	3	4	6	4	5	-	-	13	20	-	-	-	-	3	-	-	14	-	-
Kuria	206	221	2	-	1	-	2	-	-	8	11	-	-	-	-	7	-	-	2	-	-
Aranuka	88	135	-	-	-	-	1	-	-	8	8	-	-	-	-	9	5	1	3	-	-
Nonouti	1256	1290	1	2	-	-	20	-	-	33	23	-	-	-	-	15	-	-	16	-	-
Tabiteuea	2006	2226	4	3	-	-	23	-	-	69	101	-	-	-	-	39	23	27	154	-	-
Beru	1001	1154	6	6	-	-	27	-	-	36	41	1	-	-	-	11	3	6	21	-	-
Onotoa	753	940	1	-	-	-	9	-	-	25	34	-	-	-	-	-	1	-	14	-	-
Nikunau	970	942	1	-	-	-	21	-	-	40	28	-	-	-	-	20	3	-	19	-	-
Tamana	441	651	-	-	-	-	12	-	-	19	19	-	-	-	-	19	-	1	10	-	-
Arorae	725	851	-	-	-	-	18	-	-	32	28	-	-	-	-	8	3	4	21	-	-
	14052	14623	66	69	13	7	247	-	-	463	483	2	-	-	-	161	45	65	432	-	-

The most recent population figures supplied by the Administration of the Gilbert Islands at 31st December, 1950 are presented in Table II.

The high demographic density of these populations clearly demonstrates that the Gilbertese is perfectly adapted to the conditions obtaining in this environment, where he makes use of almost all the resources offered, at least from the variety, if not from the quantity, point of view. One may add that these living conditions, daily problems of food supply, and animal and plant resources, have obviously created in this race of such varied origins, a characteristic Gilbertese pattern of customs and physical and mental life.

From the physical point of view the Gilbertese are generally robust, with excellent muscular strength, but with little resistance to prolonged strain. In spite of the drought which had just occurred when we arrived, most of them were rather fat - a result of the high nutritive value of toddy, according to local medical officers.

The same medical officers state that health in the Gilbert Islands is generally good, that tuberculosis is the most serious disease and that the comparatively high tuberculinic index shows the absolute necessity of methodical detection and would justify not only the carrying out of a continuous programme, but also a great increase in the number of medical officers. It is typical that investigations carried out in 1929 already showed, in the Gilbert Islands, an estimated figure of 30% of deaths from tuberculosis alone. The head of the Health Department in Tarawa also gave a very high figure of positive reactions. However it is not our task to discuss this question here.

The Gilbertese are clean and healthy, the more so from being clad sensibly, that is to say in keeping with the climatic conditions of their country. They are extremely sensitive to the slightest fall in temperature, which explains the fragility of their respiratory system. It seemed to us that natives wearing only the ancestral riri, and whose bodies are continually exposed to sun and wind, show less sensitivity than those who are over-clothed or who - mostly women - because of acquired prudishness, go as far as swimming or fishing with all their clothes on, afterward remaining for a long time exposed to the inevitable cooling influence of the almost constant breeze.

From the psychological point of view we neither wish nor pretend to analyse the Gilbertese mentality after staying only six months with them. A stay of many years and a thorough knowledge of the language would be required for that. We shall, however, give some brief personal impressions which may throw light on the comments we shall have to make in this survey on the behaviour of the Gilbertese when confronted with certain problems of an economic nature.

The Gilbert Islanders generally appear to show sharpness only when defending their ancestral rights to land plots, which is quite logical. But they are not so astute regarding money, not enough, one might even say.

They like money, of course, but spend it with remarkable facility, and too often on items of doubtful usefulness. However, they do not like begging (with the exception of the bubuti custom practiced among natives) as do so many primitive peoples in other parts of the world. On the contrary, when they give a present because custom requires it, they are really vexed if a return gift follows so soon that it might be regarded as a payment. For the pleasure of being hospitable or of demonstrating sincere feeling, they do not hesitate to spend sums of money which are large in comparison with their small salary or budget. We are embarrassed when we think of the cost of the telegrams of good wishes spontaneously sent to us in New Caledonia by Gilbert Islands natives.

The Gilbertese are proud, but very approachable, and pleasant to deal with. Their native distinction often finds expression in kind actions which are all the more touching from their being nearly always perfectly disinterested.

Another aspect of their nature is their total confidence in others, both in moral and material dealings. We also appreciated their independent spirit and their frankness, which is often disarming. Their answers, whether positive or negative, are always direct. But the Gilbertese' forthrightness does not preclude a form of respect devoid of obsequiousness. His often unexpected reactions are never arrogant, and are a corollary of his independent, individualistic nature, as are his teasing spirit and fanciful mind. Both are expressed in choreographic attitudes, in which mimicry always has a deserved success. Finally, these people have a highly-developed artistic sense, and it would be difficult to find anything to equal some of their extraordinarily beautiful choral singing. It is really in their dances and choral singing only that the Gilbertese express the whole genius of their race, and can give rein to an exuberance which, because of a surprising modesty, is no longer manifested in the ordinary course of their everyday life.

The Gilbertese are an intelligent people. Many show real pride in having risen above the general level, but it did not seem to us that this was ever expressed in a contemptuous or even haughty way. Those working with Europeans are generally avid to learn and to understand everything, and are full of gratitude for whoever may have increased their knowledge, even about their own territory.

The bubuti custom will at times be mentioned in this report. It plays too important a part in the individual economy of the Gilbertese to be passed over entirely. It consists of asking a man of means, or a man who suddenly finds himself well supplied with money, various items recently acquired or even with gifts, for some part of his riches. We were told that there are three degrees in bubuti. At the first, the request can easily be evaded. This is more difficult at the second, while at the third, one has to meet the demand. One among many other examples: a Gilbertese comes home after one or two years' work with the British Phosphate Commissioners. He has earned 8 pounds per month, with practically no expenses. He brings back a tidy sum of money, various items bought recently such as cloth, a sewing

machine, a bicycle, fishing gear, watches, fountain pens, and stick tobacco. Close and distant relatives eagerly welcome him and, through the bubuti, proceed to take what they fancy. The opulent one is in a short time stripped of practically everything. One of the victims told us that the only way of avoiding this family octopus was to state that such an item had been bought for the father, another for the mother, and so on; in this way, the owner can still share with them the use of the "reserved" items.

It is thus easy to understand how money is bound to be squandered, and how amounts, which if kept intact, would have a high purchasing power, do not retain any great value when shared among so many spongers and can be used only for futile purchases at the neighbouring store.

With regard to the physical activity of the Gilbert Islander, assuredly he is not lazy. There is no laziness in a people who in the past carried out such hard work as the digging and excavating of babai pits with extremely sketchy implements, and who today still spend most of their time actively seeking their food supplies at sea, from the soil and at the top of coconut palms. Neither are the Gilbertese indolent in the sense of being sluggish or apathetic. They are indolent simply in the sense that they adjust themselves to the climate in which they live. Like all peoples living in sandy countries, they rest during the hot hours of the day, and stretched on the floor of their open-sided huts, wave to the white people passing through the village, thinking them eccentrics for cycling for miles when the sun is so high. They prefer to spend nights fishing on the reef flats by torch or lamp light.(1)

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(1) The Gilbertese is secure in his home environment, there are usually adequate coconuts and pandanus on his lands and fish in the sea to meet his frugal dietetic requirements and by cutting copra to provide for his needs from the store. There is little need or incentive to accumulate wealth for its own sake. Their mental approach to life is "why work if you don't have to?"; they are perfectly content to sleep the days away. On the other hand, and as Dr. Catala points out, they are equally prepared to work really hard, as has been shown by the excellent reputation they have earned working phosphate and stevedoring ships at Ocean Island and in the Labour Corps during the war. Well led - not driven - they can be most industrious. It is, therefore, certain that as workers away from their homes they are as good as most, but that at home their needs are too simple and their way of life too traditional to be able to induce them to work industriously.

A further factor which should be mentioned since it retards commercial development, is the reluctance of a Gilbertese to work for or to teach another. This is a result of excessive independence and individualism and means that a large landowner is unable to employ others to work his lands for him and is only able to get members of his family to work them. To a certain extent the master/servant problem is being overcome by employment through the Co-operative Societies, but the reluctance to teach each other is an even more restrictive practice and means that an expert cultivator, or fisherman or maker of handicrafts will not spread his knowledge and is only prepared to pass it on to his family shortly before his death. This problem will only be overcome by more advanced education.
(Note by the Administration of the Gilbert and Ellice Islands Colony.)

The Gilbertese Community

It seems necessary to add some brief information on the Gilbertese community in order to describe in greater detail the background of the various activities covered in this survey, and because the Gilbertese necessarily have the prevailing if not the exclusive role in such activities.

Villages

Villages (fig. 13) are spaced out at distances which vary considerably according to the islands. The houses stand on both sides of the road, or on one side only when there is too little space between the road and the lagoon. These villages comprise groups of from fifteen to fifty huts, sometimes more. The dwellings, built entirely of material from the coconut palm and pandanus, are most often slightly raised on coral blocks brought from the reef flats on the ocean side. In the southern islands, this elevation is occasionally very great (Plate IIa).

Some of these huts have an additional story (Plate IIb), which is reached by a small ladder. Generally, each house shelters one family only.

In an open space in the village, and standing out among the other buildings because of its size, the maneaba, or community house, is the meeting place of the notables - the "Old Men" - and it is used more generally for all the group manifestations of native life. It also serves as a temporary shelter for visitors. For others it is merely a road-post. These buildings sometimes are of considerable size, as shown in the photograph of the Little Makin maneaba (Plate IIc), one of the largest native buildings in the Gilbert Islands. In building these maneabas - as indeed any other house, or a canoe, even of the largest size - not one nail or screw is used. Mortise and tenon are never used and pegs are the exception. All main and secondary parts are assembled and held together with coir cord (Plate IId).

Other buildings in the village include canoe sheds and canoe-building shelters. Finally, a few pigsties are located in the shade of trees, outside the village on the inland side. Some are built of coconut trunks, others of landing strip matting, a reminder of the war (see Plate XIIIa).

On the lagoon side, buildings are set on piles. Some, small and of fragile construction, support a floor used for fishing at high tide, when they are completely isolated in the water. Others, more strongly built, jut out over the water, and are connected with the shore by means of a frail gangway of coconut logs. These are Gilbertese privies, but they are sometimes used for several ends. They are something of a salon, incomers and outgoers exchanging small talk with the occupier, while a fishing enthusiast who has been unable to find room on the fishing platforms is quite happy to use this excellent promontory (at high tide, of course).

The village is kept extremely clean and enlivened by flowers planted around the houses. They are mostly imported plants, some valued for their fragrance, others for the beauty of their blooms and still others because

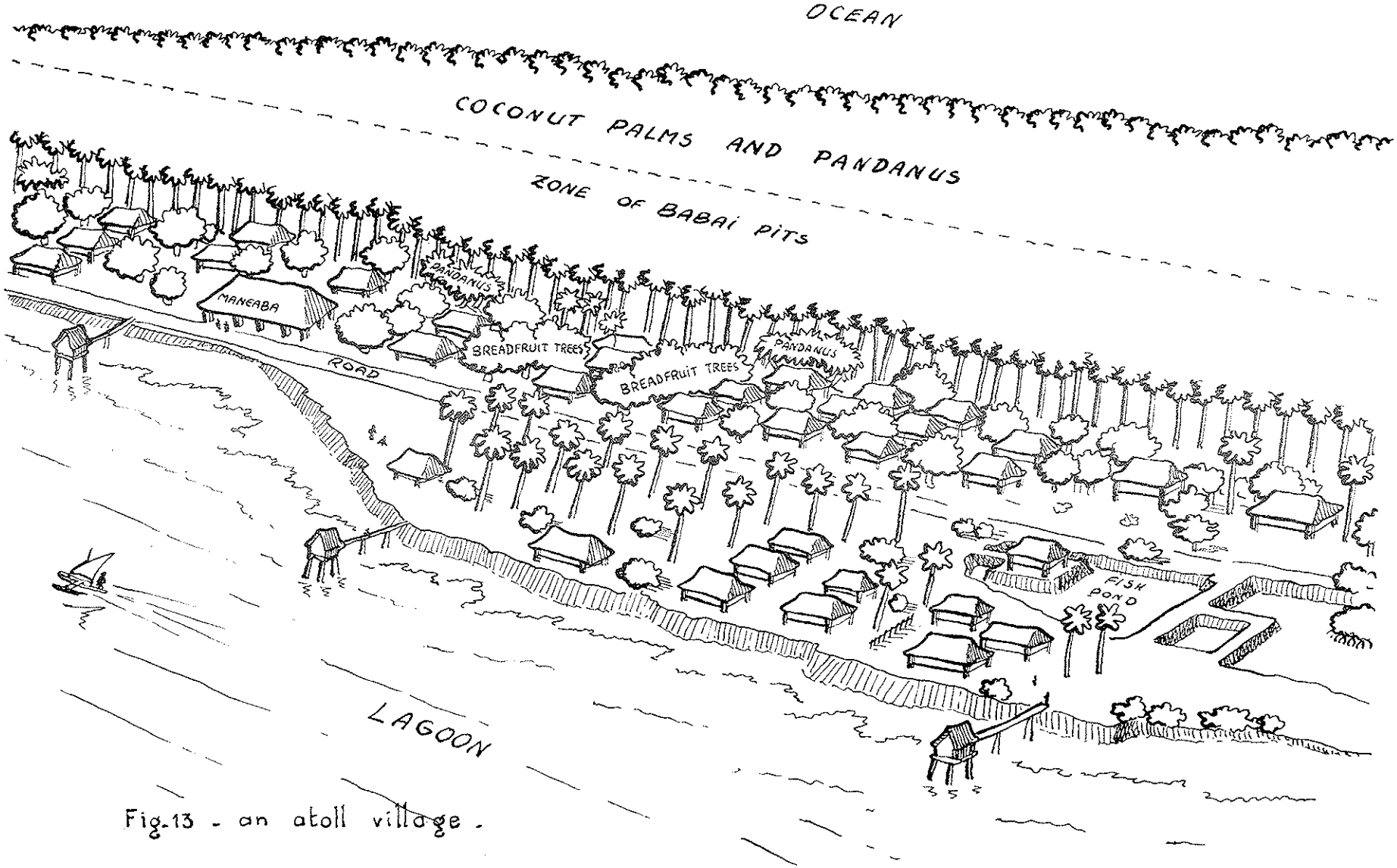

Fig-13 - an atoll village -

they do not wilt easily. This last point is important since the making of leis and ornaments for dances holds a very large place in native activities.

In the villages of the southern islands, and in particular on Nikunau one sees, usually around the huts, side by side with pumpkins, numerous tobacco plants. The dried leaves provide a rather poor substitute for stick tobacco when the latter is lacking or there is no money to buy it.

Finally, plants growing to a good height also shade or decorate the Gilbertese village: coconut palms, pandanus, breadfruit trees, pawpaws, tamanu, and a few trees or shrubs of no economic value as poincianas, acalyphas and oleanders.

Land Tenure

Almost all the land in the Gilbert Islands belongs to natives and cannot be sold to anybody else.

The establishment of land registry has made real progress only since 1939, when it was decided to appoint a Land Commissioner, while in 1948 a native land court was set up to assist the Lands Commission in clearing up an extremely confused situation caused by incessant disputes among natives, the confusion being made still greater by the extreme fragmentation of properties. However, this land registration work is said to be virtually completed in seven of the sixteen islands in the Group.(1)

We were told that in the past the Gilbertese did not live in villages, but that each family lived on its land (or rather on one of its pieces of land). It is possible that the inhabited plots were much better tended than they are now. We know that the authorities, far from opposing a return to past conditions, would possibly be ready to encourage the natives to live on their properties, but it is unlikely that, being now used to community life, the natives would, of their own accord, return to the earlier scattered mode of living.

Emigration

A young civil servant in Betio told us half seriously and half in jest: "The best produce of the Gilbert Islands is the Gilbertese, considered as labour outside the territory". With the exception of Ocean Island and Nauru, which do not take him far from his environment and where the general conditions are very similar to those in his own territory, we do not think it would be such a good thing for the Gilbertese to migrate too far and to countries where general conditions are too different from his own.

(1) There is no central Land Register, and each island keeps its own Register. As regards the Lands Commission, it would be more correct to say that real progress was first made between 1935 and 1937, when Mr. Kennedy completed settlements on four Ellice Islands and Mr. Maude carried out a settlement on Ocean Island. However, Dr. Catala is dealing only with the Gilberts and I do not think it can be claimed that real progress was made in that Group until the Commission was reconstituted in 1947.
(Note by the Administration of the Gilbert and Ellice Islands Colony.)

We were told that many of them were always ready to go, not out of necessity but curiosity, and because upon their return they would have an obvious superiority over the others. They like to travel - just like many people everywhere - rather for the attraction of things new than from any compulsion. Therefore, the word "exodus" would not correspond, in reality, to any intention or imperative need. However, greater numbers of Gilbertese might leave if some among them were specialized in a trade, but few or none are.

The most recent absentee figures made available to us were: at the phosphate works, 452 men; at Christmas and Fanning Islands, 150; and a dozen scattered on Canton and other islands. Nearly all of them are contract labourers who are only temporarily away from their home islands. The number of women and children accompanying them totals approximately 350.

CHAPTER 4

THE COCONUT PALM

GENERAL

The coconut palm, Cocos nucifera L. reaches 20 m. or more in height. Like all monocots, it has no tap root, but a radiating, much developed root system, the roots being constantly renewed. This is the reason why the palm is so flexibly attached to the ground, and so resilient to winds. Authors are not agreed on the number of leaves of a normal tree; 25 to 35 seems a reasonable figure. It is generally accepted that it is necessary for the coconut to grow in a light, deep soil, indispensable for the good development of the root system.

Standing water is nefarious and so is impervious substratum. The coconut may be regarded as a halophilous plant, because of its tolerance of salinity, but salt is not indispensable. There is a limit to this tolerance, beyond which the survival of the plant is endangered. The needs of the coconut palm for atmospheric humidity and rainfall are as great as for groundwater. It can be grown successfully on all sorts of soils, including the very highly calcareous ones of the Pacific coral islands.

Flowers: The inflorescence is enveloped in a sheath, the spathe. Toward the end of its growth, this splits along its whole length and the spadix, covered with buds, appears. The larger buds are female flowers, the smaller, male. The flowers of both sexes mature at different times, which prevents autofecundation. Fertilization is realized by crosses between trees.

Fruits: A longitudinal section of a mature coconut shows from outside in:

A - epidermis
B - mesocarp (fibrous husk)
C - Endocarp (shell)
D - kernel including oily endosperm and small cylindrical embryo
E - cavity which contained the liquid(1)

Productivity: It is usually accepted, that, under optimum conditions, the first fruit appears about the 6th or 7th year. Actually, under normal conditions, a planted coconut tree begins useful production about the 10th year, and full production about the 15th year. In the best physico-chemical conditions, and under cultivation and care, a coconut may remain productive until its 70th year and even further.

Life-span: Generally, the productive life of a coconut palm can be compared to human life in length.

(1) This liquid, rich in potash salts, is erroneously referred to as "coconut milk"; it would be much more accurate to call it "coconut water", because true "coconut milk" is a white milky liquid expressed from grated fresh coconut kernel and used as an indispensable ingredient in the preparation of many Pacific island foods and sweetmeats. (Ed.)

Yield: Various authors, especially J. Adam (1942) give as generally accepted as normal, averages of 5,000 to 6,000 nuts for one ton of copra, with extreme figures of 3,500 and 8,000. Adam also indicates as normal a copra production of 5 to 8 kg per tree per year.(1) It must be kept in mind that these figures refer to planted coconut trees.

PART I: THE COCONUT PALM IN THE GILBERT ISLANDS

Except for the very small number of coconut trees truly planted in the agricultural sense of the word, the immense majority of the palms covering the Gilberts often form a real forest rather than a plantation. This does not invalidate the remark of Turbott (1949), that most of the coconut trees of the Gilberts were planted by man. If planted means putting in place a sprouted coconut, then it can be accepted that the coconut forest has been at least in the beginning planted by man. This intervention has been less obvious as times passed and now there is a much greater proportion of spontaneous trees than "planted" trees. This will be better understood further on when the "cultivation methods" for coconuts are studied.

The height of old coconut palms ranges from sixty to eighty feet. The latter figure is rearely exceeded. Generally, the palms along the ocean shore, and even more those along the lagoon shore tend to lean outward, while those in the interior are straight. Some authors think that this leaning is not due to the wind, but to a tropism to light. The intense reflection of light from the water, especially on the lagoon side, and from the sand, intensify this effect.

The palms on the ocean side show a much less abundant leaf system than those in the centre and on the lagoon side. There are seldom more than twenty fronds. The fronds are much damaged by the spray which "burns" part of the pinnae, especially during drought periods, and the palms have a fairly consistently lower production of nuts.

The coconut palms in the central area form thick stands practically everywhere. These stands are not always only of tall palms. Young coconut palms, occasionally in large numbers, grown from nuts sprouted where they fell, are found with palms of all ages and conditions, as are also representatives of species of trees, shrubs and low plants. This jungle generally starts forty to fifty meters back from the rampart (ocean side) and covers an area proportionate to the width of the island. It is sometimes so dense that it is difficult to walk through (Plate IIIa) especially when it is also choked up with heaps of dry fronds and the trunks of dead palms.

On the lagoon side the "forest" of palms becomes slightly thinner. This is mostly due to the road common to all these islands, and to the cleaning which is done on either side of it to a distance of 8 to 10 m. The strip

(1) A coconut palm, under optimum conditions, is capable of producing well over 100 nuts a year, but, at 55 palms per acre, an annual yield of 4,500 nuts per acre may be taken as a very good plantation average. (Ed.)

of land between the road and the lagoon is sometimes very narrow, only a few metres wide. The coconut palms sheltering it are generally less close together than anywhere else.

Our first impression on arrival in these islands was extremely painful. Except in a very few privileged areas, the coconut palms reflected tragically the effects of an intense drought which had lasted almost two years. Over considerable areas on many islands, even on those of the northern group reputed to be the least affected, the rusty-yellow leaves seemed burned by the sun. Others, dry and still attached, were hanging down the trunks which were sometimes entirely covered (Plate IIIb). The almost complete absence of nuts added to this sad picture. Most palms either did not bear any nuts at all or they had extremely small or atrophied ones. Nevertheless, an unopened spathe appeared here and there. Only palms near the villages which they shelter, and some others under very exceptional conditions, still bore just enough coconuts to deserve their names.

The return of the rains enabled us, less than two months later, to form a much better impression. Almost daily rain, often very abundant, rapidly changed the dismal picture into a comforting sight; the fronds were green again; inflorescences were numerous but generally did not set fruit.(1) The inflorescences which then followed in rapid succession, also failed to set, as could be seen from the abundance of small nuts, te nimoimoi, slightly bigger than hens' eggs, strewing the ground in greater numbers every day. Later inflorescences in spite of continuing heavy rains were more successful, and less than six months after the beginning of the rains, most trees bore numerous nuts at various stages of development.

Thus, our last impression of the Gilbert Islands was the opposite of the first. Without appearing over-optimistic, we could give a most favourable forecast for the coconut crop to be gathered in under a year, even in the islands of the Southern group. Although there, the recovery was noticeably late, and perhaps proceeded more slowly, the rains were abundant and distributed over a long period; they were not completely over when we left and it was generally felt that the westerlies, expected to blow in October, would again bring some more rain, making a good crop more certain.

One of the characteristics which force themselves on the attention of an observer when examining coconut palms in the Gilbert Islands is the extraordinary development of the root system high above ground level (Plate IIIc) found in most trees. This phenomenon illustrates the need for these trees

(1) It is interesting to note that the same observation was made after the great drought of 1924-1925. In the "Handbook for Atoll Research", Pacific Science Board, National Research Council, May 18th, 1951, p.10, appear these few lines taken from the Annual Report for these years (no. 1369, 1928): "The drought then broke and the coconuts which had ceased to bear, put out fresh spathes of blossom. When the spathes opened, however, rains fell with such torrential force that the young blossom was beaten from the stalks and, though the palms throve, the first coconut crop was a failure."

to build a sort of pedestal of roots to strengthen their base because the nuts they come from simply rooted where they fell or were not planted deep enough. Such development practically never occurs on palms grown from seedlings transplanted under good conditions. Root formation along the trunk occurs also in cases of natural layering of coconut palms which for various reasons have bent towards the earth, and then started growing upright again (Plate IIId). Such cases are not exceptional in the Gilberts and even such grotesque trees have great vitality and bear many leaves and nuts.

A great many trees have at their bases and slightly above ground a number of additional roots, issuing from breaks in the bark. These breaks may be due to the influence of a parasite, but it is also possible that they may be the result of the natural growth of the roots, intended to strengthen the palms. This consolidating might be rendered necessary by erosion of sandy places where winds can easily blow the soil away. Such hypotheses are concerned only with a small number of cases. Still other trees show at heights up to 2 m. ringlike swellings, with young roots appearing where the bark cracked. Other palms had lost their bark all around the stipe on a width of several dm., and were encased in sleeves of matted roots. We have no satisfying explanation for these phenomena, which may be due to parasitic effects. Similar root production is the rule where the bark has been damaged by fire.

We observed a very large number of palms that should have been felled, as they were too old, sterile or so rarely productive that their existence was not justified. These useless palms either occupy space necessary for younger specimens, or crowd productive palms. Often the density is so high that the palms get in each other's way both at the base and summit. Some are choked, others cannot spread, and this condition can only lower the general yield, especially when the tangle is increased by the luxuriant and usually uncontrolled growth of the shrub and tree species of the undergrowth. (1)

The question of spacing seems to us to be of great importance. In some areas we were able to verify to what extent normal spacing, resulting in a reasonable number of coconut palms for a given area, could be beneficial to the trees. Good examples are the palms of the Makin School in Abemama and those on the site where the future Bikenibeu school is to be built. In spite of the irregularity of their distribution (Fig. 14), the latter will be given as an example of normal density. Table V lists the number of fronds and nuts borne at a given time by each of these 138 palms. The total number of palms in the whole area is more significant than the excessive proximity of some of the palms at the base; in fact it often happens that when the bases of palms are almost touching their summits are quite far apart.

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(1) New Gilbert Islands Regulations will provide for the establishment of Agricultural Committees. Through these organisations it is intended to plan a drive on cutting out over-age trees. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

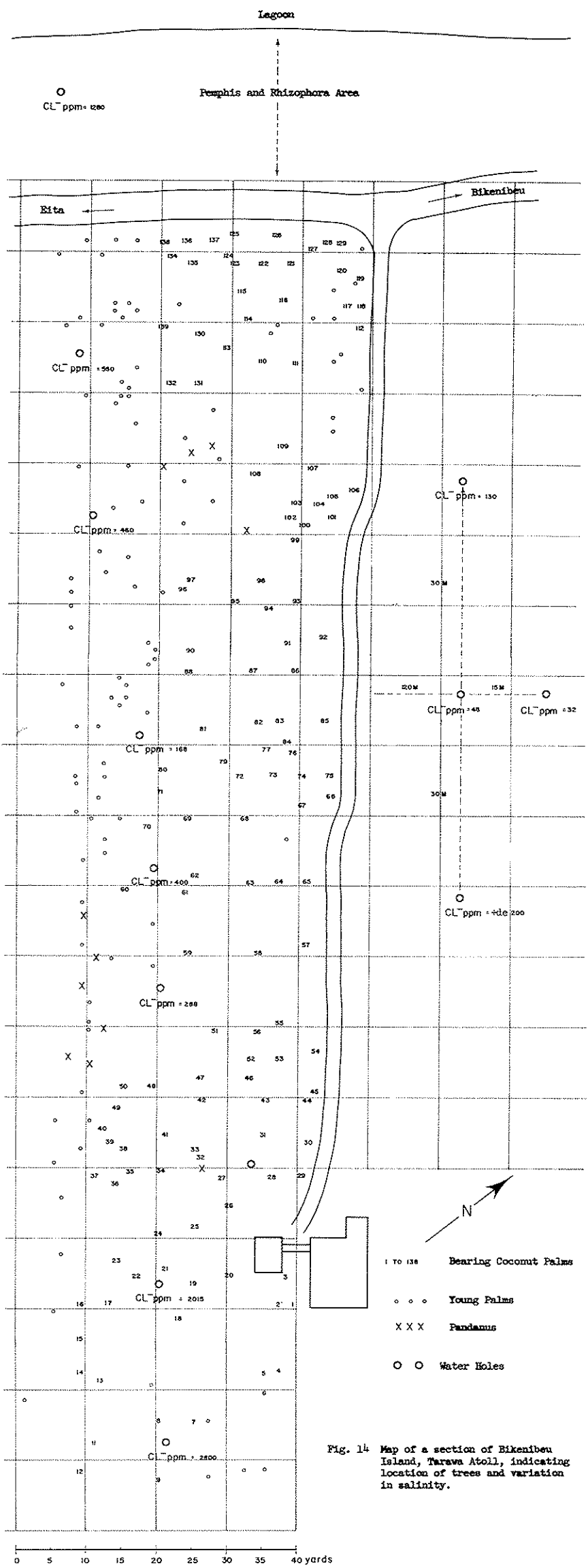


Fig. 14 Map of a section of Bikenibeu Island, Tarawa Atoll, indicating location of trees and variation in salinity.

This needed adjustment of the crowns is realised readily thanks to the easy bending, curving and later straightening up of the palms. But this balance can be achieved only if the palms are approximately of the same age and if they are not too numerous, which unfortunately is not always the case.

The most frequent picture is that of coconut palms of all ages; the youngest suffer from too much shade and cannot develop unless old palms die and make room for them. But only a few palms profit by this natural replacement; while a great many more are hampered by excessive density. At a distance from such tangles, areas will often be found where the coconut palms have been destroyed by fire and the plants of the bush have spread, forming shrubby vegetation. These observations apply to a lesser or greater extent to all islands in the Group.

Coconut palm varieties

The natives of the Gilbert Islands recognize some varieties showing really different characteristics. In Tarawa for instance, where we were able to make a careful study of these characteristics, the natives first divide coconuts into two categories according to whether the mesocarp is edible (te bunia) or inedible (te ni)(1), a characteristic of some palms and not of certain stages of the development of the fruit (Plates IVa and IVb).

In each of these groups the coconuts are then arranged according to the colour of the epidermis, two colours only being taken into consideration: green and orange.

The varieties with edible mesocarp are:

Te bunia uraura - pale yellow-green with orange tinge

Te bunia roro - pale green

The varieties with non-edible mesocarp are:

Te ni uraura - yellow-green orange

Te ni roro - true green

A few essential characteristics of the varieties will be found in Table III. Unfortunately we did not have enough nuts at our disposal and had to be content with three nuts at the same stage of ripeness (moimoto), which were however gathered on palms typical of each variety and from the same locality. It would indeed have been difficult to ask the natives to take too many nuts from their individual stock, which was limited after the drought.

(1) Synonym Te ni: the coconut palm in general.

A few remarks concerning these varieties are necessary:

1. It seems possible to connect the "te bunia" with their edible mesocarp with the "Saccharina" variety of Miquel (cf. Baas Becking 1949).

2. The use of colour only as a criterion makes it rather difficult to separate varieties especially in the case of "te bunia uraura" and "te ni uraura", which have almost the same colour. A specialist would have to study in greater detail this delicate question of coconut varieties, and we recommend that such an expert should visit the Gilbert Islands.

Gilbertese terms for stages of coconut development

The importance of the coconut palm in the life of the Gilbertese people is such that they have a comparatively rich vocabulary for it. For each stage of growth of the palm or the nut there is a special term, some of which terms will be used in the course of this survey. It should be added that some confusion seems to prevail in the works of some authors on the exact meanings of certain words in this special vocabulary.

It can be noted (Fig. 15) that the arrangement of the various growth stages of the nuts corresponds somewhat to a normal growth curve. We recorded the weight of nuts and quantity of liquid found at each successive stage. It may be noted that the greatest volume of liquid corresponds to the moimoto stage, and that the nuts are gathered precisely at this stage if they are intended for drinking purposes. The same table finally indicates the pH measured by colorimetry for the water of four nuts at each stage.

The palm itself would be called on Tarawa, for instance, by the following names:

Te riki	-	Germinated nut
Te uto	-	Stemless coconut seedling with only a tuft of fronds visible above ground.
Te ene	-	The palm when the trunk is beginning to appear.
Te kaikai	-	A palm which has not yet borne flowers or fruit.
Te ni	-	Productive coconut palm.
Te ni nikawai	-	Very old palm bearing only a few small fronds.

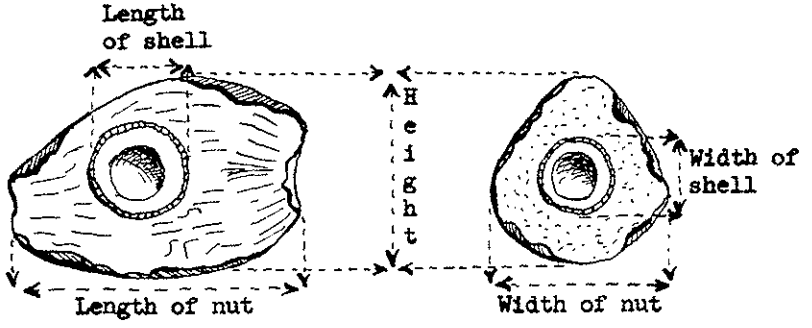
Abnormalities

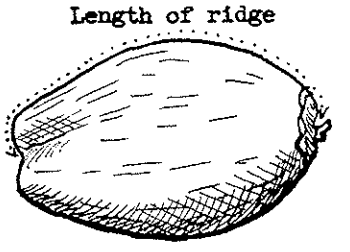
Three abnormalities may be mentioned:

I. Inflorescences are sometimes found which are not ramified and form a simple spike instead of several as is the rule. This anomaly, called ne mori, (Plate IVc) involves all the inflorescences of a single palm. The nuts reach maturity. This is quite certainly an abnormality, not a variety.

TABLE III. Varieties of Coconuts on Tarawa Atoll.

Categories	Nuts with edible mesocarp: te bunia						Nuts with inedible mesocarp: te ni					
Varieties	Uraura			Roro			Uraura			Roro		
Color of epidermis	Light yellow-green with orange tinge, almost white at the base			Light green, almost white at the base			Green-yellow orange, pure green at the base			Green		
Color of persistent tepales at the base of the nut	Dark green fringed with orange			Green, fringed with yellow			Green, broadly fringed with orange			Green, fringed with orange		
Dimensions of 3 nuts of each variety	1	2	3	1	2	3	1	2	3	1	2	3
Length of ridge 1 in cm	28.7	27.5	27.5	30.5	30.0	29.5	25.6	26.2	24.3	29.3	29.3	29.3
Length of ridge 2 in cm	30.0	30.0	29.3	30.5	30.5	29.5	28.7	28.7	26.2	29.3	30.0	28.7
Length of ridge 3 in cm	30.0	30.0	30.0	31.0	31.0	29.5	29.3	29.3	26.8	30.0	30.0	30.0
Circumference of nut in cm	51.2	52.5	50.0	48.0	51.5	50.5	45.0	45.0	42.5	47.5	50.0	47.5
Length of nut in cm	18.0	19.5	19.5	22.4	22.0	21.6	17.8	21.2	17.7	21.0	17.8	18.7
Height of nut in cm	15.5	16.5	16.3	15.0	15.3	15.5	12.8	12.8	12.0	14.8	15.3	14.8
Width of nut in cm	15.0	15.3	14.0	15.3	16.9	15.5	14.4	14.5	13.3	12.0	15.0	13.0
Thickness of mesocarp in cm	3.2	3.2	2.7	3.4	3.0	3.0	2.0	2.0	2.0	2.7	2.0	2.7
Thickness of endocarp in cm	0.35 to 0.40	0.35 to .40	0.35 to .40	0.25 to .30	0.25 to .30	0.25 to .30	0.20 to .25	0.20 to .25	0.20 to .25	0.25 to .30	0.25 to .30	0.25 to .30
Length of shell in cm	10.5	10.5	10.5	10.5	10.5	11.0	11.2	11.8	10.5	11.8	11.3	11.2
Width of shell in cm	10.5	10.5	10.5	9.0	8.8	9.0	8.7	8.8	8.5	9.0	10.0	10.0
Weight of whole fruit in g	2,405	2,601	2,265	2,375	2,570	2,405	1,868	1,952	1,583	2,120	2,405	2,092
Quantity of water in ml	440	475	426	320	334	340	381	391	323	430	505	459
Color of inflorescence and very young fruit	Light yellow almost ivory			Very light green			Yellow			Light green		
Color of rachis of young palm leaf	Yellow orange			Green			Yellow orange			Green		





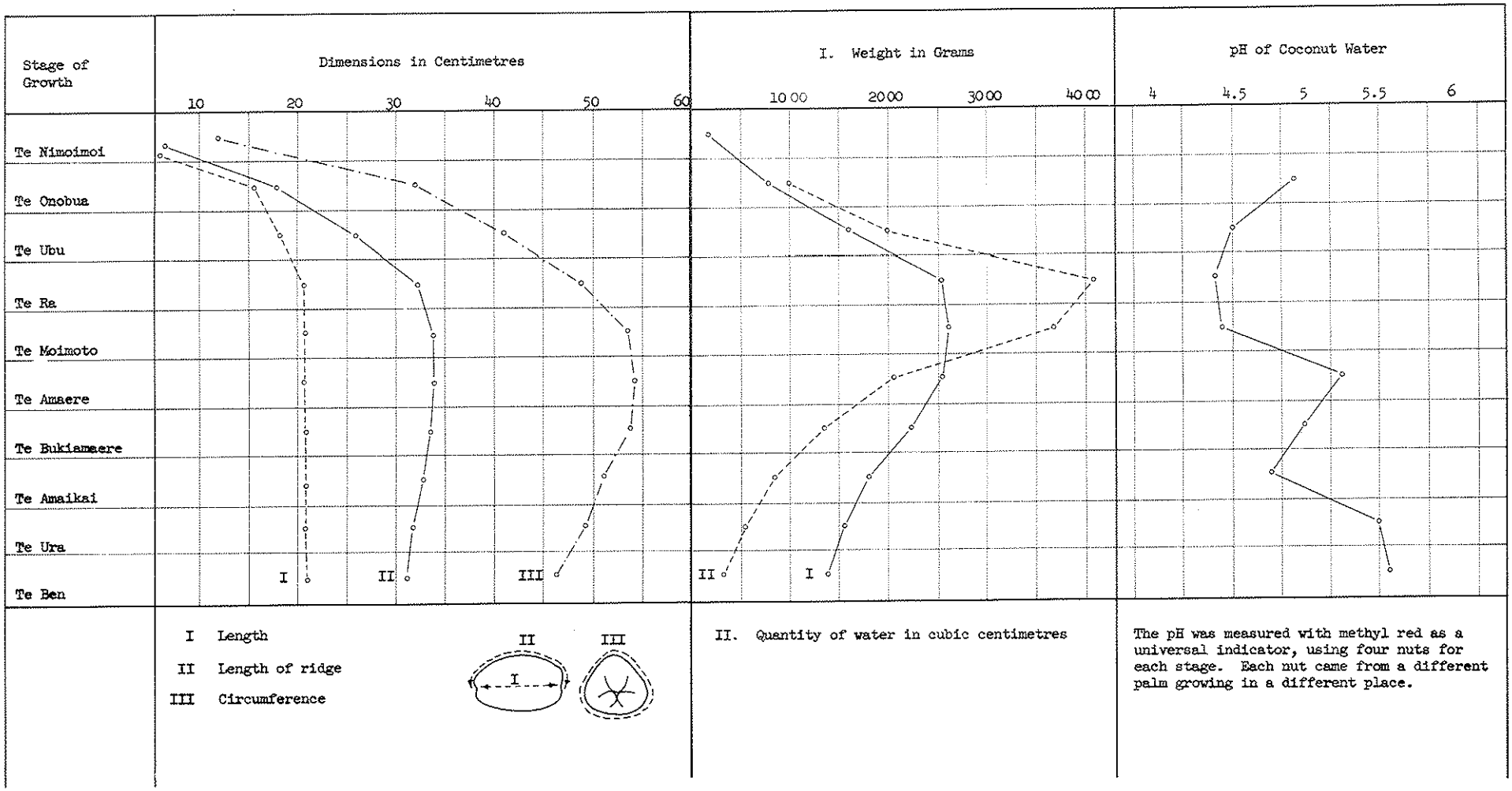


Fig. 15 Coconut palm variety "Te Ni Roro" Tarawa Atoll. Characteristics of the different stages of growth of the nuts.

II. Te wae (Plate IVd) are aspermous nuts, without hard endocarp, in which the fibrous mesocarp occupies all the space with the exception of an extremely reduced central cavity. These nuts are always very long. A curious fact is that the same palm may bear at the same time bunches of te wae and, from other inflorescences, bunches of normal and fertile nuts.

III. There is a teratological case which, while extremely rare, should nevertheless be mentioned, first because of its strange character, and second because of its connection with the harbourage of pests.

The first characteristic is that the leaflets cannot open because on one side there is a strip which fits into a slot on the opposite side of the leaflet. The second characteristic is that each leaflet shows in its proximal part two successive folds at a very acute angle. The aspect of this fasciation (Plate Va) reminds one strongly of the Elaeis with "welded leaflets" (Elaeis Dybowskyi Hua), called "Fadé" in Dahomey, but this is only a comparison of general appearance since we have here a sterile teratological coconut palm and not a variety fixed and fertile as for "Fadé". The term "welded leaflets" is inappropriate in both cases, because the leaflets are normally formed secondarily by the splitting of the blade, and here remain more or less united.

Such palms should be ruthlessly destroyed since they are homes for pests, each closed leaflet sheltering a great quantity of Decadarchis and other microlepidoptera not yet identified.

Dwarf Coconut Palm - Coco Niño

A few trial plantings of dwarf coconut palms have been made from small numbers of nuts: three dozen in 1949, six dozen in 1950, and quite recently again about the same number. It is, of course, impossible to draw any conclusion whatever from the few young palms grown from the two first consignments. These had been planted too recently, and were very widely distributed, under very varied conditions.

Pests

Generally speaking it can be stated that coconut palms in the Gilberts are at present free from the worst pests, except for those listed below and also a very tiny psychid which causes very little damage, and an undetermined borer which burrows in the blade of the leaflets and pupates under a fine silk layer near the main vein. Although these larvae can be very numerous on some trees, they do not seem to affect them. The same is true of the trees carrying a rather large number of Coccidae. The palms in the Gilberts are free of Brontispa and rhinoceros beetle.

Lepidoptera:

Decadarchis sp. (Lyonetiidae). Common in all the coconut groves of the Gilberts, but the damage does not seem cause for worry. These insects are

never very numerous on one tree, except in the aberrant palms whose fronds do not unfold, where they occur in extraordinary abundance, due to the protection they are afforded. The palms immediately around these may be more infected than those far away.

Coleoptera:

Diocalandra frumenti (F.) (Rhynchophorinae). This weevil, although fairly generally distributed in the Gilberts, does not create the kind of spectacular damage wrought by the closely related species D. tahitensis (Guérin-Meneville) in other regions of the Pacific. It was never found in great numbers, but in groups of a few individuals under the bark of the trunk, where the larvae and pupae are easy to find. They were often found on small nuts fallen on the ground who had failed to set (te nimaimoi).

Pentodon or Papuana sp.(1)(Scarabaeidae). This beetle has been tentatively identified as Papuana hübneri Fairm. by M. R. Mason (of Suva), as Pentodon australis Blackburn by Bryan and by Swezey as a small relative of the coconut borer (Oryctes sp.?). More specimens are evidently needed, we had only one male and one female, sent to Honolulu. The natives say that this insect bores into the tubers of babai and it was found easily by us (and later by R. Mason in the same part of Tarawa) on the bases of banana plants. The insect is said also to attack young coconut palms but we were unable to verify this. P. Lepesme (1947) says that Papuana woodlarkiana Montr. (for which he gives many synonyms, but no P. hübneri) is reputed to attack young coconut plants, burrowing into the ground and destroying the plants at the base of the stem.

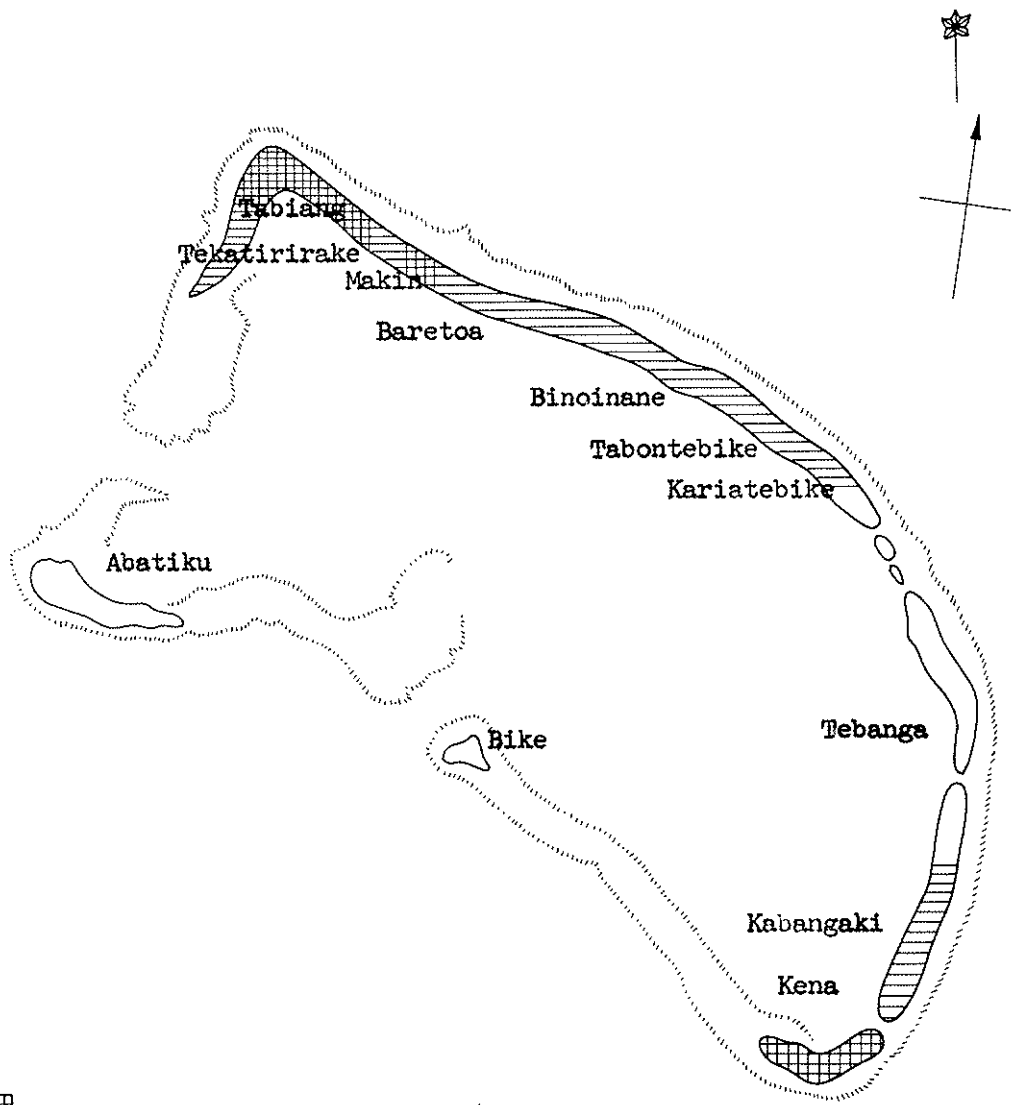
Orthoptera:

Graeffea cocophaga (New.) (formerly called Lopaphus), Phasmidae. Native name: te rokati (rokati, pronounced rokass is undoubtedly a distortion of "locust"). This insect has caused much damage to palms on Abemama and is a serious threat for the rest of the area.

Damage: The leaflets of the fronds are in the beginning marked by indentations at first rather far apart. As the blade is eaten between them, there remains finally only the vein. The eggs laid by insects clinging to the hanging part of the frond roll in the trough formed by the main vein of the frond and those of the leaflets, and fall on the ground at varying distances from the tree. Some must roll in the opposite direction, that is, toward the base of the frond, and make control of the pest difficult. Many weeks after the laying, the eggs hatch and the young insects climb the nearest palm trunk.

(1) According to Dr. O. L. Cartwright Pentodon australis Blackb. is now regarded as a synonym of Metanastes vulgivatus Olliff, found in Lord Howe Island, New South Wales and South Australia. Papuana hübneri Fairm. is found on Duke of York Island and New Britain. They are not especially restricted in food habits. - Ed.

Fig. 16 Extension of Graeffea cocophaga New. on Abemama Atoll.



History: In Sabatier, 1939, p. 36 we read: "Two pests are prospering: a long-bodied locust imported from Hawaii, which eats the leaves of the coconut palms in Abemama...." (the second pest is the beetle discussed above). We met the author, of the Sacred Heart Mission, now living on Tarawa after 40 years on Abemama, who gave us some valuable additional information: he told us that Graeffea is said to have been introduced from Hawaii or from Kusaie to be shown to the natives as a curiosity about 10 years before his arrival, therefore about the beginning of this century. He wrote: "I - the pest which eats the leaves of the coconut trees had its center in the last village to the north, Tapiang, and stretched for 3 to 4 kilometers along the road. II - Another point attacked was a little to the north of the village of Takatirika, the second village from the north. III - A third point at the south end, in an islet called Kena. There may be other points of lesser importance."

Present conditions: During our stay in Abemama we tried to make as complete a survey as possible. Here are the results:

I - Graeffea infests the atoll from the northern tip near Tabiang to a few hundred meters beyond the village of Tabontebike. In the village itself at Tabontebike, it is interesting to note that the palms were not attacked by Graeffea, while less than 20 meters away on the other side of the road a great many trees had many visible parasites. Perhaps the smoke from cooking fires and some other factors disturb the insects in the village.

II - At the other end of the atoll, the center of infestation observed by Sabatier on Kena islet has extended to the next islet and spread for about 2 km. Kena itself is completely infested. It seems that all over this islet, the damage is worse than anywhere else (in percentage of trees and fronds damaged). The map (fig. 16) speaks for itself. To justify the importance we give to this pest we can quote other authors. Froggatt (1914) quotes Wyatt Gill on an invasion of this pest on the Hervey Islands "An invasion of these voracious insects is almost as much dreaded by the Islanders as a plague of locusts in the East. - I have seen immense groves of coconut palms destroyed in a few months by this species of phasma...". Simmonds and Copeland also report cases of sudden propagation of this insect, which we had seen ourselves in other regions of the Pacific (Catala, 1948).

In Abemama the infestation is not as much of a catastrophe as that described by Wyatt Gill, but the fronds of the palms are damaged and the yield of nuts must be affected. It can always be feared that a combination of favorable circumstances may someday provoke a more serious invasion by this pest. We do not know any enemies of it, but there may be a parasite controlling it. It can especially be feared that Graeffea may migrate to other parts of the archipelago thus far all free of it. No one can predict the possible results of such a spread.

When we landed on Ocean Island, we observed on a large whale boat taking labour and freight ashore from the Tarawa ship, an acridian which, in the absence of accurate identification, would appear to be of the genus Catantops. During the next few days, we were to observe the very serious damage caused to the coconut palms of the island by considerable numbers of

the same insect. This "locust" has not yet been mentioned in the territory of the Gilbert Islands proper, and we have not observed it there.

Miscellaneous: The coconut crab (Birgus latro) does not cause very extensive damage. On the contrary, the rats do, and the damage is in proportion with the density of the plant jungle and also with the density of the palms of the variety te bunia with edible husks. In places we saw some tin sleeves intended to keep the rats from climbing the trunks, but this device is often not very efficient as the fronds of the palm to be protected touch those of other trees and rats can get from one tree to another this way. The natives do not seem to try any more active control, and it seems that a minimum of care would substantially reduce the number of rodents.

As for cryptogamic infections, they did not appear serious except for a limited area on Abemama where many leaflets were infected by Pestolozzia.

PART II: THE COCONUT PALM AND THE CLIMATE

Most of the manuals on the coconut discuss the optimum set of conditions for a rational and profitable cultivation. None of it applies in the Gilbert Islands. The coconut palms of low coral islands and those of the Gilbert Islands in particular, grow under special climatic and edaphic conditions, which, it should be said, are often mediocre, and they cannot behave like those giving a very high and more regular yield in more favoured regions of the Pacific where commercial cultivation prevails. On the other hand, the considerable size of the coconut groves and the great hardiness of the coconut palm in the Gilbert Islands make up for the poor conditions.

Response to Drought: While as regards rainfall one has to divide the archipelago into three groups, north, centre, and south, it would seem that as regards the behaviour of the coconut palm, these distinctions are less sharp, and might even be reduced to one group for the northern and central islands and another for the southern islands. It has also been indicated that the islands of the southern group were affected by droughts more than those in the centre and north. However, these latter sometimes pay a very heavy price for droughts, although the human population of these territories is not too severely affected.

From the extensive information we were able to gather on the spot, it appears that the production capacity of the coconut palm may be retained on an average for eighteen months after the beginning of the drought period. In other words, not only does the lack of rain have little bearing on the future of inflorescences which have already formed, but spadices continue to appear, and the ripening of the nuts will not necessarily be affected. Their size may decrease considerably (see Table IV of weights for Nikunau) but the meat will be well-developed and the quality of the resulting copra will not be affected. This "prolonged productivity" cannot be predicted and depends in fact upon conditions varying considerably from one place to another under the influence of basic factors (soils, moisture, degree of salinity of the ground water, etc.). It also varies from one palm to another according to individual characteristics.

TABLE IV

Size and weight of 50 Coconuts grown during period of drought on Nikunau, and the weight in ounces of the freshly cut coconut meats.

Nos.	Length in inches	Circumference in inches	Whole Nut Wt. in Oz.	Meat, fresh Wt. in Oz.
1	9	11.5	8	3
2	9	11.5	9	4
3	8	10.5	6	2
4	8.5	11	10	4
5	7.5	8.5	5	2
6	8	10	7.5	3
7	8.5	11.5	10	2.5
8	7.5	11	7	3
9	9	11	11	2.5
10	8.5	12	14	2.5
11	7.5	10	7	3
12	6.5	9.5	4.5	1.5
13	8	8	9.5	2
14	7	9.5	7	3
15	9	10	7	1.5
16	7.5	8	4.5	1.5
17	8	9.5	6.5	3.5
18	8	10	9	3
19	7	9	6	2
20	8	11.5	10	2
21	7	10	7	3.5
22	8.5	11	11	3.5
23	7	10	7	3
24	8	9	7.5	2.5
25	8	12	11	4
26	7	10.5	7	3.5
27	8.5	11	9	4
28	8	12	13	4.5
29	9	13	11	3
30	8	10	6	3.5
31	7	10	7	3
32	7	9.5	6	3
33	8	11.5	11	2
34	8	11	8	3
35	7	10	6	3
36	8.5	11	10	3
37	8	10.5	8	3
38	8	10	7	3
39	7	9.5	6	3.5
40	8	10	8	3
41	8.5	10	8	3

TABLE IV (continued)

Nos.	Length in inches	Circumference in inches	Whole Nut Wt. in Oz.	Meat, fresh Wt. in Oz.
42	7.5	10	7.5	3
43	7.5	11.5	7	2.5
44	8	12	10	4
45	8	10.5	9	3.5
46	8.5	8	6.5	2
47	8.5	9.5	7	3
48	8.5	9	6	2
49	8.5	8	9.5	2
50	8.5	9	6	2

Total weight fresh meats - 143 oz. or 4.054 Kg.

Total weight dry meats (copra) - 91 oz. or 2.580 Kg.

Loss of weight on drying - 36.35 per cent

19,380 coconuts required per ton of copra at Nikunau, Southern Gilberts, during period of drought, 1951.

As drought continues, the fresh water reserves in the sub-soil decrease and in the most serious cases they may eventually be exhausted. Such factors as sunlight and wind become adverse because they increase the loss of water from the leaves. The palms become less productive and finally not at all. But such is the extraordinary resistance of the palm, that even after weathering more than two years' intense drought and in the most affected areas, it is still able to produce inflorescences. The natives use these for the essential production of karewe (toddy) and stand in no danger of curtailing copra production by doing this, since, in most cases, the flowers would not have set or would have produced abortive nuts without any commercial value whatsoever.

It is obvious that the effects of drought are not felt everywhere in a territory with the same acuteness, and that the palms react differently according to age, individual characteristics, and, most of all, according to their location. Thus on each island there may be seen to a very great degree a replica of what was observed on another: coconut palms either killed by drought, affected to a high degree, or untouched or barely affected. A study of environmental conditions corresponding to these three categories of behaviour, and setting forth the relations from cause to effect, provides valuable information.

I. PALMS DYING FROM DROUGHTS

They are found under the following conditions:

(a) Palms on extremeties of islands, and on narrower strips of land between ocean and lagoon are particularly exposed to wind and salt spray. The ground level of corners of islands is, in some places, noticeably lower than the ridges parallel to the ocean and lagoon sides. The layer of sand is generally very thin, and the roots of the coconut are unable to penetrate very deeply, owing to the proximity of the rocky platform, and are especially close to sea water. The same conditions are realized when the strip of land around the lagoon is especially narrow (as between Bikenibeu and Bonriki on Tarawa). The promontories located at the edge of channels through which water enters the lagoon with each incoming tide and flows out at the ebb, are frequently unstable either from erosion by friction, or from deposition of considerable amounts of sterile coral shingle. All these factors contrive to render precarious (Plate Vb) the existence of the most marginal coconut palms and it is easy to understand that, in time of prolonged drought, they cannot resist. The same applies to other vegetation. The loss of these trees is relatively unimportant as they are of low productivity; they are mostly useful as windbreaks.(1)

(1) In the northern Marshall Islands, under similar conditions, the Marshallese commonly leave a strip of native vegetation to serve as a windbreak or shelter the plantation from wind and spray, and to prevent erosion. - Ed.

(b) Gravel zones, which are found at many points on most islands, comprise a surface layer of coarse coral shingle of varying thickness. This accumulation of detrital elements absorbs a considerable amount of heat, resulting in intense evaporation; this is all the more noticeable as, for lack of a cover of low vegetation, the immediate under-layer drains too rapidly. In normal times, the coconut palm grows with difficulty in these areas. It is quite obvious that it cannot resist when the drought extends over long periods.

(c) The occurrence of a hard substratum always constitutes a very important factor in the behaviour of the palms especially if this layer is so hard that roots cannot penetrate it. When it is at a relatively high level but still sufficiently deep for the root system to develop freely, the coconut palm draws upon the fresh water reserve accumulated above the hard layer. In times of prolonged drought this reserve is soon exhausted and the palm cannot survive.

(d) In addition to these usual causes of destruction of the coconut palm, accidental factors may also occur which have serious consequences only because they coincide with a period of extensive drought. Thus, considerable areas may be seen around the Marakei Lagoon where all the palms have died (Plate Vc) probably through the following combination of circumstances:

Although on a level only slightly higher than the highest watermark of the lagoon, these palms had successfully resisted previous great droughts as witnessed by their size and their age (not less than thirty years). They had of course been severely affected and each time must have been very near the limit of tolerance to salinity. The same thing happened again during the last drought, and then came an exceptional tide reaching a hitherto unrecorded level. Some even maintain that it was a tidal wave. In any case, the whole of the area was flooded for a few hours. Fresh-water reserves were practically non-existent and, as there was no compensatory correction for this sudden and massive excess of chlorides, the palms died in a large numbers.

(e) Destruction of coconut palms by fire is even more common, and affects much larger areas in time of droughts, increasing as the droughts become more intense. The hanging dry fronds of the palms are a great fire hazard (see below and Plate IIIb). Too often we saw large areas devastated in this way (Kena Island, Abemama, etc.).

II. PALMS AFFECTED BY DROUGHTS

The great majority of palms on the Gilbert Islands are affected, more or less, by the effects of prolonged droughts. We know that under normal conditions, the transpiration rate of the leaves is considerably higher among the fully grown ones, that is to say in the age group between the eighth

Especially privileged palms are those situated in the vicinity of the fresh or slightly brackish water wells. The presence of these wells was the reason why the natives chose these sites for their villages. They practically never dry up, and even at the end of long drought periods, when their level is very low and the water may have become brackish, the coconut palms draw as much water from the surrounding soil as they can, taking advantage of their exceptional position since digging the well has always necessitated breaking up the hard sub-soil layer thus creating an area of constant soil moisture.

To these factors we must add the important fact that village palms are spaced further apart than the majority of bush palms.

(b) Coconut Palms Beside Babai Pits: These palms usually grow on the embankment formed by the earth removed from the pits. Thus they benefit from the mixing of soil layers in a thicker amount of loose soil, and from constant water supply.

(c) Coconut Palms in Abandoned Babai Pits: A few rare individual palms thrive although surrounded by sterile coconut palms. Generally they are trees growing in old abandoned babai pits which easily reach the ground water lens, and in addition, profit from the considerable accumulation of organic waste in the bottom of the pit and of soil which has slid back into it.

(d) Coconut Palms around Inland Ponds: Each of the above categories contain only a relatively small number of trees while numerous coconut palms have the advantage of being in the more or less immediate vicinity of inland water pools which are sometimes quite extensive. For example, ponds in the region of Nikunau are approximately 1 km. long by 350 to 400 m. wide. During droughts the areas around these pools seem veritable oases, in the midst of general dryness. We were told that these palms are healthier and are productive only during droughts. It may be that, at such times, the water reaches a lower level more favourable to their root system, which is totally submerged when the level is higher. This theory is supported by the fact that coconut palms planted on dykes dividing fish ponds are extremely healthy (Plate VIb). According to the natives, palms growing on the edges of inland pools where there is always water, provide a kind of reserve for lean years, for their supply of nuts and toddy never fails. It should be stressed that the productivity of these palms is of little importance for copra production. Their use, and it is a valuable one, is to supply the natives of the area with considerable additions to their daily food supplies (karewe, moimoto, marai, etc.). They are also an emergency source of supply.

month after their expansion until the first signs of natural wilting. Therefore, it is the oldest leaves which use up most of the water reserves available to the palm. When a long period of drought arrives these reserves diminish, and the coconut palm gets rid of the now superfluous leaves at an accelerated rate. It is perhaps the very rapidity of this desiccation which makes these fronds hang from the palms for a long time instead of falling, sometimes covering the trunk entirely (Plate IIIb). We have observed up to twenty dry fronds forming a thick sheath around the stipe. This phenomenoa is more pronounced when environmental conditions are worse. This process reduces transpiration, therefore water consumption and the palms adapt themselves to a lower metabolic level. Thus, in spite of the length of the droughts, these palms succeed in maintaining a level of existence which enables them to survive until the return of normal conditions. Many of them retain all their life the imprint of these periods of extreme privation, as evidenced by a characteristic narrowing of the stipe, which attracts the observer's attention as soon as he arrives in these islands (Plate VIa).

III. PALMS WHICH APPEAR TO IGNORE DROUGHTS

These may be divided into four groups, as follows: village palms; palms growing at the edge of babai pits; palms growing in abandoned babai pits; palms growing around ponds and small inland lakes.

(a) Village palms. In the immediate vicinity of all sizeable centres of population we saw coconut palms, whose production, while not high, was still good. Their number is limited, they are in fact confined to a narrow belt around the village, with isolated specimens growing among the huts. Some of these sometime bear heavy clusters of nuts. We saw some which after two years of intense drought bore loads of sixty and even up to a hundred nuts (Tabontebike village on Abemama). In spite of the general cleanliness of Gilbertese villages some debris accumulate near the palms such as that from fish cleaning, shell fish preparation, animal excreta (dogs, chickens, and young pigs not yet kept in sties). The amount of such waste is not large, but is regularly added to. Thus every month, at fixed dates, hundreds and sometimes thousands of fish of the genus Albula (te ikari) are scaled, gutted and washed in the vicinity of the palms (generally always the same ones, from habit or for convenience). Also every month, on regular dates, considerable quantities of te baitari, edible jelly-fish of the genus Tamoya, are cut up and the gelatinous and useless parts buried at the foot of certain palms. Almost every day other organic waste products from the preparation of small fish or shell-fish which are eaten in abundance, make their contribution. It is impossible to assess the quantity, even approximately. To these waste products are added ashes from cooking fires. A few palms also benefit from their proximity to the little enclosures where the natives bathe and profit also from the water drawn from the neighboring well for washing cooking utensils.

PART III: THE COCONUT PALM AND GROUND-WATER

We have already pointed out the importance of water in agricultural ecology on the low coral islands, and how the behaviour of the coconut palm there depends to a large extent on the possibilities of water supply from the soil at root level.

It is often stated that the coconut palm likes salt, but, from our observations, the productivity of the coconut palm in the Gilbert Islands is higher in the neighbourhood of the fresh-water "lens". This does not change the fact of its resistance to salinity (up to 2% of chloride, according to Frappa in Baas Becking, 1949). However, it seems that even if the quality of the water available does not matter very much, it must be abundant; which confirms the remarks of Doctor Tammes (in Baas Becking, 1949), for whom water is the factor limiting the cultivation of the coconut palm.

In the Gilbert Islands, the most favourable conditions for the coconut palm are deep sandy soil with fresh to brackish water. On the other hand, conditions are unfavourable either when a hard layer prevents root penetration or excessive water remains stagnant at root level.

I. Obstacles to Root Penetration

Root penetration may be hindered when gravel or sand are cemented at a shallow level. This is particularly noticeable on the rampart, ocean side, on the majority of the islets (see Plate I). These conditions may be less unfavourable than the following. These layers are, indeed, more permeable than the breccia forming the rocky platform. The brittleness of some cemented formations ("te batano" of the natives) may be such as to enable the roots to penetrate to a certain extent. The slightest cracks in indurated layers are used by the roots to reach the water. That is why palms in better conditions than most are occasionally encountered in such areas.

We have already pointed out (see p. 9) that in the centre of the reef islands, the rocky platform was covered only by a thin layer of soil consisting mostly of coarse coral debris. These are most unfavourable conditions for the palm especially during droughts. In the rainy season a temporary water supply may form here and there over the rocky platform, but palms in such regions always give a mediocre yield.

II. Excess of Water at Root Level Remaining Stagnant

This may occur on reef islands during periods of normal rainfall. The water supply formed above the shallow bed-rock may remain stagnant at root level and injure the palms which are as sensitive to water-logged conditions as they are to drought.

Similar conditions are realized when coconut palms are growing in old babai pits with an impervious floor. Although relatively infrequent, this case is worth mentioning, since on several islands we observed coconut palms

killed through "asphyxia" of the roots caused by water stagnating in the bottom of the old pits in which the trees had been growing productively for several years.

Summary of soil and water relationships

(i) Deep sandy soils with fresh to brackish ground-water are best suited to the coconut palm;

(ii) A hard or impervious layer hampering root penetration or natural drainage is always more or less harmful to the coconut palm; and

(iii) The coconut palm may grow and produce, particularly during droughts, in the immediate neighbourhood of stagnant water, which may be even very brackish, provided that the roots are not in direct contact with the water; that is, when the palm is planted on dykes or knolls.

(iv) The relationship between the quality of the soil and the productivity of the coconut palm has been discussed earlier. As for the soil itself, the high calcium carbonate content suits the palms but the importance of the organic matter content of the soil cannot be over-stressed. Before we think of using mineral fertilizers, the practical problem must be solved of the supply of organic matter, of which the palms stand in real and urgent need.

A special case may be discussed at this point, that of Betio islet, scene of the battle of Tarawa. This was completely devastated during the battle, and has been replanted to coconuts since the end of the fighting. In many places the young palms are developing with remarkable luxuriance. Some only 6 years old were already producing nuts and toddy. This may be attributed to the 3000 bodies buried on this islet and also to the sanitary habits of the Japanese garrison during the occupation, which may have added as much as 40 kg of excreta per month per man for 20 months. There may have been also some benefit gained from the indirect action of nitro-explosives, abandoned scrap iron, etc. Whatever the reason, the ferility of some areas of Betio is probably the best in the archipelago. On the contrary the coconut palms planted on the site of an airstrip in the center of the islet are not very flourishing.

PART IV: CULTIVATION OF THE COCONUT PALM

Until the present generation, the Gilbertese did not consider the coconut as a cash crop; for him, it was only his basic food supply and the generous provider of most of his requirements. Nowadays, although most of the nuts are gathered for copra, the Gilbert Islander still retains his archaic ideas about his palms, and whilst appreciating the advantages his copra may bring, he has not yet acquired the concept of cultivation corresponding with such a valuable commodity.

Nuts for Propagation: The natives' choice of coconuts for planting is sometimes guided by size, a very "chancy" procedure, or by the fact that the nuts come from a heavily-laden tree, which may be a surer method. This type of tree, known as a niningaun or "the tenfold coconut palm", is distinguished from the others by the abundance of the bunches and the large number of nuts it bears (Plate VIc). Trees grown in or near villages are generally the most productive, and among them one finds the largest number of niningaun. It is from the latter that the native selects the seed-nuts for planting in or near his village. But for "bush" plantings, different conditions obtain, and seed selection usually depends on chance or convenience. If, near the spot where a tree should be replaced or a gap filled, there is a palm which may be considered a good seed-bearer from its outward characteristics - a fortiori a niningaun - it will be chosen by the native in search of seed. If there is no such tree, he will select nuts from any nearby palm. Unfortunately he will usually be content with any nut. Often he will just take some from a heap thrown together during a copra "campaign", and which, abandoned, have germinated where they lay. One can imagine the proportion of mediocre, deficient or degenerate trees which results from such a practice.

Ripe nuts fall to the ground and if they are not collected, they germinate and take root as best they can. This happened with those which were not collected during the war because copra could not be exported, and even today, many nuts are not harvested, either from neglect or because they lie hidden in a thick tangle of vegetation. These nuts increase still further the proportion of spontaneously-grown coconuts in the bush.

Planting: Not only does the native fail to establish nurseries, but he does not even plant in holes in the "plantation" sense of the word. At the most he will cover with a little earth the nut he has chosen. Neither is there any methodical alignment of young seedlings. Nowhere, therefore, will regular spacing be found, with one exception, of which examples are found on all islands where war-time installations involved the destruction of coconut palms. The owners received compensation at the rate of 6 shillings per coconut palm to be replaced in the bush, and 10 shillings per palm to be replaced in areas levelled for airfields, on condition that such planting be really carried out. (The extra 4 shillings were justified by the harder work involved in breaking up the surface of compacted coral and the mass of piled-up metal landing matting on the strips.) In these areas the planting of young trees was done in lines, generally with correct spacing. But usually the work was limited to breaking the landing strip surface just enough to bury the nuts. The seedlings, therefore, usually had to struggle for existence. In addition, the intense heat on the sun-beaten cement-like surface was all the more harmful as planting was followed by two years of drought. The young unshaded palms were yellow and weak-looking. Subsequent copious rainfall certainly improved their condition, but, because of their careless planting this was not as beneficial to them as to palms replanted in loose soil in the bush.

Exceptional Methods of Cultivation: Two original methods are used in special areas on the island of Nikunau. One is the planting of coconut palms on top

of dykes built by the natives to separate fish-ponds. Their root systems penetrate these earthen dykes, clinging firmly to them, and only the tips of the roots are in contact with soil that is always sodden, even during severe droughts (Plate VIb).

Noting the efficiency of such a method which protects the root system against total immersion the natives carry things a step further. Thus one sees on swampy ground near the Nikunau lakes a still stranger method of planting. It consists in cutting old coconut palm stumps about 20 inches above ground and using them as a base for germinated nuts (Plate VId). As it grows, the seedling pushes its roots into and around this pedestal, engulfing it entirely and finally absorbing it. In this way these new coconut palms have successfully been raised to a level high enough to avoid prolonged immersion of their root system. The natives of the region were not, however, in agreement on the future of such palms. Some of them, with great good sense, thought that their root systems would be so exposed for such a height that they would have to be shored up or at least surrounded by a thick layer of dead fronds or compost.

Care of the Trees: The seedling is nearly always abandoned to its fate. In periods of poor rainfall or of drought, it obviously does not have the watering which would be so beneficial at the beginning of root growth. Cleaning is very rarely carried out, and then only over very limited areas. Side by side with strips of land invaded by the bush until it is difficult to move about, one will find a piece of land roughly cleared or a perfectly clear space. This is very much an individual matter, the owner being free to do as he pleases with his own ground, even to neglect it entirely. What is true for weeding is equally true for replacement work.

When we speak of cleaning we should distinguish between complete cleaning as carried out in coconut plantations, a principle which could not be rationally applied to the Gilbert Islands, and partial cleaning which consists solely of ridding the area of the bulkier obstacles, such as dead tree trunks and thickets of Scaevola, and other plants which are sometimes so numerous and dense as to make movement almost impossible.

Clearance by fire must also be discussed. Such a procedure obviously requires no effort but usually has deplorable results. There is no accepted policy for cleaning land in these territories except for that carried out for a width of ten feet or so along the roads running on the lagoonside of every island from one end to the other. These operations, however, are intended merely to clear the road and not to benefit the coconut palms. The method is by no means general and some islands like Aranuka (almost entirely) and Abemama (to a large extent) show almost a complete disregard of this required simple operation.

Fertilizers: No fertilizer is given to the coconut palm except for a piece of scrap iron sometimes placed in a hole with a germinated nut.

Control of Pests: There is no pest control. Luckily the coconut palm enjoys almost complete freedom from large-scale or intense attacks, so no control measures are necessary in the Gilberts, except on the island of Abemama. There, an orthopteron of the genus Graeffea is abundant and a menacing pest (see p. 28). This phasmid, owing to its abundance, is obviously well-known to the natives of the district, but they are heedless of the damage it inflicts on the palm fronds. We were told that large fires were lit under the trees to make the phasmids fall off, but the truth of this statement is debatable. It is more likely that the insects fall because of the intense heat generated under the trees by fires lighted for cleaning purposes.

Gathering and Drying: Nuts for copra are gathered after they have fallen naturally, while those nuts required for food are picked from the trees. Exceptions to this do, however, occur when occasionally some native, tempted by the arrival of new supplies, needs a little copra to buy sugar, flour, tobacco, or cloth at the store.

In current practice nuts are gathered by the owners of the land, and as most of the patches of ground are very limited in area, the quantity of fallen nuts is not very large. A couple, or the wife only, brings the nuts to the spot where the husking is to be done. Often they are carried tied together two by two by a strip of fibre pulled from the husk. The coconut is opened either on a stake firmly driven into the ground, with a sharply-pointed end upwards, or more often with a little hatchet. A very sharp strong knife is then used to make radiating or parallel incisions in the oily albumen, detaching it from the endocarp. The meat is placed in sacks woven on the spot as needed, from coconut palm fronds (Plate VIIa). It is then taken to the village where it is spread to dry in the sun either on mats (Plate VIIb), on trays made of coconut fronds, on old tarpaulins, or even on old sheets of corrugated iron. The time necessary for drying will obviously depend on the weather. The degree of dryness of the kernel is also a factor. Sometimes this is so advanced that as soon as the nut is opened, the kernel can be detached whole. Once the copra is dry, it is delivered to the Boboti (Cooperative Societies). When harvested in areas remote from the purchasing centre, as occurs on large islands, it is brought to pre-arranged places (Plate VIIc) for collection by the Co-operative lorry which takes the sacks to a copra point usually situated in the immediate neighbourhood of a landing stage. Whale boats are used for loading the copra into cargo vessels.

It may happen that the native, eager to buy some more or less useful object, will bring not copra but whole nuts, and will sell them at the rate of 3 shillings per 50 nuts. As a rule he stores his nuts in small covered, latticed enclosures, te okai (Plate VIId). These crude huts enable him also to keep a small emergency food stock for periods of drought, of which undue prolongation is always to be feared. Apart from these comparatively rare cases where the native, in a hurry, sells his nuts whole, the transactions are made with dry copra.

Commercial Quality: Gilbert Island copra is sundried and of relatively good quality by South Seas standards. Although there may be abundant rainfall

almost daily for several months, accompanied by high humidity, the copra is scarcely affected as the quantities are always small and therefore easily sheltered.

Age and life-span of the Coconut Palm in the Gilbert Islands: Generally speaking, we have no dependable information on the age and life-span of the coconut palms in the Gilbert Islands. It is difficult to give any figure, but under the usually mediocre conditions of the Gilbert Islands, a fifty to sixty year old palm may be considered as already old and its yield on the decline. Causes of this premature ageing include irregularity of rainfall, severe drought, occasionally lasting several years, other physical factors prejudicial to the coconut palm, soil deficiencies of various kinds, lack of any real selection and even of elementary attention to the young palms (bad rooting of seedlings) etc., and finally, overcrowding.

As a result of these numerous difficulties - and we have enumerated only the most important - coconut palms here have a relatively short productive period. They do remain alive for many years beyond this, but have no economic value. It is to be regretted, therefore, that so many unproductive trees should be allowed to occupy valuable space for such a long time.

Yield: The only records available are the figures of the 1947 census which gives the number of productive coconut palms for each island. These figures are based on a rough estimate and however interesting, cannot be used in an agricultural survey as they are not the result of counting tree by tree over a given area, which is practically impossible. To accept what the natives say is also misleading, for occasionally there is a 100% difference between their answers and later checking of them in the field. Consequently we prefer to rely on the results of our own calculations.

Let us mention first a count made over the whole width of one section of the island of Bikenibeu (Tarawa atoll). The plan in Fig. 14 accurately plots 138 coconut palms of productive age and all young palms grown probably from nuts which germinated where they fell. The position of the pandanus trees is also indicated. This plan should be studied with Table V which gives the number of fronds, green nuts and ripe nuts, counted on three different dates. This site was chosen for our inventory because it appeared to us to represent an area of average density of palms for this atoll. We counted 138 palms over an area of 5,950 sq. metres or 231 per hectare, but it should be noted that the spacing of these trees is very irregular.

The first inventory of these 138 numbered palms was made on the 21st March, just before the beginning of the regular rains which lasted several months. It resulted in the following averages per tree: 19 leaves, 4.86 green nuts, 0.56 ripe nuts. The second inventory made on 6th June, seventy-six days later, gave an average of 22 leaves, 10 green nuts, 1.6 ripe. The third inventory made on 6th August, or exactly two months later, finally gave 24 leaves and 13.6 green nuts (the ripe nuts had been gathered by the owners).

TABLE V

Observations made at BIKENIBEU (TARAWA) on 138 coconut palms on an area of 5950 Sq. meters. (Rate of 231 trees per hectare.)

	21 March			6 June			6 August *		
Tree No.	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts
1	22	7	.	28	14	1	34	19	.
2	19	1	.	21	8	.	22	9	.
3	17	.	.	23	.	.	26	2	.
4	10	.	.	12	6	.	13	8	.
5	16	.	.	20	3	.	20	2	.
6	7	3	1	12	9	.	12	11	.
7	3	.	.	9	6	.	10	2	.
8	7	.	.	12	.	.	13	.	.
9	7	.	.	11	.	.	12	7	.
10	9	2	.	14	13	.	16	19	.
11	20	10	4	24	22	.	26	27	
12	6	.	3	9	7	.	13	29	.
13	20	3	3	24	11	.	26	12	.
14	18	3	.	22	10	.	25	13	.
15	20	8	4	25	9	8	27	32	.
16	21	.	.	26	.	.	24	3	.
17	16	4	.	20	2	4	21	4	.
18	13	.	.	15	5	.	15	3	.
19	12	.	.	16	20	.	16	22	.
20	16	.	.	20	4	.	22	13	.
21	16	4	4	20	19	4	26	25	.
22	15	6	3	18	14	6	19	12	.
23	14	.	.	16	.	.	18	2	.
24	14	.	3	18	10	.	24	19	.
25	17	3	4	20	30	2	27	28	.
26	15	7	3	18	4	5	18	5	.
27	10	9	.	14	10	1	17	15	.
28	14	2	3	19	6	3	19	10	.
29	29	6	.	12	.	.	13	.	.
30	19	.	.	34	6	.	36	23	.
31	21	7	3	24	.	.	25	3	.
32	27	7	2	25	21	7	31	40	.
33	21	10	.	23	10	5	20	13	.
34	20	.	2	26	2	2	22	.	.
35	17	6	.	20	3	.	23	2	.
36	7	.	.	10	1	.	12	1	.

TABLE V (continued)

	21 March			6 June			6 August *	
Tree No.	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts
37	18	7	.	23	16	4	26	30
38	18	.	.	22	7	.	21	11
39	24	14	2	28	14	10	29	49
40	18	6	.	21	11	2	28	20
41	19	6	.	23	20	4	27	22
42	13	.	.	16	6	.	19	6
43	17	6	.	22	0	3	22	4
44	23	.	.	27	.	.	28	15
45	18	13	.	22	.	10	20	.
46	10	.	.	14	.	.	20	1
47	24	.	.	27	.	.	34	60
48	21	13	.	24	53	.	27	11
49	18	7	.	21	7	.	26	5
50	15	7	.	18	19	.	22	1
51	21	.	.	24	.	1	26	1
52	13	1	.	16	1	1	18	27
53	16	10	7	20	26	10	21	2
54	27	.	1	29	2	.	29	2
55	20	3	1	23	7	1	23	2
56	15	3	.	18	4	3	21	6
57	24	7	.	27	.	.	29	52
58	25	21	.	28	42	17	31	71
59	20	13	.	24	67	.	28	27
60	27	12	.	30	40	.	32	19
61	28	.	.	32	9	.	38	70
62	27	17	.	31	66	.	32	2
63	15	16	.	18	2	.	20	7
64	23	4	.	26	5	2	26	26
65	24	7	.	26	20	3	29	15
66	22	.	.	25	5	.	24	12
67	25	.	.	28	7	.	26	8
68	25	6	.	29	14	.	27	16
69	22	7	2	26	11	4	28	36
70	32	17	2	37	31	4	41	.
71	21	2	2	24	.	.	24	.
72	21	.	.	25	.	6	23	22
73	20	4	.	24	12	5	26	19
74	23	.	.	26	.	1	27	.
75	17	.	.	20	.	.	19	.
76	6	.	.	8	.	.	8	.
77	22	13	.	25	25	13	26	25

TABLE V (continued)

	21 March			6 June			6 August *	
Tree No.	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts
78	19	11	.	22	22	2	21	.
79	20	17	.	24	13	.	26	10
80	21	3	.	13	.	.	12	.
81	17	2	1	20	.	1	26	2
82	24	12	.	26	22	.	25	20
83	20	8	.	23	8	7	22	1
84	6	.	.	6	.	.	9	.
85	20	10	.	20	16	6	24	7
86	16	17	.	18	22	.	22	19
87	19	.	.	19	.	.	22	.
88	27	.	.	30	8	.	30	.
89	26	7	.	28	8	3	30	24
90	26	4	.	28	1	.	28	.
91	22	.	.	22	1	.	22	.
92	19	.	.	21	1	.	26	1
93	25	7	1	28	5	4	29	9
94	21	11	3	24	4	5	26	6
95	23	7	1	27	12	5	28	7
96	16	.	.	19	.	.	14	.
97	20	7	.	23	23	.	27	49
98	22	.	.	26	.	.	27	3
99	30	7	4	34	26	5	31	33
100	21	17	.	26	54	.	28	99
101	21	.	.	22	.	.	23	.
102	3	.	.	5	.	.	11	.
103	16	12	.	20	48	.	22	55
104	28	17	.	31	44	1	34	32
105	22	7	.	26	1	.	27	3
106	22	11	.	24	18	2	24	26
107	23	17	.	26	37	.	27	49
108	19	7	.	21	10	.	22	6
109	20	.	.	22	15	.	26	23
110	20	7	.	23	28	.	30	33
111	26	11	.	33	20	1	31	16
112	30	13	.	30	7	.	30	.
113	27	3	.	27	3	.	26	.
114	21	.	.	23	2	.	23	.
115	13	.	.	16	7	.	21	.
116	20	.	.	26	.	.	29	.
117	23	.	.	27	11	.	29	18
118	23	.	.	26	12	.	18	.
119	30	.	.	34	.	.	30	.

TABLE V (continued)

Tree No.	21 March			6 June			6 August *	
	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts	No. of Ripe Nuts	No. of Leaves	No. of Green Nuts
120	22	11	.	25	10	1	30	18
121	28	.	1	30	.	.	31	8
122	12	1	2	14	8	5	16	.
123	20	.	.	22	5	1	23	.
124	9	.	.	10	.	.	12	.
125	26	.	.	29	.	.	29	.
126	22	.	.	24	.	5	24	.
127	22	.	.	26	4	.	27	5
128	20	.	.	23	16	.	31	19
129	22	9	3	27	20	.	31	8
130	33	2	.	37	.	6	26	.
131	27	11	.	29	28	.	33	38
132	31	2	.	34	10	.	28	26
133	18	11	.	22	27	3	31	18
134	26	11	3	30	16	5	34	11
135	10	.	.	10	.	.	16	.
136	26	.	.	30	.	.	32	53
137	37	.	.	42	6	0	10	5
138	21	.	.	22	.	.	19	.
Total	2694	671	78	3124	1454	221	3315	1887
Average:	19.52	4.86	0.56	22.63	10.53	1.60	24.02	13.67

* On August 6 there were no ripe nuts.

TABLE VI

Dimensions and weights of 50 coconuts at Bikenibeu, Tarawa.
Nuts from recorded trees.

No.	Length (Inches)	Circum-ference (Inches)	Whole Weight lbs.	Whole Weight oz.	Weight without water lbs.	Weight without water oz.	Weight of fresh meats oz.
1	11.5	17.5	1	12	1	11	8
2	9	15	1	4	1	3	7
3	8.5	15	0	15	0	14	5
4	9.5	15.5	2	0	1	12	8
5	10	16	1	9	1	8	5
6	8	14	0	15	0	15	5
7	8.5	14.5	1	6	1	5	8
8	12	17	1	13	1	12	6
9	9.5	17	1	6	1	6	8
10	10	16.5	1	12	1	12	5
11	9.5	15	1	8	1	8	5
12	9.5	14	1	8	1	6	7
13	8	17	1	1	1	1	6
14	9.5	14	1	8	1	8	5
15	8.5	13	1	12	1	11	8
16	8.5	17	1	2	1	1	6
17	11	12	1	8	1	6	6
18	6.5	16	0	10	0	9	4
19	8.5	14.5	1	2	1	2	6
20	8.5	16	1	1	1	1	7
21	10.5	17	1	7	1	7	5
22	10	16	1	8	1	8	8
23	12.5	16.5	2	2	1	15	4
24	12	13.5	2	7	2	6	9
25	8.5	16	1	1	1	1	5
26	9	16.5	1	4	1	3	6
27	8	13.5	1	8	1	8	6
28	6.5	18.5	1	0	0	14	4
29	9.5	13.5	1	8	1	7	6
30	8	14	1	0	0	15	6
31	8.5	14	1	4	1	3	7
32	9	16	2	4	2	3	8
33	10.5	16.5	1	9	1	8	7
34	11.5	17	0	11	0	11	4
35	10	14	1	8	1	8	9
36	8.5	17	0	9	0	9	5
37	10.5	13	1	4	1	4	6
38	7	16	1	9	1	8	6
39	11	19	1	5	1	4	6
40	10.5	16	1	2	1	2	5
41	10	13.5	1	1	1	1	3

TABLE VI, Cont'd.

No.	Length (Inches)	Circum-ference (Inches)	Whole Weight lbs.	Whole Weight oz.	Weight without water lbs.	Weight without water oz.	Weight of fresh meats oz.
42	8	14	1	10	1	0	6
43	10	18	0	13	-	-	-
44	10.5	14.5	1	4	1	4	6
45	9.5	15	1	12	1	12	8
46	8.5	17	1	14	1	13	6
47	10	16.5	1	5	1	4	7
48	10	15	1	8	1	7	5
49	10	16.5	0	12	0	12	3
50	10.5	16	1	0	1	0	4
							18 lbs 7 oz

Total weight of fresh meats	18 lbs. 7 oz.
Total weight of dried meats (copra)	14 lbs.
Average weight copra per nut	0.281 lbs.
Loss due to drying	25.9 per cent
Nuts required per ton of copra	7874

TABLE VII

Dimensions and weights of 50 coconuts taken at random from an Abemama plantation. The trees are regularly spaced, about 234 per hectare, and show outstanding vigor.

No.	Length (Inches)	Circumference (Inches)	Whole weight lbs.	Whole weight oz.	Weight without water lbs.	Weight without water oz.	Weight of fresh meats oz.
1	12	19	1	4		-	4
2	11.5	17.5	1	12	1	11	9
3	11	20	1	10		-	8
4	9.5	13.5	1	0		-	7
5	10	13.5	1	4	1	3	6
6	9	15.5	1	7	1	4	7
7	10	17.5	1	6		-	6
8	12	14	1	3		-	7
9	11	15	1	12	1	10	7
10	10	18	1	11	1	10	12
11	9.5	18	1	8		-	9
12	11.5	18	2	1		-	10
13	8	10	1	2		-	7
14	12	21	2	2		-	10
15	12	21.5	1	12		-	8
16	10	15	1	7		-	8
17	8	15	1	6	1	5	7
18	10.5	18	1	15		-	10
19	10.5	21	1	12		-	13
20	10.5	15	1	2		-	7
21	11	20	1	15	1	13	8
22	10.5	15	1	4		-	7
23	8.5	15.5	1	0		-	6
24	10	15	1	9	1	7	8
25	11.5	15	1	7	1	6	7
26	12	16	1	12	1	7	7
27	10	13	1	2		-	6
28	10	15	1	3		-	8
29	9.5	15	1	12	1	6	6
30	9.5	16	1	4	1	3	7
31	10.5	14.5	1	5		-	8
32	9	18	1	2		-	7
33	10	14.5	1	3	1	1	8
34	9.5	17	1	7	1	4	7
35	9.5	16	1	2		-	4
36	9.5	15	1	6	1	4	6
37	9.5	14	1	8	1	7	7
38	10	17	-	14		-	6
39	8.5	14.5	1	4	1	2	6
40	10	14	2	1	1	12	8

TABLE VII, cont'd.

No.	Length (Inches)	Circum-ference (Inches)	Whole weight lbs.	Whole weight oz.	Weight without water lbs.	Weight without water oz.	Weight of fresh meats oz.
41	11	17	1	3	-		4
42	10	18	1	0	-		5
43	10	15	1	0	-		6
44	10	17	1	0	-		6
45	9	16.5	0	14	-		6
46	8	12	0	12	-		4
47	8.5	11.5	1	2	-		4
48	9.5	14.5	1	2	-		4
49	8	12	1	3	-		6
50	8.5	12	0	14	-		5

Total weight fresh meats	21.8 lbs.
Total weight dried meats (copra)	16.31 lbs.
Loss due to drying	25.0 per cent
Average weight copra per nut	0.335 lbs.
Nuts required per ton of copra	6578

TABLE VIII

Dimensions and weights of 25 coconuts collected at random on the Reiher property at Abemama. The trees of the plantation are spaced 8 by 8 meters.

No.	Length (Inches)	Circumference (Inches)	Whole weight lbs.	Whole weight oz.	Weight without water lbs.	Weight without water oz.	Weight of fresh meats lbs.	Weight of fresh meats oz.
1	10.5	24	2	8		-	1	0
2	10	19	2	0		-	0	12
3	10.5	20.5	1	14		-	0	10
4	11	19.5	1	8		-	0	7
5	10.5	19	1	9		-	0	10
6	10.5	14.5	0	15		-	0	6
7	11	21	1	9		-	0	6
8	11	19.5	1	8		-	0	7
9	9.5	14	0	11		-	0	5
10	9	14	1	4	1	3	0	8
11	9	14	0	11		-	0	6
12	10	15.5	1	0		-	0	6
13	9	15.5	1	0		-	0	6
14	9.5	14	0	14		-	0	5
15	10.5	15.5	1	4		-	0	7
16	10.5	16.5	1	14	1	13	0	8
17	9.5	14	0	15		-	0	6
18	11.5	18	1	8		-	0	7
19	9.5	17	1	3		-	0	7
20	11.5	20	1	12		-	0	7
21	10.5	20.5	1	13		-	0	8
22	9	21	1	7		-	0	9
23	12	20	1	12		-	0	8
24	10.5	20	1	15	1	14	0	12
25	11	18	1	4		-	0	8

Total weight of fresh meats	12.31 lbs.
Total weight of dried meats (copra)	8.56 lbs.
Loss due to drying	30.00 per cent
Average weight copra per nut	0.342 lbs.
Nuts required per ton of copra	6436

TABLE IX

Size and weights of 25 coconuts from a single superior palm on the Reiher property at Abemama. The trees of the plantation are spaced 8 x 8 meters.

No.	Length (Inches)	Circumference (Inches)	Whole Weight lbs.	Whole Weight oz.	Weight without water lbs.	Weight without water oz.	Weight of fresh meats lbs.	Weight of fresh meats oz.
1	10	19	1	7		-	0	8
2	8	18	1	2		-	0	7
3	8.5	18	1	8		-	0	9
4	9	20	2	8		-	1	0
5	9	18.5	1	7		-	0	9
6	9.5	19	1	8	1	7	0	13
7	9	19	1	10		-	0	14
8	10	21	1	12		-	0	10
9	9	19.5	1	6		-	0	9
10	9	19.5	1	7		-	0	8
11	9	19	1	10	1	8	0	9
12	9.5	19.5	1	9		-	0	8
13	8.5	18.5	1	10	1	8	0	9
14	9.5	19	1	6		-	0	7
15	8.5	18	1	6		-	0	7
16	9	19.5	1	6		-	0	7
17	9.5	20	1	8		-	0	6
18	9	19	1	9	1	7	0	8
19	9	18.5	1	7	1	6	0	8
20	9	19	1	5		-	0	7
21	9.5	18.5	1	10	1	8	0	8
22	8.5	19.5	1	8	1	7½	0	9
23	10	20	1	8		-	0	8
24	9.5	20	1	10		-	0	9
25	9	20.5	1	10		-	0	11

Total weight of fresh meats	14.0 lbs.
Total weight of dried meats (copra)	10.78 lbs.
Loss due to drying	21.42 per cent
Average weight copra per nut	0.440 lbs.
Nuts required per ton of copra	5000

Among other things, these figures show the rapid response of these palms to the first heavy rainfall after two years of severe drought. Table V also shows that a number of very old or unproductive palms should be removed. The usefulness of continuing such observation work for several years, during normal rainfall and drought, can readily be appreciated. Valuable conclusions can be based only upon data gathered for a sufficiently lengthy period of time.

Secondly, let us mention the coconut palms on village sites. Their density is always very low by comparison with palms growing in other areas of equal value. Fourteen counts made in populated areas, gave a general average of 115 palms per hectare. Let us take for example the village of Tabontebike where, for an area of 10,750 sq. metres we counted 100 productive palms representing 93.02 per hectare (plus 36 Artocarpus). These palms, had, on the average, 17.34 nuts when the count was made before the rains. This is not an exceptional number in such conditions after prolonged drought.

Thirdly, we shall mention the figures from Makin School (Abemama). The area was chosen because of the regular spacing and vigorous appearance of the palms. We counted 234 palms per hectare with an average of 18.15 nuts (drought production).

It should not be inferred from these figures and averages that there is any absolute regularity in spacing (with the exception of the Reiher plantation on Abemama), the density varies constantly even for one hectare; for village palms it will vary from 80 to 150 and, in bush regions, from 200 to 350. The map of Bikenibeu (fig. 14) shows the irregular spacing of the palms.

With regard to the weight of ripe nuts during droughts, Table VI gives measurements and weights of 50 ripe nuts from Bikenibeu (Tarawa). These come from some of the 138 numbered palms (fig. 14, table V). The length measurement was made by following a ridge from the distal extremity to the centre of the point of attachment; the circumference measurement was made where the diameter was greatest. The nut was first weighed whole and then again when it had been opened and emptied of its liquid, if any remained. The fresh meat was extracted and weighed separately for each nut. The copra obtained after four or five days' drying was weighed. We thus have, for the region of Bikenibeu, after weighing 50 nuts, an average per nut of 0.127 kg. of copra, the loss in drying being 25.9%. The number of nuts per ton of copra is, therefore, 7,874. Similar weighings were carried out on several islands. We shall mention three for Abemama (centre group) and one for Nikunau (southern group).

On Abemama we chose the palms of the Makin School because of their healthy growth and good production and also because, while not planted with equal spacing as on a real plantation, they were fairly evenly distributed. We counted 234 palms per hectare and obtained an average per nut of 0.152 kg of copra, with a 25% loss in drying (Table VII).

On Bikenibeu, we had practically the same number of palms per hectare (231), but they were very irregularly spaced, varying from 1 to 8 per 100 sq. m., whereas those of the Makin School never exceeded 3 per sq. m. It is also important to remember that at Makin School the width of the island is approximately 700 m, whereas on Bikenibeu it is only 200 m a difference which certainly influences productivity.

Two other weighings from Abemama were made on the Reiher property where palms actually planted in the agricultural sense of the term and grown from selected seedlings (mass) are spaced at intervals of 8 m. The first of these weighings (Table VIII) was of 25 ripe nuts from different trees, all showing distinct signs of drought. These nuts gave an average of 0.155 kg of copra per nut, with a 30% loss on drying. The second of these weighings (Table IX) was for 25 ripe nuts from a single palm growing beside an old babai pit, and therefore in a situation where water would be less likely to fail. There we had an average of 0.200 kg of copra per nut with a 21.42% loss in drying. It is worthy of mention that this remarkable tree had 34 fronds and 93 nuts, of which 29 were ripe and provided the 25 we examined.

Considering this production, and the great leaf development, we may conclude that the averages for 25 nuts give a fairly good idea of the quality of the yield of this plantation in a normal season, as the selected tree enjoyed very favourable conditions in spite of the drought. According to this last weighing, we calculated that 5,000 nuts were needed to obtain one ton of copra. It is difficult to base final general conclusions on specific cases; and our long experience of plantation production statistics taught us to be prudent in this matter.

At the time of our stay on the Reiher property (April) the effects of rain had not yet appeared and 90% of the palms showed traces of the very severe drought which had lasted for two years. But the size of the stipes was evidence of the possible vigour of these trees in normal times: so also was the total number of their leaves, including those which, as a result of the drought, were hanging down the trunk (often more than twenty, Plate IIIb).

Another similar survey was made during our stay on the south islands. On Nikunau we bought 50 nuts at random and dealt with them in the same way as with the previous groups. These nuts (Plate VIIIa and b) were relatively tiny (three or four times smaller than on the north and central Gilbert Islands) but were all perfectly formed and their copra was as good in quality as that of normal nuts. For these 50 "drought" nuts, we got an average weight per nut of 0.051 kg of copra, with 36.35% loss in drying. The number of such nuts required to produce one ton of copra was here 19,380. Table IV lists sizes and weights of these 50 Nikunau nuts.

Estimated Yield on Tarawa: For the following estimates we worked from figures in the "Report on the 1947 Census" by Mr. F. N. M. Pusinelli, for the area, population and number of animals (pigs) eating coconuts. For estimates of density of trees and production of coconuts we shall use our own calculations based on the counts of trees and weighings of nuts which

we carried out in the field, and the averages thus obtained. Obviously, these figures are approximations, in the absence of more accurate sources.

The area of Tarawa atoll is estimated to be about 2,000 hectares. It is considered that 20% should be deducted for uncultivated areas such as roads, swamps and mangrove. The area actually occupied by the coconut palm is therefore 1,6000 hectares. If we assume that 231 trees per hectare on Bikenibeu give a fair idea of the average coconut palm figures for the whole of the Tarawa atoll, we obtain 369,600 palms for the whole productive area. We must deduct from this figure about two palms per group of five people which correspond to the number used for toddy, namely 955 trees, which leaves 368,645 palms as nut producers. Pusinelli's census estimates that, of the total population of Tarawa (3,582), about a third are not natives of this atoll but come from outside to work at "colony headquarters". We thus have a figure of 2,388 persons considered to be really natives of Tarawa and consequently owners of land.

We estimate that the average consumption for each individual is four nuts per day, which gives a figure of 3,486,000 nuts(1). We also calculate, from the figure of 768 pigs in the 1947 census, that consumption of nuts by these animals, at a rate of three per day, is 841,000 nuts per year.

Finally, considering that the export of copra for 1949-1950 was 662 tons and that the average of copra per nut (compare Tables VI, VII, VIII and IX) is, for the central Gilberts, 158 g, these 662 tons represent 4,190,000 nuts.

We thus have:

Annual consumption (population)	3,486,000 nuts
Annual consumption (pigs)	841,000 "
Export of 662 tons of copra	4,190,000 "
	8,517,000 "

In conclusion, if we divide this number by the number of nut-producing palms (368,645), we obtain 23.1 nuts, representing approximately the annual average production per palm. The nuts destroyed by rats and crabs, fed to chickens or sold to non-Tarawans are not included. Their number is probably not large enough to be significant.(1)

(1) Dr. Catala's estimate of consumption is an under-estimate; whereas it is true that one-third of the population is not native of Tarawa, that one-third eats a great deal of nuts. Furthermore, no account is taken of nuts which fall and are not harvested - this is thought to be a fairly large quantity. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

We have adopted a minimum figure for nuts consumed by pigs, for the number of pigs in 1949-1950 must have been substantially lower than in 1947, the census year, which had a normal rainfall. Indeed, when the Gilbertese sees that a drought is going to be unduly prolonged, he reduces the number of his pigs.

PART V: USES OF THE COCONUT PALM

FOOD

Te Karewe - "Toddy"

The production of toddy from the coconut or from other palms is practiced in several parts of the world, but nowhere has it such fundamental importance as in the Gilbert Islands.

Karewe is drawn or tapped from the unopened inflorescence after a series of manipulations requiring a precise technique (Plate VIIIc and d). When a new spathe appears and the native has observed that it is half a hand in length, he will allow approximately twenty-eight days to elapse before treating it, but some toddy experts indicated that there is an advantage in choosing such an inflorescence at the new moon and regarding it as ready for use at the full moon. The spathe, which meanwhile has reached its full length has not yet split. The first operation consists in binding it with a coir string to keep it from opening up. The elements of the inflorescence will be unable to spread or open. The inflorescence then will be freed at the extremity for a length of about 10 cm, from the spathe protecting it. A very tight binding will replace the spathe to keep the flowering branches from spreading.

This mass which is originally erect is gradually bent with a rope tied to the petiole of a lower frond (Plate VIIIc). This slow curving takes about 3 days, but varies with the technique of the operator and may take less time. After this time, the extremity of the inflorescence is cut off with a sharp blade in thin slices, 3 times a day for 3 or 4 days. The liquid, which exudes in small quantity at first, is not collected because it is too tart. This preliminary phase over, the first container, an empty coconut shell (Plate VIIId) or glass bottle is attached to the stump. A fragment from a nearby leaf is also attached to it to guide the liquid into the container. This fragment must include the mid-rib, a small section of which is freed from the blade and used as a pin to hold the fragment in place. The abundance and rapidity of formation of the liquid varies with several factors: quality of the individual tree, time of production, technique of binding and especially, according to the experts, degree of binding. Finally the precision with which the wound is reopened is also very important. This is done morning and evening when the filled containers are fetched and replaced with empty ones. Rarely do trees produce enough to need renewing of the cut in the middle of the day.

Every time the operator reaches by repeated slicing the part of the inflorescence still covered by the spathe, this must be shortened again.

Toward the end of the process when the spathe is only about 15 cm long, it is completely removed.

The duration of the exudation is about 6 weeks with about 2 full nut shells filled every 24 hours. The capacity of these containers is about 850 cc. Even the experts could not tell whether the yield was greater at one particular time of the operation. Some inflorescences produce more at the beginning, for others it is the opposite.

The choice of coconut palms for toddy production is random, except perhaps in the case of some experts with a special flair, or keen observation powers. Any inflorescence will be used without necessarily waiting for the new moon, and it is only after tapping that it is known whether one has a "winner". There are poor trees and poor tappers, so failure may be due to poor technique or to the palm itself.

It is not uncommon to tap the same palm for 15 or 20 years if it is a good producer, but it will be left to rest from time to time when a noticeable decrease in the size of inflorescences is observed. Later on, after a period varying from 8 to 10 months, the new inflorescences will be used for toddy if they are large enough. As a certain number of palms is always available to each owner, some will be producing toddy, the others nuts. This is, of course, during years of normal rainfall; this alternating use cannot be continued during prolonged droughts, especially in the southern islands, but the inflorescences though unable to set fruit, will almost always be suitable for toddy. This is a fact of the utmost importance to assure the Gilbert Islander of a balanced diet during periods of food shortage.

For their supply of karewe, the old people and very young children depend on the strong man of the family for whom climbing the tall coconut palms twice daily is an easy task. If no such man can be found in the family, and no arrangement can be made with a neighbour, a very serious problem arises that is not easy to solve. A Gilbertese will never refuse the loan of a palm, but will very seldom collect fresh toddy for any but his own family. Toddy is never sold.

We noted the following as an indication of the average quantity of toddy available to a Gilbertese family: on Nikunau, in the south, our young informant, Kiritama, used five inflorescences producing an average of seven coconut shells almost full, or approximately five litres of toddy every 24 hours.

Toddy is generally tapped from only one inflorescence per palm, but during periods of normal climatic conditions and in areas where coconut palms are very good producers, two inflorescences will often be seen in simultaneous production. Three inflorescences are very seldom used on one palm. Coconut palms sometimes are observed producing both toddy and nuts. The flavour of toddy does not vary according to the variety of the palms, but it changes from palm to palm.

For consumption as daily beverage, toddy is brought home and immediately diluted with an equal volume of water. Unless it is boiled, fermentation will be rapid. After 15 or 18 hours, it is already sour. This sour toddy, or te manging, is not often consumed as its after-effects are harmful, and most natives are wary of it. Its consumption is controlled by license.

In the preparation of kamaimai - fresh toddy is boiled until a syrup is obtained. This may be more or less concentrated, and the higher the concentration the better it will keep. When this syrup is intended for long storage, it is reduced in the ratio of 4 to 1. It may later be consumed, diluted in water. It will also be included as an ingredient of many dishes. Finally, in households where money is not plentiful enough to buy sugar, kamaimai will be used instead. We have said that karewe was never sold. On the contrary, kamaimai is sometimes an item for small local transactions. We saw it sold in the Arorae store at 9 pence a bottle. The price may rise to 1 shilling.

Preparation called kareberebe - this is obtained by cooking kamaimai until it is completely caramelized, and the resulting product is divided into small balls which make excellent sweets, similar to toffee.

Fermented toddy is used as leavening in some kinds of pastries such as the fritters called te tonati.

Food value of toddy: Fresh toddy contains 16% sugar, fermented toddy 6% alcohol. Analyses indicate the presence of Vitamin B in fresh toddy. But the high content of Group B vitamins is chiefly noticeable in fermented toddy, this being approximately equivalent to one-third of that found in brewer's yeast (Buchanan, 1947). According to Dr. Bray (in Turbott, 1949, p. 40), the protein content of toddy would be 0.32%, the carbohydrate content 13.0% with 54 calories per 100 g.

Other foods from coconut:

The mesocarp (kora) of te bunia variety may be eaten from the stage te ubu until te amaere (see Fig. 15 and Plate IXa). It is chewed somewhat like sugar-cane. The oily albumen is consumed from the gelatinous stage until it has reached complete maturity. At the early stage of marai the jelly-like meat is reserved for infants and toothless old people. Te moimoto represents the age at which green nuts are preferably picked. At this stage the nuts contain a maximum amount of water (te ranin), and the meat is fully developed but still soft. Its Vitamin B content is low, but the water is said to be a good antiscorbutic. The mature nut, ben, is an important souce of fat. It is rich in protein and carbohydrates. The Vitamin A content is negligible whatever the degree of maturity. Grated coconut te ota and the cream which may be extracted from it are poor in vitamins. But the developed germ to bebe is rich in Vitamin C. This sweet spongy mass is much appreciated and mostly consumed by natives while they are cutting copra.

To sum up, all these edible parts of the coconut palm have a very low vitamin content. There may be a compensating effect in the fact that the natives consume them frequently and in large quantities. These elements are, in fact, included in all food preparations. It should be mentioned that very few Gilbert Islanders eat the palm cabbage even when trees have fallen down or have to be felled.

Pharmacopoeia:

The mesocarp of the te bunia variety is used at the te ubu, te ra and te moimoto stages to treat cases of infantile diarrhoea (te banibong) in patients 1½ to 4 years old. The liquid obtained by beating and squeezing is mixed with coconut water to sweeten the dose. The same preparation is used as a toothpaste. The inflorescence is used to treat gingivitis: nine male and three female flowers are taken before the spathe is open. The tongo (Rhizophora) are grated after being peeled. The whole is mixed and the juice is squeezed and applied on the gums. In the case of very small children the mother takes some of the mixture on her finger and massages the gums. The same medicine in a more diluted form is used as a gargle to treat sore throats, etc.

BUILDING MATERIALS AND OTHER USES

Trunks: These are used as beams in the construction of all buildings from the small shelters for storing coconuts (te okai) to the huge maneaba (community house), and for building light bridges, pig pens, etc. The timber is also favoured for canoe building.

Whole fronds: (Te bani or ba-n-te ni). These are used for roofs, partitions, rough mats (Plate IXb). Rolled up and tied, they form the best torches for night-fishing.

Parts of fronds: These are used to make baskets for carrying leaves and compost to the babai pits and, generally carrying bags of all sizes (Plate IXc).

Midrib of the fronds (Te taboa): Their stiffness makes it possible to utilize them not only for partitions in European houses but also floors in native huts. These floors are supported by beams and covered with mats. The midribs are also used to make trays for drying fish and the various pastes and cakes made from bread-fruit, pandanus, etc.

Main vein of leaflets (Te noka): These are used to fix pandanus leaves to their supports when a roof is being assembled.

Leaflets: The tender white leaflets are often employed for ornamental purposes during feasts, but their greatest use is in the making of riri (grass skirts), hats, rather fine mats and other handicraft products. Old leaflets are used for compost and in baskets for babai.

Coconut husks (Te ewanin): Beside being employed as fertilizers for Artocarpus, Cyrtosperma, etc. they are used chiefly to make coir (te benu). After being extracted and retted in fish ponds or in the sea or even in the muddy sand near the mangrove, the fibres are hammered with a mallet, roughly separated and made into string (te kora) by the women who roll it on their thighs. This coir plays a considerable part in native life, since it is used to bind all component parts in building houses and canoes. Cord and rope everywhere replace nails, tenons, pegs and mortises. The husk of the te ni variety is used for coir, at the moimoto and to amaere stages only, the latter being the better. In the Gilbert Islands, coir making for export has not yet been undertaken, but such a development is envisaged for the future.

Coconut shells (Te nana): When hollowed out, these form the usual containers for toddy collecting (te ibu). Cut in halves, they are used as cups, small bowls, ladles, etc. Burnt, they provide the best of charcoal.

Nuts without kernel (Te wae): These aspermous nuts often attain the same size as normal nuts. When they are barely developed and the fibres of the mesocarp are still compact, the natives use them to make corks.

CHAPTER 5

THE PANDANUS

Pandanus is a tree of medium dimensions, with slender branches irregularly arranged. The base of the trunk, and frequently also the main branches close to the ground, have long adventitious roots, which are more or less hard. Long strap-like leaves are spirally inserted at the end of branches and have sharp marginal serrations. The dead leaves remain attached, hanging.

The drupaceous fruit cluster is large, sometimes weighing as much as several kilos. The drupes, which are at first green and tightly packed, grow apart as they mature and when ripe display an orange tinge at their basal, less lignified end.

Taxonomy:

The classification of pandanus is not clear yet and some authors classify as species what others consider to be simple varieties. Thus D. Anderson (in Stone, 1951b, p. 17) thinks that all the pandanus on the island of Arno (Marshall Group) are simply varieties of the tectorius species, and he enumerates sixteen. The botanist Papy (1951) also seems to consider that practically all the pandanus in French Oceania should be referred to the Pandanus tectorius of Solander.

The shape of the fruits, and more particularly of the drupes, are better criteria for classification than those provided by the leaves which vary in shape and length at different ages. Difficulties encountered in the preservation of the flowers and the desiccation of the fruits of the pandanus, as well as their bulk, do not facilitate research by botanists.

The remarks made by Papy on the Pandanus tectorius of coral islands generally agree with ours: "Pandanus tectorius Solander is, in these regions, more widely distributed geographically than the coconut palm, its edaphic requirements being practically nil. The syncarp of the pandanus was used in the past to provide the main food supply for these coral islands. The basal part of the mesocarp of each drupe is less lignified than the rest, and contains a good proportion of starch and dextrose. But fibres and crystals of calcium oxalate sometimes make it unpleasant eating." The varieties which, according to the natives, irritate the lips, are te aramboia in Tarawa, and te irikiri and te irineiaro in Nikunau.

History:

It is logical to think that the presence of the pandanus in the Gilbert Islands, as in other regions, dates from long before that of the coconut palm. Many authors believe that the germinative properties of the pandanus seeds are preserved even after long periods in sea water, whereas those of the coconut are more rapidly lost in the same conditions. From this it may be deduced that the pandanus did not, like the coconut palm,

need human intervention and that the first of them which colonized these islands grew from seeds which drifted on to their shores. Later, some varieties - as the meaning of some native terms occasionally indicates - must have been imported, some even well after the introduction of the coconut palm. In the course of the many migrations which these territories have seen slips of the favourite varieties probably continued to be transported as limited transport from island to island still takes place today. This would seem to be the meaning of the name "pandanus people" conferred by Grimble (1933-34) on the Gilbert Islanders.

The first populations of these territories must have used pandanus as a basic plant food, until the number of coconut palms in production was sufficient to supply them with new resources. Then the pandanus was gradually relegated to a secondary role. Recently, since the coconut palm has gained commercial value because of copra, the native tends to neglect more and more his ancestral te kaina which is thus relegated to the poorest land. Reliable observers (Sabatier, 1939, p. 34) whose presence in these territories over many decades has qualified them to make useful comparisons, have already drawn attention to the notable decline of pandanus on several of the Gilbert Islands, Makin and Butaritari among others. This disuse is regrettable because of the food value of the pandanus, and particularly on account of its many domestic uses. It should be pointed out that a major factor during the last decade has been the large number of trees which were felled for the United States Armed Forces and later for the Government. On many islands a limit on the use of pandanus for building has already been reached.

Varieties:

Grimble (1933-34) estimates that the natives number more than 160 kinds of pandanus. Bingham (1908) lists 170 different names (although some of them seem to correspond to parts of the plant). Finally, Sabatier reports that Frère Eloi counted 194 different pandanus. Only an ethnologist or a linguist would be interested in the translation of so many words, many of which, no longer have any very distinct meaning for the natives. Some trees, which appear to have certain particular characteristics in common, have different names on different islands. Further, on the same atoll a name used in the north will be either unknown or unused in the south, and vice versa.

We must bear in mind that the behaviour of pandanus varies according to its edaphic situation. The physico-chemical nature of the soil and subsoil, humidity, salinity, etc., are factors which influence the aspect of the trees (height, diameter, leaf development, and perhaps even size of fruit). Pandanus grown from seed may lose most of the particular characteristics of the parent plant, and may even cease to be productive. This could be a case of unstable hybrids. In the face of all these causes of variation, one can understand how the native himself gets lost. In trying to recognize as great a number of different pandanus as possible, we took in turn, round the villages and babai pits and also into the bush, several men who were reputed to have a good knowledge of the different varieties.

They could with little hesitation, give names for their own trees but they were much less categorical about those of others. In the bush, their hesitancy increased and they were often unable to assign any particular name to any particular tree. Further, when these "specialists" were brought together, interminable arguments between them testified to their inability to agree on any specified term. They were not even in agreement on the differential value of a characteristic or a group of characteristics, which we for our part had difficulty in distinguishing, so subtle were they.

Finally, we were able to retain only sixteen different names corresponding to trees about which the natives we questioned did not hesitate. These were varieties recognized on the island of Tarawa.

TARAWA LIST

1 - te antinakarewe
2 - te anikomri
3 - te aranaonimai
4 - te anabanaba
5 - te arabaikiaro
6 - te anikatouea
7 - te arataitara
8 - te anibanakoi
9 - te aratokotoko
10 - te antibitia
11 - te arateman
12 - te aratekura
13 - te aramboia
14 - te aramatakoi
15 - te aramaiki
16 - te aniwaentang

In the southern islands, names as well as varieties may be different. On Nikunau we distinguished twenty-five names. Among them only te antinakarewe is to be found on the Tarawa list. In both atolls this variety is considered the best of all.

NIKUNAU LIST

1 - te aramaru
2 - te irikiri
3 - te irimakiro
4 - te tina
5 - te iroro
6 - te antinakarewe
7 - te iritawatawa
8 - te awaneari
9 - te irineiaro
10 - te aramaoia
11 - te utongau
12 - te ararikitoa
13 - te iribaoti
14 - te irikeang
15 - te irimaoruru
16 - te irikanoabuana
17 - te irikauri
18 - te iribuangui
19 - te n'tinatina
20 - te anabanaba *
21 - te irionotoa *
22 - te iriatabu *
23 - te irimangkoriki *
24 - te irikaiwete *
25 - te tinanikarawa *

The names in the Nikunau list followed by an asterisk seem to have no meaning for the inhabitants of the northern part of the island. A fruitless variety was also mentioned to us, which has no usefulness other than as a source of a substitute for cigarette papers, but we were unable to check whether the name given, te kamoneara, is actually applied to a variety of tree or only to a type of leaves. When we study the various uses of the pandanus we shall see which are the most useful species and the advantages of each (p. 59).

Ecological Survey:

In our examination of the pandanus trees growing wild in the bush we tried to determine whether the sites they occupied corresponded to zonations influenced by existing environmental factors. These attempts never resulted in valid conclusions. The lagoon side, ocean side and interior of the islands have about an equal density of Pandanus, not for any one area considered separately, but for a whole atoll. Noting that pandanus trees develop more fully in areas where tall vegetation is rather sparse, one might think that light plays a major role and that these pandanus grow so well in such areas because they are not impeded by the heavy shade of the coconut palms. Undoubtedly the light factor is in their favour, but other elements intervene to explain their abundance in certain places. Thus here and there in the center of islands, one observes areas which appear to be clearings in the thick undergrowth, where coconut palms are rare or absent, either because those destroyed by age or fire have never been replaced or because the environment has been too unfavourable. The pandanus, less demanding and more hardy, have developed and become the predominant element here. They had to compete only with slow growing species such as Guettarda, Scaevola, etc., which they rapidly outgrew. Even when fallen nuts or very young palms were present, the survival chances of the pandanus were greater. Their plentiful seeds germinated quickly, their early growth often being helped by the protection of the shrub vegetation, and during the first months of their existence a few rains were sufficient to ensure their rapid development.

There are, moreover, other areas where the pandanus has definite advantages over the coconut palm; for example, in places which by their nature or situation, or because of prolonged drought, are so arid that even the low vegetation suffers and often disappears. There again, the pandanus manages to survive. Such is the case also for marshy regions or for lagoon embayments where the water is not frequently renewed. These areas are regularly subject to intense drought, sometimes for very lengthy periods. Salinity, no longer compensated by rain, becomes so high that the coconut palm cannot resist it, although the pandanus tolerates it. Thus it is by no means rare to see dead coconut palms side by side with healthy pandanus, the latter having benefitted from the presence of the water without suffering from the salinity.

Apart from these special cases - such situations usually being restricted topographically - the pandanus is everywhere present, either isolated or in groups, in the middle of the most diverse environments (the mangrove excepted), or in pure stands which are often very dense (Plate Xa).

Finally, the human factor may intervene in favour of the extension of pandanus or against it. Here, an owner will never clean his land, and pandanus will freely multiply on it (we frequently saw veritable "natural nurseries" of young pandanus in untended areas). There, another native will clear his property, removing these seedlings, with all the more satisfaction as he fully realizes the low value of pandanus trees raised from seed.

Far from being limited to such special cases, man's influence on these small islands is at work generation after generation in a constant fashion. The parcelling out of properties and many other factors do not allow the formation of vegetation zones that would exist under normal conditions, nor have these been able to persist from before man's occupation of these islands.

Cultural Techniques: Every pandanus planted by the Gilbert Islander is from a cutting, for reproduction from seed offers nothing but disadvantages, as it never transmits all the characteristics of the parent plant. The best cutting is obtained from a branch which already bears the beginnings of adventitious roots. Generally a hole not exceeding 30 cm in depth is made, and the cutting is inserted without further care. Such a rudimentary technique is regrettable, for many examples prove that pandanus always fares well after deep planting, with the addition of some fertilizer such as dead leaves, surface soil, or better still, compost. The more careful natives often collect, in the bush, the black surface earth under the Guettarda and fill the hole with it. They even add various fertilizers as they do for the breadfruit tree.

On the islands affected by the war, where quantities of scrap metal are found, the natives will often add a piece of iron in the hole. The usefulness of this practice is debatable since pandanus seems to be just as productive without it and, moreover, never shows the slightest sign of chlorosis.

A planting technique to be noted is the frequent tamping of the soil around the just-planted cutting, considerably increasing its chances of success. In the case of the Gilbertese pandanus two things, however, remain rather difficult to explain. One is that this tamping is done several times, long after the plant has effectively taken root; the other is that the native insists that this tamping enables him to obtain both a very low tree (Plate Xb) and a more plentiful production. We have noted the accuracy of this first point, but have no proof of the second. A further native assertion is that even if cuttings planted in the villages come from tall pandanus of the bush, trees grown from them remain small if tamping is carried out conscientiously.

Growth:

In spite of much cross-checking it is only with every possible reservation that we quote some figures supplied by the natives. A period of less than a year (nine to ten months was even mentioned) from the time when a

cutting is put in the ground and well packed is necessary to obtain the first fruit. A native on the atoll of Tarawa planted a cutting of the aratokotoko variety, a mile or so from his village in a large open space. He buried it in a hole about a foot deep which he filled with coconut husks, mesocarp, and other rotten vegetable waste to which he added rusty iron. A year later he passed the spot and was much astonished to see already a large fruit (Plate Xc). Such astonishment made us think that progress must usually be less rapid and that it would be reasonable to allow a year and a half rather than a year, with from time to time, exceptional cases of more rapid development.

On several occasions natives told us that pandanus may produce fruit after only ten months if they have been planted in villages, but that, planted in the bush, they need more than a year. If this is accurate it can be explained both by the fact that the open situation of villages affords them more light, and also because all village trees are better tended. The period is reported to be relatively the same for all varieties.

Hardiness:

In spite of the probably very diverse origins of many "varieites" we may assume that they have all an equal degree of hardiness. One cannot but be struck by the resistance of the pandanus to salinity (Stone 1951 b, p. 18), by its adaptation to the most arid soils, and by its capacity for resisting extreme drought on areas subjected to intense sunlight and often to frequent showers of salt water spray.

It must, however, be pointed out that in certain very exposed areas such as the corners of islets, and where there is a combination of many unfavourable conditions, even pandanus will succumb to the effects of prolonged drought.

Productivity and Longevity:

According to the natives of the southern islands, fruit production is spaced quite regularly over the whole year, whereas Gilbertese of the central and northern islands state that there are clearly-defined periods of good, medium and poor production. The best period is July and August; production thereafter decreases steadily until Christmas, remaining very low until April. It finally rises again progressively from May to July. In the absence of statistics, it would be very risky to try and interpret these two viewpoints, in spite of our knowledge of differing rain conditions for the south, centre and north.

The only facts which we ourselves have been able to establish relate to the very low rate of production of pandanus trees which had just suffered two years of extreme drought, and the plentiful production of these

same trees after less than three months of regular and abaundant rain, with larger fruit than in the dry season. The natives agree with the assertion that the quality of the fruit is unvaried throughout the whole life of the tree, whatever the conditions of the moment.

Since the uses of the pandanus are not confined to its fruit - its leaves and wood have a very important economic role -we must add that the behaviour of these trees in favourable rain conditions is rapidly marked by greater individual development and notable lengthening of the leaves. The natives of the southern islands, however, told us that the decrease in size of the leaves due to prolonged drought was never such as to hamper the manufacture of the various handicraft products. The productivity of the pandanus lasts for many more years than that of the breadfruit tree, but no average figure was given us. During periods of intense drought it may become very low, but it never falls to zero, as in the case of the coconut palm. As for the longevity of the pandanus, it is commonly said that it has the normal duration of a man's life.

Harvesting:

As with the breadfruit tree the fruit, if too high to be picked by hand, is gathered with the help of a knife firmly attached to the end of a pole (te butika); the fruit is detached by cutting the stem. If the tree is very high, an adjoining tree is used to get near enough, or if the pandanus is isolated, it is climbed. There is never any waste. Rarely is a fruit lost, and then only because it fell unnoticed into the undergrowth.

The leaves are gathered preferably in the early morning because they have still a little of the flexibility which night has given them (marau), and are consequently less prickly. If gathered in the heat of the day it is impossible to avoid the cruel scratches frequently inflicted by their serrated edges.

Uses:

Fruit: Sabatier (1939, p. 34) tells us that the pandanus of the Gilbert Islands produces better fruit than any other in the Pacific Islands because it grows and ripens slowly, and he adds that in Oceania there is no race which eats as much of it as the Gilbertese. In addition to forming a reserve food supply the pandanus fruit is consumed under different guises more or less daily throughout the entire fruiting season.

The drupes, or more accurately their fleshy basal part, are eaten raw or are included in various dishes which are improved by the addition of grated coconut. Some recipes rarely vary, but others depend on personal taste and available material. We shall indicate only the commonest:

Te tangauri: This is a preparation intended to be eaten quite soon.

Composition: 2 parts of drupes (juicy section only), 1 part whole drupes and grated coconut (to taste).

Preparation: The whole drupes and the juicy sections are cooked together, then crushed, either with a wooden pestle, which is the ancestral method, or in a meat grinder, to obtain a purée. First, however, any parts of the drupes which are too hard are carefully removed. This purée (unlike te tuae) remains full of fibrous elements. Grated coconut is added to taste or to achieve a certain consistency, and the whole is well mixed. This "fruit paste" is then eaten either in this state or later in the form of flat cakes obtained by drying the paste in the sun. This task, reserved for the women, consists of spreading a mat on the ground and arranging on it, side by side, the largest leaves of te uri (Guettarda). The paste is spread on these leaves with the tip of a knife to a thickness of about $\frac{1}{2}$ cm. and is then covered with another layer of leaves to protect it from flies (Plate Xd).

This tangauri cannot be kept long because of its fresh coconut content. It could be kept only by toasting the cakes, as is done for the preparation of kabubu.

Te tuae: This is a preparation intended for keeping a long time.

Composition: The juicy section of the drupes only.

Preparation: Pandanus fruit is cooked in the native oven [1] by steaming (the method called te umum) or much more simply in a container such as an enamel bowl placed on a wood fire. After cooking, the edible part of each fruit is scraped. It is well mashed and the maximum quantity of fibre removed, and the resultant paste is spread as in the above recipe. When it has ceased to stick to the leaves it is cut into flat cakes which are exposed to the sun, first on a plank or iron sheeting, and then directly on the ground (Plate XIa). Once desiccation is complete these cakes will keep for years. They form the reserve food supply with which the Gilbert Islander provides himself when he is travelling from island to island or going for a

[1] Descriptions of this oven and its installation may be found, with supporting illustrations, in several classical works such as those of Grimble.

few days to the neighbouring Mission's festivals. When he wants to use the cakes he soaks them first in coconut milk to soften them again. They are also eaten rolled up with grated coconut, then cut into thin slices and moistened with coconut milk (as we should do for French pancakes rolled with jam). Another way of using tuae consists of rolling it, cutting it into small pieces like noodles sprinkling it with kabubu (pandanus flour) and pouring kamaimai (toddy molasses) plentifully over the whole. This dish is then called te katii. The varieties of pandanus which are preferred for te tuae are (Tarawa names) te antinakarewe, te arabaikiaro, te aratataitara, and te aratekura.

Te karababa: This is intended to be eaten very shortly after preparation.

Composition: Two parts of pandanus fruit; one part of grated coconut.

Preparation: The edible part of the drupes is cut, cooked as for te tuae and mashed without removing the fibres. When this mass becomes creamy, grated coconut is mixed in and the paste spread in the sun in the same way as te tuae. Te karababa may be eaten either when it reaches the consistency of jam, or as dry cake, but generally it is made into kabubu.

Te kabubu: The cakes of karababa are toasted on both sides over a kind of grill made of flat heated stones. They are left to cool and then grounded in a large Tridacna shell (te aubunga). The coarse flour thus obtained is called kabubu. Nowadays this product is preserved in tins. Formerly it was simply rolled up and wrapped in pandanus leaves (te iria). It is said never to get mouldy. This is hard to believe for people who like ourselves witnessed for months the almost daily reneval of mould on food, clothes, shoes - and the herbarium specimens which had constantly to be redried. Four years is claimed to be the normal keeping period of te kabubu and te tuae, if placed in tightly covered containers, but many natives told us that they will keep as long as required. A last-minute item of information from L. Hudson confirms this. Kenneth Emory found in the Bishop Museum one of these iria which contained kabubu in a good state of preservation after fifty years. Kabubu may be eaten dry, as for instance by fishermen who remain for hours away from their home base. It is also put into a number of dishes, one of which - a particular favourite - is called te korokoro.

Te korokoro: Kamaimai (toddy molasses) is mixed with kabubu until it forms a kind of very thick cream which is eaten just as it is. Our Gilbertese interpreter, Te Baara, added that one needs a drink of water afterwards. In fact it is more usual to mix kabubu with water or toddy and drink it. All things considered, kabubu, although in itself rich in food value, is above all a base or "support" for other products, and it is these toddies and molasses which make it appetizing.

Food Value:

Actually, there exist very few analyses on which one can rely to estimate the food value of pandanus. Authors are agreed on the considerable importance of the fruit and its derived foods as emergency food supplies, but they indicate only the high vitamin C content of the flour, te kabubu. Neither are there any data on the amounts consumed. The Gilbertese eat pandanus at their rate of production, and consequently consumption is high in times of abundant fructification, as with breadfruit.

Leaves:

Because of their multiple uses pandanus leaves have, in native life, an importance at least as great as that of the fruit.

Roofing of houses: The minimum life of a roof (Plate XIb) is three years.

Partitions and Walls: (Occasionally the adventitious roots, split down their length, are used for this purpose.)

Mats: (a) Floor covering)
(b) Sleeping mats) The whole width of the leaf is used.

(c) Dancing — Young leaves are mostly used. Contrasts of colours are obtained by different treatment of leaves, by dyeing, or even simply by using leaves of different varieties.

Headgear: (a) Wide-brimmed hats (fine weaving).
(b) Conical fishermen's hats (coarse weaving).

Sails: For canoes (pandanus leaves tend more and more to be replaced by canvas).

Wrappings: For food supplies.

Caulking Material: For canoes (tends more and more to be replaced by European material).

Baskets for babai: Whole leaves.

Cigarette Paper: A useful substitute for cigarette paper is obtained by splitting the thickness of the leaf.

Favourite varieties for mats and generally for all finer handicrafts are:

White leaves only: Te antinakarewe

White and yellow leaves: Te aratekura and te arabaikiaro

The same varieties are preferred for cigarette paper.

Further uses:

The inedible part of the drupes is used as fuel. The natives perfume the coconut oil they use as hair oil with the spathes enveloping the inflorescence (te taba). The straight trunks provide framework pillars for houses (Plate XIb) and various supporting sections in the construction of maneaba (large communal house).

The natives remove the bark from a piece of the adventitious root and pound the ligneous part. The juice is then extracted and mixed with four parts of water or of coconut water, and the concoction is used as a febrifuge.

Summary of most useful varieties:

We have distinguished five different levels of quality among the 16 varieties clearly recognized by the natives of Tarawa.

1. Te antinakarewe: This is by far the best. A juicy fruit, fleshy and very sweet, it is the favourite for eating raw. Excellent for all culinary purposes; gives the best straw for handicrafts, white and pliable because drawn from long leaves; much valued for cigarette paper for its taste and its thinness. In the south islands this variety is also placed first. Karewe is the name for toddy. A linguist could tell us if there is any analogy with the taste (something sweet, smooth) or with the importance of this variety in the preparation of foods.

2. Te anikomri: Very useful as building material because the trunk is very slender, very tall and with few branches. The leaves are valued for handicrafts. Fruit is much prized for the preparation of te karababa and te tuae.

3. Te aranaonimai: Fleshy fruit is much prized as food, raw or cooked.

4. Te anabanaba, te arabaikiaro, te anikatouea, te anibanakoi, te arataitara. These five varieties are considered equally good for the preparation of te kabubu and te tuae. The fifth is more usually reserved for te tuae.

5. Te aratokotoko, te aratekura, te aramboia, te aramaiki, te aniwaentang, te antibitia, te arateman are the least valued varieties.

Pests of Pandanus:

The study of pandanus pests would require intensive work by a specialist in the field. We have just seen the great importance of the leaves with their many uses, and it is they which are subject to considerable damage by a burrowing larva. These attacks are revealed by the appearance of a spot, 4 to 20 cm. wide, whitish with brown or reddish edges, resulting from the necrosis of the leaf, between the two epidermal layers of which the larva lives. On both sides of the leaf over the affected area the only thing left of the blade is a kind of parchment, extremely thin, and in the form of a blister or swelling. The larva and adult insect still await identification by specialists.

Another larva, the adult insect of which could not be obtained, is sometimes found associated with the first, or installed in an old cavity as a secondary commensal which need not be considered as a pest. It feeds on dried vegetable matter. This larva reminded us very much of that of Callirhipis.

CHAPTER 6

THE BREADFRUIT TREE

The breadfruit (Artocarpus) is a tree of the Moraceae family. Originating in the Sunda Islands, it is nowadays widespread throughout the inter-tropical zone, particularly in the Pacific islands. It grows rapidly, up to a height of 20 m. The fruit is edible, both pulp and seeds. However the fruit of certain species or varieties, often regarded as the best, are seedless.

The breadfruit is well adapted to atolls, and its distribution is certainly directly related to the salinity of the ground water. If it is not too crowded by other trees, the breadfruit forms very low branches and developes a spreading crown. It is planted in villages and along roadsides.

The fruit season lasts from May to July, but may be prolonged until December. On Arno (Marshall Group) during the fruiting season, the Artocarpus forms the basic food supply. The fruit of the mai, when very ripe, is sweet and has a fruity taste.

The Breadfruit on the Gilbert Islands.

In the life of the Gilbertese these trees (te mai) play an important role which in some regions of the archipelago may even rival that of pandanus. They are, however, much less common. Whereas pandanus is one of the constituent elements of the "bush" flora and may at times form pure stands (Plate Xa), the breadfruit is found only in the villages or their immediate neighbourhood, and occasionally by roadsides, but never in the heart of the bush. In the villages the trees are automatically well spaced by the houses.

The breadfruit tree is more widely cultivated and more carefully tended in the southern islands where, because of harder living conditions, its presence is more useful than in the central and northern groups. There can be no doubt that of all economically valuable trees Artocarpus is the one which has the least resistance to prolonged droughts. Sabatier writes: "In the south islands group, breadfruit trees survive with difficulty. They are practically exterminated every ten years."

We can state as a fact that after two years of drought, many trees were dead or dying in the north and centre as well as the south. On Abaiang the percentage of Artocarpus which had died in the course of the preceding year or which were dying was estimated at approximately 60%. It was the oldest trees which were disappearing (trees which, we were told, were at least forty years old, a few even fifty). On Abemama few trees had died, but the tops and some secondary branches half way up had withered (Plate XIIIa). Similar observations were made on Tarawa. The islets at the northern extremity had suffered less than the rest of the atoll. On Arorae some areas were badly affected, others hardly at all. On Onotoa there were many dead trees of widely-differing ages (there was no replanting on the return of the rainy season, for want of seedlings. The

main reason for this lack is that Artocarpus seeds lose their germinative properties fairly rapidly). On Nikunau there was a number of dead trees, while others had only dried tops. On Beru, there were few dead trees as compared with the other islands, except in the southern part of the atoll where trees of all ages died, the proportion being approximately 60%.

In spite of its lack of resistance to drought and to variations in the salt content of ground water, the breadfruit has remarkable regenerative and recuperative powers (as shown by the breadfruit trees of Butaritari which were damaged in the war). Often the trees make a new start by throwing out a shoot at the base or half-way up the trunk, but these "resurrections" depend above all on the environment of the root system. Thus there is great contrast between the excellent survival of some trees and the dying state of their neighbours. Here as with coconut palms water is the important factor. Because they happen to be near a fresh-water well, individual trees, having survived intense prolonged droughts and reached an imposing size, live to a great age and maintain a remarkable rate of productivity.

At the old site of the village of Eita (Tarawa Atoll), about half a mile from the present site selected some ten years ago, only two trees survive out of the hundred or so which were there before the place was abandoned for lack of fresh water. Finally, to the topographic and edaphic conditions influencing survival must be added the individual quality of the trees and the attention they have received.

Species or varieties:

As a result of our own observations and enquiries among the natives, it is possible to distinguish five different Artocarpus and the botanists who are examining the specimens will indicate whether they are species or simply varieties.

Te mai: (Plate XIc). This name is the general vernacular term for any breadfruit tree in the Gilbert Islands (also in other areas of the Pacific) and in addition designates an Artocarpus of which the distinctive characteristics are:

Leaves: Pinnatilobed.

Fruit: Ovoid with a more or less pronounced median transversal "narrowing". Numerous seeds. Of all the Artocarpus te mai is the most appreciated by the natives. It is also the most prolific.

Te maitarika: This name may be broken down into mai (breadfruit tree) and tarika (brackish water). This is the hardiest Artocarpus and it is able to exist under more difficult general conditions than the others. Above all, it is more resistant to brackish water.

Distinctive characteristics: (Plate XIIa, b).

Leaves: Trilobate extremity - median lobe larger than two lateral lobes.

Fruit: Pyriform, dented rather than "narrowing". Fewer seeds than in te mai.

Te maitarika is the least tall variety.

Te keang ni makin: (Plate XId). This name indicates the striking resemblance between the leaves of this Artocarpus and those of te keang, a fern (Polypodium scolopendria Burm. f.), which is fairly widespread in the Gilbert Islands, and the supposed origin of this breadfruit tree (the Islands of Makin).

Distinctive characteristics: (Plate XIIa, b)

Leaves: Pinnatifid.

Fruit: Resembles that of the te mai rather than that of te maitarika, but it is more commonly ovoid and contains fewer seeds than te mai.

Te Keang ni makin bears later than the others. It is the least common variety.

Te bukiraro: The characteristic feature of this Artocarpus is the absence of seeds. It is, therefore, always propagated from cuttings. It is usually taller than the others. This variety is very productive and is the favourite of Europeans.

Distinctive characteristics: (Plate XIIc).

Leaves: Pinnatilobed - much like that of te mai, but wider.

Fruit: Almost spherical, neither narrowing nor dented.

Te motini wae: This Artocarpus is also seedless and, like the previous one, is reproduced by cuttings. The name contains the word te wae, which is also used for coconuts without kernel (te ni wae). This variety is less common than the others. We saw it only on Betio, growing from a cutting which had been brought from the island of Butaritari two and a half years previously. It was a tree about fifteen feet high and had no fruit.

Cultivation:

The term cultivation may appear a little exaggerated. However, the breadfruit tree does receive a certain amount of attention, both at the time of planting and throughout its first years of growth. A hole is dug, usually 30 cm by 30 cm and 20 to 30 cm deep (on Abaiang we saw holes 1.5 m deep). For several weeks the hole is filled with all possible waste

matter of which the most abundant is vegetable matter, dead leaves of coconut palms and of Artocarpus, and with all the rubbish swept up daily. Leaves of te mao (Scaevola sericea) and of te non (Morinda citrifolia) are, however, preferred. A little earth is put on top and the seed is sown. If it does not germinate another is sown later.

The pit is seldom watered but the young sapling is nearly always protected by being completely enclosed, in the beginning, with leaves or a mat (Plate XIId). Later the roof of the shelter is removed and only a circular fence is left, against very small children, piglets and fowls.

Naturally the accumulation of vegetable waste entirely filling the hole subsides progressively as it gradually rots. The native compensates for this shrinkage by adding dead leaves and other matter which serves at the same time as fertilizer. Often, as a protection against animals, as well as to keep the compost in place, a wooden frame made of four coconut logs (Plate XIIIa) or a border of small coral blocks is built about a meter from the foot of the tree. In some villages of Abaiang we noted that the refuse from the pig enclosures was collected and put inside this fence. Finally, in many cases, the hole was topped with a layer of the very fine black surface soil which is found in the bush under te uri (Guettarda speciosa).

In the Gilbert Islands the breadfruit are better respected than other trees, we mean that their trunks do not show the multiple gashes which the native is in the habit of making on coconut palms to carve his name. Under good conditions these trees sometimes reach considerable dimensions. One we saw was almost 18 meters tall and was much divided near the base, each branch more than 1.5 m in circumference, 1.5 m above ground. Some trees may even exceed 20 m in height with trunks over 2 m in circumference, and are said to be more than sixty years old, but such are the exception. We were told that trees over fifty years of age suffer more from drought than younger ones. We question this however, since for these trees to achieve such an age they must have enjoyed exceptional conditions, which should have helped them resist drought. In our opinion they must have reached the end of their life-span, and drought merely hastens their death.

Under less favourable conditions breadfruit trees from eight to ten years of age may be found, 8 to 10 m in height and 1 m in circumference at 1 m above ground.

The number of Artocarpus varies from one region to another, and from one village to the next. It is generally dependent on the number of inhabitants although on certain southern islands we noted a higher mean number of trees than elsewhere for the same population. In a village on Tarawa Atoll (see table X) for a population of 115 persons (22 families) we counted 93 breadfruit trees; only one family did not own any. In the Gilbert Islands these trees are grown only in the village. They always belong to the person who planted them and even if he moves elsewhere he always has prior right to the fruit.

Production:

Obtaining production figures per tree or per village, is not possible. No one has ever thought of weighing, throughout a normal and dry year, the fruit of one or several trees. The only information of any interest is the fact that in a dry period they are sparse and reduced in size. In July, when the rains had lasted more than three and a half months, five fruits picked from an average tree (te mai) from Tarawa gave us the following weights: 1 lb. 12 ozs.; 1 lb. 9 ozs., 1 lb. 13 ozs.; 1 lb. 8 ozs.; 1 lb. 1 oz. It is towards the end of the year that the trees bear their maximum of fruit. According to our native informants, the production of the breadfruit tree lasts nine months of the year, with a slack season of three months in February, March and April. This pause which, according to the Gilbertese expression, corresponds to the tree's resting period, may obviously vary with the rainfall. In the Society Islands, Papy (1951) reports a full harvesting season from November to April and another fructification in July and August.

The fruit is detached from the trees with a long pole (te butika) on the end of which a knife blade is fixed. If the tree is very tall the gatherer climbs it, cuts the stalk and the fruit falls, without suffering much damage. It is against customs to have women gather breadfruit.

Consumption:

The delicate flavour of this fruit makes it a favourite food of the Gilbertese. In times of abundant production, when too many fruits ripen at once, some will be made into preserves so as not to be wasted.

As an item in the daily food supply, the fruit is eaten raw or cooked, after the skin has been scraped with a knife or shell. It is cooked in a little water and steamed or baked in the standard native stove covered with mats, or alternatively as we cook potatoes "in their jackets". In the first case, the cooking water is never thrown away; it is much prized as soup.

Preparation for keeping:

The preserved product is called te kabuibui ni mai or te tuae n-te mai. The fruit is cooked in its skin or first scraped with a te koikoi shell. The slight cooking is done in a large enamelled basin, which is less work than setting up a stove in the old manner. The edible parts must then be crushed. A giant clam shell, te aubunga, and a wooden pestle of te ngea (Pemphis acidula) were formerly used; we saw them still used by very old women on Onotoa. Nowadays, the Gilbertese who have been working on Ocean Island or Nauru often bring back meat grinders. The use of these tends to become more general. Obviously there is not one for each family, but they are borrowed, like many other things, by the traditional bubuti (see pp. 16-17).

Insect Pests:

The Gilbert Island Artocarpus seem free of insect pests. We never noted any attacks, even slight, on the leaves, trunk or branches. However, from an identification list just received from the Bishop Museum we note a fruit fly, Dacus (Strumeta) frauenfeldi Schiner.

Pharmacopeia:

(a) Ear Complaints: To soothe certain painful affections of the inner ear, four or five young Artocarpus leaves are crushed, the juice extracted and poured into the ear. Alternatively a young leaf is warmed and stuffed into the ear duct.

(b) Conjunctivitis: Artocarpus buds are chewed and spat on to a piece of cloth which is squeezed above the eye and allowed to drip into it.

Other uses:

The wood of Artocarpus is used particularly for outriggers of canoes and for fishing floats. The leaves serve as fertilizer for the babai as well as for breadfruit itself. They are also very useful for wrapping many native foods for transport.

In preparing kabuibui, the hands always become sticky and stained black by the latex which exudes from the ripe fruit. Soap and other European cleansing aids do not easily remove these stains. The Gilbertese places a small piece of copra in his mouth, chews it, spits the result into his hands, then rubs and rinses them with water. Every trace of stain and stickiness disappears.

Food value:

Authors agree that the breadfruit has high food value. It is estimated that it contains about the same quantity of edible carbohydrates as taro or sweet potato. When it has reached full maturity it gives, like the banana (Buchanan 1947), a negative reaction to the iodine test, showing that all starch has been converted to sugar. The cooked fruit is a good source of vitamin C.

TABLE X

Census of a village of Tarawa comprising 23 households.

Family, Identified by number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Number of persons	6	3	8	4	3	4	4	6	4	12	5	3	9	3	8	3	8	5	5	4	3	2	3	115
No. breadfruit trees	2	1	2	4	11	5	2	-	6	3	4	5	5	3	5	8	1	3	4	5	7	2	5	93
No. of Papaya trees	14	5	6	1	5	2	3	-	2	4	6	5	-	-	-	-	-	-	2	3	3	7	42	111
No. of pigs	1	1	3	2	1	4	-	-	3	3	1	2	3	3	2	2	1	-	2	3	1	3	1	42
No. of fowls	6	15	7	-	30	6	-	2	2	12	-	3	36	4	30	15	-	-	-	5	6	-	26	205
No. of babai pits	3	1	5	5	7	7	4	3	3	10	4	2	3	8	5	7	5	-	4	3	2	4	2	91
No. of parcels of land	3	8	3	5	3	8	5	3	3	5	5	3	3	12	9	3	7	3	4	3	2	3	5	108

TABLE XI

Number of Cyrtosperma of 3 age groups for 27 families in a Tarawa Atoll village.

Families	Adults	Children	Pits	Cyrtosperma growing for		
				6 to 18 mos.	2 to 4 yrs.	8 to 12 yrs.
1	2	4	2	200*	-	-
1	2	2	1	45	9	2
2	5	3	3	97	6	8
1	4	-	3	117*	61	62
2	5	-	1	51	22	48
2	4	-	4	252*	143	38
3	6	4	2	126	54	8
1	3	1	4	107	118	17
1	2	-	1	406*	6	-
1	3	-	2	95	44	12
2	5	2	2	167	56	20
1	4	1	3	130	4	-
1	3	2	3	94	28	14
1	3	1	1	53	16	7
1	5	1	2	146	26	10
1	2	2	1	211*	31	41
1	4	1	3	124*	30	18
1	2	2	2	66	30	12
1	2	-	1	66	12	4
1	3	2	1	40	18	10
1	2	1	2	88	14	0
27	71	29	44	2681	730	331

* 80% are represented by the variety Te Katutu.

CHAPTER 7

THE BABAI

Te babai is a tuberous plant of the Araceae family which grows in stagnant water; the aerial parts reach a height of 3.5 m (Plates Id, XIIIb, c). The leaves are extremely wide, with more or less thorny petioles. The edible tubers are often wider than they are long. Food value should approximate that of taro (Colocasia esculenta).

Te babai is found in the Gilbert and Ellice Islands, the Caroline Islands, the Marshall Group, and in French Oceania. There are also small areas of babai on Fanning Island (Line Is.), Gardner Island (Phoenix Is.), Hull Island (Phoenix Is.), and large areas of wild babai and taro at Washington Island (Line Is.).

The assignment of a correct identification to the babai seems to have been, for a long time, the subject of great confusion. It has been frequently mistaken for: Colocasia esculenta (taro); Caladium cordifolium; Alocasia macrorrhiza or Alocasia indica. In 1927 Christophersen gave, according to Merrill, the correct identification: Cyrtosperma chamissonis (Schott) Merrill (1).

In the Gilberts this plant occupies an important place in native life. It is in fact the only crop actually cultivated by the Gilbertese. They grow it with the utmost care, but it should be noted at this point that the babai is not, as is generally believed, a staple food, at least nowadays. There is no doubt that, in several islands of the Group, the babai was much more extensively grown in the old days than it is now, as evidenced by the number of abandoned pits. In atolls such as Abemama the ground was literally riddled with pits which have been gradually abandoned and partly filled up by the sliding of the embankment slopes. The babai is now almost a luxury. After living in close contact with the natives we came to the conclusion that, for the Gilbertese, the value of the babai seems greater from the psychological point of view than as a foodstuff.

The growing of babai is, indeed, surrounded with a number of traditions in which pride seems to be predominant. For instance, much care is still lavished on specimens of which the only remaining value is that of ornament and the enormous size of their leaves. A native will display the greatest pride in a babai ten years old (or even older) which has reached an extraordinary size, although the tuber, if it still exists, has usually grown too hard and bitter. Moreover, pulling up a babai in order to offer the tuber to a distinguished guest is considered the greatest honour that can be paid to him. In more general terms, it will be easily understood

(1) Our friend Professor E. D. Merrill recently sent us complete indications which enabled us fully to clarify this identification.

that a plant so difficult to plant, which grows so slowly and requires so much tending, is a food that cannot be used indiscriminately.

The size of the babai pits varies considerably with topographic and edaphic conditions. They may range from ten to several hundred square meters. Several families or several individuals often share a pit (see Table XI). The shares are quite unequal; one person may own ten plants or more, while another has only two. The areas belonging to each and involving ownership of babai plants are said to derive from ancient land rights. It is generally considered that a fully-grown babai requires one square meter of living space.

Most Gilbertese pits are very ancient; we have no recollection of seeing one of recent origin or being prepared. The old pits are still used, and occasionally a pit which has long been abondoned is brought into use again.

A fact should be mentioned which at first glance seems paradoxical. Some islands of the northern group, in which the food supply is best, have remarkable pits and a proportionate abundance of babai. On the other hand, some of the southern islands where rain is extremely infrequent have very few and very poor pits. This is a matter for regret, since a greater production of tubers would be a valuable offset against the food shortages which sometimes affect these islands. But it should be recognized that soil conditions are also against them.

We shall see later that many pits are often given up because the water has become brackish. In other regions, pits were abandoned a long time ago, sometimes over very large areas. This was often the consequence of a demographic disturbance which resulted in olden times from local native politics (this is the case in Abemama, Aranuka and possibly Kuria). Brief comments on some of the atolls visited:

Marakei: This is the island where the babai seems to be most extensively grown. There is a great number of pits. Most of the plants are over 3 m tall and are well and consistently cared for.

Abemama and Aranuka: There are too few pits for the number of inhabitants, and most of them are not well kept. Abemama was, in the past, practically riddled with pits, but today coconut palms occupy the depressions which are all that remains of them; these are of course among the healthiest palms on the island. Most of these pits have been out of use for a long time, possibly since the end of Binoka's reign. In those days the babai may have had a greater ritualistic significance. There are also pits abandoned when water became brackish, as on Bike Island, now uninhabited.

Tarawa: The pits are generally very fine and the babai flourishing; for instance, those growing in the villages of Eita and Bikenibeu are almost as remarkable as on Marakei.

Arorae: The pits are remarkable, mostly because of the great amount of work required for their excavation. The rocky platform is often of exceptional thickness (Plate Id) and very compact. An enormous volume of earth sometimes has to be dug out and the sides of the pits have to be laboriously propped up. A striking feature of this island is that the material dug from the pits through centuries has formed a mound on each side.

Nikunau: In this island the pits are found mostly in the north, the pit water being said to become brackish in the southern part. The result is that the inhabitants of the south ask the northern people, as a great favour, for their permission to dig a pit in one of their plots. The rather miserable condition of most of the babai grown on this island gives a painful impression. In most cases there are even no baskets around the plants. Maintenance is so often neglected that one wonders whether such carelessness reflects discouragement on the part of the native in the face of such a poor growth. Most answers to our questions led us to think that little interest was bestowed on these pits and their babais.

Cultivation:

Cyrtosperma is cultivated in pits because it grows successfully only when living in fresh-water marshy land. Owing to the very special ground conditions in the Gilberts the natives have to dig down to the rocky platform and through it in order to reach the ground water lens. This work often represents a considerable effort, since the platform is sometimes at a great depth. As a result, the excavated material occupies much space and is sometimes as high as 1.5 meters. The conglomerate layer is often so hard that it takes a crowbar to break it. The next step is the strengthening of the pit walls wherever there is a risk of their collapsing, using blocks of muddy earth from the last excavation. Lastly, the bottom of the pit is levelled and the young babai shoots planted in it. As they grow, a mixture made of humus gathered under certain trees in the bush and of selected leaves is spread around them. A basket of pandanus leaves and stakes (Plate XIIIc) keeps this debris in place and also supports the plant. As more humus is added the increasing weight anchors the whole more firmly to the bottom. Thus this is really like growing plants in pots and - at least during the first stages - the plants are floating. If the roots, instead of spreading within the supporting mass, grew down into the deep mud, the plant would die. It grows only because it is rooted in an artificial and aerated medium.

When a pit abandoned in the distant past is restored to use, it has to be excavated and cleared of the soil which has inevitably slid into it, and the bottom must be leveled again. Instead of digging the whole of the area the natives start by digging holes of the required size for each babai plant, widening them as the plants grow, until, the holes having merged, the whole pit will have the same level. The work has thus become much less toilsome, since it has now been spread over many years.

The native always chooses for the site of his babai pit a location where fresh water is available. Contrary to the views of some authors,

the water of babai pits is not brackish. Indeed, it is often fresher than that of wells used for drinking or cooking. During prolonged droughts, if water becomes brackish the babai plants are said to wilt rapidly. Brackish water is definitely noxious whatever the age of a plant. Long immersion due to rain-water may be fatal too, but only to young plants.

Fertilizers:

Leaves from various plants and other fertilizing elements are brought to the babai pit. Each owner has his secret technique for planting and tending the plant which he keeps from everyone outside the family circle, knowledge of it is transmitted only from father to son. The secret is in the technique rather than the nature of the fertilizing material, this being obviously known to everybody since the choice is rather limited. Of these techniques very few were disclosed to us, but through scraps of information we were given to understand that they sometimes involve tamping with the feet of the soil around the young babai, or selection of particular seasons to use certain fertilizers, or sometimes the proportions of the various components used in the compost.

The leaves mainly used, are, in order of importance, those of the following plants: Te kaura: Sida fallax L. -- te uri: Guettarda speciosa L. -- te ren: Messerschmidia argentea -- te mai: Artocarpus sp. -- te wao: Boerhavia diffusa L. -- te kaura ni banaba: Wedelia biflora D. C. (this used mainly in Abaiang) -- te kanawa: Cordia subcordata Lam. Less frequently used are: te kiaou: Triumfetta procumbens Forst. and te rao: Hibiscus tiliaceus L. (called te Kiaiai in Beru). The latter is rather rare in the Gilberts.

To the leaves of these various plants is added a quantity of vegetable refuse, more particularly old pandanus leaves, pieces of rotten coconut trunks, etc. A special mention should be made of te kaura (Sida fallax). The leaves of this very common Malvaceae are very seldom brought green to the babai; when they are, direct contact with the plant is carefully avoided. The native knows that the fermentation of these leaves would produce heat which would either kill the babai or be very harmful. If time is short - or if it has been impossible for any other reason to dry the leaves first - the native will take care never to cover them with other material when placing them around the babai that they may dry more quickly and remain well aired. Generally they are dried in the sun on mats in front of the owner's hut. They are then stored in a basket to be taken later on to the pit, mixed or not with other fertilizing material (Plate XIIId). To fertilize the young babai plants, well-dried leaves of te kaura are often mixed with surface soil, preferably gathered under Guettarda trees, to which well-ground pumice is sometimes added. This preparation, on which moulds tend to develop, is stirred from time to time in the basket in which it has been mixed; we were told that it would thus be stirred, turned over and perfected for two months and longer before being applied to the babai.

Once the young babai is set the native no longer works at the bottom of the pit if it is too flooded by recent rains. Stirring the water and treading too near the plants when the root systems are still weak, might tear them from their support. Later on, when the babai is strongly rooted in, the native will go and tend it even if there is much water in the pit. The tending will consist in inspecting the gabions, replacing a loose stake or pandanus leaf, cleaning the pit of any extraneous material such as fallen coconut fronds, and weeding out certain invading plants such as te mam (Jussiaea angustifolia Lam.); te maunei (Eleocharis geniculata (L.) R. & S. and te ritanin (Cyperus javanicus Houtt.) But the most important part is the "feeding" of the babai. The tubers are said to be much more tasty if the plant has been abundantly and regularly fed. A new batch of fertilizer every three months is therefore considered necessary.

Propagation:

Several methods are used, depending on the varieties, almost always vegetative; the seeds of varieties with fertile seeds are seldom used.

1 (a). The method most often used, and which is obviously the simplest, consists in taking suckers from the base of the mother plant and setting them according to the procedure described earlier.

1 (b). Under special conditions, when suckers are lacking or when the native is dealing with varieties such as te ikauraura and te ikaraoi which produce few shoots or only after three or four years, the artificial proliferation of shoots is stimulated: Te baku, the top part of the rhizome with the bases of the petioles and terminal bud, is cut from a babai uprooted for eating and is first planted in a part of the pit where it cannot be reached by water. If it were planted directly at the bottom of the pit in a water-logged environment it might rot before growing roots. It will be left in this temporary site until the first two leaves have unfolded. The natives know that at this stage the root system has already developed. They will then cut the terminal shoot at a given height, which stimulates the artificial proliferation of suckers. When these reach a normal size they are broken off, just as spontaneous shoots would be, and planted in the bottom of the pit.

2. Another method follows much the same lines as the above but instead of cutting the terminal shoot, the whole plant is uprooted and set permanently at the bottom of the pit. By this method, a rhizome is obtained in half the time required with spontaneous suckers.

Insect Pests:

Two pests should be mentioned which do not yet cause very serious damage, but are none the less a threat.

One of these lives underground. It is a scarabaeid beetle, Pentodon sp. or Papuana sp. The larvae bore galleries in the older tubers.

Fortunately this beetle is not commonly found in the babai; it is more frequent in the old banana plants (also grown in pits), where it bores galleries just under the base of the shoot; one wonders whether it has not been introduced with banana planting stock. It might have gone from there to the Cyrtosperma. The Tarawa natives state that this beetle is also found at the foot of coconut palms. (see p.28)

The other pest lives above ground. It is a lepidopteron of the family Phalaenidae: Prodenia litura Fabricius. The caterpillar sometimes causes serious damage to the babai leaves, mostly on young plants. It may eat as far as the central part. This insect is unfortunately very widely distributed throughout the archipelago, as in many other areas. The fact that the natives seem to show no concern about this pest and the damage it causes does not exclude the necessity of undertaking as active a control of it as possible, particularly as it also feeds upon a large number of other useful plants.

Varieties:

As in the case of the pandanus, it would be easy to enumerate many babai names, perhaps representing more or less typical variations or merely different names which vary from one island to another. Our efforts were therefore primarily directed towards identifying well differentiated varieties.

The criteria used by Tarawa natives to determine the different varieties were checked and are submitted as a practical key for identification (Table XII).

Remarks on varieties:

1. Te anrairaki: also called te babue; medium height (not over 2m tall); not very common. Quality of tuber, good. Said to be eaten after three or four years.

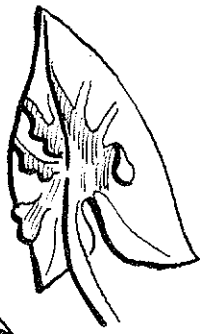
2. Te natutububua: medium height; not very hardy. The fully grown plant is said to produce no new leaves, but a considerable number of shoots (bubua - about one hundred). The tuber is wider than it is long (pail-shaped). Quality of tuber, excellent. Said to be eaten from the third year onwards.

3. Te kaikui: Very tall, reaching 3 meters. Tuber may reach a length of 50-70 cm. Quality of tuber, excellent. Said to be eaten from the fourth year onward.

4. Te ikaraoi: Extremely tall (sometimes over 3 m within four or five years). It is the finest of all babai. It requires much more tending than the others, particularly when young. Few or no shoots (propagated by methods 1 (b) and 2). Said to have the largest tuber and to be eaten around the fourth year. Quality, very good.

5. Te oineke: Height sometimes exceeds 3 m within four or five years.

I / Under surface of leaf desquamate, epidermis bearing lobiform appendices



Te anrairaki

II / Leaf undulate and upper extremity of petiole distinctly bent in "swan's neck"

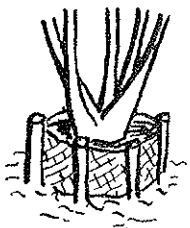
Te natutububua

III/ Leaf normal

A/ Petiole green

a/ Petiole spiny

1o/ Number of leaves normal (±5)



1/ Young leaves sometimes spatulate

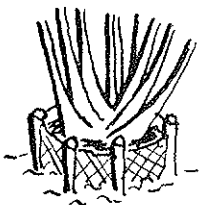
Te kaikui

2/ Young leaves always normal

Te ikaraoi

2o/ Number of leaves double (±10)

Te oineke



b/ Petiole not spiny

1o/ Seeds fertile

Te ibuota

2o/ Seeds unfertile

Te katutu

B/ Petiole yellowish orange

Te ikauraura

C/ Petiole yellowish orange only at the base

Te tukuna

Table XII. Varieties of babai in Bikenibeu, Tarawa Atoll.

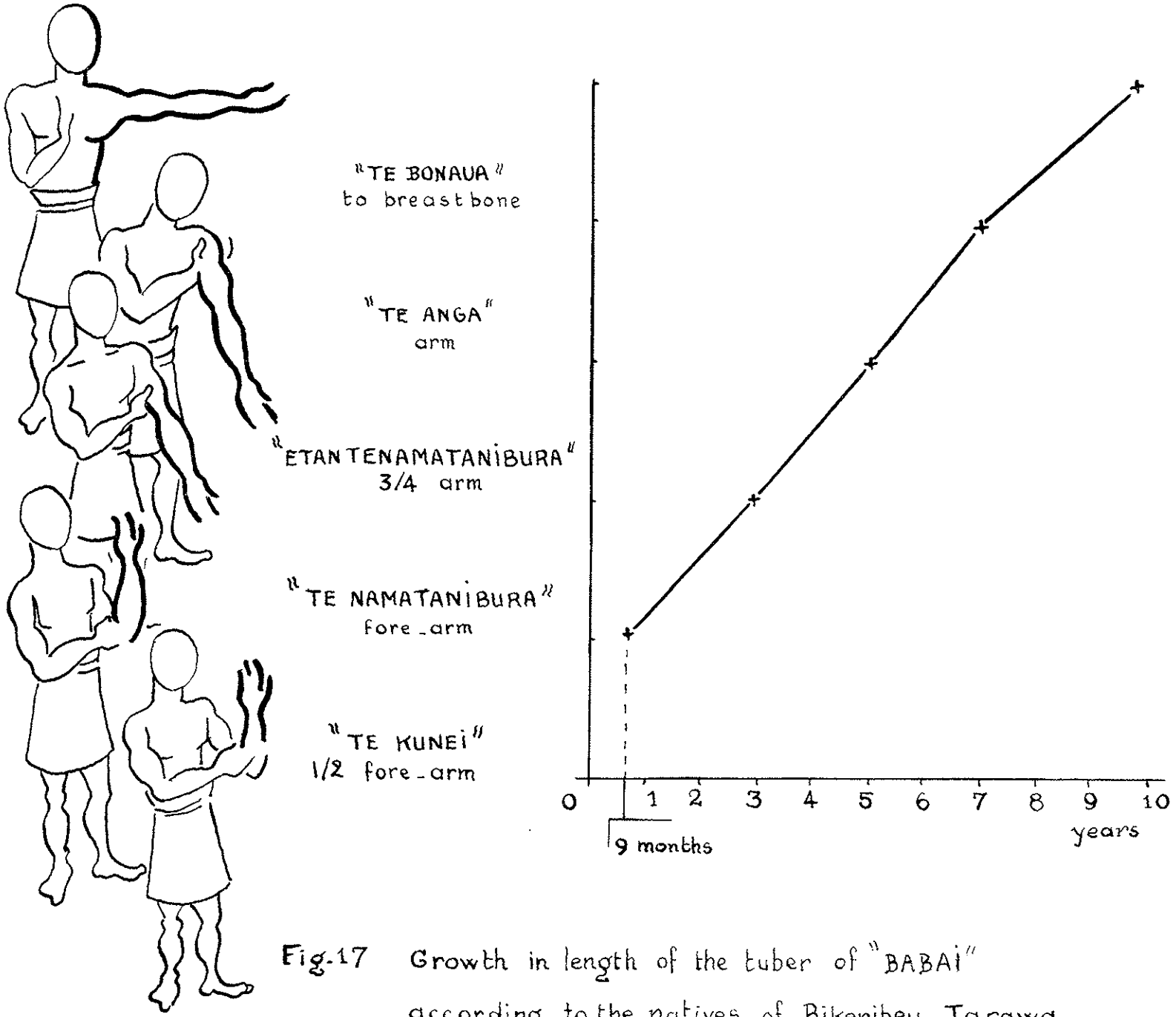


Fig.17 Growth in length of the tuber of "BABAI" according to the natives of Bikenibeu, Tarawa

Numerous leaves; it is by the number of leaves that natives distinguish it from te ikaraoi. Reproduction by shoots or by seeds. Tuber is longer than it is wide. Said to be already good for consumption after six to nine months. It is the most precocious of all and grows very large in the shortest time.

6. Te ibuota: Plant erect, medium height, not very common. Fertile seeds. Flower said to appear only after three or four years. Said to be edible after two or three years. Quality, good (a little poorer than te oineke).

7. Te katutu (pronounced kasusu): Medium height (1-2m). The natives say "man height". Very hardy, requires less tending than any other. Flower appears around the second year if the plant has been well tended. Continuous abundance of suckers requiring thinning. Some are uprooted and replanted elsewhere. The tubers are eaten as early as after 9 to 12 months when their weight ranges from 0.5 to 1 kilo. These figures vary with the fertilizers applied at the time of planting. The tuber grows hard very quickly after flowering. Some pits contain up to 90% of katutu, which means that harvesting can be carried on almost all year round. This variety is considered as too common to be used on special occasions (visits, weddings, Christmas, Easter, etc.); its quality and size are below the proper standard for gifts. Quality, good. If the leaf stalk is slightly yellow, sub-variety uraura. If the leaf stalk is quite green, sub-variety roro.

8. Te ikauraura: Very tall, sometimes over 3 m within four or five years, erect, more hardy than te ikaraoi. May flower after two years only if the plant is very well tended. Tuber does not grow as large as that of te ikaraoi. Quality, good.

9. Te tukuna (pronounced sukuna): Medium height. Very similar to te oineke. Quality, good.

The species of babai observed most frequently are: Te katutu, te ikaraoi, te oineke and te ikauraura.

Of the following varieties found on Nikunau (south), the four underlined varieties are similarly called on Tarawa Atoll: Te inawaro, te kairoro, te kaiura, te unikai, te tebon, te taninganibuki, te babue, te ikaraoi, te kaiku, te katutu.

Of those found on Marakei (north) three identical names (underlined) are found: Te moaine, te atinimainuku, te iokanai, te ikauraura, te ikaraoi, te katutu.

A last variety was mentioned to us several times, but we were never able to see it: te n-touman, the tuber of which cannot be eaten until it is over four years old. It is said to be the slowest-maturing variety, to resemble te ikaraoi, with shorter leaf stalks, and to be similar in taste.

Stages of Growth:

We were given by the Gilbertese descriptions of five different sizes of babai, which they measure with their arms. These observations were adapted to a growth curve (fig. 17).

Te kunei corresponds to a plant approximately nine months old. At this stage the tuber would be very tender. Te katutu is the variety most commonly eaten at the kunei stage. Some varieties are highly prized at the te namatanibura stage, which corresponds to a growth of approximately three years; other varieties are much less relished at that stage, the tuber sometimes being too bitter. The stage te namatanibura corresponds to a fully mature babai. The natives state that from this stage on the quality of the tuber decreases. The te anga stage refers to a plant approximately seven years old. Customs and traditions require that for certain rituals a babai of this size be selected. This is also the case for te bonaua, which may be estimated at ten years old or more. The tuber, which has grown very hard and of considerable size, is a highly-regarded present from a young man's family to the family of the girl he is to marry. Often a babai of this age has reached such spectacular development that it is kept in the pit merely for pride or, according to some people's beliefs, because it will stimulate the growth of the young plants growing near it.

Food value and importance as food:

Authors recognize the high starch content of Cyrtosperma tubers but they insist that they should be eaten only when perfectly cooked (boiled or roasted). All taro are generally considered as being poor in vitamin B and proteins.

To assess accurately the consumption of a given number of persons could only be done by continuous checking on the spot, which would be difficult. As the babai is the only crop requiring real work from the native he does not generally eat it more often than three or four times a month and increases this consumption only in those periods of the year when pandanus and breadfruit are scarce.

Methods of Use:

Foods:

Te buatoro: For this dish raw babai is grated. The paste thus made is wrapped in leaves of te mai (Artocarpus) or even te babai, divided into portions, each portion weighing approximately 1 lb. These bundles, tied with strips of fresh coconut leaflets, are immersed in boiling water. The cooking pot is placed at the edge of the fire and left to simmer for approximately 45 minutes; the bundles are then taken out of the water, opened and the preparation can be consumed as is, or mixed with kamaimai (toddy molasses).

Te bekei: Te buatoro is crushed in a pan, then covered with coconut cream which has already been prepared and heated. The mixture is well stirred and may be consumed at this stage or when cooled. Gourmets will pour kamaimai over cold bekei.

Te tangana: The babai is peeled, cooked, then crushed. In days of old it was crushed by means of a wooden or coral pestle in a giant clam shell. Today a meat grinder is more often used. Kamaimai and grated coconut are added to the crushed babai. Imported flour may also be added to make kneading easier, but this is not essential. The mixture obtained is wrapped in babai or breadfruit leaves and set in the native oven where it remains overnight if it has been put in late in the evening. This preparation may be kept for three or four days. If it is to be kept longer, it is cooked again every two or three days to avoid fermentation. Pandanus is sometimes added to this food.

Te kabuibui ni babai: This preparation is the result of a process designed to insure longer preservation. The pieces of babai to be preserved are first parboiled, then crushed or, better, put through a meat grinder. The ground product is dehydrated by sun drying, and this kabuibui may be kept a whole year or even longer. The same technique is also applied to breadfruit, then it is called te kabuibui ni mai. Fruits of te bero (Ficus tinctoria Forst.) are prepared in a similar way and the dehydrated preserve is called te kabuibui ni bero. In the southern islands these recipes of kabuibui appear to be more commonly used than elsewhere due to the more serious effects of intense and prolonged droughts.

Pharmacopoeia:

Enquiries into native pharmacopoeia too often yield little or no information, unless the investigator lives for a long time among the natives. The babai may be used for more than one treatment, but the only one disclosed to us is a formula for curing skin diseases (though no one could tell us which or show us a case.)

The tuber is cut in slices, which are laid in the sun. Yellow mould is said to develop, which is carefully scraped off and sprinkled over the sore. The gathering of this mould is the prerogative of only a few specialists on each island, and is considered a very delicate task. We could not obtain a specimen of this mould and did not succeed in isolating it. Such a variety of moulds developed on the slices of Cyrtosperma which we placed in various conditions that the natives themselves could not tell us which was the one generally used.

CHAPTER 8

OTHER PLANTS USED BY GILBERTESE

There are many other plants of economic significance used by the Gilbertese for a variety of purposes. These are listed below alphabetically under 9 headings. These lists include some plants very scarce in the Gilbert group but which will be, perhaps, useful later to the natives. Individual notes on these plants and their uses will be found in Chapter 9 Part II.

1. Food plants

Acalypha amentacea
Boerhavia diffusa
Carica papaya
Cassytha filiformis
Citrus aurantifolia
Colocasia esculenta
Cucurbita pepo
Ficus carica
Ficus tinctoria
Ipomoea batatas
Musa paradisiaca subsp. sapientum
Passiflora foetida var. hispida
Pemphis acidula
Physalis angulata
Portulaca lutea
Portulaca samoensis
Saccharum officinarum
Sesuvium portulacastrum
Tacca leontopetaloides
Terminalia catappa

2. Plants used as building material for houses, canoes, fishing rods, etc.

Bruguiera conjugata
Calophyllum inophyllum
Casuarina equisetifolia
Clerodendrum inerme
Cordia subcordata
Dodonaea viscosa
Ficus tinctoria
Guettarda speciosa
Hernandia sonora
Hibiscus tiliaceus
Lumnitzera littorea
Messerschmidia argentea
Morinda citrifolia
Pemphis acidula
Pisonia grandis
Premna obtusifolia
Pseuderanthemum carruthersii
Rhizophora mucronata
Scaevola sericea
Terminalia catappa

3. Drug, medicinal and poisonous plants

Barringtonia asiatica
Boerhavia diffusa
Bryophyllum pinnatum
Calophyllum inophyllum
Clerodendrum inerme
Cordia subcordata
Crinum asiaticum
Euphorbia chamissonis
Fimbristylis cymosa
Messerschmidia argentea
Nicotiana tabacum
Pemphis acidula
Ricinus communis
Scaevola sericea
Triumfetta procumbens

4. Plants used for ornamental purposes (mainly for making leis)

Abutilon indicum
Acacia farnesiana
Acalypha amentacea
Acalypha wilkesiana
Allamanda cathartica
Bryophyllum pinnatum
Calophyllum inophyllum
Canavalia microcarpa
Cassytha filiformis
Catharanthus roseus
Cordia subcordata
Cordyline terminalis
Crinum asiaticum
Cyperus javanicus
Dodonaea viscosa
Eragrostis amabilis
Euphorbia heterophylla
Guettarda speciosa
Hibiscus tiliaceus
Lantana camara
Lumnitzera littorea
Mirabilis jalapa
Plumiera rubra
Polypodium scolopendria
Polyscias guilfoylei
Pseuderanthemum laxiflorum
P. carruthersii
Psilotum nudum
Russelia equisetiformis
Scaevola sericea
Sida fallax
Stachytarpheta jamaicensis
Thespesia populnea
Triumfetta procumbens
Wedelia biflora

5. Leaves are used in composts prepared for babai cultivation

Boerhavia diffusa
Cordia subcordata
Ficus tinctoria
Guettarda speciosa
Hibiscus tiliaceus
Sida fallax
Thespesia populnea
Triumfetta procumbens
Wedelia biflora

6. Fiber plants used in skirts, fishing lines, nets, etc.

Agave sp.
Cassytha filiformis
Cyperus javanicus
Cyperus laevigatus
Hibiscus tiliaceus
Tacca leontopetaloides

7. Dyes and tanning materials

Ficus tinctoria
Morinda citrifolia
Rhizophora mucronata

8. Plants used to scent coconut oil

Dodonaea viscosa
Fimbristylis cymosa
Ocimum basilicum
Pemphis acidula
Polypodium scolopendria
Premna obtusiofolia
Rhizophora mucronata
Terminalia catappa

9. Plants used to feed pigs and chickens

Boerhavia diffusa
Eleusine indica
Ficus tinctoria
Fimbristylis cymosa
Phyllanthus amarus
Portulaca lutea
Portulaca samoensis

CHAPTER 9

VEGETATION AND FLORA

PART I: VEGETATION

With the exception of Pemphis stands and, of course, of the mangrove proper, no primitive vegetation types can be recognized today. The original formations have been so thoroughly modified by man that there is no trace left of them, especially as all these islands are rather densely populated.

Besides the coconut palm, which covers the largest area, some species may still have a certain density and show marked preferences for some habitats, but they form a secondary vegetation rather than ruins of former original types.

In many cases the primary components are now represented only by isolated specimens, which tend to disappear not only because of the growing prevalence of the coconut palm but also because the natives do not care to preserve or propagate them. This is the case for trees such as Pisonia, Cordia, etc. In some islands even valuable trees such as pandanus may be disappearing, as they are considered of minor importance in comparison with the commercial value of copra.

The Gilbert Islands offer today the following vegetation types:

I. Vegetation of the seaward side

Scaevola, more less dense, forms an almost unbroken belt. Their density is always greater than that of other neighbouring plants. This species grows nearest to the shore. Messerschmidia in isolated specimens or small groups are found, most of them with twisted trunks. Their height does not exceed 3 m. Pandanus, are more or less numerous, but always as isolated individuals. The prevailing low plants are: Lepturus, which is very seldom found in the shaded central zone, and Fimbristylis. A few Triumfetta and Cyperus sometimes grow among them. The coconut palm begins in this zone, the first rows growing a little above high-water mark.

II. Vegetation of the interior

The area occupied by other species is usually conditioned by the density of the coconut palms. If these are very close together, we find only the following low plants: Thuarea, Fimbristylis, Euphorbia and gramineae of the genera Stenotaphrum and Cenchrus, with a few small Scaevola here and there. If the coconuts are less dense, there will be some tree species such as: Pandanus, Guettarda and Morinda; and in addition to the low plants already mentioned, Boerhavia, Triumfetta, Fleurya, Sida, Dodonaea and Cassytha. The grasses are almost all present and Psilotum and Polypodium occur here and there at the foot of the coconut trees. Of course the number of these plants and the area they cover vary with the degree to which the ground is tended.

If the coconut palms are very sparsely planted, some trees such as Cordia and Pisonia may occur, though rarely nowadays.

Many low plants survive with difficulty in open areas while species such as Sida fallax, which seem to prefer strong sunlight, can achieve great extension there.

III. Vegetation of the lagoon side(area of roads and villages)

The roadsides being generally cleared to a certain width, few plants are to be found there except common grasses. On the other hand, the shrubs and trees of the interior may be found again between the cleared road zone and the edge of the lagoon, with the addition of small groups of Messerschmidia forming a narrow strip slightly in front of the coconut palms (Plate XIVa).

One plant will be found growing densely on sandy areas that are always damp below the surface through tidal seepage; this is Fimbristylis, which tolerates high salinity. On the contrary, Scaevola, Guettarda and Lepturus always grow above the level of the highest tides.

Village areas offer a very different aspect, due to the number of plants cultivated in their immediate vicinity and around the houses. Among food trees, in addition to coconut palms which are widely spaced, breadfruit trees predominate, and sometimes reach a large size. Pandanus trees are found in varying numbers, mostly around the village periphery, except in the southern islands where they are given the same choice locations as Artocarpus. Papaya trees are found in every village and are often very tall. Banana plants are sometimes a component of this vegetation, but are grown only in pits. Small pumpkin patches (Plate XIVc) are seen around the houses in southern islands, generally side by side with numerous tobacco plants (figure XVc), while Ficus tinctoria is usually found a little behind the last houses. Tomatoes and sweet potatoes are very scarce and we saw them only on a few islands in the centre and north of the Gilbert Group.

One of the characteristics of the Gilbertese village is the great variety of ornamental plants. The most commonly found are Crinum, Russelia, Mirabilis, Catharanthus and Pseuderanthemum. The low plants considered as weeds vary in abundance, of course, according to the cleanliness of the village and are, in fact, rather scarce. Euphorbia prostrata, Fimbristylis, Phyllanthus, Eragrostis and Digitaria are most often seen.

In addition to village and roadside vegetation, the Pemphis type should be given special mention. This shrubby plant (Pemphis acidula Forst.) forms thick stands, often spreading over large areas, just at the limit of the highest tides of the lagoon, and above the first depressions filled by high tides and occupied by Rhizophora (Plate XIVd). The latter may often cover large areas which are submerged at high tide.

PART II: PLANTS COLLECTED IN THE GILBERTS

None of the plants growing in the Gilbert Islands are endemic. In fact, most of them belong to the general coral island flora in the tropical Pacific. To assess the time when they first appeared, even very approximately, is a most difficult task. It seems, however, that three main time divisions may be recognized.

I. Plants present on the islands before the arrival of the first occupants

It is logical to assume that this group can include only plants with seeds likely to resist a prolonged stay in salt water and retain for a long time their germinating powers. These may have been introduced to these islands by currents and trade winds, and they would have been the first plant stock of these territories. Other carriers such as birds, may have brought very tiny seeds (gramineae for instance), but to a very small extent. (1)

II. Plants introduced by successive waves of immigration

It is logical to place in the second group the ancient food plants. The natives carried them along during their migrations. They probably also brought plants of ritual significance.

III. Plants introduced since the arrival of Europeans

The third group includes only plants introduced less than 200 years ago by the first navigators, by the traders who followed them, and finally in quite recent times by Europeans residing permanently or temporarily in these islands, missionaries, government officers, etc. To these intentionally-introduced plants should be added those which arrived by accident. The natives also took part in these introductions and still do so at every opportunity. Taking into account the above considerations, we shall therefore say:

Group I for plants of pre-human introduction

Group II for plants of ancient introduction

Group III for plants of recent introduction

It will be easily understood that, detailed historical documents not being available, the limits between these groups have to be somewhat flexible (especially between groups I and II).

(1) The extent of such bird transport must be larger than stated here, as plants with sticky and spiny fruits, such as Pisonia, Boerhavia and Triumfetta, and fleshy fruits, such as Scaevola, are known to be carried around by birds. - Ed.

A list of plants collected, with brief notes on each, appears below. It should be noted that the vernacular names quoted are those given us at the collecting locality, and that they may vary from one island to the next. A set of the specimens is deposited in the herbarium of the Museum d'Histoire Naturelle, Paris.(1)

It was impossible to collect again a botanical specimen of each species in each territory visited, since we had to attend to many other more important matters. This task would not, however, have been useless since the natives always showed an understandable hesitation when confronted with dried plants in the herbarium. Moreover, in some islands we were unable to stay long, and no collections could be made, so that our herbarium does not claim to be exhaustive. We feel that a botanist could still find a number of plants especially among very recent introductions. These are still continuing. When the Gilbertese return from working abroad they generally bring back new plants. A remarkable fact is that they almost always choose plants with either ornamental leaves or fragrant flowers which may be fashioned into the leis and garlands required for the dances and songs that form so important a part of the daily life in these islands. Singing and dancing are a real need for these people, who would have little joy in life without them.

We have not, of course, referred to uses of no economic significance such as those connected with games, magic, etc. Finally, most of the cryptogams do not appear after the phanerogams listed, since the identifications awaited from Professor R. Heim of the Paris Museum have not yet reached us. The algae from fish-ponds were identified by Dr. Francis Drouet, see Appendix I, p. 187.

Dr. Katherine Luomala, of the University of Hawaii, very kindly provided us with a copy of her manuscript on ethnobotany of the Gilbert Islands, including a history of plant collecting in the Gilbert Islands. Since that time it has been published as Bulletin 213 of the Bernice P. Bishop Museum, 1953. Material included in it has deliberately not been repeated here, as the original may be consulted.

List of plant species

Abutilon indicum (L.) Sweet — Malvaceae — Group III.
Gilbertese name: te kaura ni banaba; English name: Indian mallow.

Locality: Tarawa, no. 124; Ocean I., 124 bis.

This is very rare in the Gilberts, seen only on Bikenibeu, where a few specimens had been planted as ornamentals in front of a native house. It is

(1) Through the courtesy of the authorities of the Museum d'Histoire Naturelle, Paris, it has been possible to reexamine specimens of most of the plants numbered 1-139. Changes in the nomenclature of certain of these have been incorporated into the following list to bring it into accord with the names generally in use in recent papers on Pacific coral atolls.

Where there seems some room for disagreement about the group to which the plant has been assigned, the suggestion of a different placing has been indicated in parentheses. - Ed.

very common on Ocean Island (Banaba) whence it was doubtless brought, as indicated by the Gilbertese name.

Acacia farnesiana Willd. Leguminosae. Group III.
English: Spring aroma

Locality: Nikunau, no. 154

Medium-sized shrub, very rare in the Gilberts, seen only in a village on Nikunau.

Uses: The very fragrant flowers are used in garlands.

Acalypha amentacea var. Euphorbiaceae. Group III
Gilbertese: te aronga. English: copper leaf.

Locality: Abaiang, no. 78

This ornamental shrub, with red leaves, may be over 2 m tall; it is found on all the islands, mostly in villages.

Uses: The leaves are used in garlands.

Acalypha amentacea var. Euphorbiaceae. Group III.
Gilbertese: te aronga

Locality: Abaiang, no. 44.

A shrub 1.5 to 2 m tall, with brown-purplish leaves; planted around houses and villages.

Uses: The leaves are used in garlands. The Gilbertese do not eat the young shoots or leaves which are cooked as vegetables in other areas of the Pacific.

Acalypha amentacea var. Euphorbiaceae. Group III.

Locality: Tarawa, no. 115; Nauru, 115 bis

This very rare plant was seen only at the Residency at Bairiki, and on Beru, where it was about 1 m tall. It is very common on Nauru, where it forms hedges, and whence it was probably brought by Gilbertese employed in the phosphate works.

Adiantum cuneatum L. & F. Polypodiaceae. Group III.

Locality: Bairiki, Tarawa, no. 111

This fern about 40 cm tall is cultivated in pots on verandas of European houses.

Agave sp. Amaryllidaceae. Group III.
Gilbertese: te robu (English: rope) English: green aloe

Locality: Betio, Tarawa, no. 119

Only a few plants seen in Tarawa, Abaiang, Arorae and Nikunau.

Uses: After retting, excellent fishing lines can be made from the fibers.

Allamanda cathartica L. Apocynaceae. Group III.

Locality: Tarawa, no. 117

A liana with large yellow flowers, very rare, seen only in garden at Bairiki, Tarawa and in Beru. Very ornamental.

Amaranthus dubius Mart. Amarantaceae. Group III.

Locality: Tarawa, no. 94

This weed, 30-40 cm tall, with light green inflorescence, was seen only on Betio Islet. It is one of the food plants of Ethmia colonella Wals.

Angelonia angustifolia Benth. Scrophulariaceae. Group III.

Locality: Bairiki, Tarawa, no. 137

A blue-flowered plant, not over 35 cm tall, found only in European gardens.

Antigonon leptopus H. & A. Polygonaceae. Group III.
English: coral vine

Locality: Tarawa, no. 108

Climber, with old rose flowers, seen only in the garden of the Residency at Bairiki.

Artocarpus altilis (Park.) Fosb. Moraceae. Group II.
Gilbertese: te mai (general name)

Locality: Mission, Butaritari, no. 85, 86; Tarawa, no. 122; Betio, Tarawa, no. 133.

Nos. 85 and 122 represent variety te bukiraro; no. 86, te mai kora; no. 133, te moti ni wae.

Artocarpus mariannensis Trec. Group II.

Locality: Tarawa, no. 121

This is variety te maitarika.

Artocarpus altilis X mariannensis Group II.

Locality: Tarawa, nos. 120, 123

No. 120 represents variety te mai; no. 123, variety te ang ni Makin.

For a detailed study of Artocarpus, see chapter 6.

Asclepias curassavica L. Asclepiadaceae. Group III.

Locality: Tarawa, no. 151

Very rare in the Gilberts, seen only once at Bikenibeu and once in the village at Betio.

The larva of Danais plexippus usually feeds on this plant, and the insect is very rare in the Gilberts, only one was seen in the space of six months, in the Residency garden in Bairiki.

Asplenium nidus L. Polypodiaceae.

Locality: Tarawa, no. 112

Seen only as cultivated fern in a European house, Bairiki.

Bacopa monnieri (L.) v. Wettst. Scrophulariaceae. Group III.

Locality: Butaritari, no. 70

A small plant, not over 40 cm tall, flowers white. Seen only on the edges of the fish ponds.

Uses: The natives do not seem to use it, but the missionaries are said to eat it in salads, like cress.

Bambusa sp.

Locality: Marakei, no. 75

Robust and erect grass, stems used as fishing rods for very small fish.

Barringtonia asiatica (L.) Kurz Barringtoniaceae. Group I.
Gilbertese: Te baireati

Locality: Tarawa, no. 140.

Very rare in the Gilberts, only a few trees grow on Tarawa, Little Makin and Butaritari. Evidently there were no more at the time when Grimble wrote: "one or two Baireati trees grow on Butaritari and Little Makin but the supply of seeds is obtained mainly from the western beach of any island, where it is sometimes washed ashore in considerable number during the season of westerly gales."

Uses: It seemed to us that few natives knew its use as fish poison to catch fish on reefs.

Boerhavia diffusa L. Nyctaginaceae. Group I.
Gilbertese: te wao

Locality: Tarawa, no. 13; Abemama, no. 13b.

Herbaceous plant with tuberous root, very common everywhere. When exposed to intense light the leaves turn a purple color.

Uses: In cases of prolonged drought, the plant may be used for food. Merrill (1943, p. 55) reports that the roots are eaten in Fiji in times of scarcity, but affect the kidneys and should be used with caution. Generally in the Gilberts, this plant is fed to pigs. In the treatment of a disease called te ba (rickets ?), leaf petioles are crushed and boiled in toddy. The leaves are used in compost for babai plants.

Boerhavia is one of the food plants of the larva of Prodenia litura (F.).

Boerhavia tetrandra Forst. Nyctaginaceae. Group I.
Gilbertese: te wao

Locality: Bukenibeu, Tarawa, no. 27

Creeper, rather common, with small mauve flowers; can live on poor ground if there is enough shade. No uses known.

Bougainvillea spectabilis Willd. Nyctaginaceae. Group III.

Locality: Tarawa, no. 143

Liana, uncommon in the Gilberts, and not well developed. Seen only in gardens of the missions and of the Residency at Bairiki.

Bruguiera conjugata (L.) Merr. Rhizophoraceae. Group I.
Gilbertese: te tongo; te buangi

Locality: Abemama, no. 92

Sometimes occupies important areas, especially on Abemama where it forms very dense stands on the sandy zone along the lagoon. Varies in height between 4 and 5 m, with a diameter seldom over 15 cm.

Uses: The wood is used in building houses (roof props).

Bryophyllum pinnatum (Lam.) Kurz Crassulaceae. Group III.
Gilbertese: te ang English: life-plant

Locality: Bikenibeu, Tarawa, no. 21

Erect plant 50-60 cm tall, leaves fleshy; rather common.

Uses: The flowers are used in garlands. In cases of headache, leaves are crushed in water and liquid used to wash the head and make compresses which can be renewed as necessary.

Calophyllum inophyllum L. Guttiferae Group I (or II?).
Gilbertese: te itai. English: punai nut (tamanu in Polynesia)

Locality: Teaoraereke, Tarawa, no. 41

This is one of the most beautiful trees in the Gilberts, 6-7 m tall usually, but occasionally up to 12 or 15 m with a diameter of 60 cm at the base, with a straight trunk and no low branches. This tree must have been much more abundant formerly and its present scarcity is much to be regretted.

Uses: The flowers are used in garlands; the fruits in children's games. The wood is excellent, hard, resistant and fine-grained, and is used in canoes, especially for the bow piece and ribs. It is also used for diving goggles. In Tahiti (Papy 1951), oil extracted from the fruits is used in pharmacy and exported, but this utilization is unknown in the Gilberts.

Canavalia microcarpa (DC) Piper Leguminosae Group II or III (or I)
Gilbertese: te kitoko (sometimes te ruku, general name for liana)

Locality: Tarawa, no. 96

Growing luxuriantly on Betio Islet and in the garden of the Residency at Bairiki; poorly developed on Arorae.

Uses: The rose-mauve flowers are used in garlands. The natives might be taught the possible use of Canavalia as a cover plant.

Canna indica L. Scitamineae. Group III.

Locality: Tarawa, no. 144.

Seen only in gardens of European houses, and usually yellow with chlorosis or lack of water.

Capsicum frutescens L. Solanaceae. Group III.
Gilbertese: te beneka (from vinegar) English: chili pepper

Locality: Tarawa, no. 39

Shrubby plant 80-100 cm tall, very rare, seen only on Betio.

Uses: Used as condiment by Europeans, but not by natives.

Carica papaya L. Caricaceae. Group III.
Gilbertese: te papaya, or te mwemweara (according to Luomala).
English: pawpaw, papaya.

Locality: Abemama.

Papaya trees are rather abundant, but only in villages. With a few exceptions, such as those in missionary gardens, they receive no care. They may reach a height of 5 m or more, but produce few fruits. The Gilbertese, except for children, do not seem to care much for papayas, although the better cultivated ones have an especially good flavor. When eaten green, the fruit are cooked in coconut milk.

Cassia occidentalis L. Leguminosae. Group III
English: nigger coffee

Locality: Betio Islet, Tarawa, no. 53

Very rare, seen only on Betio, but seeming to increase rapidly. The natives believe its introduction to date from American landings. No known uses.

Cassytha filiformis L. Lauraceae. Group I.
Gilbertese: te ntanini

Locality: Bikenibeu, Tarawa, no. 11

Climbing parasitic plant which may entirely cover shrubs and trees, in clearings and open places.

Uses: The slightly acid fruits are eaten, especially by children. The dried and decorticated stems are sometimes used for riri. Fresh stems are used for stringing flowers into garlands.

Cassytha is one of the plants on which the larva of Prodenia litura (F.) lives.

Casuarina equisetifolia L. Casuarinaceae Group III
English: Australian pine, iron wood.

Locality: Butaritari, no. 65.

Only 3 Casuarina trees were seen in the whole area visited. Two were young plants 1.8 m tall in the garden of the Residency at Bairiki on Tarawa, and had been planted in July 1951 (brought from Australia). The third, said to have been planted by Americans during the war is on Butaritari and is a straight fine tree about 10 m tall and 30 cm in diameter, about 7 years old. It grows near a group of houses. It is surprising that this tree is not more abundant on these islands, as on so many others in the Pacific. It could profitably be planted on shores not used for coconuts.

The chart for Aranuka notes a stand of Casuarina. Actually this is a forest of exceptionally tall and dense Rhizophora.

Catharanthus roseus (L.) G. Don Apocynaceae Group III
Gilbertese: te buraroti. English: Madagascar periwinkle

Locality: Bikenibeu, Tarawa, no. 38

Small shrub, 30-50 cm tall, with pink or white flowers, seen only in villages around houses. When occasionally found in the jungle, it indicates the former site of a tomb or village.

Uses: flowers are much prized for especially fine garlands.

Cenchrus echinatus L. Gramineae Group II
Gilbertese: te kateketeke

Locality: Bikenibeu, Tarawa, no. 32

Not very common, in fact almost impossible to find before the rains. The natives seem to destroy it whenever possible, apparently following instructions given a long time ago to check the rapid spread of this grass.

Uses: young plants are eaten by pigs.

Chloris inflata Link Gramineae Group III

Locality: Tarawa; Abemama, no. 88

Not very common; grass 15-40 cm tall, with mauve inflorescences. Probably introduced by American troops.

Clitoria ternatea L. Leguminosae Group III

Locality: Tarawa, no. 113

Seen only in the garden of the Residency at Bairiki. Royal blue flowers.

Cocos nucifera L. Palmae Group I or II (prob. II)
Gilbertese: te ni. English: coconut palm.

Fragments of leaves and inflorescences collected on Tarawa, but unnumbered. See Chapter 4 for a full discussion of this tree.

Colocasia esculenta (L.) Schott Araceae Group III (or II)
Gilbertese: te taororo. English: taro.

Locality: Bairiki, Tarawa, no. 103

Taro is little cultivated in the Gilberts. A few plants are found here and there in the babai pits, but are always poorly developed, as they do not stand well the conditions under which babai thrive. Taro tubers become rotten before 8 months have passed. On Betio, where we saw more than elsewhere we learned from the owners: that taororo do not grow well in babai pits unless dirt is piled at the bottom of the pit to raise the plant sufficiently above water; that without this precaution, the tubers would start rotting after 6 months; that, however, if the ground is not too wet, tubers weighing about 750 g may be obtained, although tubers pulled up when 6 months old are too often already rotten to a depth of a few cm; that it is not necessary to build composts as for babai.

Taro is much less appreciated than babai by the Gilbertese. Some like it, but say it is too bland and not "heavy" enough, meaning probably that it is tasteless and does not seem to fill the stomach. Another objection comes from the fact that taro, since it must be pulled up after a few months, does not form like babai a reserve which can be tapped when necessary. Besides, several natives told us that the reason they did not care for taro was that it cannot be kept for a long time as babai is in the prepared kabuibui ni babai.

Most of the taros seen were more or less badly attacked by the larva of Prodenia litura (F.).

Cordia subcordata Lam. Boraginaceae Group I
Gilbertese: te kanawa

Locality: Bikenibeu, Tarawa, no. 28b, 84; Abemama, no. 28

Not very common, but must have been more abundant in the past. Shrub forming small bushy groups, or growing as isolated individuals, well formed, up to 5 m tall. Appears to be more common along shores, but may have been more abundant in the interior of islets before coconuts were planted there. Its increasing scarcity is much to be regretted, as the wood is valuable.

Uses: Flowers are much appreciated for garlands. Leaves are added to babai composts. Twigs are used as medicine: the bark is peeled off and the stems scraped. The scrapings are squeezed with water (rain water if possible) by hand. The liquid is given to drink to people afflicted with persistent diarrhoea. The wood is mostly used for canoes, especially for the key piece of bow and stern (te karetaba). Also used in fishnet floats. When the plant is shrubby, it provides good fishing poles.

Cordia is one of the food plants of the larva of Ethmia colonella.

Cordyline terminalis (L.) Kunth Liliaceae Group III
Gilbertese: te rauti

Locality: Butaritari, no. 43

Shrubby plant about 2 m tall, with pale purple flowers, grown as ornamental in villages around houses; seen only in Tarawa and Butaritari.

Crinum asiaticum L. Amaryllidaceae Group II
Gilbertese: te ruru, te kiebu.

Locality: Teaoraereke, Tarawa, no. 42

Cultivated in villages, where flowers are much appreciated. Also often marks the site of ancient graves. Mean height of 50 cm.

Uses: Flowers are used in garlands. The young inner leaves are crushed and the juice squeezed out and poured in the ear in cases of earache.

Cucurbita pepo L. Cucurbitaceae Group III
Gilbertese: te baukin. English: pumpkin

Locality: Bairiki, Tarawa, no. 136

Cucurbits are grown in most islands. There appear to be both squashes and pumpkins. In some villages in the south islands, the plants cover most of the space between houses (Plate XIVb).

Cycas circinalis L. Cycadaceae Group III
English: sago-palm, Cycas

Locality: Tarawa, no. 147

Very rare in the Gilberts, some fine specimens not over 2.50 m tall were seen at Butaritari and in the garden of the Residency at Bairiki, Tarawa.

Cyperus compressus L. Cyperaceae Group III

Locality: Tarawa, no. 99

Plant 20 cm tall, inflorescences pale green. Seen only on Betio Islet.

Cyperus javanicus Houtt. Cyperaceae Group II (or I)
Gilbertese: te ritanin

Locality: Bikenibeu, Tarawa, no. 20

Plant 50-60 cm tall, found mostly as a weed in poorly tended babai pits.

Uses: Inflorescences are used in making garlands, stems in riri.

Cyperus laevigatus L. Cyperaceae Group I or II
Gilbertese: te maunei

Locality: Nikunau, no. 129

Sedge not over 50 cm tall, with brown inflorescences, growing on the edge of the lakes, with water coming up to 1/3 of its height.

Uses: Used in riri. The stems can be pulled off without uprooting the whole plant.

Cyperus polystachyos Rottb. Cyperaceae Group III

Locality: Betio, Tarawa, no. 98

Plant 30-45 cm tall, inflorescences pale green tending toward yellow. Very common on Betio.

Cyperus rotundus L. Cyperaceae Group II or III (probably III)

Locality: Tarawa, no. 100; Nikunau, no. 131b

Plant 30 cm tall, inflorescences dark red. Very common on Betio, seen also on Nikunau, where it is rare.

Cyrtosperma chamissonis (Schott) Merr. Araceae Group II
Gilbertese: te babai

Locality: Nikunau, no. 127

See chapter 7.

Datura metel L. Solanaceae Group III
Gilbertese: te urintiana English: thorn-apple

Locality: Tarawa, no. 81

Shrub with mauve flowers, up to 1.20 m tall, found in villages as ornamental. Seen only on Tarawa, Butaritari and Abaiang.

Delonix regia (Boj.) Raf. Leguminosae Group III
Gilbertese: te tua English: flame tree

Locality: Tarawa, no. 149

Flame trees are very rare in the Gilberts, seen only in some villages of Tarawa, Beru and Aranuka, as isolated specimens. Only those on Aranuka seemed normally developed.

Digitaria pruriens var. microbachne (Presl) Fosb. Gramineae Group III (or II)
Gilbertese: te uteute (means grass)

Locality: Tarawa, no. 131a, 132

Grass not over 50 cm tall, with grey-green inflorescences, seen only on Tarawa and Abemama, uncommon.

Dodonaea viscosa (L.) Jacq. Sapindaceae Group II
Gilbertese: te kaiboia

Locality: Tarawa, no. 60

Shrub rather common in the Gilberts, 3 to 6 m tall. Grows mostly on the site of former villages, probably because numerous seeds were scattered there while garlands were being made.

Uses: Fruits are used in garlands. Young leaves are used to perfume coconut oil. Stems give good fishing poles, and also frames for dip nets.

Eleocharis geniculata (L.) R. & S. Cyperaceae Group III (or II)
Gilbertese: te maunei

Locality: Bikenibeu, Tarawa, no. 37

Plant 8-10 cm tall, never seen outside babai pits. The same name, te maunei is applied to Cyperus laevigatus L.

Eleusine indica (L.) Gaertn. Gramineae Group III
Gilbertese: te uteute (grass)

Locality: Bikenibeu, Tarawa, no. 35; Abemama, no. 89

This rather common grass is eaten by pigs when young.

Eragrostis amabilis (L.) W. & A. Gramineae Group III
Gilbertese: te uteute te aine (female grass)

Locality: Bikenibeu, Tarawa, no. 36

Very common grass, found more in the interior, along roads, than along shores.

Uses: Inflorescences are used in garlands. Children also attach them to sticks to chase flies.

Euphorbia chamissonis Boiss. Euphorbiaceae Group I
Gilbertese: te tarai

Locality: Bikenibeu, Tarawa, nos. 8, 24.

Very common on all the islands; plants 30-40 cm tall.

Uses: The plant is used as a purgative. The latex is also collected in a shell of te koikoi (Tellen scobinata L.), mixed with a little maimoto (coconut water), and the mixture given to people saved from drowning, to make them throw up the water absorbed.

This species is one of the food plants of the larva of Prodenia litura (F.).

Euphorbia heterophylla L. Euphorbiaceae Group III
Gilbertese: te kabekau

Locality: Betio, Tarawa, no. 55

Uncommon plant, 35-40 cm tall, very recently introduced by American troops.

Uses: Leaves are used in garlands.

Euphorbia hirta L. Euphorbiaceae Group III
Gilbertese: te tarai

Locality: Teaoraereke, Tarawa, no. 83

Plant about 40 cm tall.

Euphorbia prostrata Ait. Euphorbiaceae Group III

Locality: Bikenibeu, Tarawa, no. 23

Low creeping plant, 10-30 cm across, branched, leaves dark red. Very common around villages in almost all islands including Nikunau, Beru, and Arorae where American troops did not go. The name "te amerika" used in Tarawa, and implying introduction by American troops therefore does not seem justified.

Ficus carica L. Moraceae Group III
Gilbertese: te biku. English: fig

Locality: Abemama, no. 150

Fig trees are very rare in the Gilberts, and are found only in Mission gardens. They develop well and their fruit are excellent. The Gilbertese could probably obtain good fruit by giving the trees the same care as to breadfruit.

Ficus tinctoria var. neo-ebudarum (Summ.) Fosb. Moraceae Group I (or II)
Gilbertese: te bero

Locality: Bikenibeu, Tarawa, no. 3

Trees 4-7 m tall, about 40 cm around at 1 m above the ground; in the southern islands, they are smaller and the trunks not over 25 cm around. It is a cultivated plant. Each landowner has a few plants on his land. Reproduction is usually by cuttings, spontaneous seeding is rare.

Uses: The fruits are picked when ripe, sometimes when green, cooked, mashed with a pestle or in a meatgrinder. The puree can be eaten after being sweetened with kamaimai or sugar, or preserved for future use. It is then called kabuibui ni bero and is prepared as follows: the puree is spread thinly on wide Guettarda leaves spread on coconut leaf mats, and left to dry in the sun for 3-4 days. The Guettarda leaves are changed everyday as long as the paste remains sticky, later it is placed on a suitable surface, coconut leaf mat, board, to complete drying. When dry, kabuibui ni bero is stored in tin cans and will keep for several months. The fruits are also used, though much less now than formerly, to dye various objects such as hats, mats, etc. This dye was preferred to te non (Morinda citrifolia).

The leaves are fed to pigs, sometimes used in composts for babai or breadfruit. Branches are sometimes used in building houses, especially as supports for roof thatching.

Fimbristylis cymosa var. Cyperaceae Group II or III (probably I)
Gilbertese: te uteute te mane (male grass)

Locality: Bikenibeu, Tarawa, no. 9

The most common herb on the islands, and the most resistant to drought. Forming tufts.

Uses: The juice squeezed by twisting the stems is used as eye drops in cases when a foreign body under the eyelids causes pain. The roots are used to perfume hair oil, and formerly, riri. The chickens are very fond of the seeds.

Fleurya ruderalis (Forst.) Gaud. ex Wedd. Urticaceae Group II (or I)

Locality: Teaoraereke, Tarawa, no. 56

Low plant about 20 cm tall, not common. Always considered as a weed of coconut groves. One of the food plants of the larva of Hypolimnas bolina var. rarik (Esch.)

Gaillardia pulchella Foug. Compositae Group III

Locality: Bairiki, Tarawa, no. 118

Small plant about 30 cm tall, ray flowers yellow, disc flowers golden brown. Seen only in gardens of Europeans.

Gliricidia sepium (Jacq.) Steud. Leguminosae Group III

Locality: Betio, Tarawa, no. 95

Pink-flowered tree, seen only on Betio and Bairiki (Tarawa). On Betio, only a few specimens less than 3 m tall, which mark the site of the worthy but unsuccessful plant introduction garden initiated by Administrator Williams (1946). On Bairiki, one tree at least 4 m tall and well developed grows in the garden of the Residency. It is placed in exceptionally good conditions and this species may not be able to become more widespread.

Gomphrena globosa L. Amaranthaceae Group III
Gilbertese: te motiti. English: Bachelor button

Locality: Betio, Tarawa, no. 138

Plant 30-40 cm tall, with flowers and bracts of a purplish red. Rare, seen only on Beru and Tarawa in front of native houses.

Gramineae, undetermined

Locality: Abemama, no. 90

Grass 85 cm tall, sterile specimen, undeterminable.

Guettarda speciosa L. Rubiaceae Group I
Gilbertese: te uri

Locality: Bikenibeu, Tarawa, no. 25

Very common tree up to 6 m tall, one of the main components of atoll vegetation, especially in the center of islets. Its dead leaves are important in the formation of surface soil.

Uses: The wood is used in houses for rafters and wall frames, in canoes for hull and ribs. Formerly used in fire-making by friction. Flowers are commonly used in making garlands. Leaves are used as fertilizer for babai and other plants, alone or mixed with other material. All pastes and preserves are spread on them for sun-drying. They have other domestic uses, as dishes and on various occasions when we would use paper. The soil (te iarauri, te ianuri) scraped under Guettarda trees is added to composts for babai and other cultivated plants.

Larvae of Chloauges woodfordii Butler and Cephonodes pictus Cramer, feed on Guettarda.

Hedyotis biflora (L.) Lam. Rubiaceae Group III
Gilbertese: te uteute (herb)

Locality: Butaritari, no. 67

Hernandia sonora L. Hernandiaceae Group I
Gilbertese: te nimareburebu

Locality: Teaoraereke, Tarawa, no.48

Tree about 4 m tall, rather rare, seen only on the lagoon side.

Uses: The wood is used in building houses, and for outrigger floats.

Hibiscus rosa-sinensis L. Malvaceae Group III

Locality: Tarawa, no. 145

Uncommon shrub, seen as isolated specimens in front of native or European houses. Foliage poorly developed, often chlorotic. The flowers often fall before opening, especially the double ones.

Hibiscus tiliaceus L. Malvaceae Group I (or II)
Gilbertese: te rao (Abaiang); te kiaiai (Beru) English: sea coast mallow

Locality: Abaiang, no. 79

Tree 4 to 6 m tall, uncommon, completely absent from some islands; only in the south, and especially in Beru, is it seen in some numbers. It is hard to know whether it has never been more abundant, or has decreased in importance, like Cordia, Calophyllum and other trees. Its scarcity is much to be deplored as it has many diverse uses.

Uses: The retted fibers are sometimes used to make riri. The branches are sometimes used in outrigger booms, because of their elasticity. The sprouts, when straight, make good fishing rods. The flowers are worn by dancers. The leaves are much appreciated for fertilizing babai pits. Large ones may replace Guettarda leaves as food wrappings.

Ipomoea batatas (L.) Poir. Convolvulaceae Group II (or III)
Gilbertese: te kumara English: sweet potato

Locality: Tarawa, no. 155

Sweet potatoes are rare in the Gilberts, only a few timid attempts to grow them can be observed here and there. Yet satisfactory results could be obtained in years of normal rainfall.

Ipomoea pes-caprae (L.) Roth Convolvulaceae Group II (or III)
Gilbertese: te ruku English: Beach morning glory

Locality: Tarawa, no. 152

Uncommon, seen only in some abundance in Betio and near the landing place at Bairiki.

Ipomoea tuba (Schlecht.) G. Don Convolvulaceae Group I
Gilbertese: te ruku English: moon flower

Locality: Tearinibai, Tarawa, no. 57

Very common liana, very abundant especially in damp places near lakes and ponds, climbing high into the trees.

Uses: Stems and leaves are crushed in water, and used as shampoo. To kill lice, the shampoo is used in concentrated form.

This plant is one of the food plants for larvae of Chromis erotus (Cramer) and Protoparce convolvuli subsp. distans Butler (Sphingidae).

Ixora coccinea L. Rubiaceae Group III

Locality: Bairiki, Tarawa, no. 106

Very rare plant, with green leaves turning dark red, and scarlet flowers. Seen only in the garden of the Residency at Bairiki and in a mission garden on Abaiang.

Jussiaea suffruticosa L. Onagraceae Group II
Gilbertese: te mam English: willow primrose

Locality: Teaoraereke, Tarawa, no. 46

Found only as a weed, with Cyperus javanicus, in the poorly tended babai pits. Not very common; about 40 cm tall.

Lantana camara L. Verbenaceae Group III
Locality: Bairiki, Tarawa, no. 107

Uncommon, only a few plants seen on Betio (orange flowers) and at Bairiki (pink flowers), 30 cm to 1 m tall.

Uses: Flowers worn in hair.

Lepturus repens R. Br. Gramineae Group I

Locality: Bikenibeu, Tarawa, nos. 30, 33, 34

One of the most common grasses, extremely abundant; growing mostly on the edges of islets rather than in the center. Forming tufts near the shores and creeping plants further in the interior.

No. 30 represents variety subulatus Fosb.; no. 34 variety maldenensis F. Brown; no. 33 is a sterile specimen not determinable to variety.

Lumnitzera littorea (Jack) Voigt Combretaceae Group I
Gilbertese: te aitoa

Locality: Butaritari, no. 80

Shrub 4-5 m tall, seen only in Butaritari where many plants grew, often in dense stands near the swamps and lakes converted into fish ponds.

Uses: The scarlet flowers are much appreciated for garlands. The very solid wood is used in houses and for fish traps (te inai), because it does not deteriorate in sea water.

Mangifera indica L. Anacardiaceae Group III
Gilbertese: te mgo, te manko

Locality: Onotoa, no. 142

Mango trees are extremely rare, and it is surprising that any can survive and even produce some fruits, as did one in Butaritari. In Onotoa, a tree about 4 m tall had been planted 3 years earlier, as a sapling brought from Ocean Island where seedlings are common under old trees. It had not yet flowered. Another had died in the recent drought.

Messerschmidia argentea (L.f.) Johnst. Boraginaceae Group I
Gilbertese: te ren

Locality: Bikenibeu, Tarawa, no. 15. Funafuti, no. 1a.

Extremely common, as scattered groups of trees or forming a strip of sparse vegetation along the beaches, with similar density on lagoon and ocean sides. Average height 1.5 to 2.5 m, but some plants can be up to 5 m tall and over 2 m around 1 m above ground. Branches thick and brittle, leaves covered with silvery hairs.

Uses: The young leaves, crushed with a pestle are placed in a te ing (fibrous stipular sheath at base of coconut leaf) and in water, and the juice squeezed out. It is a febrifuge. Dose for children, 3 leaves; for adults, 9 leaves.

The wood, moderately hard, is the most appreciated as fuel. It sometimes replaces te itai (Calophyllum) for the main piece of canoe bows.

Mirabilis jalapa L. Nyctaginaceae Group III
Gilbertese: te aoua. English: Four o'clock flower

Locality: Bikenibeu, Tarawa, no. 1

Seen only in villages around houses. Said to have been brought from Ocean Island. Plant usually 40 cm tall; in Butaritari, plants with white, yellow or purplish flowers were seen.

Uses: Flowers are used in garlands.

Morinda citrifolia L. Rubiaceae Group II
Gilbertese: te non

Locality: Bikenibeu, Tarawa, no. 6

Present on all the islands and rather common. Plant 3-5 m tall. Flowers white.

Uses: The wood is used to build houses, especially roofs. From the roots, a red dye is extracted and used to color mats, hats, etc. This excellent stain, unfortunately, tends to be replaced by imported dyes, although the Handicraft Department tries to encourage anew the use of local dyes.

The leaf-cutting bees Megachile cut most of their little discs from the edges of Morinda leaves, which are often so scalloped that the appearance of the tree is changed. The discs are rolled into tubes for the protection of the larvae. Morinda is also the food plant of larvae of Chromis erotus (Cramer).

Musa paradisiaca subsp. sapientum (L.) O. Ktze. Musaceae Group III
Gilbertese: te banana

The herbarium specimens (flower buds) of 3 bananas apparently of different varieties, were lost during their transport from Tarawa to Ocean Island, and the photos of the plants were not enough for Professor L. H. MacDaniels to identify varieties.

Bananas are not common in the Gilberts. They are usually grown in pits, but not in flooded soil as for the babai. The banana plants are placed in slightly higher part of the pit, or in old pits partially filled up. At Butaritari we saw a few beautiful plants growing in a small depression behind the village near the last houses. The bunches were heavy with fruit.

The most interesting observations on bananas were made at the Makin School on Abemama, and at the Manoku Catholic Mission on another islet of the same atoll. In a pit in the first locality, 30 banana plants showed a remarkable development; they had been planted 10 months previously, and one already had a flower bud. At Manoku the plants in some pits were already

bearing, in others the plants were less vigorous and seemed weakened, possibly as a result of serious damage caused by a Noctuid larva.

Generally, it must be pointed out that the establishment of such banana plantations requires much work. A rather deep trench (about 1 m) must be dug around the bottom of the pit to keep coconut roots out. A layer of earth scraped from under Guettarda, Scaevola, etc. must be spread. Pieces of scrap iron must be buried here and there. Some school teachers have tried to fertilize the pits with algae and sea grasses but have failed, perhaps because the plants were not washed in fresh water first.

Father Brandstett of the Manoku mission said that if the suckers are removed while the bunch is developing on a banana plant, it ripens rapidly without growing larger. We asked some natives why they did not try to increase their banana production. Their answer was that the first bananas to mature would systematically be stolen and that, when the bunch was cut off, the owner would be deprived of his crop by bubuti. These customs are too deeply anchored in the Gilbertese life to be easily changed.

Bananas are attacked by the larva of Prodenia litura. The leaves are often bored through before they unfurl. A single plant may bear hundreds of larvae. A beetle Pentodon sp. or Papuana sp. (see p. 28) burrows into the plant a little below soil level.

Nephrolepis hirsutula (Forst.) Presl Polypodiaceae Group III

Locality: Abaiang, no. 71

Seen also on Butaritari and Tarawa.

Nerium oleander L. Apocynaceae Group III
Gilbertese: te orian English: oleander

Locality: Tarawa, no. 146

Uncommon shrub, not over 3 m tall, seen near churches on Tarawa, Arorae, Abaiang, etc.

Nicotiana tabacum L. Solanaceae Group III
Gilbertese: te kaibake English: tobacco

Locality: Bikenibeu, Tarawa, no. 4

Tobacco is cultivated on practically every island, but is abundant only on the southern islands, especially Nikunau, where each house (Plate XIVc) is bordered with one or two lines of tobacco plants, 50 cm to 1 m tall. The care of plants and preparation of leaves are reserved for old women. Curing is rather sketchy and the resulting product far from satisfactory: the leaves are simply dried on hot stones. If more leaves are available than are needed daily, they are suspended singly or in bunches in the huts. The natives much prefer stick tobacco and use their own only when the store is out of sticks, as happens often, or when money is lacking.

Ocimum basilicum L. Labiateae Group III
Gilbertese: te marou English: basil

Locality: Tarawa, nos. 105, 130

Rare plant, said to have been brought from Ocean Island, seen only on Tarawa and Nikunau as isolated individuals growing in front of houses. Flowers mauve, plant about 35 cm tall.

Uses: The very fragrant leaves are much appreciated for garlands.

Cultivated palm Palmae Group III
Gilbertese: te bam (palm)

Locality: Tarawa, no. 153

Uncommon, but well developed.

Pandanus tectorius Park. Pandanaceae Group I
Gilbertese: te kaina

Locality: Teaoraereke, Tarawa, no. 50

See Chapter 5.

Paspalum vaginatum Sw. Gramineae Group I
Gilbertese: te uteute (grass)

Locality: Butaritari, no. 72; Betio, Tarawa, no. 97; Nikunau, no. 128

Grass not over 30 cm tall, seen mostly in protected places on beaches and in swampy areas where it forms a very dense sod. Found in Butaritari along the fish ponds, in Betio near the beach, and in Nikunau in swampy places near the lakes, often with Cyperus laevigatus.

Passiflora foetida var. gossypifolia (Desv.) Mart. Passifloraceae
English: Stinking passion fruit Group III

Locality: Butaritari, no. 64

Seen only on Butaritari, where it is not common.

Uses: The fruits are eaten by the natives.

Passiflora foetida var. hispida (DC.) Killip Group III

Locality: Bairiki, Tarawa, no. 139

Pemphis acidula Forst. Lythraceae Group I
Gilbertese: te ngea

Locality: Aranuka, no. 16

Extremely common on all the islands, in dense stands on sandy areas near the mangroves. Trees 2-4 m tall, sometimes up to 5 m with trunks over 0.5 m diameter at the base. Trunks irregular, irregularly branched, with cracked bark.

Uses: The small fruits are sometimes eaten. The rotting wood added to coconut oil is used in a cosmetic. The young leaves are said to have anti-scorbutic properties, but are not eaten in the Gilberts.

The roots, scraped in water, are used to stop hemorrage after child-birth; this drink is supposed to have real hemostatic properties. To cure running sores (te kiniman) a root is carefully cleaned, and the juice from the scraped bark applied to the sore.

The dense and hard wood of Pemphis has many uses. Many pieces of the framework of houses are made of it. It is always used for the top part of canoe masts, and preferred to all others to make pestles. It is also used to make pipes, traps for moray-eels, and in former times, fishing hooks; it is not attacked by sea-water.

Pemphis is one of the food plants of Achaea janata larvae.

Pentas carnea Benth. Rubiaceae Group III

Locality: Tarawa, no. 116

Seen only in the garden of the Residency at Bairiki. Plant 30-40 cm tall, with flowers of a very pale mauve.

Phyllanthus amarus Sch. & Th. Euphorbiaceae Group II (or III)
Gilbertese: te kaimatu

Locality: Bikenibeu, Tarawa, no. 17

Very common low herb, much appreciated by chickens.

Physalis angulata L. Solanaceae Group III
Gilbertese: te bin (northern Islands), te baraki (southern islands);
English: ground cherry

Locality: Morikao, Abaiang, no. 66

Very common plant preferring sunny openings.

Uses: The ripe fruits are eaten raw and much appreciated.

Pilea microphylla L. Urticaceae Group III

Locality: Bikenibeu, Tarawa, no. 87

Low plant, not over 6 cm tall, rather common on some islets such as Bikenibeu, especially near the lagoon.

Pipturus argenteus (Forst.) Wedd. Urticaceae Group II or III (or I)

Locality: Abaiang, no. 68

Pisonia grandis R. Br. Nyctaginaceae Group I
Gilbertese: te buka

Locality: Tarawa, no. 102

Tree not over 10 m tall; in other islands of the Pacific, it may be up to 20-25 m. Rare, found only as isolated individuals or small groups. Like many other species with useful wood, this tree must have been much more common formerly, it has been much cut because of its soft wood, and replaced by the coconut palm.

There have been various reports on the toxicity of soils under Pisonia trees, which would have been fatal to coconuts planted in their place. We could not find any justification of this idea and believe that the leaves and branches form a good humus.

Uses: The soft wood is useful only to make outrigger floats.

Pluchea indica (L.) Cass. Compositae Group III

Locality: Butaritari, no. 61

Seen only on Butaritari, probably introduced from Ocean Island.

Pluchea odorata Cass. Compositae Group III

Locality: Bikenibeu, Tarawa, no. 22

Said to have been introduced by American troops who were said to call it "curray plant." Shrub up to 2-3 m tall, with mauve flowers and very fragrant leaves.

Pluchea is one of the food plants of Chrysodeixis chalcites (Esper.)

Plumiera rubra L. Apocynaceae Group III
Gilbertese: te meria English: frangipani

Locality: Tarawa, no. 148

Shrub about 2 m tall, with very ornamental flowers.

Uses: The flowers are used in garlands.

Polypodium scolopendria Burm. f. Polypodiaceae Group I
Gilbertese: te keang

Locality: Bikenibeu, Tarawa, no. 19

Rather common but only in the shade, often at the foot of large trees.

Uses: Leaves are used for the best garlands. The stems to perfume coconut oil used as cosmetic.

Polyscias fruticosa (L.) Forst. Araliaceae Group III

Locality: Abaiang, no. 77

Plant about 1 m tall, used for hedges by Europeans.

Polyscias guilfoylei (Cogn. & March.) L. H. Bailey Araliaceae Group III
Gilbertese: te toana

Locality: Tarawa, Bairiki, no. 45; Teaoraereke, no. 45b

Shrub up to 3 m tall, found only in villages.

Uses: The fragrant leaves are used in garlands.

Portulaca lutea Sol. ? Portulacaceae Group I
Gilbertese: te boi English: purslane

Locality: Bikenibeu, Tarawa, no. 18

Low fleshy plant, creeping or erect, much branched. Very common. P. oleracea may also be present, though not represented by a specimen.

Uses: The leaves are eaten in times of scarcity. The plant is fed to pigs, and chickens are very fond of the seeds.

Portulaca samoensis v. Poelln. Portulacaceae Group I
Gilbertese: te mtea. English: purslane

Locality: Bikenibeu, Tarawa, no. 14

Low fleshy plant, almost creeping, with tuberous root.

Uses: The leaves are boiled in several waters, and when soft, mixed with karewe and eaten in times of scarcity. The tuberous root is also cooked and eaten. The plant is fed to pigs.

Premna obtusifolia R. Br. Verbenaceae Group I
Gilbertese: te ango

Locality: Tarawa, Mission, no. 40a; Tearinibai, no. 40c; Butaritari, no. 40b

Not very common, but must have been more abundant formerly. Tree 4-6 m tall, sometimes up to 15 m.

Uses: The wood is used in building houses. The roots perfume coconut oil for cosmetics. Straight sprouts make fishing poles. Formerly the wood was much appreciated to make fire by friction.

Pseuderanthemum carruthersii var. carruthersii Acanthaceae Group III
Gilbertese: te iraro

Locality: Abemama, no. 47

Shrub up to 2m tall, seen only in villages. May have been introduced from the Marshalls.

Uses: Flowers are used in garlands. The supple twigs are much appreciated to make fishing rods for ninimai (Gerres sp.) and other small fish.

Pseuderanthemum carruthersii var. atropurpureum (Bull) Fosb. Acanthaceae Group III

Gilbertese: te iaro

Locality: Marakei, no. 73

Shrub up to 2 m tall, purple leaves. Seen on all islands visited, cultivated as ornamental in front of houses, also in gardens of missions. May have been introduced from the Marshall Islands.

Pseuderanthemum laxiflorum (Gray) Hubb. Acanthaceae Group III

Locality: Tarawa, no. 110

Seen only in the garden of the Residency at Bairiki. Shrub 1 m tall, leaves green or green-purplish, flowers slightly mauve.

Psilotum nudum (L.) Griseb. Psilotaceae Group I
Gilbertese: te kimarawa

Locality: Tearinibai, Tarawa, no. 58

Seen only once at the foot of coconut trees in the Boariki area of Tarawa. Plant 25 cm tall.

Uses: The extremities of the green branches, bearing yellow sporangia are used in garlands.

Rhizophora mucronata Lam. Rhizophoraceae Group I
Gilbertese: te tongo. English: mangrove

Locality: Bikenibeu, Tarawa, no. 7; Aranuka, no. 93

One of the main components of the mangrove, usually found on the lagoon side and along the channels between islets; exceptionally found on the ocean

side, as on Bairiki, Tarawa, where 8 Rhizophora grow on the windward reef. Their bases are submerged at high tide, but in spite of the breaking waves during ebb and flow the plants are able to persist.

Rhizophora usually forms very dense stands, of average height of 4 m, but under exceptional circumstances, much taller. Thus on Aranuka, this species covers such a large area that it creates an illusion of two hills, even close-up. The trees grow in deep and foul-smelling mud, and may be up to 18 m tall and over 1 m around at the base. This stand, possibly because of its height, has been erroneously identified as Casuarina on charts of Aranuka.

Uses: The dense and extremely hard wood is used in houses for rafters and sometimes for small posts. It is used also in stakes for fish traps, because it resists sea-water and ship worm (Teredo navalis). The bark produces a red dye, rich in tanin, but is not used to color cotton nets. The bark is used to perfume coconut oil (cosmetic).

Rhoeo discolor (L'Her.) Hance Commelinaceae Group III

Locality: Abaiang, no. 156

Plant 30-40 cm tall, flowers white. Very rare, seen only on sites of ancient graveyards, especially on Abaiang.

Ricinus communis L. Euphorbiaceae Group III
English: Castor-oil plant

Locality: Betio, Tarawa, no. 114

Not very common, seen here and there in villages, as ornamental. In Butaritari it seemed to be growing spontaneously away from the village. All the plants are well developed, sometimes over 3 m tall. The capsules are pink or sometimes almost red. The natives do not use them, and seem to be unaware of the purgative properties of the seeds.

Ruppia maritima L. Potamogetonaceae Group I
Gilbertese: te bukare

Locality: Nikunau, no. 125

Small (40 cm tall) aquatic plant with white flowers, living completely submerged in the Nikunau lakes (fish ponds).

Russelia equisetiformis Schlecht. & Cham. Scrophulariaceae Group III
Gilbertese: te kaibaum

Locality: Bikenibeu, Tarawa, no. 2

Plant 1 to 1.2 m tall, with scarlet flowers, found only in villages around houses.

Uses: Flowers used in garlands.

Saccharum officinarum L. Gramineae Group III

Locality: Tarawa, no. 141

Only two plants were seen, one at the Bairiki School, one at the mission school on Butaritari. Both were poorly developed, not over 50 cm tall.

Scaevola sericea Vahl Goodeniaceae Group I
Gilbertese: te mao

Locality: Bikenibeu, Tarawa, no. 5

Most abundant shrub in the Gilberts, found everywhere: along windward beaches, across the whole width of the islands if the coconut trees are sparsely distributed, or absent, and on the lagoon side (leeward). Height from 2 to 4 m, stems 30-40 cm around at the base, and branching from the base. Flowers white or yellowish; plant fruiting the year round.

Uses: The flowers are abundantly used in garlands. It is a very common sight in the morning to observe young girls and children picking off flowers, or holding Guettarda leaves in which they are collected and taken to the village. The fruits, besides some uses in magic are said to be part of certain medicines. The branches are sometimes used for roofing strips, they are said to be less attacked by insects than those of other plants. Because of its great abundance, Scaevola plays an important role in protecting the soil against intense evaporation, and the leaves form humus.

Sesuvium portulacastrum var. griseum Deg. & Fosb. Aizoaceae Group I
Gilbertese: te boi English: sea-side purslane

Locality: Nikunau, no. 126

Prostrate plant, about 30 cm, with white-greenish flowers, growing by the lakes. It is curious that it is not eaten by the Gilbertese who use Portulaca (also called te boi).

Sida fallax Walp. Malvaceae Group I
Gilbertese: te kaura

Locality: Bikenibeu, Tarawa, no. 10

Low shrub very common all over the islands, especially on open or burned areas, where it may get very dense and tall (1.20 m).

Uses: The flowers are used in garlands. The leaves are very important in fertilizing babai plants (see pp. 87-88).

Sida is the preferred food plant for larvae of Hypolimnas bolina, which are sometimes very numerous on it, especially in the sun.

Solanum torvum Sw. Solanaceae Group III

Locality: Bairiki, Tarawa, no. 109

Plant 2 m tall, with white flowers, seen only on Tarawa and Abemama.

Sophora tomentosa L. Leguminoseae Group III

Locality: Abemama, no. 91

Shrub said to have been brought from Ocean I. Only one plant was seen in front of a native house on Abemama; plant 2.5 m tall, non-woody shoots 1.80 m. No flowers or fruit.

Stachytarpheta jamaicensis Vahl Verbenaceae Group III
Gilbertese: te uti. English: blue cat's tail

Locality: Bairiki, Tarawa, no. 104

Blue-flowered plant, not over 90 cm tall, very rare, seen only as ornamental around houses.

Uses: The flowers are used in garlands.

Stenotaphrum micranthum (Desv.) Hubb. Gramineae Group II

Locality: Bikenibeu, Tarawa, nos. 29, 31

Very common grass, everywhere except in a zone about 20 m wide along lagoon and ocean side. Reddish in open areas, 25 cm tall.

Synedrella nodiflora (L.) Gaertn. Compositae Group III

Locality: Butaritari, no. 74

Plant still rather rare, probably introduced by American troops. Seen only in Butaritari.

Tacca leontopetaloides (L.) O. Ktze. Taccaceae Group III
Gilbertese: te makamaka

Locality: Tearinibai, Tarawa, no. 135

Seen only once on Tarawa near the village of Tearinibai. The plants formed a dense stand over a rather large area under sparse coconut trees. Average height 1.60 m. Tacca is said to have been brought from the Marshalls about 15 years before by a Gilbertese who married a Marshallese woman.

Some natives thought the plant to be poisonous, although no one could recall a case of poisoning. Perhaps their lack of interest in propagating this plant is due to the amount of work needed to make flour from the

tubers. This is regrettable, since Tacca could be a valuable resource as supplementary food. Its propagation raises no problem; its requirements are met by any of the better soils in the Gilberts and its resistance to drought is remarkable. The part above ground may wither entirely but the tubers resist and send up new stems as soon as the rain starts again. When the plants are pulled out to gather the tubers, a few always remain in the ground and give new plants. In soil of good quality at Tearinibai, Tacca showed very satisfactory development. The soil (fresh) had a pH of 7.8 (tested with phenol red). The rhizomes were at an average depth of 9 inches. The total weight of all the tubers of 4 plants were: 2 lbs., 2.6, 1.9, 3.3. The largest tubers on one plant: 8 oz., 7, 4, 5, 4.5. The tubers are gathered when the flower stalk is turning yellow. They are washed in salt water and the outer skin scraped off. The tubers are grated with a stick tightly bound with coir rope and the grated pulp tied in a cloth and placed in a basin of sea water. The starch is forced out by pressing the cloth, and left to settle for 3 hours. Then the sea water is replaced and the starch settled again for 3 hours. Finally fresh well-water is used and as soon as the starch has settled, it is spread out to dry in the sun.

Because it is not extensively grown, the uses of Tacca are not well known. Still the owners of the plants ate the flour cooked in a porridge with kamaimai (toddy molasses); it can also be mixed with fresh toddy into a very thick pancake mix which can be fried. Buatoro is made up of Tacca flour, grated babai and kamaimai. Finally Tacca is used to make fritters called te tonati. The flour is mixed with sugar and baking powder, or, if the latter is unavailable, with fermented toddy. Small amounts of the very thick paste are deep fried in coconut oil or lard. Strangely enough, eggs are never used in native cooking, although a number of people have had many opportunities to learn to do so in European recipes.

The stems are said to be used in making hats but we did not learn the process for separating the fibers.

Tamarindus indica L. Leguminosae Group III
English: tamarind

Locality: Tarawa, no. 134

Seen only on Betio islet, as 8 shrubs 3-4 m tall, normally developed. They were growing near a house and in a region where coconut palms and other plants are more luxuriant than anywhere else, so one cannot guess how well they would do in other parts of the archipelago.

Tecoma stans L. Bignoniaceae Group III

Locality: Little Makin, no. 69

Shrub with beautiful yellow flowers; variety with pinnatisect leaflets.

Terminalia catappa L. Combretaceae Group I (or II)
Gilbertese: te kunikun

Locality: Bairiki, Tarawa, no. 82

Tree up to 15 m tall, and over 80 cm in diameter at the base, relatively rare and always found as isolated individuals.

Uses: The wood is used in houses, and for various other purposes. The fruit called te ntarine includes an almond much appreciated by the Gilbertese.

The leaves of all Terminalia seen were eaten by the larvae of Anua coronata and Badamia exclamationis.

Thalassia hemprichii (Ehrenb.) Aschers. Potamogetonaceae Group I
Gilbertese: te keang. English: sea grass

Locality: Tarawa, no. 157

This marine plant is very common in all the channels separating the islets. The natives sometimes use it to fill pillows.

Thespesia populnea (L.) Sol. ex Correa Malvaceae Group I
Gilbertese: te bingibing

Locality: Butaritari, no. 51

Shrub growing along the sea; the wood has a peppery smell. Rare.

Uses: The flowers are used in garlands, the leaves in composts for babai.

Thuarea involuta (Forst.) R. & S. Gramineae Group I

Locality: Bairiki, Tarawa, no. 59

Common everywhere; inflorescences cream-colored, plant 30-40 cm tall. Pigs like it and chickens eat the seeds.

One of the food plants of the larvae of Prodenia litura.

Tridax procumbens L. Compositae Group III

Locality: Tarawa, Betio Islet, no. 54

Low plant 20-25 cm tall, seen only on Betio; said to have been introduced by American troops. It is very common on Ocean Island.

Triumfetta procumbens Forst. Tiliaceae Group I
Gilbertese: te kiaou

Locality: Bikenibeu, Tarawa, no. 12

Creeping plant with very long runners (sometimes several meters long), forming an often compact carpet, and preferring open places where it can withstand strong sunlight.

Uses: The leaves are used in garlands; in compost for babai; as a medicine for stings of stone-fish (Scorpaena) leaves are boiled until very soft and applied to the swollen limb, and renewed if necessary. A week treatment is said to be sufficient; without it, the pain would persist for 3 weeks.

Triumfetta is one of the many food plants of Prodenia litura larvae.

Vernonia cinerea (L.) Less. Compositae Group III

Locality: Teaoraereke, Tarawa, no. 52

Small plant 20-25 cm tall, found everywhere but not very common.

Vigna marina (Burm.) Merr. Leguminosae Group I

Locality: Butaritari, no. 63

Wedelia biflora (L.) DC. Compositae Group III
Gilbertese: te kaura ni banaba

Locality: Abaiang, no. 76

Said to have been introduced from Banaba or Ocean Island (hence the name) and to be spreading rapidly on Abaiang, the only island where it was seen. It does not much resemble Sida (te kaura) except for the color of flowers.

Uses: The flowers are used in garlands, the leaves in composts.

PART III: PLANTS GROWN IN EUROPEAN AND EXPERIMENTAL GARDENS

Vegetables in European gardens listed in order of frequency:

Cichorium endivia crispa L. -- chicory

Cichorium endivia latifolia L. -- endive

Basella rubra L. -- country spinach

Solanum lycopersicum L. -- tomato

Raphanus sativus -- radish

Vigna sesquipadalis L. -- "asparagus bean"

Ipomoea batatas (L.) Lam. -- sweet potato

Citrullus vulgaris Schrad. -- water melon

Mentha piperita L. -- mint

Petroselinum sativum L. -- parsley

These plants develop only moderately well in spite of continuous care and frequent waterings. Big oil drums are cut in two lengthwise and 3/4 buried, and filled with earth. This is either earth obtained locally by scraping the soil under Guettarda, Scaevola, etc. or composts like those prepared by the natives. Some gardens have even formerly been made up from earth imported from Fiji (reportedly at 5 pound sterling a ton). The system of drums is mostly intended to stop coconut roots and burrowing crabs. But it does not stop the ants, and very often, plants have to be grown in crates placed on supports resting in containers filled with kerosene. Whatever the system, all vegetables grown on these atolls require much work and the results are often poor. But the lack of fresh vegetables is such that salad leaves less than 15 cm long and tomatoes hardly bigger than cherries are a luxury and much appreciated.

Behavior of imported legumes:

We tried to plant various legumes from seeds brought from New Caledonia or obtained from the Department of Agriculture of Suva. The seeds were planted at Bikenibeu, Tarawa in good soil; table I gives an analysis of this soil. Seeds were planted on March 24 and April 24. The species used were: Calopogonium mucunoides, Canavalia ensiformis, Centrosoma pubescens, Crotalaria incana, Dolichos biflora, Leucaena glauca, Phaseolus calcaratus, Vigna sinensis, Vigna unguiculata.

The nurseries were kept in natural conditions, with no addition of fertilizer or black earth. Our assistant, R. Mason had a nursery in the same region to which he added various fertilizers. His results were not much more encouraging than ours. All the care we gave the soil was a surface ploughing, followed by harrowing and elimination of large coral pieces, roots and crabs.

The almost daily rains, often very abundant, which started 2 days after the first seeding and had not yet stopped by August did not have the expected effects. Generally all the seeds came up rapidly but after a few weeks the young seedlings were obviously chlorotic except for Leucaena glauca which were a little pale; Phaseolus calcaratus grew extremely rapidly but the other plants stopped growing after a few weeks. Seeds of Phaseolus calcaratus planted on April 28 at Bairiki germinated in

3 days. They were watered everyday with used water from the kitchen and all plants were bearing pods in July. Chlorosis was no less marked than on the plants of Bikenibeu, but the latter flowered rarely and the number of pods was negligible. Altogether, only Leucaena plants were able to maintain themselves in acceptable vegetative conditions. They reached the following sizes:

On June 6, those sown on March 24 were	stems 20 cm long roots 14 cm
On June 6, those sown on April 24 were	stems 14 cm roots 10 cm
On August 20, those sown on March 24 were	stems 25 cm roots 17.5 cm

In Mason's nursery the Leucaena plants probably sown in March and receiving various fertilizers reached sometimes larger sizes; some individuals measured on August 20 had stems 35 cm long and roots 22.5 cm.

As pointed out in the chapter on soils, a careful examination of the roots showed no nodules. Trying to inoculate the roots with nitrifying bacteria might improve the development of these legumes, but this would be worth while only if not limited to a small area.

To conclude, it does not seem that even Leucaena has much future in the Gilberts. To be really useful as a soil improver, such a legume should be able to grow without care, once sown, and to cover large areas. One of our nurseries, where the seeds were sown very close together might have led one to think that the plants could be used as green manure, but the price of seed gathering in Fiji or elsewhere would make the project too expensive. As for the seeds planted about 1 m apart, in unprepared soil, they all came up but their growth was even slower than that of the others. On an area of about 1/2 hectare, children to whom we gave bags of such seeds were happy to sow them under these conditions, and it would be interesting to know what will remain a year from now of these thousands of seedlings.

CHAPTER 10

INSECTS COLLECTED IN THE GILBERTS

During our field surveys, particular attention was paid to the collection of insects most frequently found on economic plants, but time was obviously lacking to organize methodical collecting expeditions. Our colleague, Mr. R. Mason, Agriculture Department, Suva, showed commendable initiative in making general collections which would have represented a valuable contribution to the study of the entomological fauna of the Group. We were sorry to learn recently, that these collections had been almost entirely damaged in the ship's hold.

Several of the insects mentioned may be considered as more or less dangerous pests, others are merely present without being a threat. Some are new in the Gilbert Islands. It is obvious that a methodical investigation of the entomological fauna of these islands would appreciably add to the present knowledge, from the biological and systematic point of view. A detailed study of some groups such as Hymenoptera, for instance, would certainly yield valuable data in connection with the biological balance observed. It seems, indeed, that the small extent of the damage caused by insect pests may be imputed to the large number of their predators.

The following list, and the enumeration of specimens still being identified will represent only a minute contribution. In order to give a more comprehensive view, it would have been essential to pursue this single aim only, and a much more considerable period of time would have been necessary.

The polyphagous nature of some species, such as the caterpillar of Prodenia litura (F.) (very harmful) and that of Hypolimnas bolina subsp. rarik Esch. must be mentioned. Their adaptation to recently introduced plants is sometimes extremely rapid, as we observed when we found caterpillars of Hypolimnas on Phaseolus calcaratus in our Bikenibeu nurseries, six weeks after sowing.

List of Insects Identified

LEPIDOPTERA

Achaea janata (Linné) - Family Phalaenidae
Caterpillar on Pemphis acidula Forst.

Agrius convolvuli subsp. distans Butler - Sphingidae
Caterpillar on Ipomea tuba

Amyna octo (Guénée) - Phalaenidae
Caterpillar on Abutilon indicum (L.) Sweet

Anisodes ceramis (Meyrick) - Geometridae
Host unknown

Anua coronata (Fabricius) - Phalaenidae
Caterpillar on Terminalia catappa L.

Badamia exclamationis (Fabricius) - Hesperidae
Caterpillar on Terminalia catappa L.

Cephonodes picus Cramer - Sphingidae
Caterpillar on Guettarda speciosa L.

Chloauges woodfordii Butler - Pyraustidae
Caterpillar on Guettarda speciosa L.

Chromis erotus (Cramer) - Sphingidae
Caterpillar on Morinda citrifolia L.

Chrysodeixis chalcites (Esper.) - Phalaenidae
Caterpillar on Pluchea odorata Cass. and Solanum lycopersicum L.

Danais plexippus (L.) - Nymphalidae
Caterpillar on Asclepias curassavica L.

Decadarchis sp. - Lyonetiidae
Caterpillar on Cocos nucifera L.

Ethmia colonella Walsingham - Ethmiidae
Caterpillar on Cordia subcordata Lam. and Amaranthus dubius Mart.

Hypolimnas bolina subsp. rarik (Eschscholtz) - Nymphalidae
Polyphagous caterpillar. Preferred food plant: Sida fallax Walp.

Nagia hieratica Hampson - Phalaenidae
Host unknown

Precis villida villida (Fabricius) - Nymphalidae
Caterpillar on Scaevola sericea Vahl

Prodenia litura (Fabricius) - Phalaenidae
Polyphagous

Spodoptera mauritia (Boisduval) - Phalaenidae
Host unknown

Utetheisa lotrix (Cramer) - Arctiidae
Caterpillar on Messerschmidia argentea (L.f.) Johnst.

COLEOPTERA

Conoderus pallipes Eschscholtz - Elateridae
The larva attacks those of other insects.

Cylas formicarius (Fabricius) - Curculionidae
Considered as very harmful to sweet potatoes, but only found on Ipomoea tuba.

Diocalandra frumenti (Fabricius) - Rhyncophorinae
Found on many coconut palms but never in considerable numbers. None of these trees gave signs of injury which could be attributed to damage by this insect.

Harmonia arcuata (Fabricius) - Coccinellidae
This predator is very common everywhere.

Lacon modestus (Boisduval) - Elateridae

Necrobia rufipes (de Geer) - Cleridae
This species of Cleridae is found in considerable numbers chiefly in copra lots.

Papuana sp. or Pentodon sp. - Scarabaeidae
Pest of Cyrtosperma, Musa and possibly of young coconut palms.
See p. 28.

Sessinia livida (Fabricius) - Oedemeridae
This insect is called "toddy beetle" and is found in great numbers. It has very bad fame in Gilbertese circles, and any toddy container in which one of these beetles is found is immediately emptied. Grimble writes that in the past, these toddy beetles were used for criminal purposes; the designated victim was given a drink mixed with the juice of a definite number of these beetles. The effects on the bladder were said to be frightful.

ORTHOPTERA

Cutilia soror (Brunner) - Blattidae

Graeffea cocophaga (New.) - Phasmidae
Pest of the coconut palm (see Chapter 4, p. 28).

DERMAPTERA

Chelisoches morio (Fabricius)

HETEROPTERA

Pachybrachius nigriceps (Dallas) - Lygaeidae

DIPTERA

Chrysomya megacephala (Fabricius) - Calliphoridae

Dacus (Strumeta) frauenfeldi Schiner - Tephritidae

Homoneura acrostichalis (Meijere) - Lauxaniidae

Pseudeuxesta prima Osten Sacken - Otitidae

Rhinia testacea R. Desvoidy - Calliphoridae

Sarcophaga dux Thomson - Calliphoridae

HYMENOPTERA

Megachile diligens hedleyi Rainbow - Megachilidae

Megachile fullawayi Cockerell
In the Gilbert Islands, the Megachiles do not affect palms, but prefer many bush plants, particularly Morinda citrifolia L. They cut circular pieces in the leaves for use in their nests.

Odontomachus haematoda (Linné) - Formicidae
Extremely painful venom.

Pachodynerus nasidens (Latreille) - Vespidae

Pheidole umbonata Mayr - Formicidae

Polistes fuscatus aurifer Saussure - Vespidae

Szepligetella sericea (Cameron) - Evaniidae

CHAPTER 11

MARINE RESOURCES

PART I: GENERAL SURVEY

The value of the resources drawn by the natives from the sea is considerable. It is important enough during normal periods, when plant products are found in abundance, and even more so when these resources fail, exhausted by prolonged droughts. Thus in the southern islands, fish, crustaceans, and molluscs are a substantial help for populations temporarily affected by real shortages of food. Sea foods obviously do not have a dietary value equivalent to that of products such as grated coconut and especially toddy, which is so essential, but they bring a quantitative contribution with which the native is able to hold out until the return of normal conditions.

It is often believed, partly because of the extensive activity formerly associated with deep sea fishing such as fishing for Ruvettus that the natives chiefly fish in the open ocean. Of course some fishes can usually be caught only at considerable depths - 100 fathoms and over - and for others canoes must go several miles off-shore, as in bonito fishing. Around some northern islands the capture of flying fish and tuna involves rather elaborate means and great qualities of seamanship. But these spectacular operations are not everywhere a daily occupation. After observing the various fishing activities of these territories as best we could, we are now convinced that apart from these particular regional cases the fish supply of most Gilbertese populations is found much more frequently in the immediate vicinity of the land and in the shallows than far offshore. This observation is even more true of atoll islands, since the lagoon and especially its shallow parts are the most commonly frequented fishing grounds. It is also the place where a maximum subsistence may be found with a minimum of effort.

In some privileged islands, the sea brings to the door, so to speak, fish or other edible organisms, sometimes in considerable quantities. This is the case with ikari, a fish of the genus Albula, and of baitari, edible jelly fish of genus Tamoya (family Carybdeidae). The native utilizes almost all the varieties of fish he is able to catch, provided they are not poisonous, and very few are. (It should, however, be noted that some fishes which are commonly eaten in some islands are considered as toxic in others.) While the native very seldom eats chicken or eggs, he will not scorn even such species as diodons and tetradons, in which there is really very little to eat once the toxic parts have been removed. It is an interesting fact that cases of poisoning by shell-fish or fish are extremely rare.

PART II: DEEP-SEA FISHING

Formerly, the Gilbertese went fishing in groups for Ruvettus preciosus Cocco, using remarkable techniques and going far out to sea, out of sight of land. This fishing is no longer practiced on a wide scale, both because the Government has forbidden canoe trips from island

to island (except between Tarawa and Abaiang) and because the natives of today have completely lost the remarkable science of long-range navigation and astronomical reckoning which their ancestors had developed. A few Ruvettus are caught not very far from shore, but they are not sought in preference to other varieties.

The following species are still sought away from the shores of the islands, although never out of sight of land: large tuna, (Neothunnus macropterus Sch., te baibo), bonito (Pelamys sp. te ati), and small tuna (Neothunnus sp,, te natiati)(1). Their presence is indicated, as everywhere else, by hundreds and often thousands of sea-birds coming to join the predatory fish in their feasting on shoals of sardines and flying fish. These great flocks of birds, which present a most lively and noisy spectacle, are always a promise of productive fishing for the natives. From far away they can assess the size and behaviour of a shoal of bonito or tuna by the appearance of the birds. When the birds are densely concentrated, flying very near the surface, diving quickly and often, the prospects are excellent, while dispersion, hesitating flight at a greater height, and few dives will indicate a scattered and not very important shoal. But whether the signs are more or less favourable, the alarm is given as soon as they have been noted, and the canoes leave. All the better if the wind is in the right quarter; they will be on the spot sooner and with less noise. Sometimes six, seven or eight canoes arrive together at the seething swirl caused by the preying fish.

The method used is a kind of trolling. The equipment consists of a line 25-30 m long; it may be shorter or longer according to circumstances. This is followed by a wire leader on which a feather lure is mounted, made of cock feathers predominantly red, tied on to a fish-shaped wooden body and armed with a single hook, very sharp and barbed. The Gilbertese seem to disregard completely the use of the spoon but are not surprised to find that it also catches many fish. Actually metallic lures obtain such good results only because they are used with nylon lines which obviously require a reel with adjustable drag. Such a method being only attractive as sport, there is no reason why the natives should take an interest in it.

Cruising to and fro through the shoal and along it, the fishermen often have barely time to haul in and unhook the fish, and pay the line out again until the fish scatter. It is not uncommon for each canoe to bring back a dozen fish weighing altogether around 130 pounds. These expeditions are all the more productive when a moderate breeze enables the canoes to sail regularly and noiselessly without using the paddles, which disturb the foraging fish.

(1) Te natiati is the name given in Marakei to the species called te baiura in Tarawa.

Fishing for Great Tuna (te baibo: Neothunnus macropterus) and Some Other Predatory Fishes

Different fishing practices are used for the red-fleshed yellow-fin tuna, and it seems that it is chiefly in the north and centre of the Gilbert Islands that this fish gives rise to a frequent if not regular activity. It is productive chiefly from April to September, but isolated specimens are found all the year around (in the south the best tuna fishing occurs from October to March). It is no longer the chance appearance of bird concentrations which tells the Gilbertese that it is time to fish; they rely rather on their great experience of tuna migrations at fixed seasons, in relation to some factor or clue the knowledge of which is handed down from one generation to another. The methods used will be either trolling in the daytime at variable distances, generally over two miles from the shore, or drift fishing without sail by day or night at similar distances.

Finally, the natives fish for te awai (Aprion sp.) chiefly at the entrance of the lagoon passes where they also catch the small tuna and bonito already mentioned.

Drift fishing: The great tuna are also caught by drift fishing using weighted lines baited with flying fish (te onauti = Cypselurus sp.). By day, the bait will be let down to a depth of 30 to 50 fathoms (in some southern islands such as Nikunau, baibo measuring 0.80 to 1.80 m are caught at this depth). By night the tuna will bite at between 50 to 70 fathoms and some times te ikabauea (Sphyraena) will be taken at the same depth. If the tuna do not bite, the fishermen go a little farther out at sea and may hook te ikanibeka (Ruvettus preciosus) at depths varying from 90 to 160 fathoms with a special hook which has often been described. It seems that this "castor oil fish" was much more highly appreciated in the past, but we were unable to find the reason why. The natives laugh every time ikanibeka comes into the conversation since the flesh of this fish, unless cooked several times, has purgative results of irresistible rapidity (as indicated by its name).

It is obvious that we have mentioned here only the fishes especially sought by these methods, but others are often caught in addition, ubiquitous species which chance and circumstances bring as a supplement, such catches will be all the more frequent when the natives use lines with several hooks at various depths, as is often done in the north, especially around Abaiang.

Sharks are also caught in these regions by drift fishing at depths of from 20 to 30 fathoms, and often with the help of large shells (te ang).

Trolling (te katiki): This method derives its chief advantages from the speed and remarkable manageability of the outrigger canoe, and it is practised with the equipment already described for drift fishing. The only difference is that the hook and sometimes the line will be stronger.

The latter is fixed to the canoe with or without a slip knot according to the area where the great tuna are caught. Their average weight seldom exceeds 40 kilos, and it seems that specimens of 20 to 25 kilos are most common. We did not stay long enough in some islands to form an exact idea of the number of tuna which may be caught, but we were told that the natives voluntarily limit themselves to the quantity necessary for their family or, to what they are sure of selling in their village. In the event of "overproduction" the excess would eventually be processed but the Gilbertese do not seem to like processing tuna, which is too oily and difficult to keep in good condition.

Sometimes, while a canoe is engaged in trolling, swordfish may strike the lure and cause the fisherman much worry, especially if they are large. Some such occasions were described to us when rakuriri (Istiophorus) or rakuika (Tetrapturus) fought for a long time without the fisherman being able to do anything except let his canoe be towed or wait until the fish was exhausted to land it. On other occasions these swordfish were so large that there was no hope of subduing them or of towing them to the island, and the only thing to do was to cut the line. Finally, we were told of two fatal accidents, the details being confirmed from several sources. One happened a few years ago and the other more recently. On both occasions a large swordfish was hooked, and after fighting for a while made straight for the canoe and impaled the unfortunate fisherman.

Other fish also caught by fast trolling are te ikabauea (Sphyraena sp.) a species of barracuda rather common in these waters, and te baara (Scomberomorus sp.)

Flying Fish

Catching flying fish occasions great activity at certain times of the year, the seasons varying widely from the north to the south. They are used partly for bait for tuna and partly for food.

These flying fish (Cypselurus sp. = te onauti) are found in greatest abundance between April and September in the northern and central islands, and from October to March in the southern group. They are never caught in the lagoon, but outside the breakers on the ocean side. They are noticeably more abundant around lagoonless islands (reef islands) and also at Marakei (which, though having a lagoon, offers an outside shore similar to those of reef islands).

A distinction is generally made between three main fishing methods:

(i) Daytime fishing with special trolling lines equipped with floats (te ai-onauti). We have not observed this and obtained this information from I. G. Turbott.

(ii) Twilight fishing, which begins a little before sunset, lasting till darkness is complete (te kababa).

(iii) Torch fishing at night with dip nets at the time of the full moon (te tatae). The natives are said to state that the best night is that of the full moon, and that if the fish are abundant the three nights before the full moon and the three following, are also good. These indications, which were confirmed by Turbott, may be compared with those concerning massive concentrations of te ikari (Albula vulpes) along the shores outside Tarawa Atoll (see p. 132).

We had the good fortune in March to take part in a torch-fishing expedition off the shores of Marakei. Of this most striking and beautiful spectacle, with flaring torches illuminating sea and canoes, only the technical aspect will be described; ethnological details such as rites and customs associated with this activity will be omitted.

At the bow of each of the dozen or so canoes each paddled by 2 or 3 people, including some women, stood a man holding in his left hand a coconut leaf torch, in the right a large, long-shafted dip net with which he caught with the skill of a butterfly catcher, the fish attracted by the light. For one canoe we counted one flying fish caught approximately every three minutes. It is not uncommon for the catch to be larger, and it may include over 100 fish after a few hours of careful fishing. The least successful expedition results in a dozen fish per canoe.

The system of distributing the fish caught at night differs according to the islands and to the particular agreements which the canoe owners conclude with fishermen, paddlers and steersmen. In the northern islands it is customary when fishing has been productive to reserve a large portion of the catch for preservation by sun-drying and salting. The rest is eaten fresh, except of course the fish intended for tuna bait. The delicate meat of Onauti is appreciated by natives as well as by Europeans. It is said that the Gilbertese like this fish for the oil contained in its head.

PART III: REEF AND LAGOON FISHING

Fishing on the reef on the ocean side

The natives actually "glean" rather than "fish" whatever they can find which is edible. Generally comprising small but widely varied species, the catch, after a few hours' gathering, represents a substantial addition to the routine family meal.

We often observed with amusement - and this is a typical sight in the Gilberts - the similarity between the natives and the herons, both hunting on the same reef at the same time for the same prey, most often a few yards from each other. Criss-crossing these large flats in all directions, they give the same methodical care to their search. The spear and the bill do the same work; each crack, each hole is explored. The native obviously has the advantage of being able to turn over heavy stones and thus uncovering rich puddles. The heron will very soon follow and complete the inspection.

Which species are most commonly seen in the basket of a fisherman returning from his almost daily tour? A few crabs, small morays, fishes of which the largest do not exceed a hand's width, shell-fish and almost always small octopus. To catch the moray eels hiding under rock edges, the natives use an umbrella rib or some other metallic spike curved at the end. When the eel is forced out after much prodding this flexible spike will be used to whip it until it is easily grabbed. For added safety the natives will sometimes bite these eels behind the head to kill them. Alternatively a noose at the end of the spear is used.

It is at night that the most extensive activity can be observed on the reefs. Coconut leaf torches or kerosene lamps are used. In every puddle some fish trapped by the receding tide is blinded by the intense light and easily captured. The fishermen, however, seek mostly the young octopus. New moon nights are the best. The small octopus is caught by hand at the moment when it flattens itself on the sand to hide. Here again the natives will kill by biting. These small specimens of octopus (kikao) are preferred to any others both for food and for bait. As everywhere else they are one of the best bait obtainable. The large specimens of octopus (kika) are caught only during spring tides on the reef enclosing the lagoon. This fishing is done at the new or full moon, and also by day.

Shellfish: On the whole most of the edible mollusks gathered on the lagoon side are bivalves. The shells of other groups are gathered on the ocean side reefs. They are in order of preference:

Turbo setosus Gmel.	(te nimatanin)
Circe pectinata Linné	(te koumara)
Tellen scobinata Linné	(one of the species called te koikoi)
Drupa ricinus Linné	(te kerekaka)
Modiola agripete auriculata Krauss	(te nikarinei and te katati)
Strombus gibberulus Linné	(te newenewe)
Atrina nigra Dillwyn	(te katete)
Conus lividus Hwass	(te anikomri)

Gathering shellfish is the privilege of the women and children and is done by scratching in the sand of the uncovered flats at low tide, both on the lagoon and ocean sides. Koikoi (Asaphis deflorata) are found marked by little holes and one or several may be dug out, with a piece of coral or coconut shell, at a depth of 10 to 20 cm. Another bivalve, smaller but of more delicate taste, will be gathered a few centimeters below the surface of the sand along an almost regular line in the wet zone just left by the ebbing tide. This is te katura (Atactodea glabrata Gmel.) which is eaten in great quantities. We have sometimes observed large baskets full of these shells being brought into centres such as missions, where the practice of collective meals is more common than elsewhere. In the villages, each family usually gathers its own supply of katura and other mollusks. Te nouo (Strombus luhuanus) is also frequently eaten, especially in Abemama, where it is more common than in other areas.

Finally particular reference should be made to the Tridacna (te verevere) of all sizes, and especially to Hippopus hippopus Lam.(te neitoro) which the Gilbertese like very much. Fishing for these giant clams is practised at the entrance to some lagoons in atolls such as Onotoa and Aranuka, where they are found in abundance in the living coral reefs. This activity is carried out by divers on te rakai (shallows) and requires the use of goggles and a strong knife. The diver quickly inserts the latter between the two valves of the shell which close and strongly grip the blade, making it easier for the diver to free the shell from the bottom. These large bivalves are generally eaten fresh, but may be preserved after sun-drying. This type of fishing is also practised at the edge of some outer reefs, weather - and sharks - permitting.

Edible jellyfish: Another organism of the ocean side reef which is highly appreciated by Gilbertese natives is te baitari, jellyfish of the family Carybdeidae, genus Tamoya. Every month - seven days before the full moon - the sea casts up on the shore, on the ocean side, large quantities of this jellyfish (Plate XVa). Only the inner part is edible. The natives prepare them on the spot, by scraping away with a knife all the outer gelatinous parts. The rest is spread on strings stretched between two coconut palms or two stakes, and sun-dried for two or three days according to the weather (Plate XVb). The final product, which in appearance faintly resembles tripe or large sausage skins, is placed over pit-ovens and left on the very hot stones until crisp. It is then eaten, generally with babai, breadfruit or grated coconut. Baitari may also be cooked in water. We made a point of tasting it, cooking it like fried potatoes. Fried crisp, and well-drained, baitari is really delicious.

While baitari is not a basic element of native diet, it is one of the little side-dishes which are an addition to the daily fare. One can form an idea of the pleasure they give to the Gilbertese by observing how eagerly they eat them. We may be able to learn their real food value from analyses which will be made later on. We made arrangements for a sufficient quantity to be collected during the last full moon of our stay, but unfortunately, a contrary wind blew during the whole of the preceding night, and no jelly-fish were thrown on shore. It was then too late to go back to the opposite side of the atoll, which benefited by this wind. We could only leave instructions with reliable persons that a shipment of dried baitari be made during the next month.

Fishing at the edge of the reef

This fishing technique is very interesting and is practised both by men and women. Each fishes for himself, and 5 or 6 fishermen avoid getting in each other's way along a kilometer of shore line. At the rising tide, the fishermen follow the zone where the rollers, after breaking violently, rush into the identations at the reef edge. The fishing gear includes, in addition to a little basket tied to the belt, a pole of the greatest possible length, a line made of fine string and sometimes weighted

with a small piece of coral, and a hook baited with a fragment of shellfish or hermit crab, or even better, of young octopus. The bait follows the alternating movements of the continual swirl, so that the hook is very seldom snagged. The same species of fish, te reiati (Cirrhitus) is almost always taken, seldom over 20 cm in length. A catch of 20 to 30 reiati taken in a few hours is considered quite good. This is the only fishing technique requiring less sketchy gear than usual, since the pole must not only be long but also flexible. A native addicted to this method tries even when his means are limited, to buy a tall bamboo pole (this plant does not exist in the area) for which he will not hesitate to pay the 8 or 10 shillings required at the Betio store (Tarawa).

Although we have very seldom seen it done - quite understandably - we will also mention that young sportsmen even go and stand on isolated coral heads right in the breakers. Their chances will obviously be greater, but so will the efforts required to keep on their feet. One cannot but admire the agility with which they cut through the waves, or disappear under them without losing hold of their gear, only to start fishing again, taking advantage of a series of lesser waves to catch the fish which bite better at such a distance from shore. The species most regularly taken is te koinawa (Hepatus triostegus). The experts sometimes take more than 20 in one hour.

Fishing outside the reef

This type of fishing is done in canoes, and must have been the most popular in the past. The canoes were more numerous(1), and so were the men able to use them and to make the most of this type of craft in often choppy waters. Now, only three or four canoes at most are seen along a reef several miles long, such as the Bairiki reef (Tarawa), and only in very good weather. They generally keep at distances affording depths of 15 to 20 meters. There are two methods.

In the first, the canoe is anchored and the fisherman uses a long weighted hand-line. The hook is generally rather large and baited with a piece of fish or octopus and held on the bottom or a little above. Serranidae and Lethrinidae and generally sedentary species typical of rocky or coral ground, are taken in this way.

With the second method, the canoe is allowed to drift with the current or with a slight breeze, this drift being checked now and then by a stroke of the paddle. The line is tied directly to the canoe, with a loop tied with a slip knot to serve as a visual indicator and to hook the fish all at once. The same fishes will be taken with this method as with

(1) Although there may be less canoes nowadays at Tarawa this should not be the case on other islands.
(Note by the Administration of the Gilbert and Ellice Islands Colony.)

the preceding one, with the addition of a few species which prefer a moving bait to a still one: Carangidae, Sphyraenidae, etc. These two techniques, used with a bottom or a half-depth line, are always productive. In four or five hours, it is not unusual to catch seven or eight fish with a total weight of from 10 to 20 kilos.

A few fishermen will venture farther off shore, especially when they intend to catch sharks. The method used is drift fishing with "hanging sail". The gear includes a rope line followed by a chain and a sharp hook with small barb. Fish will be used as bait. The hook will be let down to 20 or 30 fathoms. It must be mentioned that some Gilbertese fishermen have the greatest faith in a "call" produced by knocking together several large shells tied to a rope and immersed at a slight depth. These helmet shells are Cypraecassis sp. probably C. rufa (te ang). The characteristic rattle (te kakerukeru) is said to attract sharks without fail. We were not able to try it.

Shark fishing is not a frequent occupation. Rather it is considered as a sport. It is practised only in groups. The offers made by the co-operative officer for shark fins do not seem to incite the natives to go fishing more often. Actually one must admit that the fishermen are not equipped for large-scale operations; they prefer to fish for food than for uncertain long-term profit. Sharks are cumbersome beasts which cannot easily be hauled into fragile craft, and have to be towed back to shore once they exceed a certain size. Some fishermen told us of letting go a 4 meter shark in order to resume fishing for te kuau (Serranidae) or te rou (Lethrinidae). They even neglected to take the fins although knowing that co-operative organizations would buy them.

Scarcity of fish at certain times

Besides the natural factors which determine the abundance or scarcity of some species of fish at particular seasons or times, two occurrences may be discussed.

The first is the scarcity of great (yellow-fin) tuna around Marakei Island at a time of the year when they are normally numerous. According to the natives, this scarcity was due solely to the quantity of rain which had fallen in the area for weeks. The fact itself was indisputable, but the explanation was less satisfactory.

The great tuna comes near the shore under favourable circumstances. It is known that it can live only with high salinity and temperature, and seeks these conditions especially at spawning time. It is possible that during periods of heavy daily rains such as fell at this particular time, these conditions are not realized. A decrease, even temporary, in the surface salinity might have a direct influence on tuna, or it might affect them indirectly by having an influence on the shoals of flying fish which they follow, or even merely on the plankton on which flying fish feed. Only a special survey carried out on the spot could give a reliable answer.

The second occurrence is the alleged scarcity of fish in the southern group of islands, following intense and prolonged droughts. Grimble (1933-34) says: "...in times of drought, when not only vegetable foods but all kinds of fish are scarce..." While the influence of rain might easily be admitted, this coincidence of drought and fish scarcity is difficult to accept. No definite confirmation was given by the natives of the territories in question, but this belief is so firmly held in some circles that it may yet express an observed fact. A tentative explanation may be offered until more information is secured. Since the species involved are mostly fished for from canoes and outside the reef, the natives, during long periods when food procurement is difficult, would be less prepared to make the physical effort required for offshore trips, as a certain apathy results from food shortage during these hard times.

Lagoon fishing

Surprisingly few large fish live in the lagoons, which are often quite vast and sometimes deep. The only predatory fish commonly found in them are ikabauea (Sphyraena sp.) and tauman (Caranx sp.) both of rather small size, foraging among the shoals of small fish inhabiting in considerable numbers these slightly clouded waters. Aua (Mugilidae) and ninimai (Gerres sp.) predominate, and are each represented by several species. Another important member of this lagoon fauna is tarabuti, a clupeid of the genus Harengula, which is caught in abundance in the vicinity of channels, wharves, and generally in the deepest parts of the shallowest areas.

Net fishing: Lagoon fishing is practised at high tide on the immersed reef flat. Purseless seines are used (a type of purse seine, te rienan urakaraka, was mentioned to us but we have never seen it), with mesh of variable dimensions according to the type of fish sought, sardine mesh, whiting mesh, and mullet mesh. For the latter the seines are made of thread as fine as possible so as to be less visible. The nets are made of cotton; coir seines have become extremely scarce, though cotton nets may be seen mounted on coir ropes. The floats are most often of te kanawa (Cordia subcordata Lam.) wood, while weights are generally made of shells (te koikoi, Asaphis sp.). The nets with the largest mesh are used to catch the species called by the natives "angry fish" (ika-nun), for instance the Carangidae (te rereba) and to catch ikari (Albulidae). The medium-meshed nets are chiefly used to catch Mullidae, Gerridae, Lutjanidae, etc., and the very small meshed nets only for Clupeidae (te tarabuti = Harengula sp.). We were also told that in Abaiang Island small nets with very close mesh are used for te maebo (Mullidae) and mosquito netting for sardines (te tarabuti).

Fishing by casting-net is very little practised in the Gilbert Islands. We have only seen these nets used once in Tarawa by a few fishermen who did not display very great skill. They were fishing near a wharf where mullet, sardines, and whiting were concentrated.

The ways of using the seines are of the greatest simplicity, but are always practised with great skill. In a place where fish shoals can be

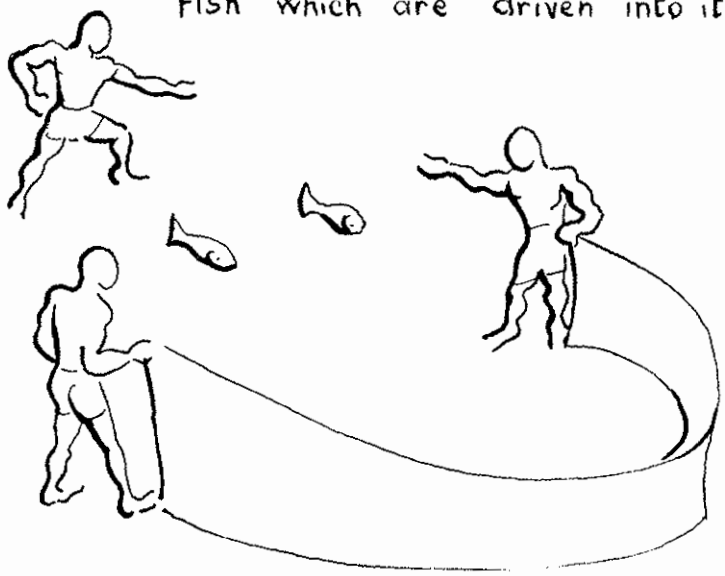
detected, either by the characteristic shimmering caused by fish swimming near the surface or by the presence of a few sea-birds taking their toll of the small fish, a group of men, sometimes accompanied by a few women, advance slowly on the sunken flat. They move noiselessly in water up to their waists, dragging behind them the seine already spread out. When they are near a shoal of fish, they rapidly arrange the net in a circle. While two men carry out this maneuver, the others beat the water in the area facing the opening of the seine. Once the net is closed the fish rapidly enmesh themselves, although some always escape by leaping over the top. The natives do not regret their loss since so many more are caught. All that is left to do is to take them off the net. They are killed with a bite behind the head and thrown outside the net, where they are collected in small baskets. Then the whole operation is resumed a little further on. This method of fishing is generally productive, and without much effort full baskets have been carried ashore several times in a couple of hours. All the fish are then tied together with a coir string and hung from a pole carried on strong shoulders and brought to the village (Plate XVIb). These loads often exceed a hundred pounds and provide the fishermen not only with food for themselves and their families, but also with money, since a pound of fish may be sold on the spot at an average price of three pence.

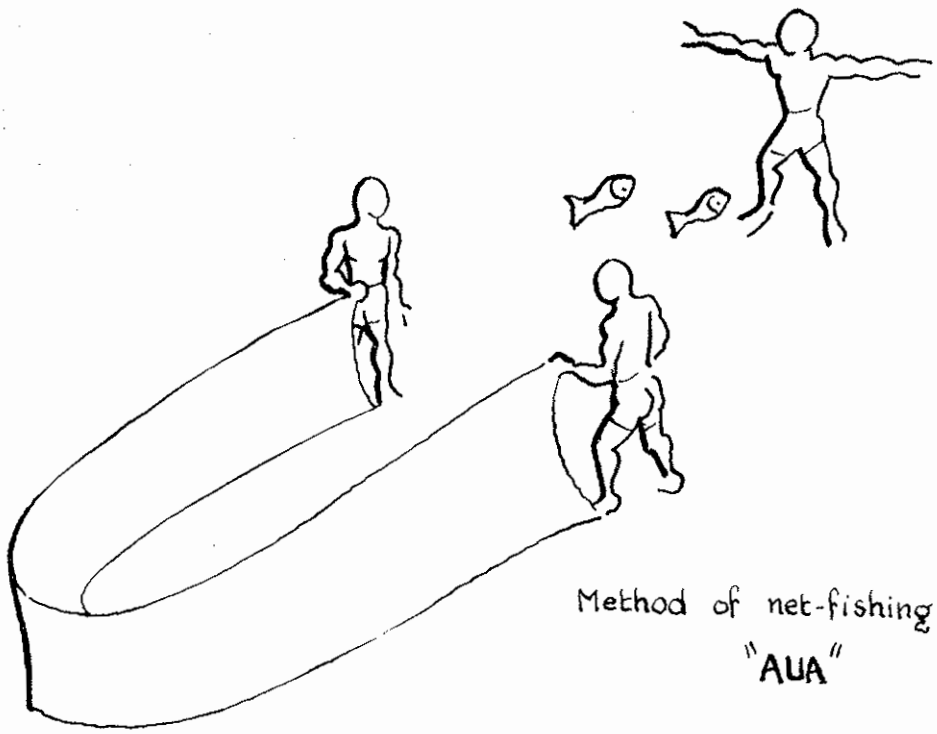
This fishing method mostly brings in Mugilidae and Gerridae of small size, but the dull color of a small shark (generally Mapolamia spallanzani) is sometimes seen among the silvery glitter of the other fish, or, one occasionally observes the bright colours of some Canthidermis or Scarus caught near coral formations. At the edge of these lagoons - but only in the vicinity of channels between the islets where the water is more often renewed and somewhat less murky - there are small coral heads, not very luxuriant, around which are found, as in a miniature replica, the usual animals of the ocean side reef. The fishermen take no chance of snagging their nets, but often work them near these coral growths.

In addition to the extremely simple method described above, two other more specialized techniques are practised mostly in the north and especially in Abaiang. The first of these is used for capturing Albula (te ikari). The principle is illustrated by the sketch (Fig. 18). The fishermen place their seine in a given spot where they think the fish are likely to go. The helpers come up behind the shoal and try to drive it towards the net. If they succeed, they move faster and the fish are rapidly driven into the seine, which is then closed as quickly as possible. The second method, illustrated by sketch (Fig. 19), is designed solely for the capture of mullet (te aua) and differs from the first in that the seine, instead of being wide open, has both its ends very close together. Whenever a shoal of mullet appears in the vicinity of this opening the presence of the net and of the two men holding it frightens them. They swim off. At this moment the helpers scare them suddenly and they turn around. The mullet rush into the net, which is immediately closed and can then be lifted since most of the fish have enmeshed themselves at once. The success of this method is due to the fact that mullet are very easily frightened and very swift-moving.

Method of net-fishing for
"IKANUN" and "IKARI"

Fig. 18 The wide-open net is placed in front of the fish which are "driven" into it by a beater.





Method of net-fishing for
"AUA"

Fig. 19 The half-open net is placed behind the fish which rush into it in endeavouring to escape the beater.

Two types of fish traps in the Gilbert Islands

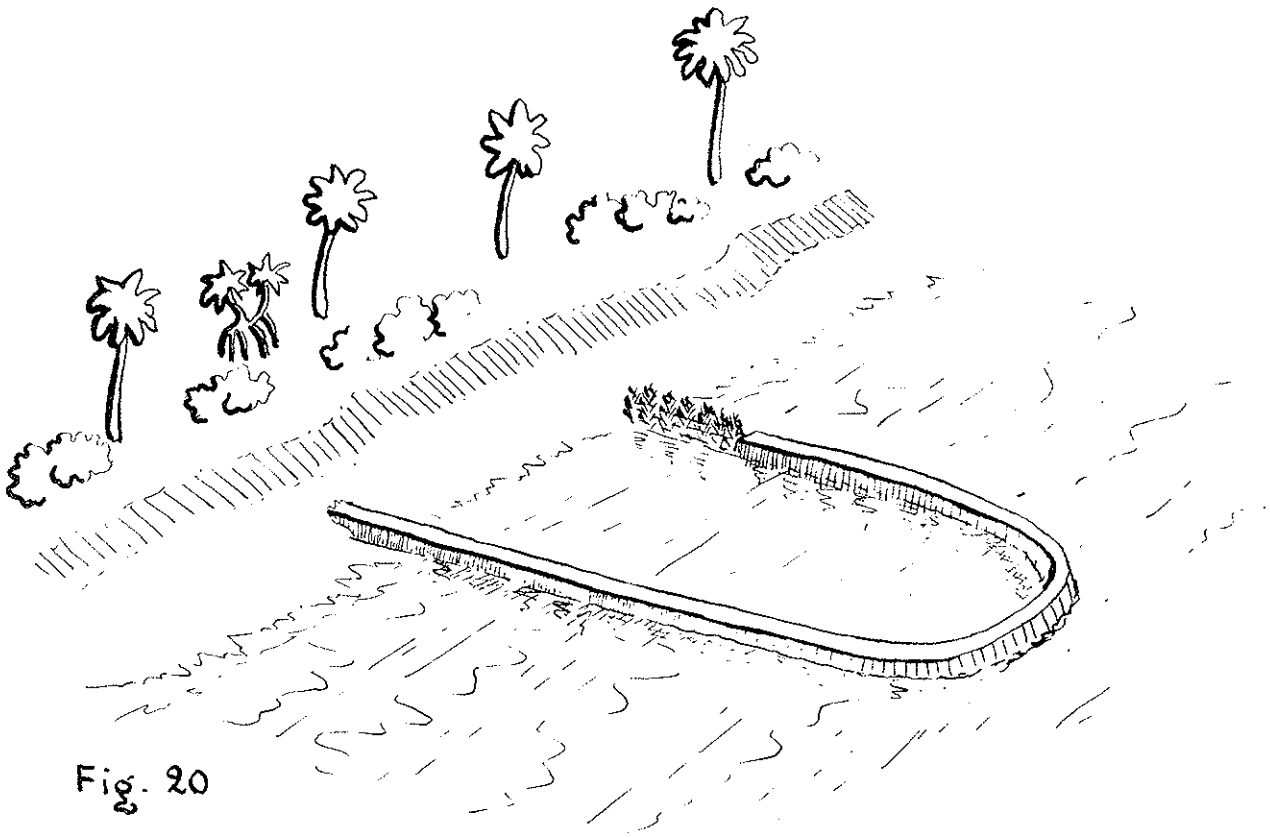


Fig. 20

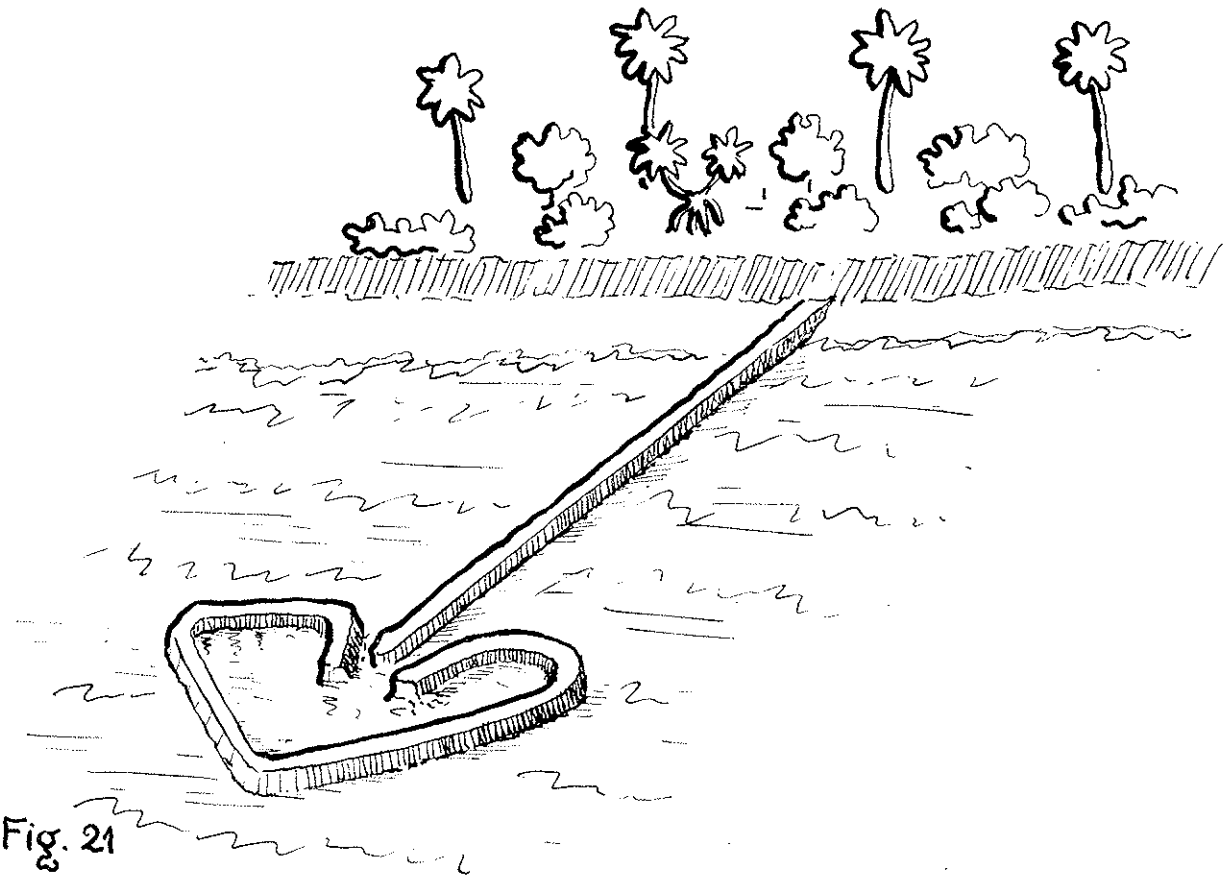


Fig. 21

Although very localized, another fishing method must be mentioned here. It seems to be practised only in Abaiang and is interesting in that it involves collective effort (it is a well-known fact that the Gilbertese are very seldom willing to work collectively). This method, designed for mass fishing of ikari, makes use of very large nets handled by almost 300 persons. We were unfortunately unable to see it since we were not on the spot at the time of month when the ikari arrive on the shore (full moon). In the Tarawa area these huge concentrations of Albula do not give rise to net-fishing expeditions since the fish come and trap themselves in large stone enclosures (see p. 131).

Hook and line fishing: This is also practised in the lagoon, and although it does not bring many fish should be mentioned, since it is almost a daily activity in some regions. One type is often used by old fishermen no longer of an age to face rough seas or even the combers at the edge of the reef. Some distance from the lagoon shore their little canoes are anchored above an isolated coral head. In sun, wind or rain they will remain there for several hours. Their fishing gear is limited to a line of coir string weighted with a pebble, a medium-size hook and a few shellfish (Asaphis and Atactodea) for bait, or even better, some hermit crabs. They never come back empty handed. Small specimens of Serranidae (particularly te kaura = Epinephelus corallicola), of Mullidae (te teve and te kaira), of Theutidae (te riba), of Labridae (te reiawawa) are most regularly taken, and the catch may now and then be augmented by a larger fish, small barracuda or medium-size jack (Carangidae) caught with a smaller fish.

A second method is practised by loafers of all ages and both sexes, but mostly by young boys and old women. Sitting on little platforms on stilts (Plate XVIIa) isolated at high tide, they use the sketchiest of equipment, a more or less flexible short pole, very often made of branches of te iaro = Pseuderanthemum sp. a line of coir or even of ordinary string bought at the store, and a medium-sized hook, with the same baits as are used by the old fisherman in his canoe. There is generally no weight on these lines; the bait trails on the bottom. The fish most commonly caught are ninimai (Gerres sp.) and kuia ni rereba (very small jack). Although this method is practised daily, it is considered as a pastime rather than work. However, the resulting catch is a valuable contribution to the daily fare. These small fish are of course eaten immediately upon returning home.

Special Fishing Method for ikanibong: Reference must be made to a very special method which appears to be used only on Abaiang, and in a very limited area there, since it is practised only between the islets of Manra and Anariki. It is especially meant for te ikanibong (Lethrinus sp.) and is used only during the four days following the new moon, and only during the ebbing tide. First ground bait or "chum" is thrown in the current, crushed crabs and hermit crabs being used. A weighted line tied to the canoe is then paid out. The ikanibong follow the trail of the bait and are caught on the line. This fishing area is reserved as a family privilege.

Fish Traps

1. Temporary Moveable Traps: Of the temporary moveable type of fish trap, some are collectively-owned and are very large; others belong to individuals, and are small.

A. Collectively-owned Traps: It is chiefly on Abaiang Island - and most frequently on Anariki - that a rather special type of weir is used. It consists of a semi-circular line of stakes planted along a distance of one to 2 km. These are used to support the inai, an assemblage of split coconut leaves plaited after a short period of drying. These inai are tied end to end and at the right moment the whole can be maneuvered like a seine, gradually reducing the space between the net and the shore. At high tide the fish swim over the weir without being frightened, but at the ebb they are caught in it, and once this space has been reduced as much as possible, they are collected with dip nets.

Ikarikiriki Fishing: These large moveable weirs are especially used for ikarikiriki fishing. This fish is a Scombridae of the genus Gymnosarda (probably G. unicolor) varying in size between 12-20 cm, the largest specimens reaching 25 cm. In the Abaiang area - and more commonly at Anariki - they come in large numbers during some years, while none or few are seen during others. These scarcity periods may sometimes last for ten years. It is in February and March that they come near the island, but when they come in great numbers as they did in 1950, they start arriving around Christmas. The ikarikiriki are chased by predatory fish such as arua (Caranx sp.) and ikabauea (Sphyraena sp.) and take refuge along the shore, passing from the ocean to the lagoon at regular hours following the tides. In general they are found on the ocean side in the morning and in the lagoon during the evening and are caught here and there with traps placed on either side. During the peak fishing days, especially the second and third days after the full moon, men are assigned as watchers and, perched at the top of the highest coconut palms, they carefully observe the movements of these fish shoals.

A rather peculiar processing method is used for this fish, of which the natives say - without any further explanation - that they are very difficult to dry because they are so small. After gutting they are tied in bundles of about twenty, head down, and wrapped in pandanus leaves. The head is not taken off until after cooking. A fairly wide hole is dug in the ground. Stones are put in it and heated to a maximum. Leaves are placed over the stones so that the bunches of fish cannot come in direct contact with them. Cooking time is approximately three hours. The fish are extremely dry and are so hard that they are gnawed rather than chewed. Sometimes, however, they are softened in water. According to the natives it is absolutely necessary that the fish should be placed head down; and that the blood should run down towards the head while the fish are cooking otherwise they would not be well cooked and would not keep. The ikarikiriki are also caught in permanent traps which will be described below.

B. Individually-owned Traps: These are made of dried coconut leaves which the natives set in places where some species (Mugil or Gerres) are known to collect, and which they arrange taking into account some irregularity of the bottom to facilitate the capture of a few fish with only the help of one or two members of each family. Of all the systems used this is certainly the most primitive. The supporting stakes which are sometimes included in these little weirs come from the mangrove and especially from te aitoa (Lumnitzera littorea).

2. Permanent Traps: There are two models, both made from solid material, i.e. coral blocks arranged as enclosures on the flat.

A. The first type is used for catching ikarikiriki. As indicated in the sketch (Fig. 20) a small lateral section forms a removable panel, made of stakes and inai, enabling the fish to gain easier access into the trap at rising and high tide. This panel is closed a little before the ebb. The ikarikiriki are caught with dip nets.

B. The second type of trap is the most remarkable system and also the most productive. Practically all native villages of any importance have one or more fish traps built on the flats on the ocean side. Their size and shape vary widely, but the principle is the same. The walls are made of heaped-up coral blocks. Calcareous algae and other binding factors have slowly cemented the blocks together and welded the whole to the substratum. The height of these enclosures seldom exceeds two feet and the length of the outer wall is not generally over 100 meters. Their location and shape are determined by the topography of the reef. Whatever their approximate geometrical form, these enclosures always have their longest closed side facing the sea, with a small opening on the opposite side. The natives say that the long straight wall leading from the shore to the trap, at right angles to the shore line, guides the fish towards the opening or openings of the trap (Sketch Fig. 21 and Plate XVc). In any case, the fish collect in the trap at high tide and are caught in it at the ebb. We saw no recently-built traps, the complete cementation of the blocks examined proving the construction to be ancient. The traps always required considerable work since they were not a co-operative achievement of the whole village but the work of a few individuals of the same family, or at most of two or three families. In addition to the actual building of the trap, blocks constantly shifted or torn off by strong waves had to be put back in place. The descendants of the builders are now the owners and in fact these constructions belong to them on the same basis as a plot of land. But these property rights are a real benefit only at the times when the ikari are caught. The rest of the time the catch is small and made up of the same very small species that anybody can gather on the reef flat daily.

Te Ikari Fishing: This fish (Albula vulpes L.) is very common in many regions of the warm seas, where it frequents sandy shores. It likes shallow waters and follows the incoming tide which covers the reef flats where it finds its usual food of shellfish, worms and crustaceans.

Generally it is extremely abundant in Gilbertese waters, where it is represented by the variety salmoneus. However, it is rarely or never found off some islands of the archipelago. The reasons for this irregular distribution remain obscure to us, and it seems that the presence of the lagoon in the atolls is a condition for the greater abundance of this fish. However, even in this case, and in Tarawa in particular, it is generally on the ocean side that they are caught in large quantities, and not in the lagoon itself. It would be an interesting study for a biologist with enough time available to investigate the distribution of this species and to follow the migration of these dense shoals at such precise times of the year.

It is indeed exactly at the moment of the full moon that they approach the shore and that a great number of them get caught inside the traps without being incited to escape by the ebbing tide. Unlike mullet caught in this way, they do not jump over the walls; or when they try to do so, it is too late. The fishermen are around the trap spearing them. The women carry them to the shore (Plate XVc) where the sharing is done in the shade of the coconut trees (Plate XVd) between the owner and the close relations and friends, a portion being left for the people who helped catch or carry the fish. Of course the bubuti custom is exercised, especially when the catch has been good. The haul will vary in importance each month. We were fortunate enough to attend one of these distributions at the full moon of August. While not a record, the catch was nevertheless one of the best of the year, totalling over two thousand fish for one trap only. Only four hundred had been caught the preceding month, which was considered a very low figure. The weights we recorded gave a total of 45 lbs. for twenty fish, taken at random. The largest weighed $4\frac{1}{2}$ lbs.

When a truck is available and a certain quantity of these fish can be quickly transported, they are easily sold in less than an hour, purchased both by individual buyers and by the boboti (co-operative society section) where people can buy them later. The ikari are generally sold on the basis of two to three pence a pound. When transport is not available, the fish is prepared and sun dried, except for what is kept to be eaten fresh on the same day.

Processing consists of scaling with the edge of a shell (te koikoi) and of gutting the fish. The viscera, liver and stomach, and also the roe are carefully set aside to be eaten immediately, boiled or fried, either mixed with rice or some other food, or even alone. After being washed in sea water (the fish will often receive no other salting) they are cut around the gills, the rest of the head being sometimes left on, and slit along both sides of the spine, which is completely cut away except at the tail. The tail is folded back and the fillets are spread out on trestles, mats, coconut trunks, etc. (Plate XVIa). A few lengthwise slashes are made, care being taken not to cut through the skin. The same would be done for salting, but here the incisions are designed only to hasten drying. The drying process takes from three to four days if the sun shines. If it rains, the fish is covered with old pieces of

tarpaulin, or if this material (left behind by the American troops) is not available, it is quickly taken into a neighbouring hut. The women assigned to watch the fish drive off the flies, more numerous in overcast than in sunny weather. If in spite of this watching, more maggots appear than can be picked off by hand, the fish is washed again in salt water, thus benefiting from a second salting. This fish is eaten raw or boiled. We never saw any smoking process, and it does not seem to be practiced.

C: Other Fish Traps. There is also a differently-shaped type of trap, made of the same material (heaped up coral blocks gradually cemented together and welded to the substratum). These low walls are built across certain channels connecting the lagoon to the ocean. They may be seen on Marakei, Abemama and many other atolls. They form a network like a chessboard, disposed in such a way that at low tide each compartment is isolated from the next and becomes a real fishpond where the fish are retained until the next incoming tide. Small coral growths on a base of Porites strengthen the walls and create an environment which induces the fish to stay. These traps are visited chiefly at night by torchlight, and the fish, blinded by the light, are easily caught with a dip net. At the next high tide, when the water circulates once more between ocean and lagoon, the fish move back and forth again and constitute each time a new supply. Two factors largely contribute towards increasing it. The first is the current itself, often very strong, caused by the ebb from the lagoon to the ocean. The fish tends to take cover behind the walls placed across the current so as to avoid fighting it. The second factor is the continuous pursuit by jacks (te tauman), of the smaller fish, especially te bawemara (Lutjanus sp.). These small fish take refuge in the compartments of the weir to escape from their pursuers.

Fishing by Poison

Fishing with poisons of vegetable origin is not practiced in the Gilbert Islands. Some natives are of course aware that certain plants may be used to this end, but the only one growing in these islands, te baireati (Barringtonia asiatica Kurz) is extremely scarce, represented by only a few specimens. On the other hand, a sea-cucumber te ntabanini (Holothuria sp.) is sometimes used; a large quantity is necessary to obtain results. These holothurians are thoroughly crushed and the contents of the body cavity are thrown into the water to stupefy the fish.

Special Fishing Gear

The Gilbertese use two types of spears. The first is a spear with many points for tarabuti (sardines). It consists merely of a rather long wooden shaft, generally made of te kaiboia wood (Dodonea viscosa), tipped with sharp metal spikes, which are sometimes umbrella ribs. It is hurled into sardine shoals, which are often so dense that each spike spears several fish.

The second is called te katebe and is comparatively recent. We believe it to be of European origin. It consists of a spear sliding in a

wooden trough and propelled by means of a rubber band. It is used for fishing at the edge of the outer reef and in the shallows (te rakai), of some lagoons, where living coral formations with a rich fish fauna are found, as for example in Aranuka lagoon.

The Gilbertese also use small diving goggles made of local woods for underwater spear fishing.

General Method of Processing Fish

Since we have already mentioned the special methods for processing ikarikiriki and ikari, we will indicate here only the method most commonly used for other fish of a certain size which are first salted and then dried.

The head is cut off, but never thrown away, since the Gilbertese consider it a delicacy. The following operations are then carried out: Gutting, washing, splitting, incisions for salting (one outside and one inside), and salting. To promote better penetration of the salt the two halves are placed together and the fish are tightly packed in woven baskets. Later they are sun-dried. Before the fish is consumed it is occasionally necessary to wash away excess salt. However, this seldom happens as the women who prepare the fish have to be sparing with salt. The natives of some islands gather a little salt on the edges of fish ponds.

PART IV: COOKING METHODS

1. "Umum" cooking

The bottom of a hemispherical hole, 50 cm deep, is lined with flat stones on which coconut husks are placed. When the stones have been thoroughly heated by the slow and regular combustion of these husks, a basket of fresh coconut leaves containing the fish to be cooked is placed in the hole on the stones. The whole is covered with babai leaves (Cyrtosperma), then with an old mat, then with earth. The basket is not dug out until about two hours have elapsed; or more exactly, when the odour indicates that the fish is cooked as required.

2. Grilled fish

(a) Tinimaki method (grilling): After the fish has been cleaned and skewered, it is grilled on coconut leaf embers.

(b) Kauraki method (scorching): The whole ungutted fish is placed between two coconut leaves; the leaves are then burned.

3. Soup

Fish soup cooked on a slow fire is now made in a modern container (basin, pot, pan, etc.). In the past, the natives used the shell of the large Tridacna (te aubunga).

PART V: TRADE

Trade is hardly the right term when dealing with transactions which are few and far between, and involve such small quantities, generally limited to supplying the natives employed by the Administration or by European officers. The market is, therefore, restricted to the two islands of Tarawa Atoll, where the administrative headquarters (Bairiki) and the co-operative centre and docks (Betio) are established. These native employees have no time to spare to ensure their own food supply, nor could they find it on the spot, owing to the very limited surface of these islets where the total population is generally large. They are, therefore, the eventual customers for dried or salted fish. Fishermen from the far islets of Tarawa Atoll sell their catch usually to the local co-operative organizations (Boboti) which, in turn, retail it to the natives concerned.

The fishermen of other atolls would have no advantage in fishing and processing fish, just as the "Boboti" of these islands would only encounter risks in trying to store it, because the date of arrival of a boat is a most uncertain factor. The warning comes a few days before by telegraph, or when the ship is actually in sight. It is obviously too late to go fishing and process the catch. Besides, boats call very seldom, and an island may not see a ship over a period of many months. It is understandable that no fish, however well prepared, could be preserved for such a time in this climate.(1)

The other form of transaction in connection with fish - for which examples were given in connection with ikari fishing - consists of selling to the "Boboti" the surplus remaining after the amounts required for immediate consumption have been set aside. This amounts at the most to a few hundred kilos of fish (which may be valued on a basis of 2 pounds 10 shillings per 100 kilos), and this only once a month. It should not be forgotten that the profits go to a very small number of persons, the owners of the large fish traps. The prices are rather variable and are based either on weight or on a given number of fish of approximately the same size. We have noted the following figures: 2 or 3 pence per lb., or lots of 3 lbs. for 6 pence, or 3 ikari for 1 shilling.(2)

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(1) Dr. Catala tends to magnify the shipping difficulty of trading in fish. Islands near to Tarawa rarely have to wait for more than a month for a shipping opportunity. The real difficulty is, however, that the present method of processing fish is not good and the fish become unfit to eat after two months. Furthermore, there is already a fairly regular small internal island trade on several islands (e.g. Butaritari) where the fishermen do receive advantage from fishing and processing fish. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

(2) Prices for fresh fish on Betio, Tarawa now are: 6 pence lagoon fish; 9 pence deep-sea fish. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

PART VI: FISH PONDS

Chanos chanos Forskal (milk fish) which is widely distributed in the Indian and Pacific Oceans is often important as a food element and is reputed to have excellent flesh. The size of adults varies from 0.80 to 1.60 m. It is a shore fish and particularly likes sandy bottoms. In some areas of the Pacific the young chanos - and some species of mullet - are "parked" in natural or artificial ponds, where their growth takes place until adult stage. In the Gilberts, this fish is common, but the fish ponds are not as important as they could be. The Gilbertese names of Chanos vary according to age. The smallest are called te tawatawa; slightly larger fish, te tawa; medium sized adults te baneawa (which is also the general name); and the very large specimens are called te awatai.

The fish ponds of the island visited may be of several types:

First type: Mere ponds varying in area from 100 to 200 square meters where very young specimens swimming in groups can hardly be seen in the stagnant water. Such miniature pools are generally found near villages. Their small size and the stagnant conditions of their waters account for the inability of the chanos to develop normally. The economic role of such ponds is negligible.

Second type: Enclosures placed in the deepest parts of narrow corners of lagoons in the middle of Pemphis stands, and generally bounded by earthen dykes, the highest tides reaching their top. Some of these enclosures are connected with the lagoon at each tide, either because the dykes have crumbled or even because they were never finished. This type of fish pond may be seen in the eastern part of Tarawa, between Bikenibeu and Bonriki. Their area may be estimated as around 3 to 4 hectares and their average depth is about 40 cm; at low tide it is only a few centimeters.

The chanos observed there were barely 30 cm long. According to the owners of these fish ponds, it takes about 1½ years for these fish to reach a useful size. These natives also stated that they exploited these ponds only in exceptional circumstances, as for instance when fishing conditions in the lagoon or on the ocean side were unfavourable at a time when fish was urgently needed for feasts in the village or at the neighbouring mission (Easter, Christmas, etc.).

Third Type: This is the type of fish pond which may be seen in the south of Beru in the vicinity of Tapoiaki village (Plate XVIc). These ponds look like a chess board of little enclosures divided by low stone walls. The compartments are from 100 to 300 square meters and consitute individual properties. A pond about half a hectare in area is available for the community.

A certain number of chanos were swimming in several of these ponds, but the largest did not exceed 40 cm. A few children were fishing for them, but in spite of the number of ponds and of their good condition, the general impression was that the owners did not take much interest in them.

The aquatic vegetation of these ponds consists mainly of micro-algae forming compact layers (Plate XVId), varying in thickness with the depth of the water. In 30 cm of water a layer of approximately 12 cm would be found, in 1.5 m of water, a layer of 60 cm. In one place where we took samples, the depth of the pond was 1.10 m and thickness of the layer was from 40 to 50 cm. The surface layer was grey-green. By delicately lifting this first layer, 5-7 cm thick, we revealed a second layer, a raspberry pink in colour, which continued to the bottom. Most of these algae are probably Cyanophyceae and are being studied. The Cyanophyceae specialist in America, Dr. Francis Drouet has identified one as Gloeocystis grevillei (Berk.) Dr. & Daily.(1)

The temperature of the water about 2 p.m. was:

at the surface	79°F
at 70 cm (upper level of the layer of algae)	82°F
on the bottom	81°F

The pH above the layer of algae was 8.5 and the salinity 18,000 cl-ppm.

Edible Algae (te bukabuka and te takarokaronnataia uea): We had been told that on Beru we would see the natives eating earth, or even, mud. Actually the natives eat neither earth nor mud, but algae, and the use of this strange food does not imply that they are in any way on the verge of starvation. It only proves once again to what extent the Gilbert Islanders have tried everything and know how to make the best of anything edible. Yet, it is surprising that the Gilbert Islanders do not use Nostoc, since this land alga which exists in some areas would be much easier to gather than the bukabuka, although in smaller quantities. The natives were not even aware that it could be eaten. Of course it is possible that Nostoc jelly would not lend itself to mixing with other products.

Actually, bukabuka is used rather for bulk, mixed with other foods. In Beru it is found in the inland ponds where the fish ponds are built. It is none other than the second layer of pink algae mentioned above. A woman who sets out to collect it, carefully chooses a place where this "pureé" is absolutely clean, and free of sand and impurities. This is delicately separated from the surface layer, which is always more compact, and a certain quantity is placed in a basket. At this depth the algal layer looks curdled and granular, and reminds one of pearl barley. At the village, it will be thoroughly washed with well water in order to take the salt away. Finally, after being drained, it will be mixed with kamaimai (toddy molasses) or if this is not available with pure toddy (karewe). It would be impossible to eat it without this sweetening which, while it does not eliminate the abominable odour characteristic of freshly-gathered bukabuka, at least partly overcomes it. The mixture seemed very popular. Beru children said that they preferred it to kabubu. The opinion of the adults was less definite. The natives of Nikunau who, it is said, started eating bukabuka when the Beru people told them how, like kabubu much better, and eat bukabuka only in time of food shortage.

(1) Several of the Catala collections are identified in Drouet and Daily, 1956. See also Appendix I, p. 187. Ed.

Fourth Type: This is represented by the lakes of Nikunau which deserve a more detailed study, although they are also almost abandoned. This neglect - perhaps only temporary - is unfortunate since these lakes offer a wonderful environment for the cultivation of baneawa.

There are two lake areas in Nikunau (Sketch Fig. 22). The first is in the centre of the island (in the vicinity of Rongata) and includes only one lake. The second is in the north-west of the island and includes two lakes so close to each other that they may have been one in the past. These lakes are located in a place called Taunei, and are rather large, about 1 km long and 400 m wide. Unfortunately, there is no map of Nikunau on such a scale that these lakes can be more exactly located. At the time of our stay the Land Officer was starting to prepare one, however. The average depth is 2.5 m with maximum depths of 3.5m. The pH figures recorded were 8.5 at some depth and 8.8 at the surface. At the northern end of the island the salinity of one lake varied between 6,000 and 8,000 cl-ppm., and that of the second lake (shallower) from 4,000 to 5,000 cl-ppm. The large lake in the centre of the island gave the following figures of salinity: 6,000 to 8,000 cl-ppm. at the surface; 15,000 cl-ppm. at a depth of 1.2 m (immediately above the algal layer).

Because of the central location of the lakes, we do not think that tides have any influence on them. Unfortunately, without instruments it was impossible to measure tidal variations of sea level, especially since these lakes are surrounded with low and most often marshy ground. However, at times variations in level are rather important, they are probably due only to heavy rains or prolonged drought (see p. 35).

At the time of our stay in this area, these lakes had no interest as fish-ponds, yet they must have flourished in the past and may do so again. It is quite interesting from a general point of view, to observe that local quarrels are enough to provoke complete neglect of the lakes, even in the middle of the period of drought and very low coconut production. This does not mean that the chanos are unimportant. The truth is that the natives prefer to fish individually in the ocean rather than try to solve by themselves the problems created by their quarrels. These lakes had therefore not been re-stocked for over a year. The last extensive baneawa fishing operations had been carried out a year previously, and we were not able to see a single specimen in several hours of swimming with diving goggles. The natives stated that there were practically none left.

We will now set out the main data, derived from the most reliable native sources, on fish breeding technique, ownership, fishing and distribution as they are applied in normal times.

These lakes are communally owned. Only two villages - or rather a family in each - are designated by the community to look after these fish ponds. But this responsibility does not entail any particular fishing or priority right. These two families appoint one man to watch the fish.

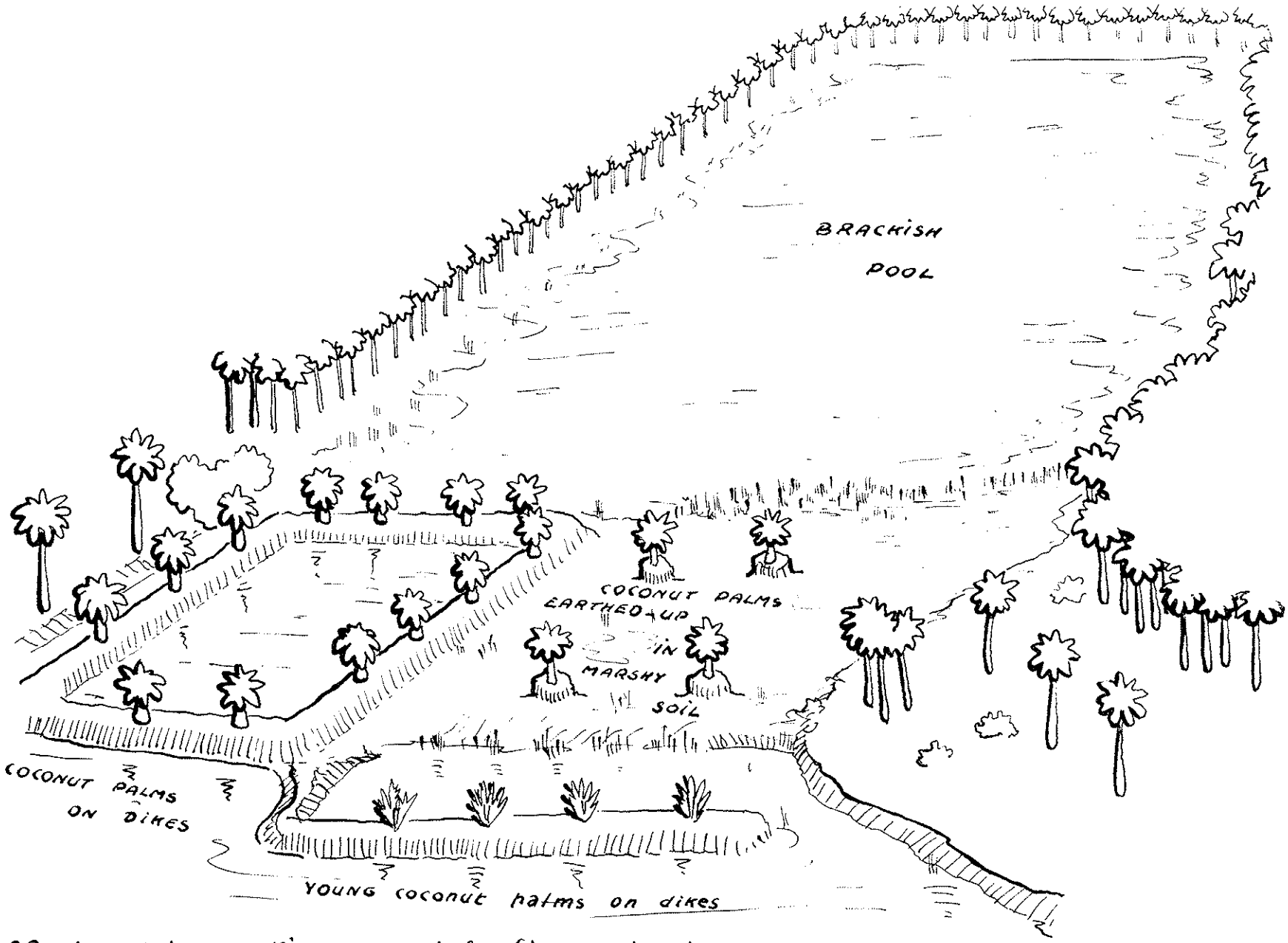

Fig 22. Inland lake on Nikunau used for Chanos breeding.

In fact this "specialist" will have no other task than that of observing the growth of chanos and advising when they have reached a size justifying their capture. They are then 70 or 80 cm long. Although chanos fry (te tawaa) may be found at any time on the shore of the island, it is gathered only twice a year during spring tides. The tiny chanos are caught at low tide in the reef puddles with nets of very small mesh made of mosquito netting or even canvas. The east-south-east area of Nikunau is said to be the richest. The lakes are stocked as the fry are caught. They are transported in all kinds of containers, even in coconut shells. The adult chanos in the lakes are fished only once a year. Sometimes the natives wait for two years if the fish have not reached a sufficient size. All the inhabitants of the island have a right to participate. This fishing is done with moving nets, which are more efficient on account of their number and mobility than of their dimensions or shape. They are usually simple large-mesh nets mounted on two wooden stakes similar to those placed at the ends of a seine. Except for the few chanos which manage to escape, the whole reserve is fished out. The fish which is not eaten fresh is processed (salted and sun-dried). Some will be kept for a time in the huts, and some will be sold at the co-operative centre (Boboti).

The Nikunau and Beru natives spoke highly of the remarkable quality of the baneawa, which is considered superior to all other fish. When asked why they were not content with catching adult baneawa on their shores, they specified immediately that the baneawa coming from nei (fish ponds) had much more fat on their backs. In this area, which is ideal for the pond culture of chanos, we did not see a single specimen of baneawa. In other regions we have, on several occasions, examined the contents of the stomach and intestines of this fish and always found a mixture of mud and algae (bukabuka).

PART VII: MISCELLANEOUS MARINE RESOURCES

Trepang (Holothurians)

Lacking adequate equipment to make the necessary marine surveys ourselves, we enquired from the natives about the possibilities of catching marketable holothurians. But no one was ever able to bring us reliable information or interesting specimens. Those brought to us were always of the common and valueless species which we saw for ourselves on the uncovered reef-flats; te ntabanibani, te uniganikakua, te nei karua kereboki, the prevailing species was most often te riburibunimainiku, of the Aspirochirota group. We were told that the teat fish, a holothurian of the greatest value (Holothuria mammifera) exists in this area, but this information needs to be borne out by specimens. This sea cucumber is said to be called in the vernacular te uningauninga. However, even if the commercial species were present in sufficient quantities in some areas of the archipelago and at depths where fishing would be possible for average divers, the Gilbertese would feel no urge to undertake such work. It seems, in fact, that trepang fishing has been abandoned for two or three generations.

Mother of Pearl Shells

We found the same lack of information in relation to trochus shell, of which we never saw a single specimen. As to pearl shells, they are said to be found around Abaiang and Onotoa, and seem to be called te baio[1] in the vernacular. It appears that there is some confusion in the minds of some natives who also gave us the name te katai. But this latter word actually applied to Atrina nigra.

Sponges

In spite of the absence of trade in sponges[2], they are found in abundance in some areas and particularly in the Marakei lagoon where numerous specimens were gathered for us belonging to the genus Euspongia, probably E. irregularis. The sponges found on the lee side of some lagoonless islands such as Nikunau undoubtedly belong to this species (vernacular name te ongantari). Substantial samples were sent to various firms in Great Britain. We did not see the documents estimating their worth, but it appears from verbal information that these sponges are very inferior to those of the Mediterranean and could find only an industrial use in filters. In any case, it appears to us that the stock is quite insufficient to supply a market.

Shark Fins

Sharks are plentiful around all these islands but, as mentioned earlier, they are fished for only occasionally. Just after the war, the Co-operative Wholesale Society undertook a publicity campaign to encourage the natives to build up stocks of shark fins on each island. The total production of 7,660 lbs. for the whole archipelago in 1950 represented a value of 383 pounds sterling, and shows the small importance of this resource (Table XIX). Considering the irregularity of the Chinese

(1) Trochus shell does not appear to exist in the Gilberts. The name baeao, not baio is correct for the usual kind of mother of pearl shell - the name katati is that of a razor sharp shell which is too thick for commercial pearl purposes. Te katai is not known amongst the Gilbertese but may be a local corruption of katati. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

(2) Before the last War, a trader (MacArthur) sent samples of sponges to the United Kingdom but failed to find a market for them. After the war, a limited number of samples of sponges from Marakei were sent by the Government to Australia and the United Kingdom where firms (including the Imperial Institute) reported that the samples were of similar quality to the West Indies or Red Sea sponges, but would only be suitable for industrial use. Several firms requested 400 lbs. or more of samples, but, despite the efforts of the Colony Wholesale Society, the Co-operative Societies Officer and Tangitang, the people were too disinterested to supply so much as one pound and the scheme was dropped. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

market and the fact that it is closed for an unpredictable period, the market for this product is at present limited to the small Asiatic population of Ocean Island. This outlet, while sufficient to absorb the quantity produced now, would no longer be sufficient if shark fishing was intensified.(1) The leaders of the Co-operative Wholesale Society, thinking that the Chinese market might be closed only temporarily, wisely advised the Gilbert Islanders to keep all the fins of sharks occasionally captured so that a stock could be built up against the day when business should reopen. We saw shark fins in some islands but in a very bad state of preservation. The natives lack the most elementary knowledge for the processing and preservation of this product. Shark fins are sold rather than thrown away when a shark is caught by chance, but the natives will not go shark-fishing deliberately.

CONCLUSION

Our study of marine resources has shown the great variety of organisms concerned, whether derived from the ocean or lagoon or found on the uncovered flats. It has emphasized how easily the Gilbert Islander, alone or in small family groups, may find every day a substantial portion of his food, and often quite considerable quantities of fish in return for a negligible effort.

We have seen on the other hand that fishing techniques are always very simple and even sketchy and that, with very few regional exceptions, fishing is not practiced on a community basis, which explains why the means used are limited. A suggestion made to fishermen for improving some of their methods, such as adding a purse to their seine so as to lose less fish, or using longer seines, is always answered by smiles and by the argument: "We catch enough fish as it is!"

We have mentioned in the paragraph on ikari (Albula) that the natives cannot be expected to try to regularise their consumption by spreading it from one full moon till the next, although this could be done by improving preservation processes. The natives prefer to consume everything at once, since between these dates they are certain to catch or gather other foods, some of which are brought by the sea at fixed times and sometimes in very large quantities.

(1) It was the Government which undertook the campaign to encourage the shark fin industry, through District Officers and Co-operative Societies on Islands. The market is not at present limited to Ocean Island. Colony Wholesale Society is supplying Australia in a small way. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

CHAPTER 12

DOMESTIC ANIMALS

Pigs

In the vicinity of almost every village and generally in the shade, one may observe pig enclosures built of coconut logs or of landing strip matting. In some southern islands, pigs are not always kept in pens but tied with a rope to a pandanus tree in the bush and moved from time to time. Others are left completely free.(1)

The pigs kept in enclosures receive an irregular and variable number of coconuts, and some fish waste or unusable food scraps (unusable parts of pandanus fruit for instance). They are also given low plants such as Boerhavia, Thuarea and also the leaves of shrublike plants such as Messerschmidia and Ficus tinctoria.(2) Very rarely, this meagre pittance is supplemented with toddy, which gives a remarkable improvement. The weight of these pigs varies from 40 to 60 lbs. at six months. They seldom exceed 150 lbs. after one year. A few two-year old pigs may reach 200 lbs. The average purchase price (on the hoof) is 8 pence per pound.(3)

It is a common saying that the number and condition of the pigs follow roughly the alternation of periods of abundance and of scarcity of coconuts. But we observed two-year old pigs almost everywhere which, although rather thin, were not in really bad condition, and the country had just been through a very hard drought which lasted two years.

Actually the Gilbertese is quite incapable of seriously raising pigs, although this might provide him with some income. But the sale of copra constitutes a resource which makes the people neglect all other activities, pig-raising in particular. A very severe slump in copra prices would perhaps modify their point of view: this possibility will be examined in the recommendations.

The 1947 census gives a total of 6,326 pigs for the whole Gilbert Group, or an average of 0.23 per inhabitant. But percentages are highly

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(1) Pig owners who allow their pigs to run free are liable to prosecution under Island Regulations.

(2) Pigs receive probably on an average two coconuts a day but the main pig foods are: te boi - Portulaca oleracea; te wao - Boerhavia diffusa; te mtea - Portulaca samoensis of which two handfuls a day are given to a pig.

(3) The purchase price mentioned is that of Tangitang to island sellers. The meat is sold at 1 shilling, 8 pence per lb. (now 2 shillings), after freighting, handling, loss and profit charges. (Notes by the Administration of the Gilbert and Ellice Islands Colony.)

variable from one island to the next. Where marketing facilities are found near some village, the number of pigs is higher. Thus in the village of Eita (Tarawa) we counted 42 pigs for 23 families, giving a total of 115 persons and an average of 0.36 pig per inhabitant.

Poultry

The Gilbertese give hardly more attention to their poultry than to their pigs and they seldom eat chicken. Besides what the fowls can pick in the village, they find in the bush seeds of Fimbristylis, Portulaca, Phyllanthus and generally of all the grasses. Besides at each low tide they go on the uncovered flats both on the ocean and lagoon sides, and find animals (copepods) and seaweeds, although in small quantities. The absence of sargassum, Cystophyllum, and generally of all the large algae which in other areas are left in abundance at the high water line, is not favourable to the chickens of the Gilberts. The only seaweeds reaching individually a large size are Turbinaria and Halimeda, and their texture is not very well adapted to sheltering crustaceans. In villages providing poultry for an administrative centre, as is the case in Tarawa, the chickens are fed grated coconut and, when fishing has been very productive, some fish.

In the village where we counted the pigs the poultry census gave 205 for 115 persons, or an average of 1.78. But like many other averages in these areas, this figure does not mean much since one family may have 40 hens while another has only 2 or 3. The weights recorded are more interesting and indicate an average of 1.05 kg calculated from 20 live chickens.

Note: In some islands such as Abemama and Aranuka, wild cocks and hens are quite commonly found in the thick bush. They appear to be of the same race as the village birds.

CHAPTER 13

QUALITATIVE STUDY OF GILBERTESE DIET

General Considerations

Some documents have already provided useful details on the diet of the Gilbert Islanders, e. g. Turbott, 1940. These undoubtedly give valuable information on the nature and quantity of the products eaten, although data on quantities are only approximate, as the authors point out. Information on quality (calories, vitamins, etc.) can be based only on studies made outside the Gilbert Islands. No detailed study of the Gilbertese diet can be undertaken until analyses of the foods actually produced in these islands, or at least of a number of them, have been made. If we rely on those made in America, in Fiji, or elsewhere, for corresponding products, we may introduce errors. The comparative Food composition tables of the Food and Agriculture Organization are not based upon the products of the low coral islands. As the authors indicate, the composition of each product may be greatly influenced by botanical varieties, climatic conditions, cultivation, or preparation, and many other factors. While resources from the sea may not show much variation, those from the land must vary greatly. The poor soil, the scarcity of water at certain times and, generally, the special environment of low coral islands must have great influence on the quality of animal and vegetable resources.

Besides, certain common items of consumption are strictly Gilbertese, and analyses of them are indispensable if we are to get data based on the total available resources. What do we know of the real value of baitari, a jelly-fish eaten every month, of the value of kabubu and other preparations? Analyses of such foods would be the most useful work which could be undertaken by a dietician. Such analyses could obviously not be made in the field, for lack of specialized laboratories, but samples could be sent to research centres with every chance of success provided an expert dealt with their preservation, preparation and conditioning. Air transport would greatly facilitate such research.

It must also be pointed out that estimates of potential production and of average consumption are either fragmentary or inaccurate. It was difficult to avoid this. To obtain an idea of the native diet, one had practically always to study people who had been some considerable time away from their normal surroundings, as for example Government employees, medical orderlies, domestic servants, or other "exiles". For some of our information we ourselves were unable to avoid this facile solution. Indeed it must be recognized that any enquiry into the total food supply of the natives in their own environment encounters many difficulties. For one thing the Gilbertese seem to experience a certain shame-faced embarrassment in stating exactly what they have eaten each day and, to an even greater extent, in eating in front of one. Once this embarrassment has been overcome because he has become used to one's presence, it will still be necessary, and this is the second difficulty, to live in very close contact with one or two families for long months (something we could not do). And even then one would not have a strictly accurate idea of the

complete diet. In addition to meals taken "at home", the Gilbert Islander, in point of fact, consumes other food the nature and quantity of which cannot be checked. According to the circumstances of the moment, this may consist of coconut embryo or meat, eaten while the nuts are being opened, pandanus fruits, berries from small trees, or even marine organisms eaten raw during hours spent on the shore at low tide. And yet - and here we have the third difficulty - it is almost impossible to follow the daily comings and goings of any one individual. It must also be noted that certain foods are eaten on one island and not at all or in very small quantities on another island. Thus on Nikunau, the natives seem to like sea birds such as te io (Anous sp. = white-capped noddy tern) which are not eaten elsewhere. It is, therefore, difficult to try to fix standards of consumption for people whose activities and behaviour show such marked individuality.

Our modest contribution to the study of their diet will include, in addition to general information, some figures compiled with the greatest possible accuracy. Table X gives the census of a village of twenty-three homes, table XI, gives the number of Cyrtosperma plants owned by twenty-seven families. Table XIII shows the quantity of imported goods which ten families from one village bought in a month, with the addition of estimates of the average consumption of rice and sugar. Family no. 1, with 4 members, who had no toddy, consumed 8 ounces of sugar per day, while all the other families who could drink diluted toddy, used much less sugar.

Table XIV shows the different items which constituted the meals for three persons for seventy-five days at a stretch, and the number of times that these items were eaten. The three persons in question lived away from their native village, but not far enough for them to be debarred from obtaining provisions from it. The fact that they were employed and had regular wages, enabled them to buy imported goods frequently and obliged them to maintain a certain regularity in their food habits: they had a light meal, at 7:30 a.m. before going to work, consisting of toddy diluted with water, of sweetened water, or again of tea, sometimes accompanied by bread, less frequently by rice. A second and larger meal was taken about 10 o'clock, and consisted of babai or rice with fish or European canned food. The evening meal was similar in importance and type of foods.

In addition to these tables we have drawn up three lists of food products taken from the "Food Composition Tables" of the Food and Agriculture Organization (October, 1949). Table XV shows the value in calories, proteins, fats and carbohydrates of sea food corresponding approximately to what the Gilbert Islanders can procure locally. Table XVI shows the same approximate values for the main items which they can produce on the spot from agriculture and stock breeding, and table XVII for the main imported goods they can buy in the co-operative shops.

Local Products

Bearing in mind the constant availability of the various products of the coconut palm, and the diversity of sea food at the disposal of the Gilbert Islanders, we may conclude that these two sources of food supply would in themselves, be sufficient to prevent serious deficiencies, particularly of vitamins. Many other items, fresh or canned, are added and still further increase the margin of security. Several of these are said to have but a very mediocre food value, but their variety and quantity automatically compensate for this. For instance pandanus keys give 26 calories per 100 g, but foods made from pandanus, such as kabubu, are useful more because they contain a large proportion of grated coconut which has a value of 608 calories. In other cases the low value of certain products is compensated by the very great frequency with which they are eaten. Other valuable foods such as coconut meat from the gelatinous stage to the copra stage are also eaten in large quantities, even between meals.

Finally, there are some very important products which play a predominant role in the dietetic balance, for example, toddy; if it is eliminated from the diet obvious and undeniable signs of disequilibrium follow, after a length of time varying with the individual. According to Dr. Bray the food value of toddy is: Proteins 0.32, fats 13.0; caloric value per 100 g., 54. It is still an important part of the diet, but it is characteristic that every person or family whose finances permit shows a marked tendency to abandon karewe and replace it with sugar. In many respects this is a regrettable substitution.

Many authors have drawn attention to the frequently drastic deterioration in teeth brought about by the consumption of sugar among people whose percentage of decayed teeth had remained insignificant as long as their diet had remained natural. The same authors usually agree in recognizing the role of white flour in the progressive weakening of teeth. The great majority of Gilbert Islanders have superb and healthy teeth, so it must be concluded that this majority has not yet slipped into an unbalanced diet, thanks to isolation and the small quantity of imported products that are procurable.

We may add that the powerful mastication which is required by people's diet is an additional factor which tends to preserve their excellent teeth. It takes much chewing to cope with certain dried fish, coconut meat, babai tubers, or tuae, or to shred the edible mesocarps of bunai nuts or pandanus keys.

We have dwelt upon this question to draw attention to possible repercussions of the substitution of sugar for toddy, were it to become general. This is not the only danger, however, and we noted that the preparation of traditional dishes derived from babai, breadfruit or pandanus, and the collecting of sea food are totally neglected as soon as any money becomes available in a household.

TABLE XIII

Amount of imported commodities bought in one month by each of ten families in a village on Tarawa Atoll.

Family	1	2	3	4	5	6	7	8	9	10
No. of persons	4	5	10	6	3	5	3	5	4	5
Infants	-	-	1	-	-	-	-	-	-	-
Commodity										
Meat -16 oz. can	2	2	22	2	2	4	-	-	4	-
Salmon - 8 oz. can	2	-	-	-	-	-	-	-	-	-
Herrings in tomato sauce	3	2	4	-	-	-	2	2	1	-
Meat and vegetable stew 16 oz. can	1	-	2	-	2	-	-	-	-	-
Pears	1	-	-	-	-	-	-	1	-	-
Powdered milk - 12 oz. can	4	2	4	-	-	-	-	-	2	-
Rice - lbs.	20	26	32	15	23	8	8	18	12	12
Sugar - lbs.	48	16	18	24	4	10	0	6	10	-
Average daily consumption of rice and sugar per person.										
Rice - lbs.	2.6	2.7	1.7	1.3	3.0	0.8	1.4	1.9	1.8	1.2
Sugar - lbs.	8.0	1.8	0.9	2.1	0.7	1.0		0.6	1.3	

TABLE XIV

Number of times the food items listed below have been consumed by 3 Persons (A, B and C) during 75 days

	A	B	C
Mature coconut meat (te ben)	18	32	40
Unripe coconut meat (te moimoto)	3	7	11
Toddy	20	116	83
Toddy molasses (te kamaimai)	30	2	1
Cyrtosperma (te babai)	21	19	43
Food based on babai			
Te tangana		8	1
Te buatoro			6
Te Bekei	9	4	4
Breadfruit (te mai)	7	1	
Dried breadfruit (te kabuibui ni mai)	2	1	1
Dried pandanus fruit (te tuae)		1	5
Pawpaw, papaya	1	1	
Squash	3	1	
Poultry	7	1	
Eggs		2	
Pork	2	1	
Fish, fresh or dried	78	88	71
Crabs	1		
Shellfish	2		1
Octopus	1		
Rice, polished	74	112	100
Fish, canned (Herring in tomato sauce)	17	7	21
Meat, canned	57	31	32
Bread	42	32	50
Food based on white flour			
Te Katiobuki	10	12	2
Te Tonati	2	2	
Pancakes	4	4	1
Tea	57	31	32
Sweetened water	83	54	106
Milk	5		2
Jam	1		1
Coffee		1	1
Potatoes	2		

TABLE XV

Showing the composition of certain fish and sea food, number of calories per 100 grams, the percentage of proteins, fats and carbohydrates for each item. The serial numbers are those of the FAO report (FAO 1949) and have no other meaning.

Serial Number	Item and Description	Calories per 100 g	Proteins %	Fats %	Carbohydrates %	Comments
	Fish, fresh					
222	Cod and similar species - filleted	75	16.4	0.5	0	Hake, Haddock, "cusk"
223	- whole	75	16.4	0.5	0	"Saithe"
224	Other species - filleted	104	19	2.5	0	Includes: flat fish,
	- whole	104	19	2.5	0	sharks; barracudas, mullet, sea perch, sea bream, fresh water fish.
226	All species without distinction - filleted	132	18.8	5.7	0	
	- whole	132	18.8	5.7	0	
	Crustaceans and Mollusks, fresh					
228	Crustaceans	103	17.8	2.1	2.0	Lobsters, crayfish, crab, etc.
229	Mollusks	80	13	1.5	2.9	Oysters, mussels, clams, etc.
230	Both, without distinction	88	14.6	1.7	2.6	
	Fish, kippers - salted, smoked, dried					
	Species rich in fat					Herrings, sardines,
	Slightly treated:					Salmon, mackerel.
231	Large fish, bones discarded.	189	21	11	0	In brine; smoked and
232	Small fish, bones eaten.	189	21	11	0	salted herrings.
	Moderately treated:					Bloaters.
233	Large fish, bones discarded.	261	40	10	0	
234	Small fish, bones eaten	261	40	10	0	
	Strongly treated:					
235	Big fish, bones discarded	361	55	14	0	
236	Small fish, bones eaten	361	55	14	0	
237	Dried - fish eaten whole	446	60	21	0	Very dry

TABLE XV
(Continuation)

Serial Number	Item and Description	Calories per 100g	Proteins %	Fats %	Carbohydrates %	Comments
	Species poor in fat:					Haddock, cod, sea bream, maigre
	Slightly treated:					
238	Large fish, bones discarded	135	27.5	2	0	
239	Small fish, bones eaten	135	27.5	2	0	
	Moderately treated:					
240	Large fish, bones discarded	223	46	3	0	
241	Small fish, bones eaten	223	46	3	0	
	Strongly treated:					
242	Large fish, bones discarded	310	62	5	0	
243	Small fish, bones eaten	310	62	5	0	

TABLE XVI

Showing the composition of certain fish and sea food, the number of calories per 100 grams, the percentage of proteins, fats and carbohydrates for each item. The serial numbers are those of the FAO report and have no other meaning.

Serial Number	Item and Description	Calories per 100g	Proteins %	Fats %	Carbohydrates %	Comments
	Coconuts					
64	Ripe meat	351	4.2	34	12.8	
65	Meat of immature nut	180	4	15	10	
277	Pure oils	884	0	100	0	Olive, cotton, sesame, coconut
36	Sweet Potatoes (Ipomea batatas)	117	1.3	0.4	27.3	
96	Ipomea shoots (Ipomea spp.)	31	2.7	0.3	6.1	
40	Taro (Colocasia spp.)	104	1.9	0.2	24.2	
43	Starches, pure, dry	362	0.5	0.3	86.9	Arrowroot, corn starch, tapioca, etc.
114	Pumpkins and other cucurbits mature	33	1.3	0.3	7.7	Cucurbits eaten when mature
115	Gourds, squashes, green, (Cucurbitaceae spp.)	15	0.8	0.1	3.5	Summer squashes, marrows, and other cucurbits eaten green.
119	Bananas and plantains, unspecified (Musa spp)	103	1.2	0.4	26.5	
121	Lemons (C. limonia)	41	0.8	0.5	9.5	
138	Breadfruit, jack fruit, "monkey fruit" (Artocarpus spp.)	84	1.1	0.4	21.3	
141	Figs (Ficus carica)	65	1.2	0.4	16.1	
148	Pawpaw (Carica papaya)	39	0.6	0.1	10.1	
187	Pork, lean - carcass	376	14.1	35.0	0	Weight, live 75 kg., carcass 54 kg.
285	Pork, fat, all categories	816	3.	89.0	0	Fat trimmed from carcasses
204	Plucked chicken, total edible part	200	20.2	12.6	0	Weight - plucked, not cleaned (all categories) 1,500 grams.
215	Hen eggs - natural state - fresh	163	12.4	11.7	0.9	

TABLE XVII

Showing the composition of imported products which the native can buy in the shops, the number of calories per 100 g , the percentage of proteins, fats and carbohydrates for each item. The serial numbers are those of the FAO report and have no other meaning.

Serial Number	Item and Description	Calories per 100 gm	Proteins %	Fats %	Carbohydrates %	Comments
3	Flour, white, (Wheat)	370	10.9	1.1	75.5	
12	White Rice	360	6.7	0.7	78.9	
77	Onions, ripe (Allium cepa)	40	1.4	0.2	9.0	
164	Fruits, canned - in general (excluding sugar)	36	0.5	0.2	9.0	Applies to net weight of canned fruits.
165	Orange juice, unsweetened	49	0.6	0.1	12.9	
245	Fish canned in oil, all categories	314	22.0	24.0	1.0	
246	Fish, canned without oil - species rich in fat.	188	20.0	11.0	1.0	
247	Fish, canned without oil - species poor in fat.	108	21.0	2.0	0	
248	Crustaceans, canned	92	17.5	1.5	1.0	Crayfish, lobster, crab, etc.
249	Mollusks, canned	47	7.0	1.0	2.0	Oysters, mussels, cuttle fish, etc.
260	Milk (Cow's) - canned, whole, condensed, unsweetened.	138	7.0	7.9	9.9	Standard for United States, Canada and United Kingdom.
263	Milk (Cow's) - canned, whole, condensed, sweetened.	336	8.2	10.0	55.0	Standard for United Kingdom
268	Cheese - processed, whole milk.	387	25	31.0	2.0	Cheddar, Gruyere, etc.
288	Chocolate, ordinary, unsweetened.	517	(5)	50.0	(20.0)	Cocoa beans after shells (about 20%) removed.
(1)	Canned Meat	314	25.5	22.5	0	

(1) Figures for canned meat have been borrowed from Dr. G. W. Bray's Dietetic Deficiencies and Relationship to Disease, in Turbott 1949.

TABLE XVIII

Estimate of vitamin contents. Vitamin content calculated for edible portions of 100 g of selected food products. Figures taken from the tables prepared by Buchanan, 1947.

PRODUCTS	Thiamide B-1	Riboflavide B-2	Nicotinic Acid P-P	Ascorbic Acid C
	mg	mg	mg	mg
Cereals				
Biscuits - dry	0.11			0
Biscuits - sweet	0.05			0
Bread - white	0.1			0
Flour - white - sifted to 70%	0.06	0.05	1.0	0
Rice - husked at home or slightly bleached.	0.24	0.1	2.0	0
Roots and Farinaceous Roots				
Arrowroot	0	(0)	(0)	0
Bananas	0.05	0.06	0.5	10
Breadfruit pulp - cooked				
Breadfruit pulp - raw	(0.2)	-	-	(15)
Plantain, green	0.05	0.06	0.5	10
Animal products, Proteins - Fish				
Crabs, crayfish, spiny lobsters	-	0	0	0
Fresh, with oil	0.05	0.13	3.0	*
Fresh, without oil (medium)	0.06	0.15	3.0	*
Freshwater and sea-water shrimps	-	0	0	0
Salted, dry and hard	0.06	0.31	4.6	*
Sardines in oil	0.02	0.2	4.0	0
Shellfish	0.05	0.1	4.0	*
Tortoise	-	-	-	-
Meat and Eggs				
Eggs	0.14	0.34	*	*
Fresh Pork, lean	1.04	0.28	5.0	*
Fowls, plucked and cleaned	0.15	0.15	6.0	*
Fats				
Butter	0	0	0	0
Vegetable Oils: ex. coconut oil and peanut oil	0	0	0	0
Nuts				
Coco - ripe flesh, fresh.	0.11	-	(0.4)	1
- milk, ripe nut.	*	*	*	*
- water, ripe nut	0	-	-	2
Green coco - pulp				Found only in green nuts.

TABLE XVIII
(Cont'd)

PRODUCTS	Thia-mide B-1	Ribo-Flavide B-2	Nico-tinic Acid P-P	Ascorbic Acid C
	mg	mg	mg	mg
Fresh Vegetables				
Beans, these are all eaten green.	0.08	0.12	0.5	20
Cucumbers	0.04	0.05	0.18	10
Leaves, fresh, dark green, such as: leaves of Cassaba, gourd, sweet potato, Chinese cabbage, young pawpaw, taro.	0.15	0.25	0.85	100
Onions and shallots	0.03	0.1	0.1	15
Gourds or squashes	0.04	0.05	0.7	5
Unpeeled tomatoes	0.05	0.04	0.7	25
Drinks				
Cocoa powder	0.12	0.27	1	-
Coffee grounds	-	0.1	13.2	-
Tea leaves	-	1.0	6.1	-

Note: * contains such a small quantity that it may be ignored in estimating the food ration.

0 nil.

( ) probable value.

Earlier, Grimble wrote: "When times are good, they live 'off the land'; in times of famine they live on reserve supplies". We may paraphrase this by saying that nowadays, in times of wealth the Gilbertese rush for canned goods, rice and flour, and only poverty forces them back to the balanced diet of local products. It would indeed be unwise to generalize, but it is characteristic that the consumption of many imported goods tends to become an unbalancing factor, instead of an addition or supplement to the diet. The Gilbertese still consume toddy molasses (kamaimai), but, actually, they never eat as much of it as they do of sugar, which they take by the spoonful, with real avidity. (1)

The balanced diet obtained from some rich foods and the diversity of others may be the reason why the natives fail to use other resources easily available to them. In other words, if these people were really suffering from an ill-balanced diet, they would not disdain, as they do, fowls, eggs, and the fresh leaves of certain plants, which are freely eaten in other regions of the Pacific.

The very small quantity of pork - the only source of fat meat - in the annual consumption of the Gilbert Islander is obviously very largely compensated by the protein contribution from fish and many other marine organisms, such as crustaceans and mollusks which are eaten in great quantities. In this connection it would be very useful to have the results of analyses of the edible jelly-fish baitari. The kolukale of the Tonga Islands, another edible jelly-fish, belongs perhaps to the same group of Carybdeidae. To return to that most important food supply - fish, it must be noted that the Gilbert Islander uses almost every part of it and that he is particularly fond of the liver, very rich in vitamin D. Often he will not even wait to bring the catch back to the village but will cook on the spot, liver, hard and soft roe (milt). Sharks' livers also are always used except, of course, when they show certain signs recognized by the fishermen as indicative of poison.

We have already said that chickens are very rarely eaten. (2) It would be wrong to infer from this that the Gilbert Islander does not like

(1) Although the Gilbertese have a liking for sugar, it is not as marked as their liking for fat, which amounts at times to a craving.

(2) One important reason (not mentioned by Dr. Catala) for the Gilbertese not making a habit of eating chickens or eggs is their desire for a large quantity of food at each eating session. A whole chicken or at least six eggs would be required to satisfy them. As the local supply of these commodities is insufficient to satisfy such gargantuan repasts, the Gilbertese do not bother much with them, although in the last 4 years more interest in this form of diet has been evident. (Note by the Administration of the Gilbert and Ellice Islands Colony).

chicken. Sufficient proof of the contrary is the rapidity with which he disposes of every scrap left over from a European meal. But on the admission of several, this neglect of fowls is due solely to the trouble in preparing them: plucking, cleaning, and lengthy cooking which must be supervised. They will take all this trouble only for the nourishment of old people, very young children, and invalids, who are given chicken broth, or for certain special occasions, or when a visitor has to be entertained. Curiously enough, eggs are not prized either and are eaten almost exclusively by children. They are not used in any of the dishes in which the Gilbertese might profitably include them, such as katiobuki, tonati, etc. There is the same neglect of pawpaw fruits which are also reserved for small children. Yet the papayas of these regions have quite an outstanding flavour. As for bananas, they are a luxury and form only a minute proportion of the diet of the mass of the community.

Pork is very rarely eaten, not because it is disliked, but because there is little of it and it seems to the Gilbertese quite useless to take the trouble to raise pigs. As one native remarked: "We have already more than enough to do feeding our babai!" It is deplorable that such a small quantity of pork should be included in the diet of the Gilbertese, in view of the wealth of high-grade proteins it contains, particularly in the liver, kidneys, etc. which are also rich in vitamins A and D.

Imported Products

Rice is eaten in increasing quantities throughout the islands, and it is regrettable that this is solely polished rice. As a result of our conversations with the Gilbert Islands authorities, we discovered that the native is now so accustomed to this form of the product that it would be difficult to make him accept it in any other. We are not so pessimistic and, rightly or wrongly, we think that if the Gilbert Islander had nothing but a less highly processed rice, for lack of better he would begin to use it, and would gradually become accustomed to it.

It would be necessary to find a rice with a lower processing rate than bleached and polished rice, perhaps even cargo rice. The ideal would be to deliver for consumption either fortified rice, or simply rice still in the paddy state although we cannot visualize the Gilbertese family making the effort to husk imported paddy.(1)

(1) Consignments of semi-polished rice imported by the Colony Wholesale Society have not been popular. Dr. Catala's other comments on imported products are correct, but the quantities imported are small, i.e. some 20 pounds rice, 20 pounds flour, 12 pounds sugar per head of population per year and a high proportion of this is consumed by Headquarters staff. It is amongst the highly concentrated population on Betio and Bairiki that the danger of an unbalanced diet is most to be feared. As the ordinary Gilbertese only does the minimum of cultivation for himself, it is difficult to encourage him to cultivate for trade. Brown Malayan rice has been imported into the Gilberts, but was only purchased by the people when no other rice was available, and even then with much grumbling. It would take time and the complete stoppage of white rice supplies to accustom the people to such diet. The islanders show no interest in food values, and compulsion will be necessary if more nutritious foods are to be introduced. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

We can simply express this wish: that an excess of polished rice in combination with an increased consumption of too highly purified export flour may not one day coincide with a period of restrictions affecting products rich in vitamin B, like toddy. We have already seen that there is too great a tendency to substitute sugar for it. The results would be an unbalanced diet which might lead to more or less serious cases of beri-beri. Toddy making is neglected as soon as there is enough money to buy sugar. From the most reliable sources it was learnt that every load of sugar arriving on an island is bought up almost at once, until every one's available funds, earned from the sale of copra or possibly some handicrafts, are exhausted.

Canned Goods: We shall not enumerate here the varieties of canned goods which may tempt the Gilbert Islander. Fortunately canned meat is most often eaten. Table XVII shows its high value in calories, protein and fat. As a result of our calculations we find that the "average Gilbert Islander" eats approximately ten cans of meat per year. Wage earners eat much more, and the figure of two tins per week is often exceeded (see table XIV).

Next to meat the most highly valued item is herrings in sauce. In stores in the southern islands, we even saw cans of salmon, but they had not proved popular and had been in stock for two years. We were not able to find out whether this was because of their price or because the cans were swollen.(1) It must also be pointed out that the natives are very fond of fruit in syrup but do not often buy it because it is too slight a return for the money expended. "Navy biscuits" are much liked.

One more word on the subject of flour. It is very often used in many culinary preparations which could do without it, because it makes them easier to knead.

Very surprising mixtures indeed are encountered, such as sweetened milk with meat. We must, however, make it clear that it was only in very exceptional cases that we saw cans of milk in the shops of islands other than Tarawa. The Gilbertese like tea and coffee; old people drink tea morning and evening with sugar, not so much because they like it as because they have no one in the family to collect toddy. Coffee is rarely consumed, prices being extremely high.

Note: Generally speaking, it is estimated that the minimum ratio of carbohydrates over fats should be greater than 1/4, and that the minimum weight of carbohydrates should be from 50 to 60 g per day. Such a figure for the Gilbert Islanders has yet to be determined, if it were known, it might provide an explanation for their marked tendency to eat more and more sugar and flour, always supposing that this tendency is not only the result of greediness. If it turned out that additional carbohydrates were really necessary, it would be essential to add a complementary amount of vitamin B which, in practice, would not be easy.

(1) The only reason canned salmon is not bought is because of its price; the people like it! (Note by the Administration of the Gilbert and Ellice Islands Colony.)

Conclusions

1. Contrary to what is generally thought, the majority of the Gilbertese people do not suffer from malnutrition or, stated in another way, from an unbalanced diet. Useful conclusions should be drawn from the fact that it is precisely those natives who have remained most natural in their food habits, and generally speaking, in their mode of life, who are least affected by the difficulties resulting from drought. The Gilbert Islanders - particularly those from the southern islands - experience, at least once every six or seven years, a period of intense drought which may last two years, but the ill effects of which really begin to appear only after the first ten months. These people are thus compelled to adopt a frugal diet which often borders upon the restricted, but does not appear to affect them very greatly, for the majority of products at their disposal in normal times, except coconuts, are still available. They are protected against serious famine by the continual diversity of their food supply and more particularly by the continued production of toddy. It is noteworthy that the people of the southern territories, more severely affected than the others, are the ones which take the greatest care to build up various food reserves from pandanus (kabubu) and breadfruit (kabuibui). It is on these islands also that the greatest care is taken to preserve desirable varieties and to replace trees as they are depleted through age or after a drought.

2. In speaking of the Gilbertese there is too great a tendency to confuse under-nourishment with malnutrition. They are subjected to the one without, however, suffering from the other. From this confusion there has arisen a kind of famine myth which does not correspond to fact. The Gilbert Islanders themselves, while recognizing that they occasionally experience periods of serious quantitative restrictions, never exaggerate the gravity of these, and tend to smile if one commiserates with them. Moreover, when we asked them, after two years of drought, how it came about that they were still in such good physical condition, they gave us this unexpected reply: "Here, food is so easy".

It would, however, be inadvisable to ignore the lowering in activity and resistance to which their constitution is subjected as a result of such restrictions when prolonged. The so-called "depletion" of fish around certain southern islands would really seem to be attributable to a general state of asthenia among the fishermen. The Gilbert Islands' Medical Officers mentioned the almost complete absence of beri-beri but emphasized the fragile balance of these peoples. It seemed to us, but only on the island of Arorae, that the physical state of a rather large number of people reflected the particularly poor condition of the vegetation, especially the coconut palm. Everywhere else, although an era of privation had just ended, the general appearance of the natives was far from distressing, even in the southern territories. There, as in the rest of the archipelago, many available sources of supply were neglected, such as chickens, eggs, pigs, proving that no need for them was felt and that the diet of these people, however monotonous it may appear to us, was still sufficient.

We may conclude thus. This race has a much greater need of balanced rations than of a super-abundant diet. As long as the Gilbert Islanders' food supply remains what it has been in the past, there is every reason to believe that he will possibly be subjected merely to temporary food restrictions, not to an unbalanced diet. These periods of restriction will never have on the constitution of the Gilbert Islanders the consequences which would result from a diet unbalanced by the over use of imported products (without compensation). In a way, the poorer these people are, the better the balance in their diet; this paradox may vindicate the system of holding back stocks as emergency supplies, as practised by the native co-operatives. In this connection, there is one important point: throughout the entire Gilbert Islands territory, there is not one of these firms for which, generally speaking, "business has its reasons which reason does not recognize". All imported products are in the hands of a single organization, the "Co-operative Wholesale Society".

The administrative authorities of the archipelago who have more or less - but, in our opinion, to an insufficient degree - the right of supervision of these co-operatives, - have here an exceptional opportunity. They can prevent the "stores" from being induced to sell too much of certain products, or products which are more harmful than useful. They may likewise suggest that preference be given to one commodity rather than another. They will be able to do this even more successfully when decisions can be based on research work conducted in the field, over a considerable period of time, by a dietitian whose presence in the immediate future is imperative. The dietitian should always have precedence over the grocer.(1)

(1) Although a Co-operative Society is at liberty to import its requirements direct from overseas it rarely does so in practice, preferring to buy from the Colony Wholesale Scoiety on which it is often financially dependent. The Government has, therefore, (through the Colony Wholesale Society) the power to limit the amount of imported foodstuffs. For the time being international quotas provide a sufficient restriction without having to resort to the somewhat objectionable form of control advocated by Dr. Catala. There is a genuine public demand for imported foodstuffs which Government would find difficult to resist and which would inevitably be satisfied by some other, and probably less desirable, means should Government insist. Furthermore the Colony Wholesale Society is not a charitable organization and must make profits in order to build up adequate liquid assets to enable it to trade. It is of considerable economic value to the colony since there are no share holders nor overseas invested capital, and every penny it makes remains in the Colony. The present policy of the Colony Wholesale Society is not to create artificial tastes for imported luxuries but to concentrate on the import of basic commodities which are of real value in supplementing local production whilst making no attempt actively to discourage individual Co-operative Societies" orders. It is misleading to say that the administrative authorities of the archipelago have the right of supervision of the Co-operatives. Although the Co-operative Societies' Officer is in practice an administrative officer his primary concern is the business success of the Co-operatives and every effort is made to prevent the Co-operative movement becoming a quasi-Government Organization. (Note by the Administration of the Gilbert and Ellice Islands Colony.)

CHAPTER 14

GILBERTESE HANDICRAFTS

In addition to various objects needed in their daily lives, the Gilbertese manufacture certain other articles to sell, such as single or double mats not dyed but made of differently coloured straws, children's mats, coconut fibre mats, woven baskets (round or rectangular), various kinds of small table mats, wide-brimmed, finely-woven hats, and swords of hardwood decorated with sharks' teeth (models of old weapons). Unfortunately, the trade value of these articles is much less than it could be. For example, a place mat is sold for 1 shilling 6 pence and a glass mat or coaster 3 pence. Providing the fibres were already prepared, one could be made in a day. A single sleeping mat costs 12 shillings. It would take a week to make one, at the rate of ten steady hours of work a day. We do not think that any Gilbert Island woman would make this effort, even in double the time. For information, we have included in the table XIX the quantities of handicrafts exported in 1950 with their value for each island (sharks' fins are included).

These articles are manufactured particularly in the southern islands where, living conditions being more severe than in the north, the Gilbert Islander has greater need of a subsidiary source of income during years of drought. However, as soon as copra sales soar again with the return of favourable conditions, he immediately abandons this additional source of income. Indeed, the greater the production of copra the smaller will be the output of handicrafts; but inversely, handicraft manufacture will not increase at a rate proportionate to the decrease in income from copra.

The diversity of articles manufactured varies with the islands. Thus Arorae mainly produces wide-brimmed hats, table mats and sleeping mats; Onotoa, coir strings and ropes, and baskets; Nikunau, various types of baskets and swords decorated with sharks' teeth; Tamana, coir string, belts and mats. The Island of Beru produces everything, while Butaritari, in the north, has concentrated on the production of baskets.

Since these various articles should be considered here only in relation to their export value, which is conditioned by their appeal for outside buyers, it may be useful to examine their chances and conditions of success.

Among articles of limited appeal are replicas of early weapons. However pleasant may be the tradition which impels the Gilbert Islander to offer the visitor these models bristling with two rows of sharks' teeth, it is regrettable that he takes such pains to make them. Apart from museums and a few collectors, who specialize in this kind of trophy, few curio-hunting tourists would be interested in such cumbersome objects, which are difficult to transport and can inflict injuries too easily. Articles having a ready sale include table and sleeping mats, coir door mats, and other products of coconut or pandanus leaf fibre. These are both original and useful, with very attractive patterns resulting from

TABLE XIX

Quantities of Handicraft Products exported in 1950.

	Mats	Fans	Swords	Baskets	Sharks' fins	Export value in pounds sterling		
Island	Units	Units	Units	Units	Weight (lbs)	Pounds	Shil-lings	Pence
Makin	-	-	-	-	80	5		
Butaritari	-	-	-	200	-	38	10	
Marakei	-	-	-	-	108	6	15	
Abaiang	9	-	-	-	185.5	15		
Tarawa	1	-	-	-	2,722	179	7	4
Maiana	15	-	-	-	-	4	19	
Abemama	-	-	-	-	-	-	-	-
Aranuka	-	-	-	-	-	-	-	-
Kuria	-	-	-	-	85	5	6	3
Nonouti	6	-	-	3	-	2	1	10
Tabiteuea	7	-	-	-	2,267.5	153	13	6
Beru	536	-	-	53	228	62	9	2
Onotoa	-	-	-	39	157	23	3	11
Nikunau	-	7	55	-	388.5	43	3	11
Tamana	150	-	-	-	310	68	17	6
Arorae	221	-	-	15	1,128	184	3	11
Totals	945	7	55	310	7,659.5	792	12	4

the skillful use of light and dark straws. Fine straw hats are very handsome articles and there should be quite a good outlet for them once the search for markets likely to absorb them regularly has been properly organized.

Quality and Defects

Many of these articles display very fine handwork and remarkable regularity in weaving. Unfortunately, little attention is paid to uniformity in pattern or size. For example, we always found it impossible to make up a matching set of a dozen or even half-a-dozen place mats and coasters, however great the number of articles of each type brought to us. (1)

Conclusions

Despite their indisputable importance, these products can bring only a limited monetary return to be added, for the benefit of the native, to the reserve funds already formed by the co-operatives. They would not suffice to save the population of the Gilbert Islands, were they one day to suffer a more intense and prolonged drought than they have done so far, and need to buy great quantities of food.

(1) The shortcomings of non-matched sets of table mats, etc. has long been appreciated and since the inauguration of the Co-operatives every endeavour has been (and is being) made to remedy this. There is, however, too much splitting up of the work between individuals which inevitably results in badly matched sets. (Note by the Administration of the Gilbert and Ellice Islands Colony).

CHAPTER 15

CO-OPERATIVE SOCIETIES

It is not within our province to go into details of the structure and accounting of the co-operative societies as they are described fully in the annual reports of the administration, from which much of the information below was obtained. The principle of these organizations and their various objectives are the only matters of interest here. It is, however, useful to review briefly the successive stages of their development.

In 1931 Mr. H. E. Maude was responsible for supervising the formation on the island of Beru of two co-operative societies, known in the vernacular as boboti. They were a replica of a society established at Vaitupu in the Ellice Islands in 1926 by Mr. Kennedy and their rapid development showed that they met a real need. However, they were only small organizations; the number of members of each did not exceed two hundred. Their income derived partly from the difference of 10% between the price at which they bought goods and that at which they resold them to members, and partly from the difference of 10 shillings per ton of copra between the price paid the producer and the selling price to the private trading companies.

As early as 1934, the Gilbert Archipelago alone had thirty-four of these small societies through which were channelled a very high proportion of the transactions between producers and consumers on the one hand, and the trading companies on the other.

In 1941 came the war and the Japanese occupation. The societies were automatically liquidated by the cessation of their activities, and private companies disappeared for the same reason. The war thus created a new situation. From 1944, the Government, which was concerned with restoring the economy of the Gilbert Islanders, supplied them with stocks sent from Fiji, and shortly afterwards formed a "Government Trade Scheme" on the strength of a loan of 28,250 Australian pounds granted by the metropolitan Government.

The aims of this new organization were to import various consumer goods, to export copra, and to develop other exportable products. Since 1946, however, new encouragement has been given to the formation, on a wider basis, of a co-operative organization extending to all the islands. As a result of the activities and perseverance of men such as W. G. Alexander and I. G. Turbott, confidence in the co-operative societies steadily increased. These organizers have taken into consideration the different traditions of each group of islands.

A committee with its own administration was formed on each island. The "boboti", the former private native companies, and the "tangitang", a sort of syndicate, were incorporated into the present co-operative societies.

In 1947 the number of members was 5,050; in 1948, 7,898; in 1949, 9,671, and in 1950 approximately 12,000. In the same period the number of customers increased from 6,000 in 1947 to 24,800 in 1948, to 27,500 in 1949, and to approximately 32,000 in 1950. Everyone on an island can be considered a customer. Although only the head of a family is normally a member of the local Co-operative Society, all his family consider themselves equally members.

The continual improvement in the standing of the co-operatives may be attributed both to the system of organization and to a very high copra price level as a result of which the Colony Wholesale Society made large annual profits. The Stabilization Fund is at present (1951) of the order of 120,000 pounds, of which some 40,000 pounds are on loan to the Colony Wholesale Society and 80,000 pounds invested in Australian Commonwealth Treasury Bonds. The interest is 3% and is reinvested every six months.

As copra is the major resource, it may be advisable to indicate the percentage distribution of the F.O.B. price paid by the United Kingdom Ministry of Food. The following are the figures given us by the Administration of the Gilbert Islands.

		%
I.	Export Taxes	25
II.	Cost of handling and loss in weight at the "Colony Wholesale and Island Co-operative Societies"	17
III.	Commission and profits of the above-mentioned Societies	15.25
IV.	Contribution to the development fund of the Co-operative Societies and Copra Stabilization Fund	12.75
V.	Net producer's price	30
Total		100% (1)

(1) The 1952 copra price figures were as follows:

I	Export Taxes	20. 6. 3 *	25%
II	Cost of handling and loss of weight; at C.W.S. 12.19. 3, at island approx. 3 pds.	15.19. 3	19½%
III	Commission and Profits: C.W.S. 6.19. 6 Island Society 3.16. 8	10.16. 2	13½%
IV	C.S.D. and C.W. Fund	8.10. 0	10½%
V	Net Producer's Price	25.13. 4	31½%
		81. 5. 0	100 %

(Note by the Administration of the Gilbert and Ellice Islands Colony).
* Prices are in pounds, shillings, and pence.

The relatively high proportion which is placed in reserve will be noted. The latter could serve as a security fund in the event of a disaster or if the price of copra fell so low that even its transport would no longer be justified.

Apart from the reserve funds in the banks, the co-operative organizations already own considerable equipment; two motor boats, six sailing ships, three launches, three punts and seven trucks, to which must be added docks, copra warehouses and miscellaneous equipment. Finally, in addition to voluntary contributions to the reserve funds or the equipment purchasing funds, the co-operatives are responsible for the costs of administrative and executive personnel.

In addition to activities directly related to copra, there is the Colony Handicrafts Co-operative Society (1) which since 1950 has been dealing with various products and manufactured articles - see earlier chapter.

Conclusion

Apart from the present importance of the co-operatives in the activities of the archipelago, the future role which the accumulated reserve funds may play one day ensures for the mass of copra producers - in fact, for all the Gilbert Islanders - security which might extend over several years. The co-operatives have already anticipated that in the event of a disaster such as the collapse of the copra market, war, etc., expenditure would first be reduced in ways which would not affect the producer. It has been calculated that a fall of 25% in the price of copra would not affect the natives' income. It is estimated that present reserve funds would be sufficient to meet four years of slump, or other difficulties, while guaranteeing 10 pounds per ton of copra to the producer.

The size of these reserve funds, which are continually increasing, is such that one may contemplate the possibility of an expert enquiry into the utilization of secondary products from the coconut palm. This view has encouraged us to suggest a programme for the improvement of coconut groves in the whole archipelago, in the belief that the co-operatives could meet the outlay necessary for such a programme, as outlined in our recommendations. (2)

(1) The Handicrafts Society has been taken over and run by the Colony Wholesale Society since 1950.

(2) It should be borne in mind that although the Reserve Funds may be large most of the Societies are still in debt and the value of their assets is extremely doubtful. The Co-operative Societies could not in present circumstances possibly meet the cost of the Coconut Palm enquiry envisaged by Dr. Catala since their funds and energies must for some time to come be devoted to consolidation and the attainment of a satisfactory financial position. (Note by the Administration of the Gilbert and Ellice Islands Colony)

We have observed that, apart from European "supervision" (quite indispensable), the whole co-operative movement is in the hands of the natives. It is astonishing that the individualistic character of the Gilbert Islander should have fitted itself so quickly into these community organizations. The beginning was certainly very difficult, but the natives themselves assured us that what had impressed them most was the sense of ownership which they rapidly acquired toward all the equipment which works before their eyes, and which they know belongs to them - from the truck which comes for their copra and which enables them to travel about the island, to the ship which takes that same copra to Tarawa and on which they themselves may travel. Their money is working and they are seeing it working.

Whether or not they are aware of the security which the financial funds in the banks represent is of less importance than the fact that this security does exist.

A few discontented, or perhaps ill-informed, people (not, however, in native circles) have disapproved of the fact that the owner does not receive a little more money for the copra which he produces. But we are of the opinion that the outstanding merit of the promoters and the organizers of the co-operatives was precisely this ability to impress upon the members the wisdom of forming reserve funds as a precaution against bad years, rather than squandering their money. And "squander" is the right word, if one considers the rapidity with which money can disappear in a few hours. Even if the Gilbert Islander wanted to accumulate personal savings he could not do so, as he clings so tenaciously to the current practice according to which parents and friends may quickly impoverish any native returning to the village, rich from a sale of copra or wages earned abroad. This practice of bubuti divides the money to such a degree that it leaves to each person only a tiny purchasing power, sufficient to buy insignificant trifles such as sweets, fripperies or other useless articles. So, if the native earned double what he does for his copra, his position would be exactly the same. And, as the Co-operative Societies Officer told us, the more money the native has, the greater his tendency to neglect the work which provides the money and the more he upsets the balance of his diet.

Formerly, in the days when a few big firms monopolized trade, the native received more, but no reserve fund was established. It is obvious that the Gilbert Islander, with the little money which his individual income represents, would never have had the advantages which he enjoys today from the trucks and ships of the co-operatives, and in particular the latter, which enable him to travel from island to island in a region so lacking in means of communication, and in which the ancient knowledge of navigation has been lost.

Therefore, we cannot but admire unreservedly such a remarkable organization which has only some small defects which time, much better than any detailed recommendations, will remedy.

CHAPTER 16

CONCLUSIONS AND RECOMMENDATIONS

PART I: A PROPOSED PROGRAMME OF AGRICULTURAL IMPROVEMENT

Experiment Station

Any programme for the improvement of Gilbertese resources will hinge on the creation of an agricultural experiment station, which will have not only technical but educational functions. Its establishment is therefore of the utmost importance. Even within the limits of a modest and reasonable undertaking, the work of the station will be effective only if it is carried out under conditions which reproduce the customary native environment. The station should be an experimental garden devoted chiefly to the improvement of economic plants already existing in the islands rather than a plant introduction garden. Along these lines, it would be excellent in providing useful and practical demonstrations.

The slow response of the coconut palm to attempts made to improve the yield precludes any hopes of spectacular and rapid results, and intense droughts will further delay them. However, the programme should be envisaged on a long-term basis, and the two objections just mentioned should not discourage its implementation.

The projected station will have to deal with many other problems besides those of the coconut palm. It will be necessary to study the selection and improvement of species of basic economic importance: Cyrtosperma, Pandanus and Artocarpus. The station should also give attention to other plants of secondary importance, particularly the banana, fig and Tacca. Finally, it will be essential to establish nurseries for tree species including trees already present in the group but gradually disappearing in the absence of replanting and those which are recommended for introduction: Casuarina and Araucaria.

Proposed Programme for the Coconut Palm

At the moment, it is rather difficult to estimate even approximately the expenditure involved in the implementation of a programme of improvement for the coconut groves. Such a programme can have really profitable results only if sufficient means are made available. It necessitates, in addition to the organization and functioning of the projected experiment station, the permanent presence of a coconut specialist assisted by Europeans and natives. Other expenses, although temporary, mustbe taken into account; for instance, a survey by a hydrologist would be very useful for the practical study of the rocky platform in some islands such as Nikunau. After much observation, we came to the conclusion that a series of cracks in this rocky platform made at regular intervals with explosives might improve the condition of coconut palms growing above it. However, as we cannot forsee the exact results and do not know whether unpleasant repercussions might follow, we think that a specialist in geology and hydrology

could formulate a plan of blasting to be carried out on definite sites. The cost of this work would be very low, and it might then be possible to give thousands of coconut palms a chance to develop better and increase their yield in proportion. This specialist would, of course, also help in the improvement of the culture of other plants such as babai and his role will be discussed again below.

Assuming that a coconut improvement program should extend over a minimum period of fifteen years (the necessary time to obtain tangible results), and that the expense involved should be approximately several thousand pounds per year, the invested capital could probably be amortized quite easily..

If this programme could be implemented in a constructive spirit similar to that which has led to the success of the co-operatives, one could expect an extra production of copra more than sufficient to redeem in a few years the capital invested, even with prices lower than they are at present. It is understood that only unproductive or nearly unproductive palms would be replaced, so that their destruction would cause as little loss as possible. Considering the relative nature of any forecast under present conditions, and because no production data for a long enough period are available for these islands, it is impossible for us to cite even tentative figures.

To follow another train of thought, the output of copra made from nuts on certain islands will always be very low. Thus in the southern islands where drought conditions are more intense, the number of nuts required to make a ton of copra will be two or three times that in the northern or central islands; even during periods of nearly normal rainfall the difference will always be great, because of the generally more adverse conditions peculiar to the south. It is expected that general improvements and the necessary replacement programme will, nevertheless, increase the number of nuts produced on these islands. Excessive optimism should be avoided in this connection, and we strongly advise leaving aside figures for the southern islands when compiling production forecasts, in any estimate established on a large scale. Even after an improvement programme, the increase in production of these islands would probably be very small.

The overall increase in production which should be expected from the ten other islands should be in relation to the effort made. Technicians studying a large scale improvement programme would see whether the increased production of a limited number of coconut palms in each island would be sufficient after a time to amortize the expense involved. But it is obviously necessary that this amortization not be at the expense of the income to which the natives are entitled for each ton of copra produced, or of the normal quota of eating and drinking nuts that they require. It seems from the data in hand that this can be avoided.

On the other hand, it should be made clear that the problem should not be considered exclusively from a financial point of view. There is, indeed,

another important aspect, which is really the human aspect. In fact, the question here is to insure the livelihood of a regularly-increasing population, and the projected improvement program concerns the basis of Gilbertese subsistence, the coconut palm.

We recognize, however, that a government faced with so many other problems more important than this, cannot tie down capital in such an investment for a very long period. Another obvious solution suggests itself, that is the undertaking of this programme by the co-operative organizations.

Two reasons favour this proposal: the first is that these co-operatives build up annually - chiefly because of the high prices of copra over the past few years - large reserves in comparison with which an annual expenditure of a few thousand pounds would not be prohibitive. The second is that an increase in production is needed for the subsistence of the Gilbertese population. Therefore, even in the event of a copra price slump before complete amortization the investment would still be justified. If the Gilbertese are one day deprived of the income from high-priced copra, at least their existence will be ensured by the production of their coconut palms and the situation will be improved if the coconut palms produce more. However, if copra prices decreased to a point where freight expenses would no longer be justified, this product, in addition to its place in human diets, could be successfully utilized in pig-raising, a source of income hitherto entirely neglected by the natives.

Interim Attention to Coconut Groves

Pending the establishment of the projected experiment station, a preliminary campaign of improvement could be undertaken immediately in some particularly neglected areas. Abemama and Aranuka Islands are the most typical in this connection, and it appears that Kuria, which we were not able to visit is in a similar condition. Considering the neglect in Abemama (with the exception, of course, of some well-tended areas such as the site of the Makin school group, and two plantations) and the presence of the insect pest Graeffea, it would be most advisable to start with this island.

What should be done: It would be highly desirable that each owner should remove, in the plots of land belonging to him, palms undeniably unproductive because of their age or defects, and trees killed by fire. He should also destroy the self-sown palms grown from fallen nuts, creating a dense tangle of useless and unproductive plants, and should suppress ruthlessly the abnormal or unhealthy specimens, some of which are breeding grounds for pests. He should make more frequent inspections of his land to collect fallen nuts. He should heap all the scattered debris around the palms. Fortunately, Oryctes rhinoceros does not exist in these islands, so these debris heaps do not entail the risks found in other regions of favoring its development. Suitable areas abandoned without reason, or devoid of palms through fire or other causes, should be replanted. Pending the day when

real selections can be effected, seed nuts should be taken from palms offering a combination of favourable characteristics (the natives know the best ones).

This will be the last of our recommendations on what could be undertaken immediately. If further guidance were needed at this stage, useful advice could be given in relation to nurseries for seed nuts, to the banking of earth around certain coconut palms under special conditions, and to various fertilizers.

Errors to be avoided: To pass from the present state of affairs to the exact opposite would mean upsetting the existing balance. In other words, one should refrain during the early stages from completely clearing the ground as is done in plantations. Clearing away all elements with a fertilizer value such as rotting trunks, coconut husks, and old leaves, should be avoided. Shrub-like species, such as te uri, te mao, and te ren should not be systematically destroyed for the sake of tidiness; this applies even more to low plants which are often of considerable value, especially in areas where the palms do not grow very densely.

Recommended restrictions: Because of this balance which should be preserved, it would be advisable not to permit the introduction of certain mammals, and in particular rabbits which have already caused untold damage in other Pacific Islands. Goats would be another undesirable introduction, but probably could not survive on their own on low islands.

Quarantine measures for protection of plantations: We are firmly convinced - and we are not alone in this - that without the coconut, the native would not be able to exist for any length of time. Without the food resources from it, chiefly the valuable toddy, the life of the Gilbertese would perforce be most tragically unbalanced. Any serious attack affecting the existence of these palms would therefore threaten the very life of these people.

We have seen that in the Gilberts, the coconut palms are free of the major pests found in other parts of the Pacific. However, Abemama Island is the scene of a very slow but indisputable increase of Graeffea cocophaga. Therefore, in the matter of careful protection of the coconut palm in the Gilbert Islands, equal care should be devoted to the control of pests already present and of those which may be introduced later.

Internal measures concern only the territory of Abemama. They should be directed constantly to the avoidance of any possible transfer of Graeffea to other islands of the archipelago, especially to the northern islands which have a heavier rainfall and would probably be more suited to the rapid multiplication of this pest. The shell of the eggs of this orthopteron is extremely hard and resistant. The egg hatches out only several weeks after being laid. These two factors therefore increase the chances of eggs hatching out in places far from the infested area. While we may wonder why this insect has fortunately not yet spread, we must admit that this could easily happen. For example, the eggs fall from the leaves into

open bags during copra-cutting or gathering. The bags which are likely to leave the island should therefore be very carefully examined.

External communications, while infrequent, are nevertheless quite sufficient to facilitate the introduction of insects which may become dangerous pests. Cargo should therefore be very carefully checked, not only in the Tarawa area, which is the first port of call for most ships, but also in all the islands of the archipelago to which some ships sail directly. Numerous other examples could be given of the many possibilities of contamination from sources outside or inside the group. In fact, to ensure effective control, an elaborate quarantine organization will have to be established and we are well aware of the difficulties involved.

In brief, the control of imports from overseas, including ill-considered introductions of new varieties of coconut palms to areas chosen at random (this could extend to the introduction of any plants), the institution of adequate quarantine and, if possible, of cleaning-up operations in territories such as Abemama constitute the basis of this recommendation. Since it is intended to safeguard the basic wealth of the Gilberts we feel that no effort should be spared to ensure its implementation.

In several cases, we have only touched upon certain questions and others have been purposely neglected because they are related to problems restricted to certain islands or strictly connected with local politics. Generally all the recommendations for the improvement of the present conditions in coconut groves come back to the need for better land utilization. While the Gilbertese frugally make the best of everything in their daily life, they neglect much of their land.

The population of these territories is increasing and it will be necesary, in the interests of the people, to survey much abandoned or neglected land. There are even some islands where ancient constraints still burden the inhabitants and make them ashamed to work certain lands for fear of being mistaken for slaves. Such factors are so many hindrances to the increased activity which the authorities would like to encourage. The present situation is far from alarming, but the problem appears greater when considered in relation to the future. It is likely, however, that an improvement programme would easily bring results within 15 years and that the increase in production would then be sufficient to meet the increase in population. But it must be said that any improvement undertaken would, initially at least, encounter everywhere the indifference and indolence of the natives which are quite understandable. Observers in other areas of the Pacific have made the same remark in connection with the same problem. No attempt to improve the coconut groves and generally the material living conditions of the natives will be successful unless they themselves lend their support to it. The Gilbertese are not systematically opposed to something new, but they are not inclined to persistent effort, especially if they have no proof that this can be quickly profitable. It is unfortunate that the coconut programme ranks first among the improvements to be carried out. The coconut palm is a slow-growing plant and the best attention given

to it will bear fruit only after many years. In other words, spectacular results should not be expected from the experiments. This does not mean, however, that they should not be attempted, though much perseverance, great consistency in the aims, and the most diversified forms of propaganda will be needed.

Finally, it must not be forgotten that any result obtained on the Gilbert Islands will automatically apply to the coconut groves of other low coral islands in the Pacific where prevailing conditions are comparable. We would thus be tempted to suggest that any proposed improvement programme be planned for a wider area than the Gilbert Islands, and that governments controlling territories with the same problems consider participating financially in the improvement programme for the Gilbert Islands group.

Improvement of other useful plants

Cyrtosperma: Although babai is not an absolutely essential food, it appears that the Gilbertese, who are so fond of it, eat it in such small quantities only because of the trouble of growing it. As this plant can only grow in pits, its area of cultivation is very limited and could be increased only by very hard work. We have pointed out that we never saw recently-made pits. We can understand why the native, once he has an assured minimum of babai, balks at such arduous labor which must be undertaken with tools only slightly less rudimentary than those of his ancestors. We wonder whether the physical difficulties which are such an obstacle to the expansion of babai cultivation could not be eliminated to a great extent with the use of modern machinery. Such equipment could excavate as far as the rocky platform, clear away the earth and finally break the platform. This recommendation is closely allied to an earlier one (see p. 158) which advocates a preliminary survey of the problem by an hydrologist, whose advice would be essential before undertaking such an experiment. A "pilot" experiment could be tried out in one of the southern islands, e.g. on Onotoa or Nikunau, where an increase in babai areas is most necessary. It could then be tried on Abemama (particularly at Kena) where so many babai pits have been abandoned. We have not overlooked the main objections, the first of which is the difficulty of unloading under the landing conditions prevailing on most of these islands (the days of landing craft being past). The cost of such equipment would obviously be high, but one can imagine the satisfaction of the Gilbert Islander at seeing completed in a few days the work of clearing the land, digging and breaking the rock which would take him years were he to undertake it himself. It is certain that any such excavations would at once be planted with babai. Let us repeat that we do not advocate here the general use of modern machinery all over the islands but merely an experimental operation.

Colocasia (taro): Our study of the Colocasia showed the advantage of using old abandoned babai pits. The native must decide if this work of reclamation is worth while or not.

Pandanus: It has been pointed out that because of high copra prices, several islands showed an increasing tendency to neglect the pandanus trees

which are replaced by the coconut palm. It is absolutely essential that the present stands should be maintained, and it would be advisable to increase them as a precaution against the uncertain future.

Artocarpus: The breadfruit tree is everywhere well tended. Any future agricultural station, however, will have to improve the seedless varieties, in particular.

Fig trees: The distribution of saplings in the villages could be studied in order to increase the present insignificant number of trees. They would provide an excellent additional food for children.

Bananas: It has been noted that banana plants were very rare, except in certain centres where serious efforts have been made - missions, schools, etc. The natives, the children especially, are so fond of bananas that these should be planted in the neighbourhood of all villages where there are old abandoned babai pits already more or less filled in.

Dwarf varieties should be tried because of their ability to resist winds, and their large number of shoots. Like Stone, we would advise correcting iron deficiencies by the application of soluble iron, and nitrogen deficiencies by covering the soil with a thick layer of leaves and organic matter.

Papaya trees: It is recommended not only to increase the number of papaya trees in the villages, but also to introduce varieties likely to appeal more to the adult taste.

Tacca: The advantages of Tacca, so fully described earlier, are such that its expansion is recommended; this food can be grown between coconut palms. Instruction in improved methods of eliminating the toxic element and in less primitive techniques of extracting the starch will be needed.

Tobacco: This plant is successfully grown even in the villages of the southern islands, where the natives, in the absence of twist tobacco or of money to buy it, fall back on the few plants which grow round the huts. It is recommended that an expert should teach the Gilbertese how to prepare the leaves correctly in order to improve their smoking tobacco which, though still not of good quality, would be better than the pitiful product which they now obtain.

Other plants: We have listed earlier the plants the wood of which is used by the Gilbertese, but this use is too often restricted by depletion of these species. In spite of the slow growth of some of them, we recommend replanting. Each village could well replant the surrounding areas, to some degree, with a few useful trees. Our preference would be for te itai (Calophyllum) and te kanawa (Cordia). Native preference will obviously be for trees with multiple uses like te mai (Artocarpus). This species, however, has to be cultivated. Found today only in villages where little space is available for increased plantings, its cultivation could be attempted in inland areas where ground water and soil conditions are favourable.

The main experiment which should be tried, however, concerns two trees the introduction of which, if successful, would have the happiest results. These are Casuarina equisetifolia and Araucaria cookii. From a very fine specimen on Butaritari, we know that Casuarina can grow just as successfully in the Gilbert Islands as on other coral sands. Areas near the sea at the ends of islands and islets are to be recommended.

Araucaria is found in very dense stands on many coral islets in New Caledonia where edaphic conditions are similar to, and average rainfall not substantially different from, those of the Gilbert Islands in normal times. Obviously, the resistance of these Araucaria to very long droughts cannot be foreseen, but they are worth trying along the coastal areas, preferably on the lagoon side and in some central regions unsuited to the coconut palm.

Finally we should like to repeat this essential recommendation: there should be no decrease in the number of plants of the various species which play a primary role in the vegetative balance necessary for the flourishing of plants of high economic value, such as the coconut palm. The coconut groves may be "tidied" without destruction of the useful shrub species. It must always be remembered that undergrowth is of great importance for the production of humus and the limitation of evaporation.

PART II: EXPLOITATION OF MARINE RESOURCES

Basic marine resources

It has been seen in Chapter 11 that in the Gilbert Islands fishing is a daily activity, whether outside the reef or in the lagoon, or limited to the collecting of a great variety of organisms on reef flats uncovered at low tide. We indicated that if the natives so wished, and if the call of the sea attracted as many young men as in the past, they could easily increase their resources in sea products. We also pointed out that the number of canoes is small in proportion to the density of the population. We would, therefore, recommend that the Gilbertese be given all possible facilities for increasing their equipment (canoes and fishing gear), and that these facilities be supported by intelligently conducted propaganda and even with a certain amount of subsidy.

It should be stressed, however, that fishing should remain a native affair. Anything of an industrial nature would entail the risk of most unfortunate repercussions on the fish populations around these islands. In all our conversations with old fishermen we could sense that the balance is very precarious. These men of great experience in sea matters were of course unable to cite specific facts, but they had an intuitive knowledge that any increase in the quantities of fish caught would destroy the balance which enables them to count upon sufficient daily supplies. We are, therefore, obliged to recommend that no attempt should be made to intensify, for example, the fishing of large tuna (te baibo) in the northern and central islands.

An exception, however, might be made in favour of the southern islands. It has been noted that in periods of under-nourishment on these islands, during droughts when land crops become less plentiful, the Gilbertese fish less often because they are disinclined to make the necessary physical effort. One of the co-operative boats might be fitted with simple gear which, in times of restricted food supplies, would make it possible to catch a substantial amount of fish which would be a valuable additional supply. This boat would fish for a few days around each island. If the fish were not plentiful enough in the waters of the southern islands to justify such an undertaking, nothing could prevent the northern islands from supplying the required quantities during the tuna and bonito seasons.

The native crew permanently attached to the boat could be reinforced with extra fishermen chosen from among the best on each island, whose services would be required only while the boat was in their own territory. There would be no need to bring European personnel from outside, with the possible exception of a specialist in the gear to be used, whose presence would be required only for a time. We met several boat masters whose curiosity in sea matters and outstanding knowledge of the hydrography of the most difficult areas fit them well to carry out this type of operation.

However, in the field of protection of fish resources, one question seems much more urgent, and should, forthwith, engage the attention of the authorities. Elsey (1951) writes: "There is no doubt that the Japanese, with a population increasing at more than a million a year, are scraping the bottom of the barrel so far as fishing is concerned, and the situation is one that cannot easily be dealt with on a satisfactory basis." We also find (Anon., 1950) a short article which states: "Japanese Fisheries Board officials hope that after a peace treaty is signed they will be allowed to fish as far south as 5 degrees South of the equator, BCOW (Army newspaper) said recently. At present Japanese fishing is not allowed south of 24 degrees North of the equator." [written in 1949]

In view of our previous comments, our fears that the Japanese fishermen may come and "scrape the bottom of the Gilbertese barrel" will be widely shared, all the more so for their already having an intimate knowledge of the waters in these regions. The consequences of such an intrusion would be disastrous. Hence our recommendation that there should be established forthwith around the sixteen islands very wide territorial zones, strictly closed to all non-Gilbertese fishing boats, except with special authorization granted only after the most careful examination. The areas traversed by migrating tuna, bonito and other fish should also be protected.

Secondary marine resources

We have seen that the number of profitable marine products is extremely limited; that the native sponges are not of sufficiently high quality to reach a wide market; that mother of pearl products are either non-existent or insignificant; and that good species of holothurians are probably not

sufficiently numerous to justify development and do not interest the Gilbertese. There remains, therefore, the only product which actually has a commercial value: shark fins. In spite of the small extra income brought in by this product, we do not think that it would be possible to persuade the Gilbertese to increase shark fishing deliberately. We can only recommend better methods of preparation and a study of the best procedure for stocking, pending the reopening of the Chinese market.

Sponges: It might be useful to examine the possibility of introducing, in certain islands of the group, sponge species of high commercial value such as Spongia officinalis subsp. molissima. This sponge was successfully cultivated on Ailinglapalap in the Marshalls by the Japanese (Tressler and Lemon, 1951, p. 739), who asserted that it is native in the Marshall Islands. But it is debateable whether in competition with existing species of negligible value, the latter might not win.

Chanos and fish-ponds

We would recommend a better use of certain fish ponds, especially of small inland lakes like those of the island of Nikunau which, because of their size and location, offer ideal conditions for growing baneawa (chanos).

PART III: MISCELLANEOUS RECOMMENDATIONS

Handicrafts

The first condition for the success of those handicrafts most likely to have a regular market in considerable quantities is that they should be uniform: the native must be convinced of this. For example, table mats would sell readily in overseas countries but only in matched sets. Unmatched, their appeal would be limited. A disciplined system of working should also be established. Other defects that could be corrected are usually the result of ignorance of commercial psychology. Many Gilbertese girls have learnt in the missions to do embroidery work, cross-stitch, etc., which is very fine and reflects as much credit on the teachers as on their pupils. But the designs selected are generally European while those with a South Seas motif would undoubtedly have stronger sales appeal overseas. There is no lack of subject - huts, canoes, fish, etc. The natives themselves took a surprising interest in the designs shown in Plate XVIId.

It is also necessary to find markets. This will be impossible, however, if sample consignments are not uniform, and if the purchasing firms are not certain of receiving articles strictly in accordance with their orders. Possibilities of selling abroad, especially well-finished articles, can be examined but will have to take into account the prevailing fashions and the competition of similar products of equal and even superior quality from China, Japan, etc. Finally, we were told that one of the most likely markets would be Australia but that its customs tariff was too high. The small amount of handicraft produced in the Gilbert Islands would not

upset the Australian balance of trade, and considering the help this would be to the Gilbertese, it is most desirable that these excessively rigid conditions should be modified. There was even a hope that the South Pacific Commission might lend its support in this direction.

Pigs

In the course of our brief study of the diet of the Gilbert Islanders, we have pointed out how little pork they eat, and how their lack of interest in pig rearing is simply a result of extreme indolence which we do not think can be overcome by any amount of advice.

However, the problem of pig raising should be considered from an angle other than that of supplementary food which, for the moment, the Gilbertese do not really appear to need. Provision has to be made for the day, which we hope may be as far off as possible, when there might be such a slump in copra that its transport would not be justified. If that day were to arrive, the money available to the Gilbertese would consist only of the reserves accumulated by the co-operative societies during prosperous years. However large these reserves, it would be essential to make them last as long as possible. Every device that would help in achieving this end should be most carefully studied. The Gilbertese would have very little money, but more copra than he knows what to do with. It is then that pig raising would be an important resource.

The question may be looked at in this way. There are two phosphate extraction centres less than two days distant by steamer which provide ready-made markets, and their buying possibilities are relatively good. The British Phosphate Commissioners must provide the entire food supply for a certain minimum number of people. It is of course to the advantage of the Commissioners to use the empty holds of their ships to import from Australia the necessary supplies for the entire population of these islands which, apart from a little fresh fish and a few chickens, produce nothing but phosphates. Without doubt, should copra prices slump to an unprofitable point, the British Phosphate Commissioners would not refuse to assist the Gilbert territories by buying their pork production, especially as the majority of the workers who extract the phosphates are Gilbertese. The volume of Australian trade would not be affected by this preference, while the assistance given to these people might be of real importance.

From the technical and practical point of view no great difficulty is apparent. Gilbert Islands pork is excellent in spite of the sparse, unvaried feeding. An improvement in these animals might immediately be attempted on a very small scale; later the introduction of selected breeding animals could be considered. Should breeding be thus organized, the pigs should receive more abundant, and, if possible, more varied food than they do now. In addition to the various plants which are sometimes given them (see Chapter 8), nothing would preclude the addition of a certain amount of fish to their ration. Since the Gilbertese would have no need to limit their personal consumption of coconuts, they might perhaps be

induced to divert for the benefit of the pigs a few of the ikari which every month fill the fish traps, often in thousands. On the islands where this species of Albula is rare or non-existent, groups of fishermen could always find enough Serranidae on the edge of the reef, or bonitos further out, to make up for the absence of Albula.

Finally, expansion of Tacca cultivation, the only food plant which can grow under the coconut palms, could probably provide an additional source of food for pigs.

Pigs could be loaded alive onto one of the co-operative boats (which would have little else to transport) and brought to the slaughter house which could very easily be located on Betio (Tarawa). There, after cutting up, the pork could be properly salted so that it could be taken in an excellent state of preservation to Ocean Island, thirty-three hours sailing from Tarawa (Nauru is a few hours further away). It could then be kept in cold storage.

If we deal only with the population of Ocean Island, approximately 2,000 people, and if we count only three rations of 180 grs. of pork per individual per week, the market offered by this island would be fifty tons, which represents a stock of 1,000 pigs. If the Gilbertese would take the trouble, and if the British Phosphate Commissioners would agree to purchase this production, then breeders would enjoy substantial additional income.

Diet

It it recommended that a dietitian, already familiar with native food problems, should make a lengthy stay on the Gilbert Islands. He should be of an age and physical condition permitting him to dispense with modern comforts in order to be in close contact with the islanders, and to move from place to place quickly and easily. As well as his research work in the field, this specialist should arrange for further analyses of specifically Gilbertese products to be carried out by the laboratories best equipped for the task. Additionally, he could give the authorities the necessary guidance to enable them to curb the excessive consumption of certain products and increase that of others. Among many other things, this specialist would have to study the vitamin B value of brewers yeast extracts (such as Vegemite) and specify the amount of these extracts to be used for a given quantity of rice and flour, in other words, what added amount of vitamin B is sufficient for the complete utilization of the carbo-hydrates.

The work of this dietitian and the information he collected could form the basis of a practical dietetic plan, applicable to other low coral islands.

General Conclusions in the form of Recommendations

We do not wish to disguise the unavoidably limited scope of many of our recommendations; we are aware that it is easier to make than to

implement them. We have, however, attempted to consider them all from a purely objective viewpoint, limiting ourselves to the strictly economic aspect of the survey entrusted to us.

We have repeatedly emphasized the importance of the oft-threatened equilibrium between the people and their environment and the need to do everything possible to maintain it, both by preserving vegetable and animal sources of supply and by watching the diet of the people in the Archipelago. However, if we had had to study the problem as a whole, we should have dealt with additional aspects, for instance the need for a type of clothing suited to the climate and the importance of a cultural equilibrium, an essential condition for a happy living. It was with pleasure that we noted that the local Administration was also imbued with this idea.

GILBERTESE VOCABULARY

This short vocabulary is but a provisional and very incomplete list. Some words, not appearing in Gilbertese dictionaries, may not be accurately spelled because our Gilbertese informants occasionally had difficulty in spelling them correctly. It must also be pointed out that terms used may differ greatly from one island to another. The article-like "te" has been omitted throughout.

ai - coconut crab - Birgus latro
aine - female
ai onauti - daylight catching of flying fish by trolling, using a special line fitted with floats
aitoa - tree, Lumnitzera littorea (Jack) Voigt
amaere - stage in the development of coconut
amakai - stage in the development of coconut
amerika - plant of recent introduction ascribed to American soldiers, e.g. Pluchea odorata Cass.
amori - fish of genus Gerres
ana - fish of genus Hemiramphus
anabanaba - variety of Pandanus, on Tarawa (native of Ocean Island)
aneang - canoe mast
ang - airplant, Bryophyllum pinnatum (Lam.) Kurz
ang - shellfish of genus Cypraecassis
anga - stage of growth of Cyrtosperma tuber
ango - tree, Premna obtusifolia R. Br.
anibanakoi - variety of Pandanus, on Tarawa
anikatouea - variety of Pandanus, on Tarawa
anikomri - variety of Pandanus, on Tarawa
anikomri - shellfish, Conus lividus L.
aniwaentang - variety of Pandanus, on Tarawa
anoi - hammerhead shark, Genus Sphyrna
anrairaki - variety of Cyrtosperma (also called te babue)
antemai - inedible inner part of Artocarpus fruit
antibitia - variety of Pandanus, on Tarawa
antinakarewe - variety of Pandanus, considered best of all
antinamainuku - variety of Cyrtosperma on north islands (Marakei)
aoua - four o'clock, Mirabilis jalapa L.
arabaikiaro - one of the favourite varieties of Pandanus for preparing tuae
aramaiki - variety of Pandanus, on Tarawa
aramaru - variety of Pandanus on south islands (Nikunau)
aramaoia - variety of Pandanus whose drupes irritate the tongue; this is also one of the favourite varieties of tuae
aranaonimai - variety of Pandanus, on Tarawa
arantebwe - one of the favourite varieties of Pandanus for preparing te tuae
ararikitoa - variety of Pandanus on south islands (Nikunau)
arataitara - one of the favourite varieties of Pandanus for tuae

aratekura - one of the favourite varieties of Pandanus for tuae

arateman - variety of Pandanus, on Tarawa

aratokotoko - variety of Pandanus, on Tarawa

ari - spathe of coconut palm. Used also for the bound inflorescence from which toddy is obtained

arinai - fish of genus Scarus

aronga - shrub, Acalypha amentacea var.

ata - rope from mast to outriggers of canoe

ati - bonito. Pelamys sp.

atine - small tuna. Neothunnus sp.

atinimainuku - variety of Cyrtosperma on Marakei

atuaro - small bonito

aua - fish of Mugilidae family, in general

auamaran - fish of genus Mugil

auatara - fish of genus Mugil

aubunga - large-sized Tridacna

awai - fish, Aprion virescens Val.

awaneari - variety of Pandanus on southern islands (Nikunau)

awatai - fish, large specimen of Chanos chanos Forsk.

ba - leaf

baara - fish of genus Scomberomerus (Tasard)

babai - Cyrtosperma chamissonis (Schott) Merr.

babue - variety of Cyrtosperma on south and centre islands

baibai - fish of the Pleuronectes group

baibo - red-fleshed tuna Neothunnus macropterus Schlegel (yellow-fin tuna)

baiku - fish: rays in general

baireati - tree, Barringtonia asiatica (L.) Kurz

baitari - edible jellyfish of genus Tamoya, Carybdeidae family

bakoa - sharks, in general

baku - top of rhizome and base of petioles of a Cyrtosperma used for artificial proliferation of shoots

bam (= palm) - a cultivated palm

banaba - Ocean Island

banana - banana, Musa sp.

baneawa - fish, Chanos chanos Forsk.

bani - coconut leaf

banikaina - Pandanus leaf

ba-n-te ni - coconut palm frond

banu - fallen coconuts eaten by rats

baraki - weed, Physalis angulata L. (southern islands)

bari - fish of Carangidae family

baru - fish of Serranidae family

batano - "rocky platform" of medium hardness

batua - fish of genus Canthigaster

batua - small clam of genus Hippopus

baua - fish of genus Mugil
baukin (= pumpkin) - pumpkin, Cucurbita pepo L.
baweina - fish of genus Lutjanus
bawemara - fish of genus Lutjanus
bebe - spongy ball of the developed germ inside the coconut kernel
bekei - culinary preparation of Cyrtosperma tuber
ben - oily albumen of coconut, at ripe stage; also ripe nut
beneka (= vinegar) - chili pepper, Capsicum frutescens L.
benu - coconut fibre for coir
bero - wild fig, Ficus tinctoria Forst.
biku (= fig) - fig, Ficus carica L.
bin - weed, Physalis angulata L. (northern islands)
binaing - fish of genus Sphyraena (Barracuda)
bingibing - tree, Thespesia populnea (L.) Sol. ex Correa
bitati - jasmine, Jasminum sambac L.
bobo - fish of genus Gerres
boboti - (phonetically Boboss). Local branch of Co-operatives
boi - purslane, Portulaca lutea Sol. (probably also used for P. oleracea L.)
boi - fleshy plant, Sesuvium portulacastrum (L.) L.
bon - black soil
bon abana - "It's his land"
bona - coconut husk dried for fuel
bonaua - stage in development of Cyrtosperma tuber
bonubonu - annelid of genus Sipunculus (used for scenting coconut oil)
bouro - black soil
bu - shellfish, Charonia tritonis L.
buangi - mangrove tree, Bruguiera conjugata (L.) Merr.
buatoro - culinary preparation with Cyrtosperma
bubu - fish, Balistapus aculeatus L.
bubuti - act of asking, or soliciting, see Chapter 3.
buka - tree, Pisonia grandis R. Br.
bukabuka - edible algae from fish ponds on Beru
bukare - water plant, Ruppia maritima L.
bukiamaere - stage in development of coconut
buki buki - fish of genus Tetradachnum
bukiraro - variety of Artocarpus
bukiri - distal part of coconut
bukiroro - fish of genus Gerres
buni - fish, Diodon hystrix L.
bunia - (uraura and roro) - varieties of coconut, the mesocarp of whose nuts is edible
buraroti - ornamental plant, Catharanthus roseus (L.) G. Don
bure - shellfish,- genus Cypraea (in general)
buro - shellfish, Monetaria annulus L.
butika - pole fitted with a knife blade to detach the fruits of high Pandanus and Artocarpus

bwebwe - lepidoptera
bwenarina - steering paddle

ene - coconut palm of which the trunk is beginning to appear
etan te namatanibura - stage in growth of Cyrtosperma tuber
ewanin - coconut husk

ianuri, iarauri - surface soil under te uri (Guettarda)
iaro - shrub, Pseuderanthemum carruthersii Seem.
ibaba - fish of genus Chaetodon
ibo - edible annelid of genus Sipunculus, family Gephyreanidae
ibu - endocarp of coconut used as a container
ibuota - variety of Cyrtosperma with good quality tuber
ie - canoe sail
ika - fish (in general)
ikabauea - fish of genus Sphyraena (Barracuda)
ikabaun - fish of genus Gambusia (in inland lakes on Nikunau and in the circular drainage ditches of most Cyrtosperma pits)
ikamotoa - fish of genus Lethrinus
ikanibeka - fish, Ruvettus preciosus Cocco (Castor oil fish)
ikanibong - fish of genus Lethrinus
ikanimoimoi - fish of genus Pterois
ikanun - used of fish called "angry" by the Gilbertese (for example, Carangidae which struggle fiercely in the nets)
ikaraoi - variety of Cyrtosperma - finest of all. The same name is given to particularly beautiful women
ikari - fish, Albula vulpes var. salmoneus L.
ikarikiriki - fish of genus Gymnosarda (Scombridae)
ikauraura - the most precocious variety of Cyrtosperma
inai - ropes of coconut palm leaves used for certain fish traps
inato - shrub, Clerodendrum inerme L.
inawaro - variety of Cyrtosperma in south islands (Nikunau)
ing - persistent tissue of a closed sheath which comes apart from the petiole (coconut palm frond)
ingo - fish of genus Lutjanus
io makorinawa - the treacherous little porpoise which is said to lead others until they become stranded on the shore (from io - to deceive)
iokanai - variety of Cyrtosperma on north islands (Marakei)
irare - sliding rope for hoisting the sail
iraro - shrub, Pseuderanthemum carruthersii Seem.
iri - drupe of Pandanus fruit
iria - Pandanus leaves when used as a wrapping for kabubu and other food preparations

iriatabu - variety of Pandanus on south islands (Nikunau)
iribaoti - variety of Pandanus on south islands (Nikunau)
iribuangui - variety of Pandanus on south islands (Nikunau)
irikaiwete - variety of Pandanus on south islands (Nikunau)
irikanoa buana - variety of Pandanus on south islands (Nikunau)
irikauri - variety of Pandanus on south islands (Nikunau)
irikeang - variety of Pandanus on south islands (Nikunau)
irikiri - variety of Pandanus whose fruits irritate the tongue
irimakiro - variety of Pandanus on south islands (Nikunau)
irimangkoriki - variety of Pandanus on south islands (Nikunau)
irimaoruru - variety of Pandanus on south islands (Nikunau)
irineiaro - variety of Pandanus whose fruits iritate the tongue
irionotoa - variety of Pandanus on south islands (Nikunau)
iritawatawa - variety of Pandanus on south islands (Nikunau)
iroro - variety of Pandanus on south islands (Nikunau)
itai - tree, Calophyllum inophyllum L.
kababa - catching flying fish at dusk
kabanaki - shellfish of genus Pterocera
kabekau - weed, Euphorbia heterophylla L.
kabi - base of the hull. Canoe keel formerly of coconut wood or of te uri; now of imported blue gum or Oregon pine
kabubu - coarse flour made from Pandanus fruit
kabubu - fish of genus Hemiramphus (young form of te ana)
kabuibui ni babai - preparation with Cyrtosperma intended for long-keeping
kabuibui ni bero - preparation with bero (Ficus tinctoria Forst.) intended for long-keeping
kabuibui ni mai - preparation with Artocarpus, intended for long-keeping
kai - heron
kaiai - young coconut palm which has not yet borne flowers
kaiao - leaves of various plants when they are intended for compost
kaibake - tobacco, Nicotiana tabacum L.
kaibaum - red flower, Russelia equisetiformis Schlecht. & Cham.
kaiboia - shrub, Dodonaea viscosa (L.) Jacq.
kaikarewe - sugar cane, Saccharum officinarum L.
kaikui - variety of Cyrtosperma producing an excellent tuber
kaimatu - weed, Phyllanthus amarus Sch. & Th.
kaina - Pandanus (general term)
kainibwena - simple pointed stake formerly used for digging Cyrtosperma pits
kaira - fish of Mullidae family
kairoro - variety of Cyrtosperma on south islands (Nikunau)
kaitewe - small specimens of fish of Mullidae family

kaiura - variety of Cyrtosperma on south islands (Nikunau)
kakauro - shellfish, Certagus cedonulli Sowb.
kakawa - crab, Uca tetragonon Herbst. (by analogy with the way in which very small children crawl on the ground)
kakerukeru - noise made by te ang shells (Cypraecassis) striking against one another (to attract sharks)
kamaimai - toddy molasses
kamakama - crab. Grapsus maculatus Catesby
kamamanga - fish of genus Tetraodon
kanawa - tree, Cordia subcordata Lam.
kapinea - shellfish, Mitra pontificalis Lam.
kara - coral debris
karababa - preparation of Pandanus drupes intended to be eaten within a fairly short time
kareberebe - caramel obtained by cooking toddy (karewe)
karere - fish of genus Hemiramphus (juvenile form)
karetaba - part of canoe
karewe - toddy, sap from coconut inflorescences
karuru - bracelet
katati - shellfish, Atrina nigra, and/or Modiola agripeta auriculata
katebe - harpoon, recently-introduced type (with rubber sling)
kateketeke - sand bur, Cenchrus echinatus L.
katete - shellfish, Atrina nigra
katii - culinary preparation with tuae and kamaimai base
katiki - trolling line
katura - shellfish, Atactodea glabrata Gmel. (One of the bivalves eaten in greatest quantities)
katutu - variety of Cyrtosperma with continual formation of numerous shoots
kaura - fish of family Serranidae
kaura - shrub, Sida fallax Walp.
kaura ni banaba - shrub, Abutilon indicum (L.) Sweet
kaura ni banana - plant, Wedelia biflora (L.) DC.
kauraki - a method of cooking fish by charring
kawaruwaru - shellfish, Pterocera lambis L.
keang - fern, Polypodium scolopendria Burm. f.
keang - turtle grass, Thalassia hemprichii (Ehrenb.) Aschers.
keang ni makin - variety of Artocarpus
kekerikaki - fish of Belonidae family
keriboki - echinoderm of genus Holothuria
kerekaka - shellfish, Drupa ricinus L.
keti - flying fish of genus Cypselurus
kiaiai - tree, Hibiscus tiliaceus L. (Beru, southern islands)
kiaou ni marawa - sea weed: Turbinaria sp.
kiaro - spars of canoe outriggers (of old coconut palm trunk)

kiau - creeping plant, Triumfetta procumbens Forst.
kiebu - lily-like plant, Crinum asiaticum L.
kika - octopus
kikakang - one of the names of shellfish Mitra pontificalis Lem.
kikanang - echinoderm of Ophiurid family
kimarawa - plant, Psilotum nudum (L.) Griseb.
kimokimo - fish, Decapterus pinnulatus L.
kinara - Pandanus trunk
kitoko - vine, Canavalia microcarpa (DC.) Piper
koikoi - shellfish Asaphis deflorata L., eaten in large quantities
koikoi - shellfish Tellen scobinata L.
koikoinanti - edible shellfish. Isognonum australica Reeve
koinawa - fish, Hepatus triostegus
kora - rope, in general
kora - sennit string and/or fibrous part of edible mesocarp
korokoro - preparation from kabubu and kamaimai
korono - Muraena of genus Lycodontis
koumara - shellfish, Circe pectinata Linné
kua - porpoise
kuau - fish of Serranidae family (Epinephelus corallicola C.V.)
kui - fish of Carangidae family (young form of te tauman)
kuia n rereba - very small specimens of Carangidae family
kumara - edible shellfish, Planaxis sulcatus Born.
kumara - sweet potato, Ipomoea batatas (L.) Poir.
kunei - stage in growth of Cyrtosperma tuber
kungkung - fish of Carangidae family
kunikun - tree, Terminalia catappa L.
kuu mane - fish of genus Holocentrus

ma - adventitious roots of Pandanus
mae - garlands and necklaces
maebo - fish of Mullidae family, Genus Pseudupeneus
mai - Artocarpus (breadfruit trees in general)
maikereke - variety of Artocarpus
maitarika - a variety of Artocarpus
makamaka - island arrowroot, Tacca leontopetaloides (L.) O. Ktze.
makauro - crab, Coenobita clypeatus Latr.
makaurontari - shellfish, Planaxis sulcatus Born.
make - fish of genus Hemiramphus
makei - lateral spines of Pandanus leaves
makenikarawa - fish of genus Hemiramphus
mam - weed, Jussiaea suffruticosa Lam.
mama - crab, Ocypode ceratophtalma Pallas
manai - crab, Cardisoma carnifex Herbst
mane - male

maneku - fish of genus Plectropomus
mangin - fermented toddy
mango - noise made by a shoal of Mugilidae swimming on the surface
mango - main parts of prow and poop of canoes (of te kanawa)
mango - common fly
maniberu - all hymenoptera
manko (= mango) - mango, Mangifera indica L.
mao - shrub, Scaevola sericea Vahl
marai - meat of coconut at moimoto stage
marang - fish of Serranidae family, Plectropomus maculatus Bloch
marou - herb, sweet basil, Ocimum basilicum L.
mata - all caterpillars or larvae
matabari - fish of genus Caranx
matakai - fish of genus Caranx
maunei - sedge; name used for various Cyperaceae
mawa - fish of Mullidae family
meria - frangipani, Plumeria rubra L.
mgo (= mango) - mango, Mangifera indica L.
moaine - variety of Cyrtosperma on north islands (Marakei)
moimoto - coconut at best stage of development for green drinking nuts
mokouro - fish of genus Tetraodon
mon - fish of genus Priacanthus
moro - flying-fish of genus Cypselurus
motiniwae - variety of Artocarpus with aspermous fruit
motiti - everlasting flower, Gomphrena globosa L.
mtea - purslane, Portulaca samoensis v. Poelln.
mweang - decomposing plant waste (future humus)
mwemweara - tree, Carica papaya (accord. Luomala)

namatanibura - stage in development of Cyrtosperma tuber
nana - woody endocarp of coconut, coconut-shell
nano n taume - inflorescence of coconut palm (also, by analogy, clear-complexioned girls)
nari - "hard rocky platform" of Cyrtosperma pits
nari - fish of Scomberoides group
natiati - fish of genus Neothunnus
natutububua - variety of Cyrtosperma with a considerable number of shoots (bubua - some hundred)
ne mori - abnormal coconut palm inflorescence bearing only female flowers (mori - sweet or very ripe)
nei - pools; ponds for Chanos breeding, fish-ponds
nei karua kereboki - echinoderm of genus Holothuria
neiroba - Opisthobranchia, Aplysia sp.
neitoro - clam, Hippopus hippopus
newe - spiny lobster, Palinurus sp.
newenewe - shellfish, Strombus gibberulus L.
ngea - shrub, Pemphis acidula Forst.

ni - fully grown coconut palm. General name for coconut palm in production

nikarinei - shellfish, Modiola agripeta auriculata Krauss

nikatebetebe - crustacean of genus Crangon

ni maimoi - name of small nuts fallen through crop failure

nimanainai - fish of genus Pseudoscarus

nimanang - fish of genus Epinephelus

nimareburebu - tree, Hernandia sonora L.

nimatanin - shellfish, Turbo setosus Gmel. A much valued shellfish for eating purposes

nimatoi - caterpillars, especially those causing serious damage. Name given particularly to caterpillars of Prodenia litura F.

nimoimoi - early stage in development of coconut

ninikawai - very old coconut palm with only a small clump of fronds (unproductive)

ninimai - fish of genus Gerres

niningaun - coconut palms bearing many bunches ("tenfold coconut palm"), chosen as seed bearers

ni roro - variety of coconut palm, the mesocarp of whose nut is not edible

ni uraura - variety of coconut palm, the mesocarp of whose nut is not edible

noka - main vein of coconut leaflets

non - shrub, Morinda citrifolia L.

nongai - shellfish, Isognonum australica Reeve

nonnon - crab, Calappa hepatica L.

nou - fish of genus Antennarius

nouo - shellfish Strombus luhuanus L.

ntababa - crab, Lydia annulipes (M.-Edw.)

ntabanibani - echinoderm of genus Holothuria

ntaningamea - fish of Mugilidae family

ntanini - parasitic vine, Cassytha filiformis L.

ntarena - fish of Blennidae family

ntarine - tropical almond, fruit of Terminalia catappa

ntinatina - variety of Pandanus on south islands (Nikunau)

ntokomaung - fish of genus Gobius

ntouman - variety of Cyrtosperma whose tuber is edible only after more than 4 yrs.

nuonuo - fish of genus Canthidermis

oineke - commonest variety of Cyrtosperma

okai - small shelters for storing coconuts as a food reserve

onauti - flying-fish of genus Cypselurus

ongantari - sponge of genus Euspongia

onobua - stage in development of coconut

orian (= oleander) - oleander, Nerium oleander L.

ota - grated coconut

papaya - tree, Carica papaya L.

ra - stage in the development of coconut

rabono - fish of Muraenidae family, Siderea picta L.

raim - lime, Citrus aurantifolia (Christm.) Swingle
rakai - shoals of certain lagoons
raku - sword-fish (in general)
rakuika - sword-fish, Tetrapturus mazara J. and S.
rakuriri - sword-fish, Istiophorus sp.
rama - float of canoe outrigger (of te bingibing)
ranin - coconut water
rao - tree, Hibiscus tiliaceus L. (Abaiang, northern islands)
rauti - shrub, Cordyline terminalis (L.) Kunth
reiawawa - fish of Labridae family
reiati - fish of genus Cirrhitus
reibu - fish of genus Abudefduf
reke - tip of canoe mast (of te ngea)
ren - tree, Messerschmidia argentea (L.f.) Johnst.
rere - model of old weapons bristling with two rows of sharks teeth
rereba - large specimen of fish of Carangidae family
riba - fish of Teuthidae family
ribataukarawa - fish of Hepathidae family
ribu and riburibu - sort of mud or sand coagulated by micro-algae, having a characteristic sulphurous smell
riburibunimainiku - large holothurian of genus Aspirochirota
riena n urakaraka - seine net with pocket
riki - germ of coconut and germinated nut
rimai - fish of Belonidae family
ritanin - sedge, Cyperus javanicus Houtt.
riri - skirt of vegetal fibre or straw of various plants
roata - centipede
robu (= rope) - century plant, Agave sp.
rokati - (corruption of word "locust"). Graeffea cocophaga New.
ruku - beach morning glory, Ipomoea pes-caprae (L.) Roth
ruku - moon flower, Ipomoea tuba (Schlecht.) G. Don
ruku - liana
ruru - plant, Crinum asiaticum L.

taba - light coloured, pliable young leaves of the Pandanus and/or spathe of inflorescence
tabanibani - see ntabanini
tabanou - crab, Carpilius maculatus L.
tabataba - juicy part of the Pandanus drupe
taboa - rachis (midrib) of coconut palm frond
tabokai - fish, Plesiops nigricans Ruffell.
takarokaronmataia uea - edible seaweeds (Cyanophyceae), eaten on some southern islands
take - supporting rope for sail
tangana - culinary preparation with Cyrtosperma tuber base
tangauri - preparation from Pandanus fruit

tangitang - a sort of syndicate
taninganiba - fungus of the genus Pezize
taninganibuki - variety of Cyrtosperma on the south islands (Nikunau)
tano - sand - soil - earth
taororo - taro, Colocasia esculenta (L.) Schott
tarabuti - sardine of genus Harengula
tarai - plant, Euphorbia chamissonis Boiss.
tarai - weed, Euphorbia hirta L.
tarai - fish of Scaridae family
tarika - brackish water
tatae - catching flying-fish by torchlight
tauman - fish of Carangidae family
tawa and tawatawa - Chanos chanos Forsk.
tawaa (?) - chanos spawn
tebon - variety of Cyrtosperma on south islands (Nikunau)
tewe - fish of Scaridae family
tina - variety of Pandanus on south islands (Nikunau)
tinanibo - see ibo
tinanikarawa - variety of Pandanus on south islands (Nikunau)
tinimaki - a method of grilling fish on embers of leaves
tiri - branches of Pandanus chosen as cuttings
toana - shrub, Polyscias guilfoylei (Cogn. & March.) L. H. Bailey
tonati - fritters with a base of white flour
tongo - mangrove tree, Bruguiera conjugata (L.) Merr.
tongo - mangrove tree, Rhizophora mucronata Lam.
tou - whole fruit of the Pandanus
tua - tree, Delonix regia (Boj.) Raf.
tuae - preparation of Artocarpus or Pandanus fruits, intended for long-keeping
tukuna - variety of good quality Cyrtosperma (very like te oineke)
ua - fruit
uan - pumice stone
ubu - a stage in the development of coconut
ue - flower
umum - method of cooking by braising used for various culinary preparation
umum - a way of cooking fish
uniganikakua - echinoderm of genus Holothuria
unikai - variety of Cyrtosperma on south islands (Nikunau)
uningauninga - holothurian, probably Holothuria mammifera
ura - stage in development of coconut
uri - tree, Guettarda speciosa L.
urintiana - thorn apple, Datura metel L.
uteute - grass; name used for various Gramineae
uteute te aine (female grass) - grass, Eragrostis amabilis (L.) W.&A.
uteute te mane (male grass) - sedge, Fimbristylis cymosa R. Br.

uti - shrub, Stachytarpheta jamaicensis Vahl
uto - leaves of coconut palm just emerging from ground
utongau - variety of Pandanus on south islands (Nikunau)

wae - anomaly of coconut without kernel
wanin - fibrous mesocarp of coconut, husk
wao - creeper, Boerhavia sp.
werewere - giant clam, general name

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Appendix I.

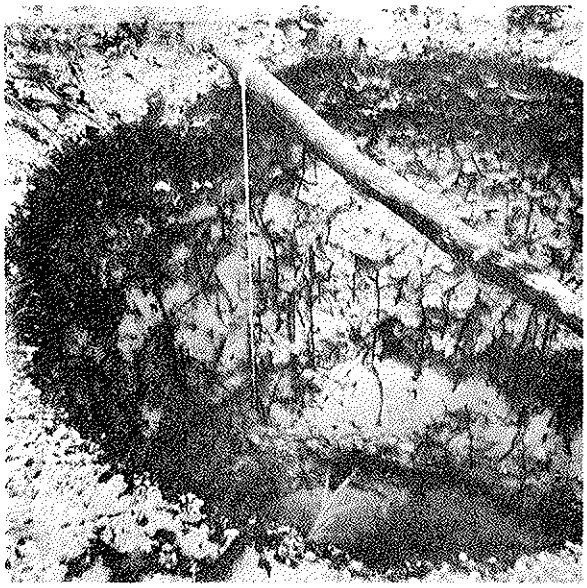
Algae of the Gilbert Islands, collected by Mrs. R. Catala, July 1951, determined by Dr. Francis Drouet

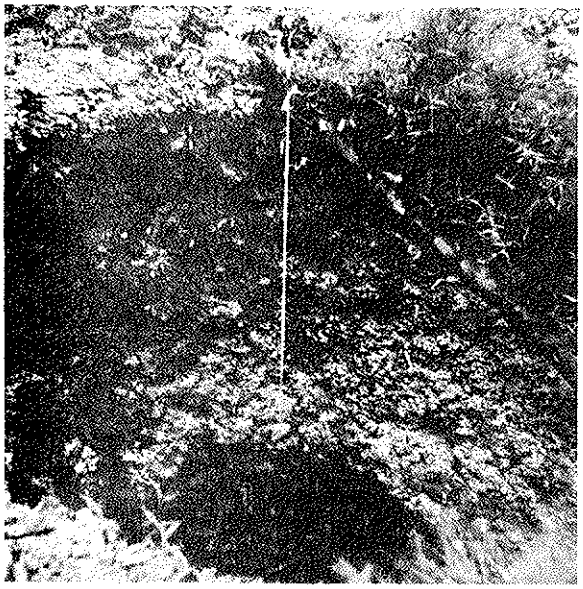
3. Plectonema nostocorum Born.
4. Oscillatoria nigro-viridis Thw. chiefly; also some Plectonema nostocorum Born., Lyngbya semiplena (Ag.) J. Ag., Anacystis dimidiata (Kütz.) Dr. & Daily, A. thermalis (Menegh.) Dr. & Daily, Agmenellum quadruplicatum (Menegh.) Bréb., Lyngbya versicolor (Wartm.) Gom., and Spirulina subsalsa Oerst.
5. Anacystis montana (Lightf.) Dr. & Daily and Plectonema nostocorum Born. chiefly; the other species listed under no. 4 are also sparingly represented here.
6. Plectonema nostocorum Born. and bacteria /= chiefly Lamprocystis rosea (Kütz.) Dr. & Daily/
8. Palmogloea protuberans (Sm. & Sow.) Kütz. and bacteria
9. Bacteria and what appears to be parasitized Palmogloea protuberans
10. Chiefly Anacystis montana (Lightf.) Dr. & Daily and A. thermalis (Menegh.) Dr. & Daily
11. Agmenellum quadruplicatum (Menegh.) Bréb. and Plectonema nostocorum Born.
12. Lyngbya semiplena (Ag.) J. Ag.
13. Protococcus grevillei (Ag.) Crouan, Palmogloea protuberans (Sm. & Sow.) Kütz., and bacteria
15. Bacteria and some of what seems to be Plectonema nostocorum Born.
16. Lyngbya semiplena (Ag.) J. Ag., Oscillatoria nigro-viridis Thw., Anacystis montana (Lightf.) Dr. & Daily, and A. thermalis (Menegh.) Dr. & Daily
17. Lyngbya semiplena (Ag.) J. Ag. and Plectonema nostocorum Born.
18. Rhizoclonium hieroglyphicum (Ag.) Kütz. and Anacystis dimidiata (Kütz.) Dr. & Daily
19. Rhizoclonium hieroglyphicum (Ag.) Kütz. and sterile indet. Oedogonium sp.
20. Rhizoclonium hieroglyphicum (Ag.) Kütz. and sterile indet. Oedogonium sp.
21. Palmogloea protuberans (Sm. & Sow.) Kütz.
22. Palmogloea protuberans (Sm. & Sow.) Kütz., parasitized in part
23. Coccochloris elabens (Bréb.) Dr. & Daily, Schizothrix lacustris A. Br., Palmogloea protuberans (Sm. & Sow.) Kütz., and Plectonema nostocorum Born.
24. Schizothrix lacustris A. Br.

Without number - "Gilbert is., well water". Phormidium tenue (Menegh.) Gom.

Localities

Nos. 3 - 9. In northern fish-pond of Nikunau
Nos. 10-20. In southern fish-pond of Nikunau
Nos. 21-24 In fish-pond on Beru Island



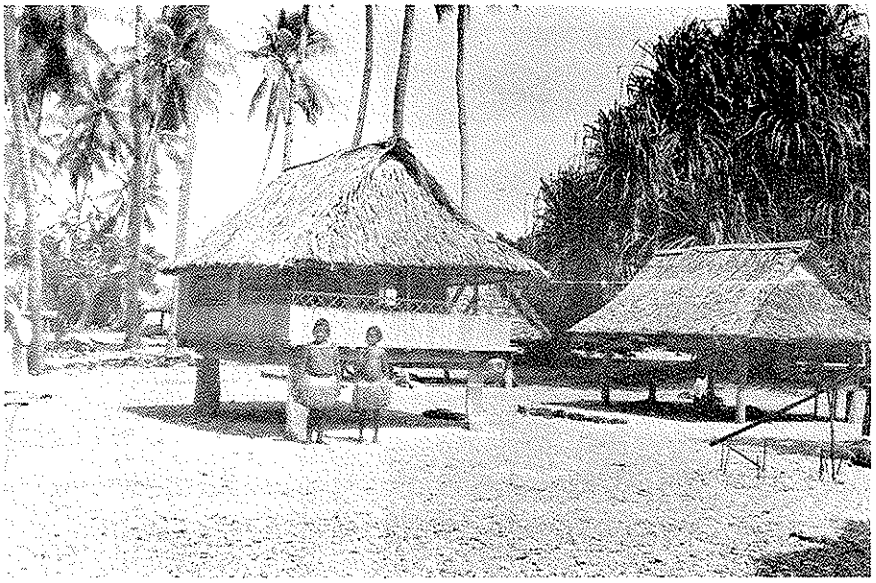


a and b. Soil profiles on Bikenibeu Islet, Tarawa Atoll. See Fig. 7b for location.

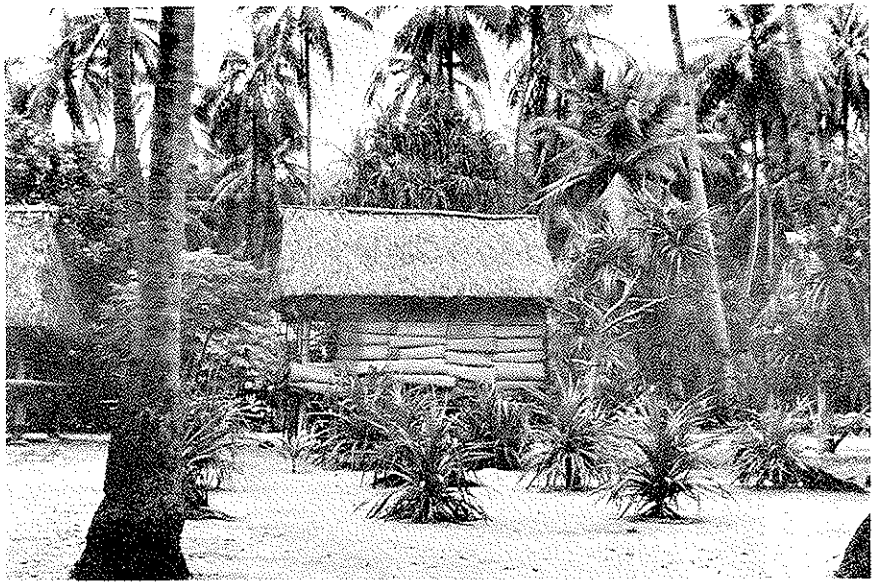
c. Soil in region of babai pits. See Fig. 6, profile 4.

d. Babai pit, showing section of rocky platform.

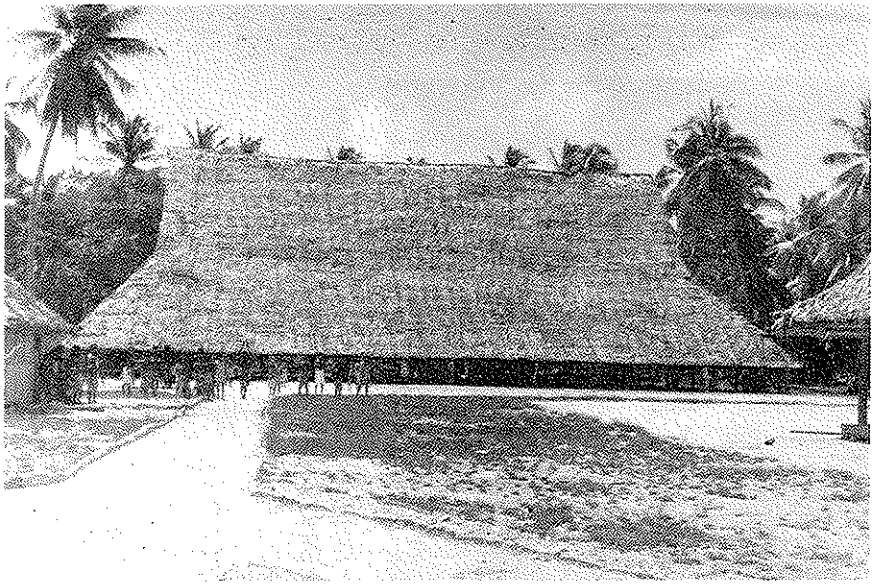
Plate I.



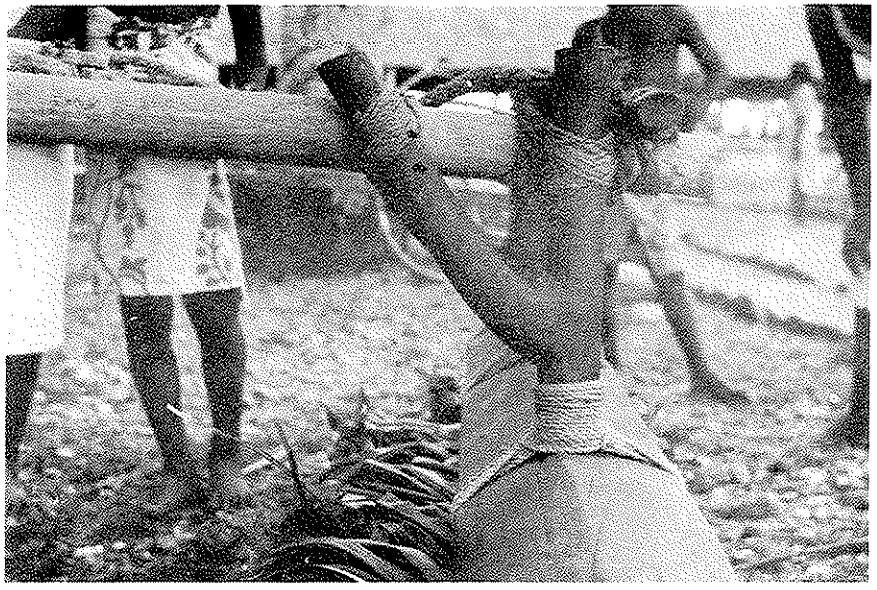
a. Hut raised on coral blocks in Southern island.



b. Two-storied hut on a Southern island.



c. Maneaba in Little Makin.

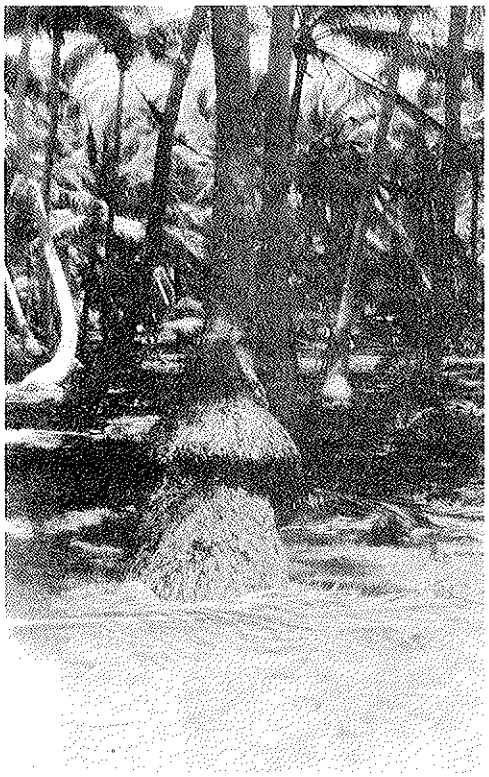


d. Coir lashings.

Plate II.

a. Dense undergrowth in coconut forest.

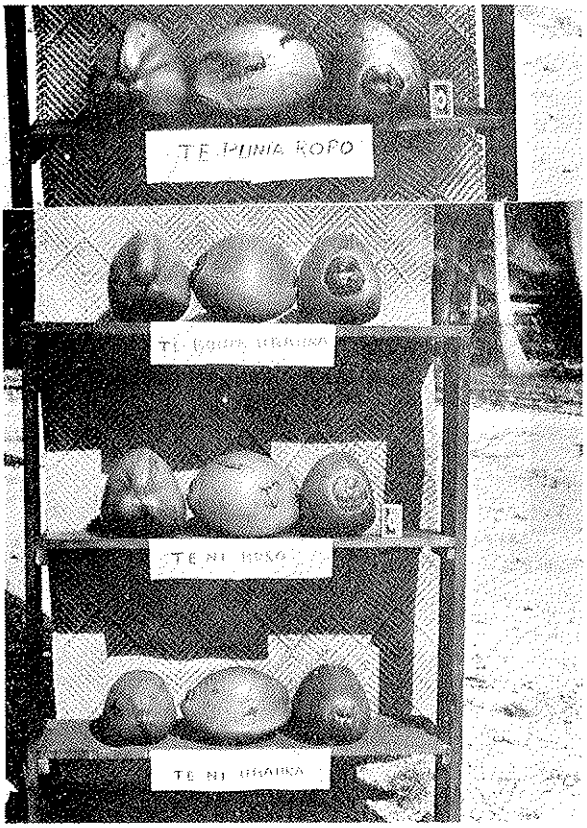
b. Drooping coconut fronds after drought.



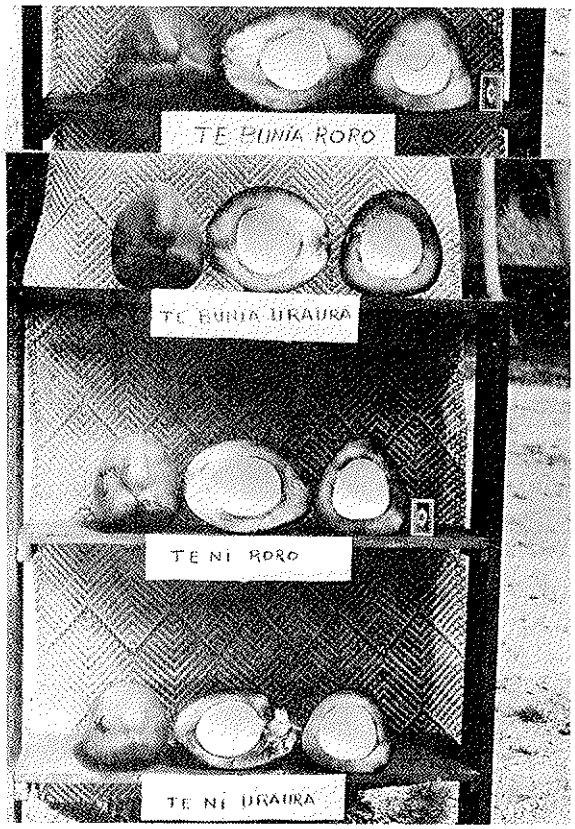
c. Abnormal root system of palm.

d. Accidental layering of coconut palm.

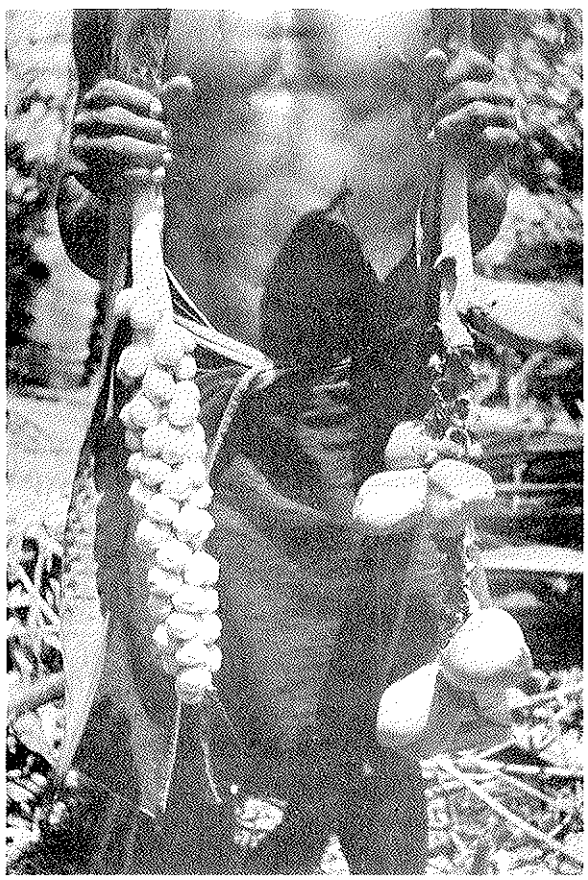
Plate III.



a. Four varieties of coconuts.



b. Same, cut open.

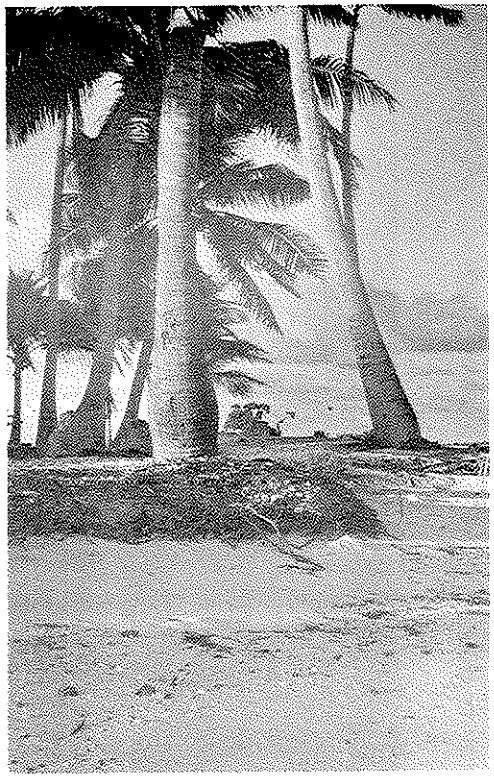


c. Coconuts on unbranched inflorescences (na mori).

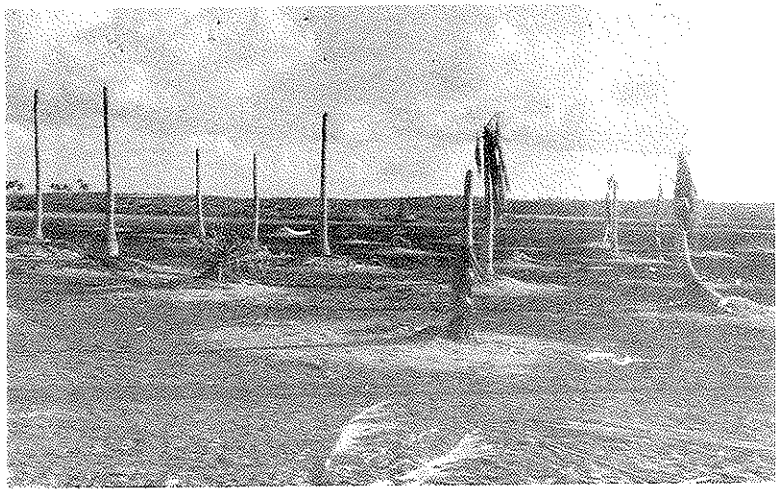
d. Aspermous nut (left) called te wae.

Plate IV.

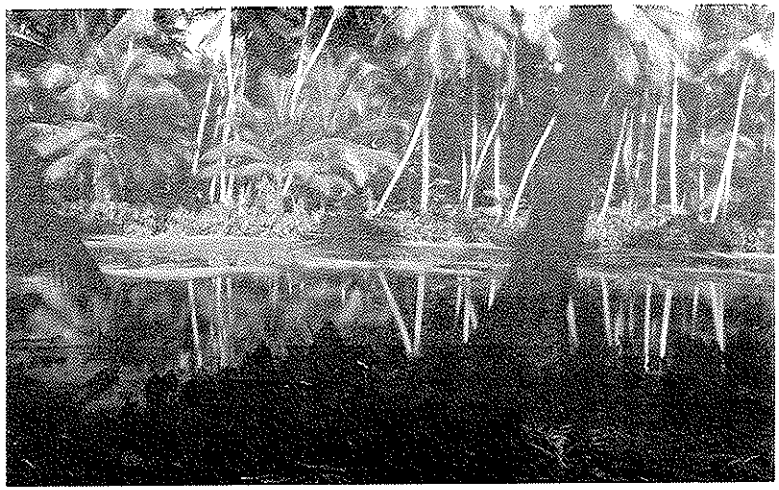
a. Palm with unopened leaflets on Marakei.



b. Trees undermined by sea erosion at end of islet.

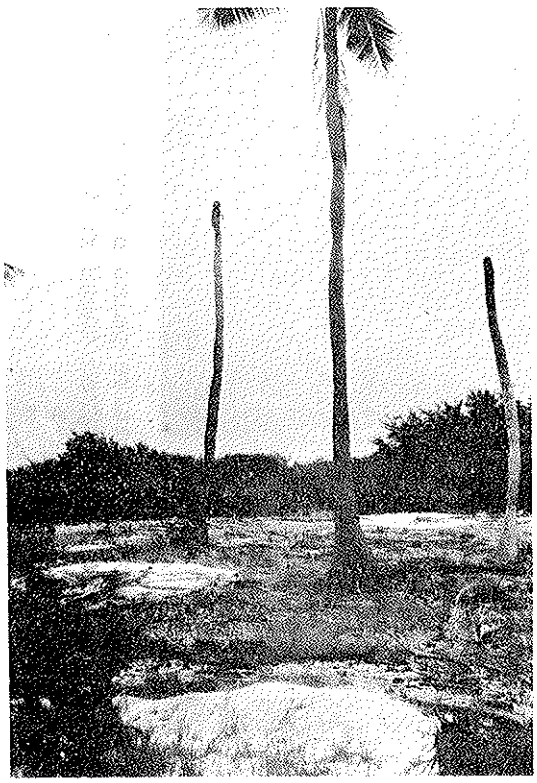


c. Palms killed by exceptionally high tides on Marakei.



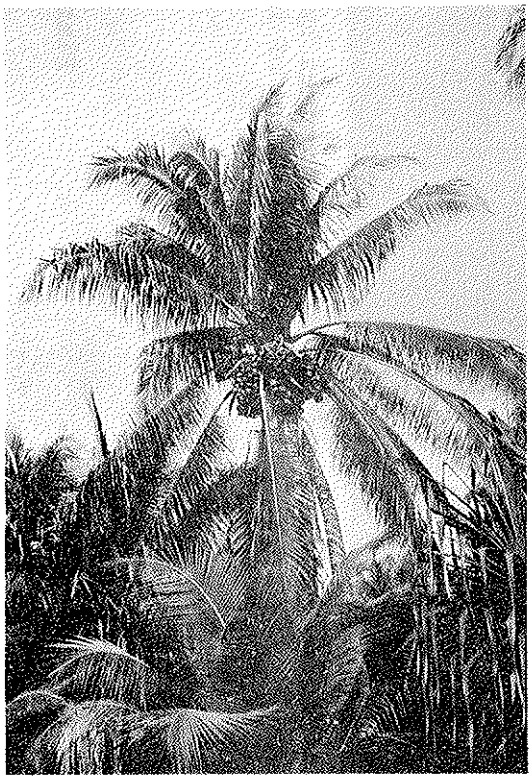
d. Very productive palms a few hundred yards away from those in V c.

Plate V.

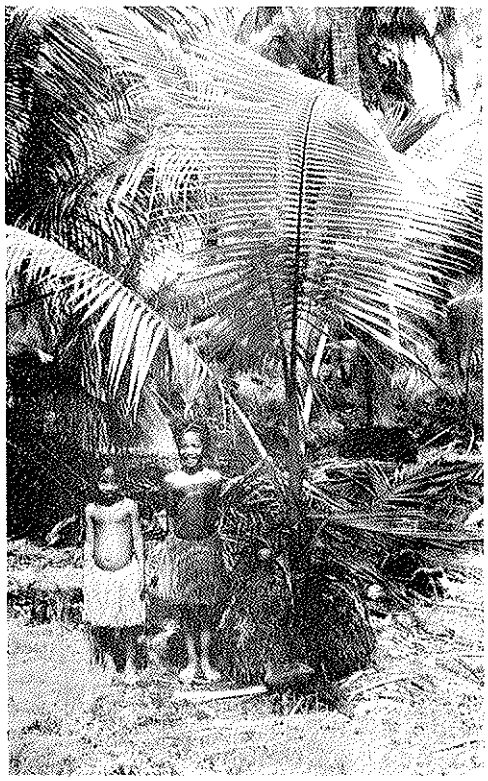


a. Marks of droughts: successive narrowings of trunks.

b. Palms on earth banks, Nikunau lakes.



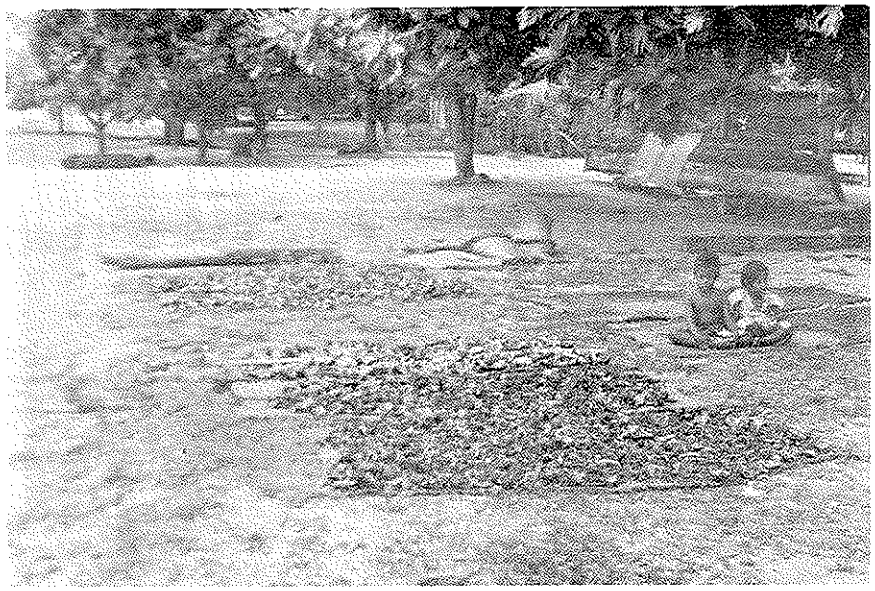
c. Palm of ninigaun type, used as seed bearer. This bore over 150 nuts.



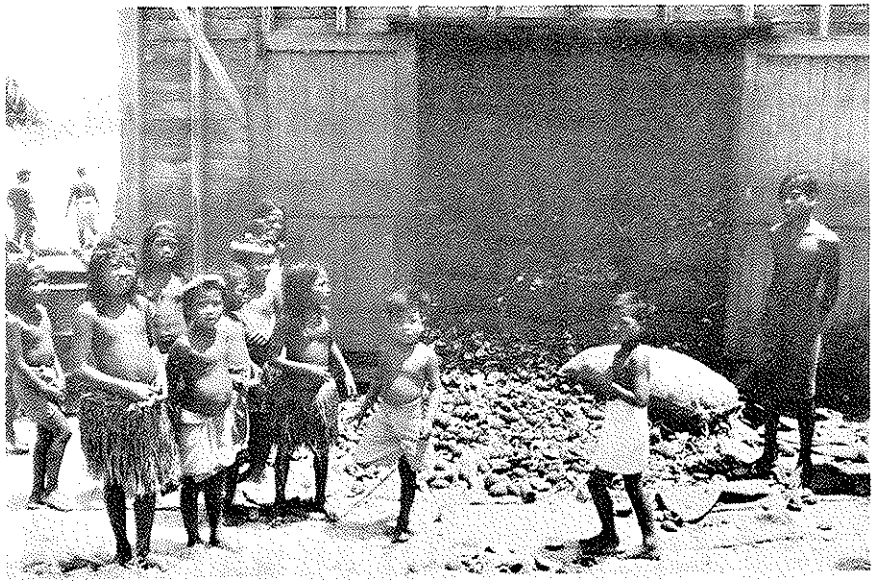
d. Palm planted on old stump, at edge of Nikunau lake.

Plate VI.

a. Cutting copra.



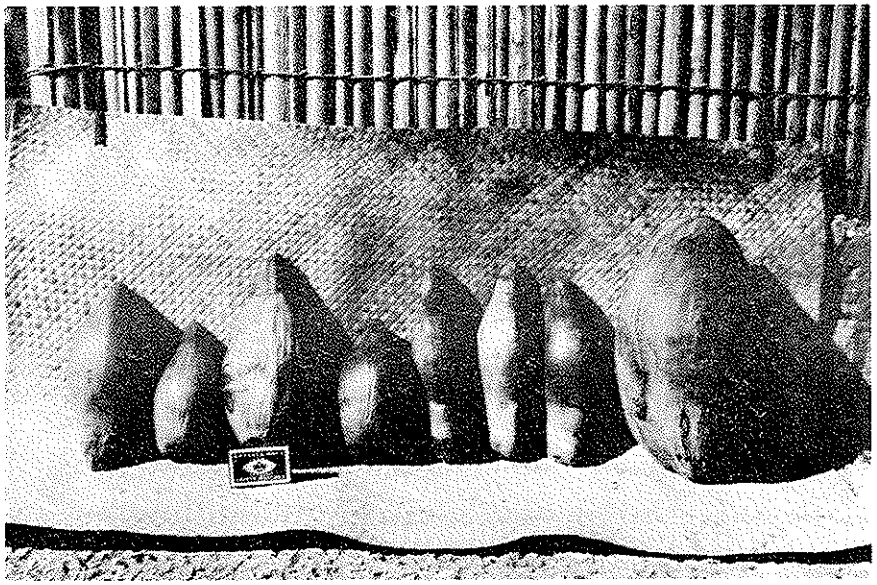
b. Copra drying in the sun on coconut leaf mats.



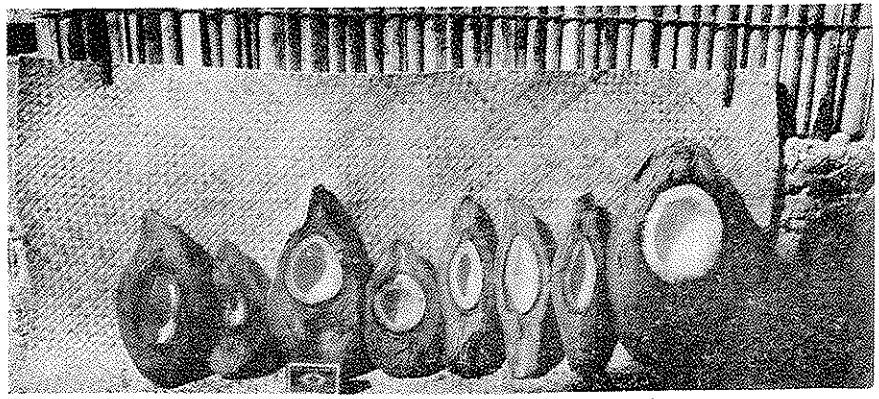
c. Copra pick-up point on Aranuka Island.

d. Te okai, shelter for eating nuts.

Plate VII.



a. "Drought nuts" from Nikunau. The medium-size control nut (extreme right) came from Tarawa.



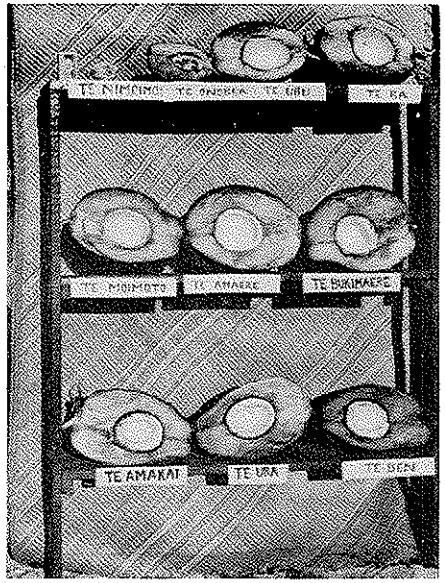
Number	1	12	29	43	46	13	49	Control	
inches	9	6.5	9	7.5	8.5	8	8.5	11	Length of rib
inches	11.5	9.5	13	11.5	8	8	8	17	Circumference
ounces	8	4.5	11	7	6.5	9.5	9.5	24	Whole nut
ounces	3	1.5	3	2.5	2	2	2	10	Albumen

b. Cross section of same nuts

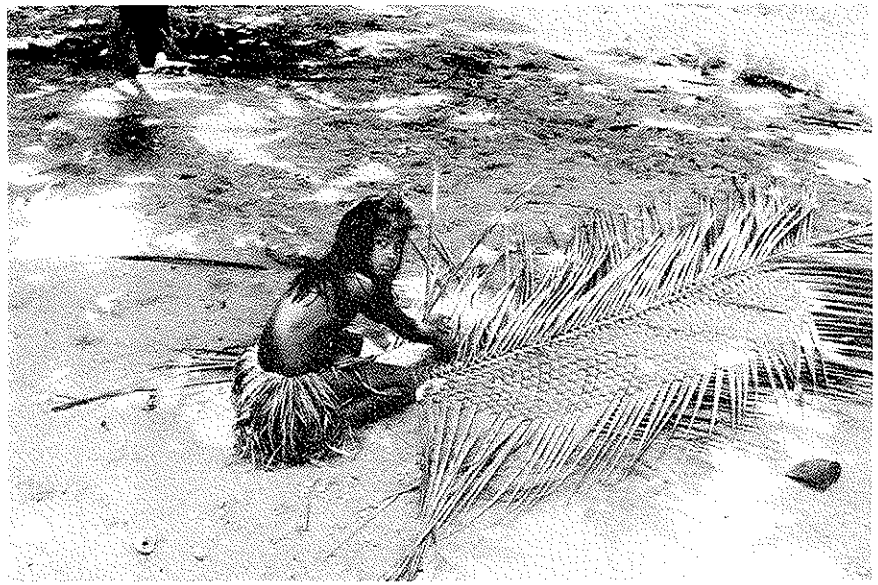
c. Tapping toddy. Note string tied to petiole below inflorescence to bend the latter.

d. Coconut shell container for toddy, with fragment of foliole guiding sap into it.

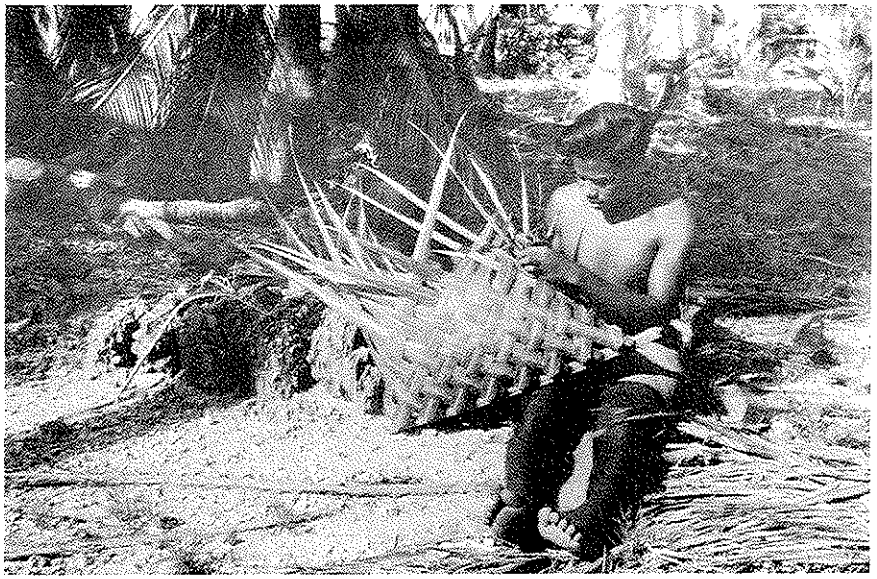
Plate VIII



a. Growth stages of coconut, with their Gilbertese names.



b. Plaiting a coconut leaf mat. Child's riri is made of young coconut leaves.



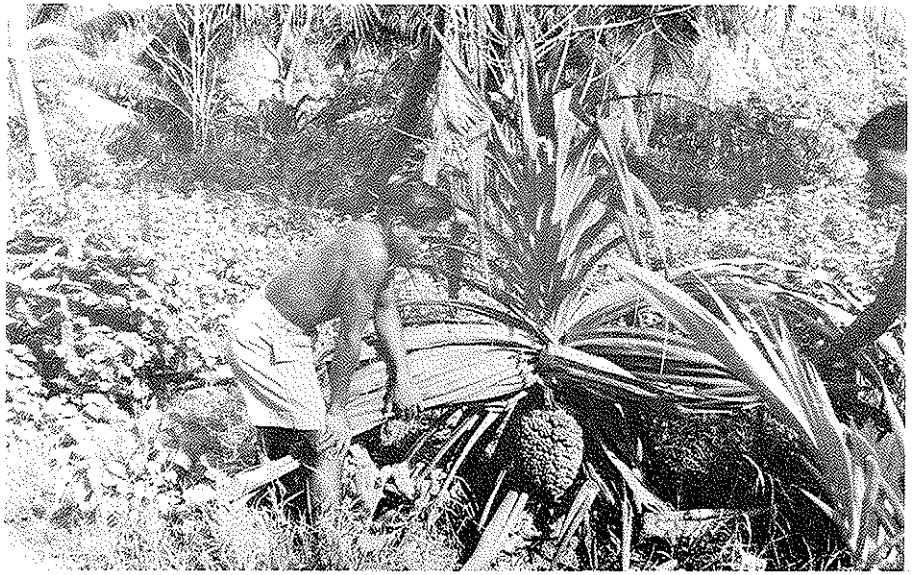
c. Plaiting a coconut leaf basket.

d. Two piece riri of te maunei (Cyperus laevigatus L.), southern Gilberts.

Plate IX.

a. Dense stand of Pandanus, babai pit in foreground.

b. Dwarf Pandanus on Nikunau Island.

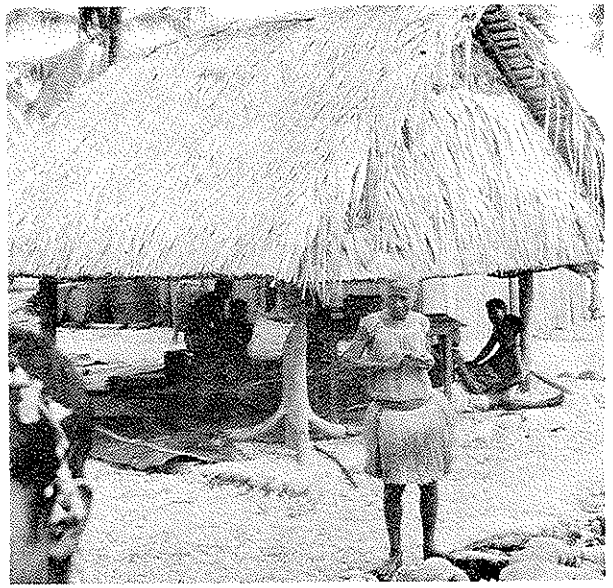


c. Arotokotoko variety of Pandanus, remarkably precocious dwarf plant.

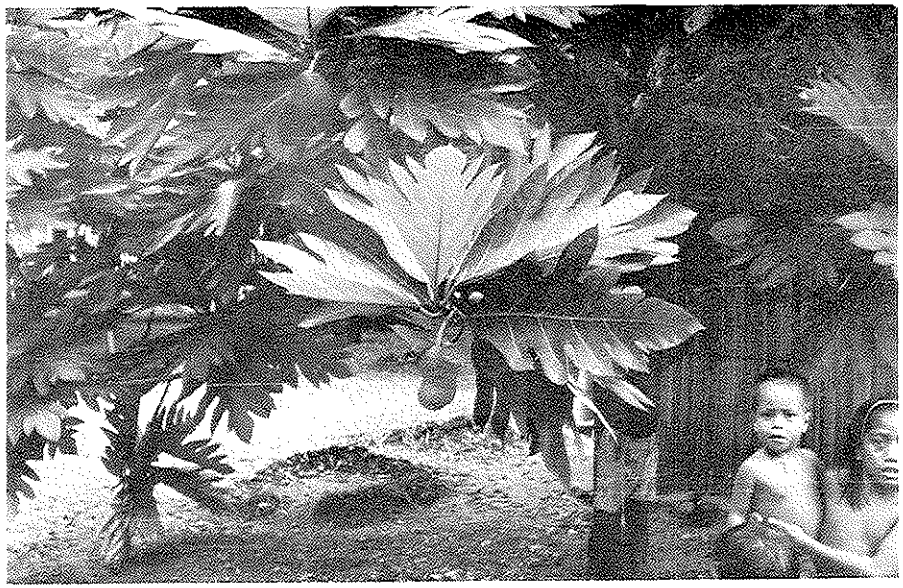
d. Te tuae paste, from Pandanus, spread on Guettarda leaves and covered with layer of leaves.

Plate X.

a. Cakes of te tuae in last stage of drying, spread on ground.



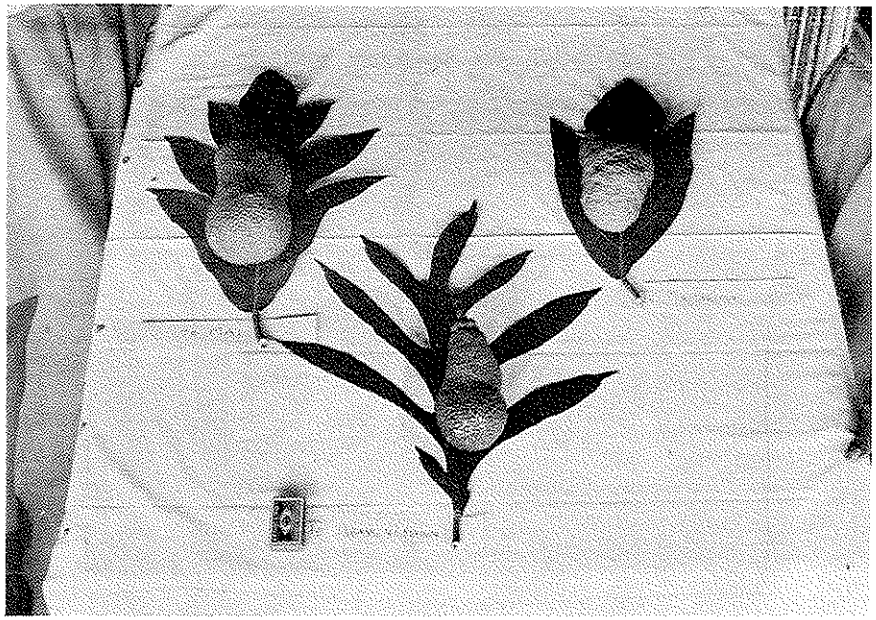
b. Cooking shed. Pillars made of branched Pandanus trunks.



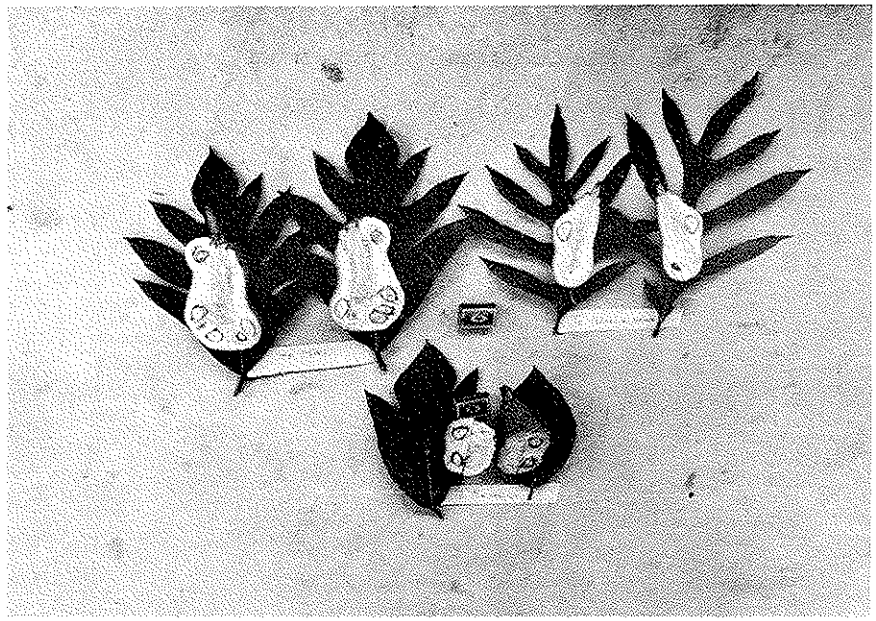
c. Te mai variety of breadfruit, fruit almost ripe.

d. Te keang ni makin variety of breadfruit.

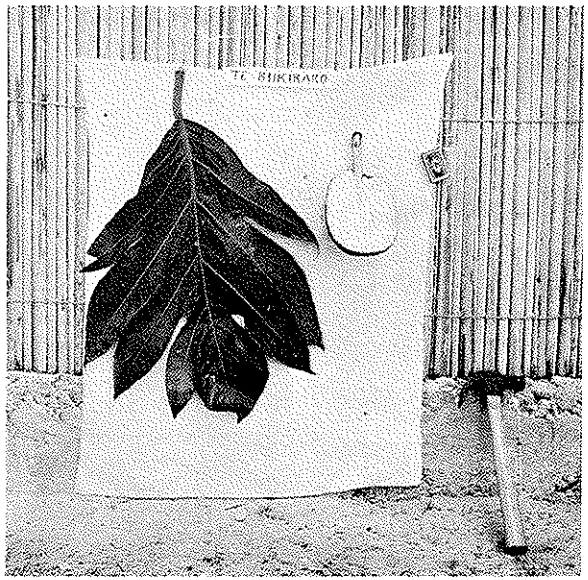
Plate XI.



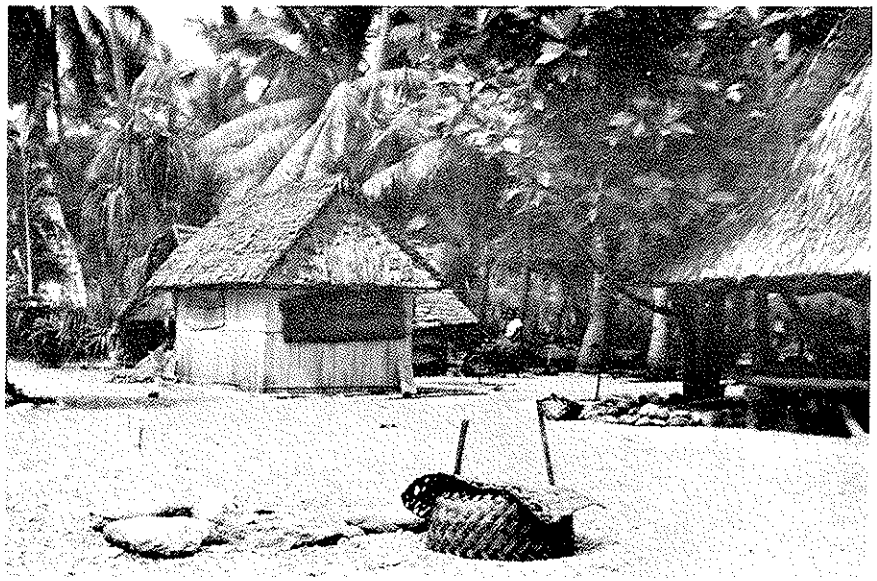
a. Fruit and leaf of varieties te mai, te maitarika, te keang ni makin.



b. Same varieties, fruit cut open.

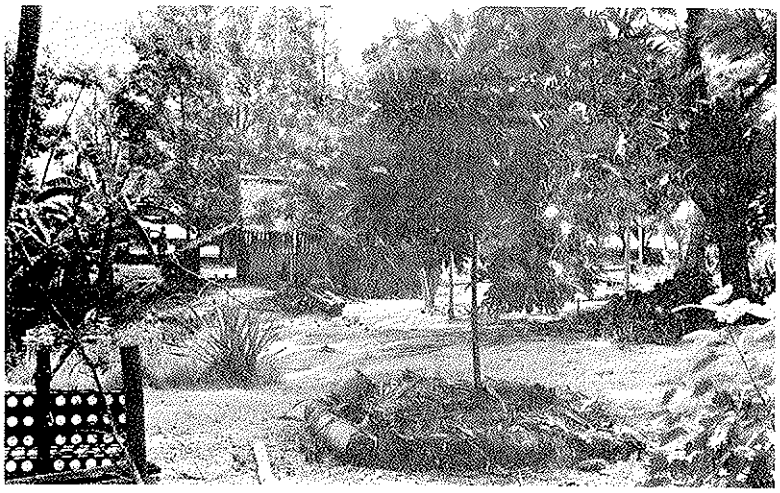


c. Seedless variety te bukiraro, reproduced by cuttings.

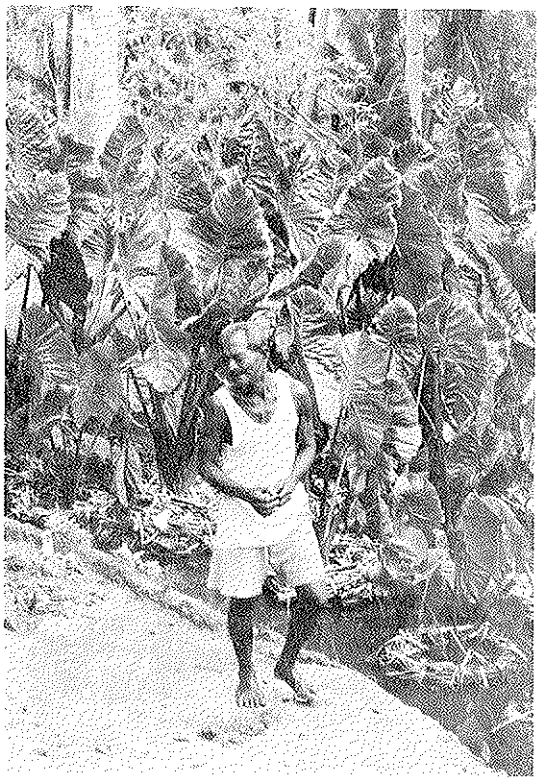


d. Coconut leaf mats protecting young seedling from children and animals, and from sunlight.

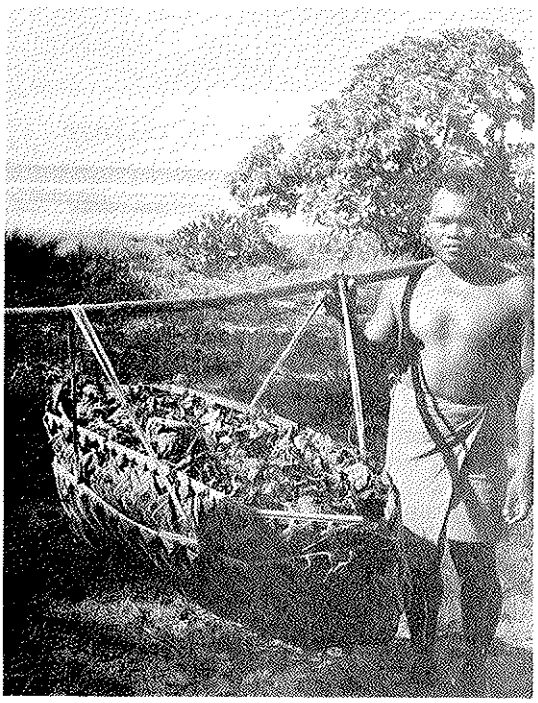
Plate XII.



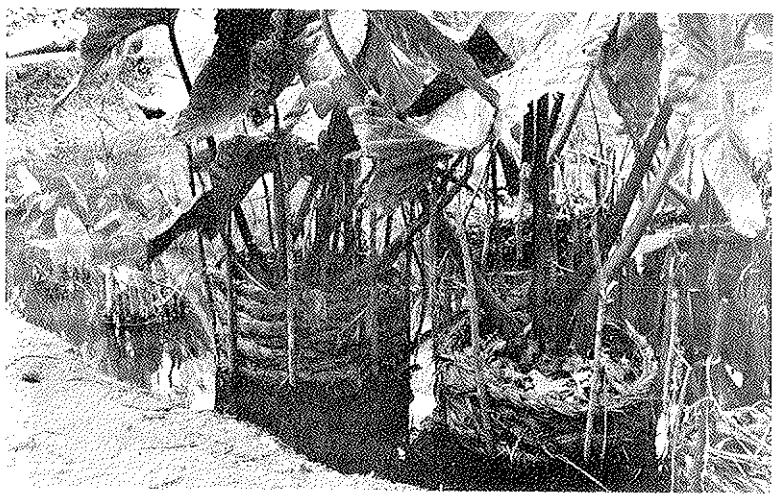
a. Te mai breadfruit, 4-5 years old, with frame of coconut trunks holding compost. Some branches withered by drought. Banana plants in old babai pit. Pig enclosure.



b. Babai plants, about 5 years old, well-tended.

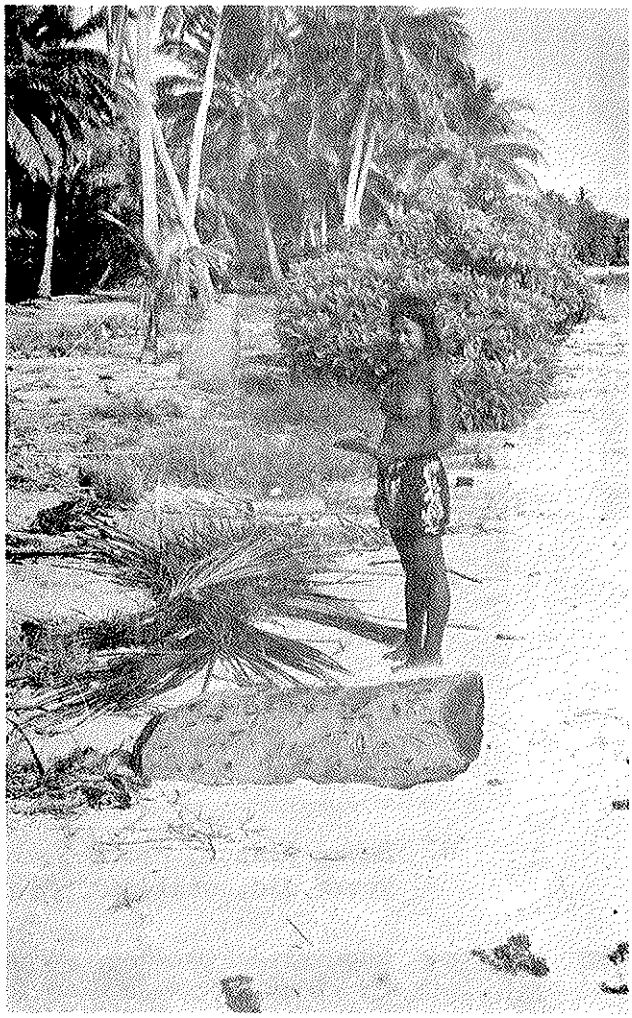


d. Carrying compost for babai plants in a coconut leaf basket.

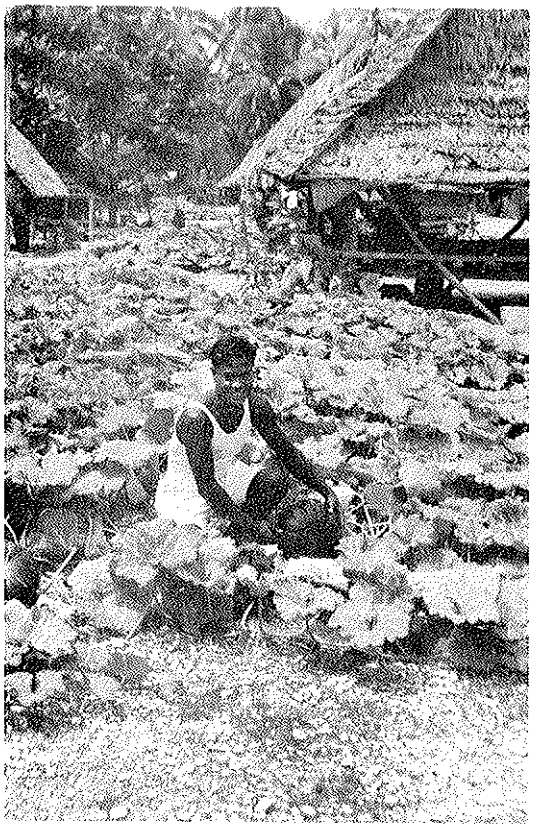


c. Baskets holding compost around babai plants.

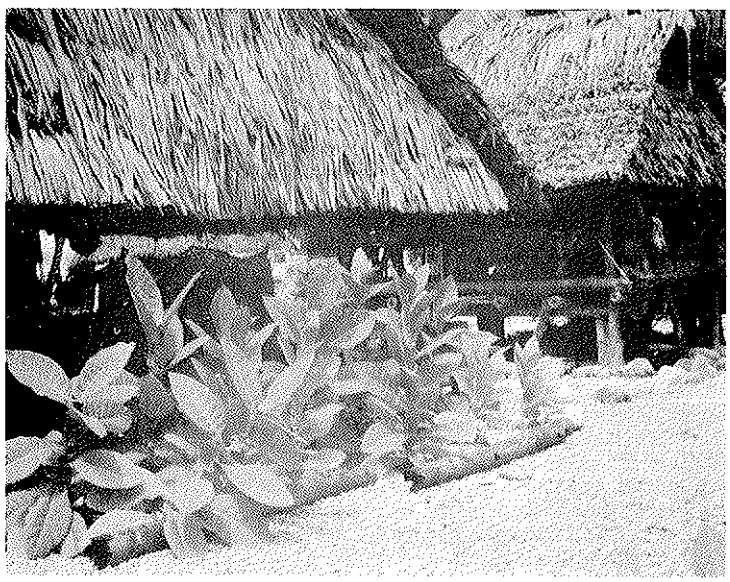
Plate XIII.



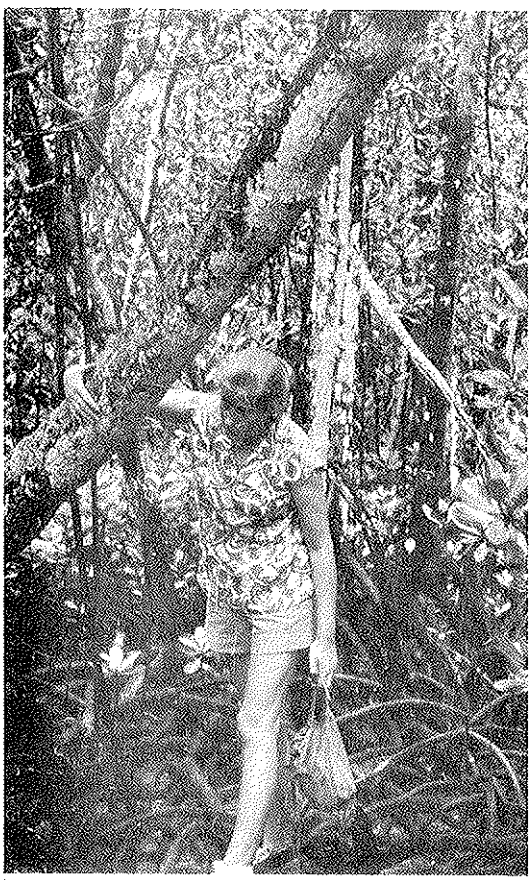
a. Vegetation at top of beach.



b. Pumpkin plants in village on Nikunau.

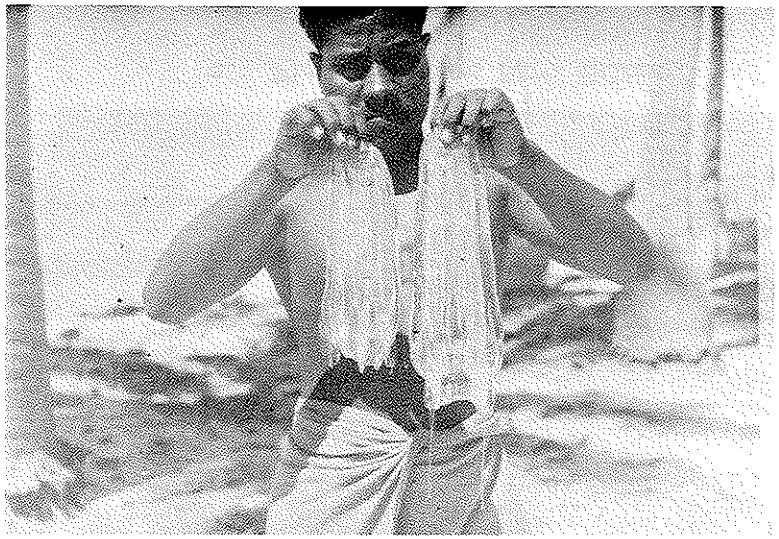


c. Tobacco plants in village on Nikunau.



d. Rhizophora mucronata on Aranuka Island.

Plate XIV.



a. Edible jelly fish te baitari. Tarawa Atoll.

b. Edible part of te baitari drying in the sun.

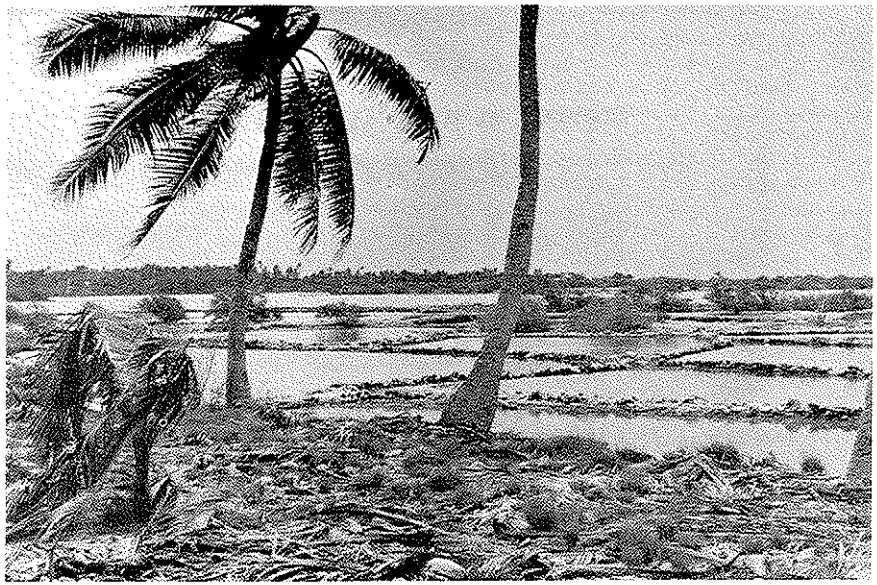
c. Stone fish-trap, on ocean side of Tarawa Atoll. See sketch fig. 21.

d. Part of a catch of 2,000 ikari trapped in one night in trap shown in XV c.

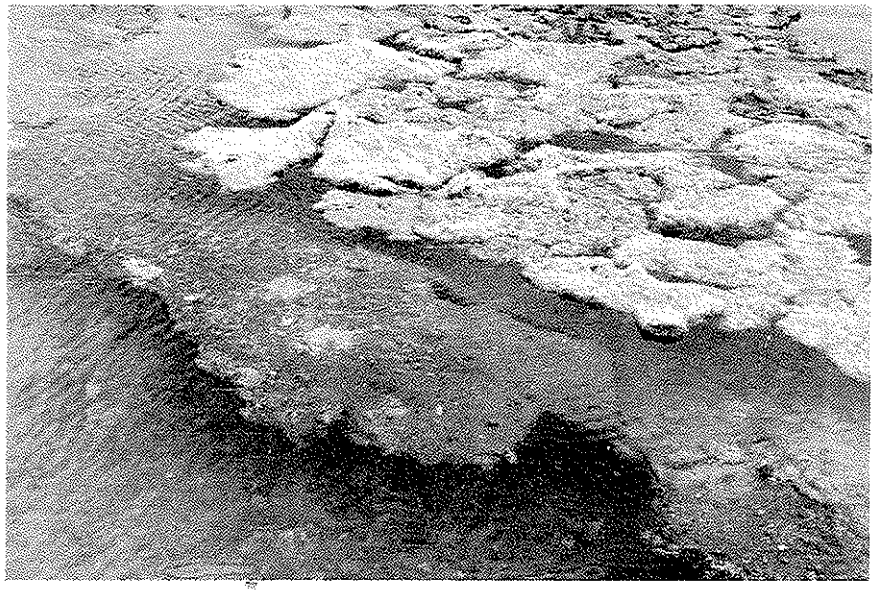
Plate XV.

a. Drying filets of ikari in the sun.

b. Carrying ikari back to village.



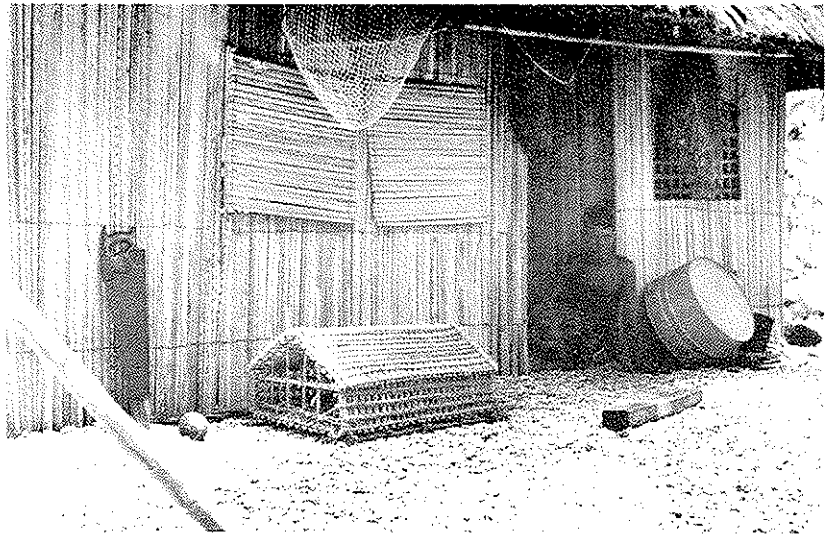
c. Fish-ponds on Beru Island.



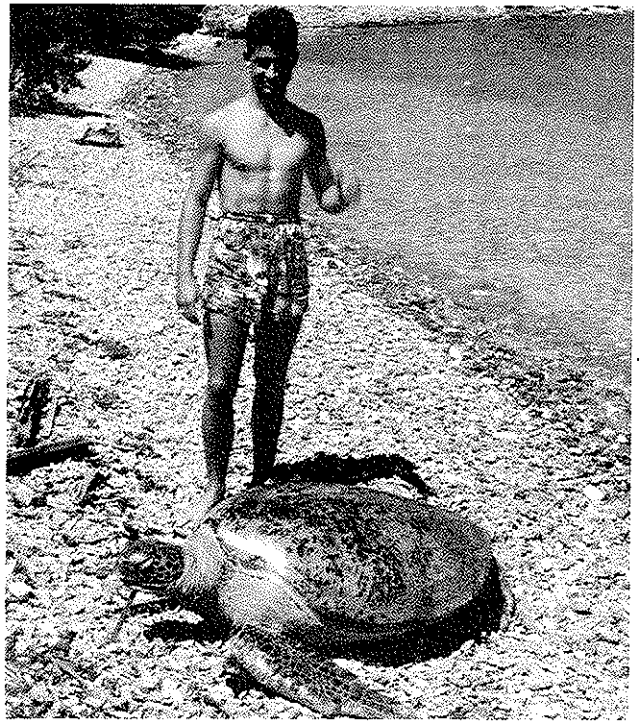
d. Edible algae in fish-pond.

Plate XVI.

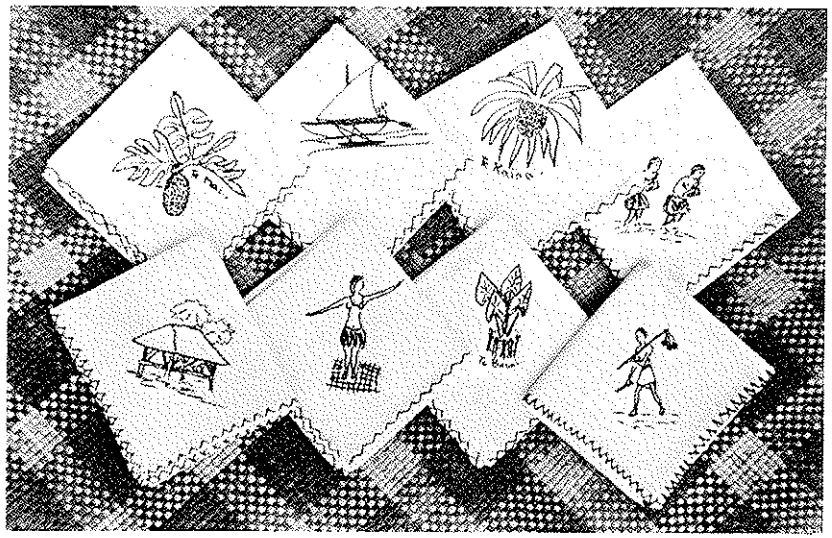
a. Native outhouses, sometimes used as fishing platforms.



b. Eel trap.



c. Green turtle.



d. Embroidery designs inspired by Gilbertese scenes.

Plate XVII.