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SIX MONTHLY REPORT OF THE WILDLIFE CONSERVATION UNIT, KIRITIMATI (CHRISTMAS ISLAND). KIRIBATI, CNETRAL PACIFIC OCEAN

Report No.10 June - December 1982

1) General

Many changes and events have taken place in the period covered by this report. Some of these represent several first major events both to the Unit and the wildlife and also to development and Government. In one way or another some of the changes resulted directly or indirectly from the events but it is interesting that the natural occurance of such events coincided with human activity so that this report presents an interesting period in the history of the Unit, the wildlife, development and Government.

2) Dissolution of Kiribati Parliament

The Kiribati Maneaba Ni Maungatabu (House of Assembly) was dissolved in early December, 1982 following an order made during the day's sitting of the House. It is hardly a year since the formation of the new House after the preceeding Government came to the end of its term. This is the first time in the history of Kiribati particularly after the attainment of independence that the House is dissolved. Another general election has been scheduled for 11th January next year and hopefully members of the House will assemble by the end of that month. Election of the Beretitenti (President) will then follow.

3) Staff news

Martin Garnett left Kiritimati at the end of his assignment last September so that this report is the first to be written entirely by his successor. Martin's departure, however, does not neoessarily mean the end of his connection with Kiribati. While in England, he will continue to serve the Unit in his role as Secretary to the Advisory Panel on Nature Conservation in the Line and Phoenix Islands. His first months there will be devoted to the completion of the 'prescription' part of the Management Plan for Nature Conservation in these islands. The first and second parts of the plan were completed while he was here. Everyone here compliments Martin on the splendid work he accomplished as our Wildlife Warden from which the Unit achieved much both in the past and for the future. Wildlife Assistant Jotam Kirata is also expected to leave the Unit in January following his previous request to be transferred back to his former employment in the Agriculture Division on Tarawa. Mr. Moiaua Toariri, an ex member of the Kiribati House of Assembly, has been appointed to take his place. Mr. Toariri was originally a teacher by profession before joining Parliament as representative for Kiritimati.

His appointment to the Wildlife Unit will be a help to our teaching programme. His previous qualification and experience in teaching at Primary Level meets the requirement needed for the teacher-type Assistant. We hope that in the New Year Moiaua will take over the teaching work from Utimawa Bukaireiti but we will continue to help him with the overall planning of the course as well as with the preparation of weekly lessons.

4. Weather

a) The recent rise of the sea.

Christmas Island was affected recently by the rise of the sea which began in mid-July. According to reports the rise increase significantly peaking at approximately 170mm above the 1982 average which is equivalent to an approximate 7 inches increase in sea level. Following the rise the prevailing Easterly soon collapsed and wind direction became variable with strong Westerly winds sometimes occurring. The following month (August) heavy rainfall began and increased steedily right through the rest of the year. Extended long calm periods persist at intervals. This unusual weather has been identified by the Research Institute in Hawaii as an El Nino condition which had accured in 1940, 1953, late 1957 to early 1958, 1965, late 1972 to early 1973 and late 1976 to early 1977. El Nino conditions are limited to an area along the equator of between 5°N and 5°S and is characterised by certain factors such as the increased sea level, occurance of heavy rainfall, etc. The current El Nino condition is predicted to subside by March 1983 at the latest.

b) Heavy rainfall

Christmas Island has been and is still being blessed with heavy rainfall. This began last August soon after the rise of the sea level. Records show that November was the wettest month with 25.41 inches measured at the *Bridges station near Banana and 485.2mm at London village (same month). The greatest fall in one day was on the 14th November with 104.7mm recorded. This was followed consecutively by another 89.2mm the following day. The table below summarises the rainfall pattern during the year ending 1982.*(28.46" in December at Bridges though)

Figures are in mm.

Month:	J.	F.	M.	A	M.	J.	J.	A.	S	O.	N.	D.
Amount(mm):	13.1	6.7	37.8	79.2	73.4	76.5	65.4	236.8	154.0	339.8	485.2	284.9

The total derived from these figures(1852.8mm) showed a new record since 1973 when the last heaviest rainfall occured. Comparative figures during the preceeding years from 1972 is given in the table below:

Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Amount:	1600.4	1642.2	303.6	472.8	1470.4	1059.1	371.9	701.4	734.5	710	1852.8

The rainfall of 1982 came with a relieving result. Tap water is now as fresh as rain water but before the rain it was as salty as normal sea water. Elsewhere on the island the immensity of the rainfall has freshened the highly saline waters of many of the land-locked lagoons particularly the small ones. The bigger lagoons on the other hand have been significantly reduced in salinity, filled full and overflowed, On the 14th and 15th November the consecutive immensity of the greatest fall was so tremendous that the tarmac road, especially between London and the new leased village was continously flooded. The memory of these days was the sight of vehicles parked alongside the road having developed mechanical problems after been driven through deep water and also the sight of children paddling their corrugated aluminium canoes as a means of transportation between the two villages and people fishing with gillnets in the road. In the villages the flooding caused by the heavy rain was so severe that several houses had their wooden or concrete floors completely submerged(some 6 or 8 inches) below the surface. Even the workshops and some of the offices were affected. Various significant changes resulting from the rain are evident both to the birdlife and development as reported in the next heading.

c) Effect of recent weather on Wildlife

The recent unusual weather brought several first major effect both to the Wildlife and development. For the first time ever to be recorded, the Sooty-terns have been unable to turn up for their breeding season (December 1982). These birds usually appear in mid or late but sonetimes early November. Afew individuals and pairs were occasionally seen in flight. At the south-east peninsula boobies, especially the ground-nesters, are no longer to be seen roosting. Normally individuals and groups are present at any time of day. Few have been seen flying around over certain parts of the island. The Wedge-tailed shearwaters were probably the most seriously affected. It is difficult to give a mortality estimate of the chicks as the flooding of the rain spoiled the evidence from which we could make a rough guess. At several accessible mainland colonies the burrows had been partly or completely filled as a result of erosion while others collapsed. Though the main colonies are on high ground, burrows could not stand prolonged periods of heavy rainfall. The low-lying outlying colonies were completely submerged during such periods. On islets, as noticed on Motu Tabu, many of the burrows were surprisingly in better shape. Perhaps the size of Motu Tabu(being tiny) allowed drainage of rain easily into the surrounding sea. High chick mortality was also evident to the Lesser Frigatebirds. During a recent check-up of the colony many of the chicks had already died while many others were completely helpless. Probably the parents were forced to abandon them during the storm. On islets tree-nesting terns and noddies are still present but in noticeably lower numbers than before. The effect on the vegetation also resulted in mortality but this is evident only in certain low-lying areas where the final drainage(usually in the vicinity of lagoons) takes many weeks.

5. Development

a) Air Tungaru

Another change was made to Air Tungaru's flight schedule during the period and for maintenance reasons flights were cancelled in December between Honolulu and Christmas Island and so to Tarawa. The Captain Cook Hotel was empty in December as the last visitors departed before the last flight. However, in November the hotel, for the first time in its history had received more guest than it could accommodate and the overflow were accommodated in the Development Officer's house. Flights have now been resumed from 8th January with a weekly service to Christmas Island and a bi-weekly service to Tarawa. With Air Tungaru now working closely with the Tourism Office we hope that a smooth running of the aircraft could now be maintained to a better extent in the future.

b) Christmas Island sea link with the World

A new shipping route has connected Kiritimati with the mainland USA and several other Pacific Islands. This commenced in August when the "Cenpac 2", a 5,855 ton cargo liner of the Nauru Air and Shipping Agency made its first call. The vessel operates every fifty-five days from the US West Coast ports of Long Beach and San Francisco to Honolulu, Christmas Island, Western Samoa, Tarawa, Majuro and Ebeye and returns by the same way. The link to Christmas Island provides a means of reliable transportation of our copra to its new market in Samoa. In addition the service also provides a means of importing goods into the island at cheaper prices than as by air. Investigations are underway to see whether new exportable products such as fresh coconuts and hearbs of palm can be shipped regularly to customers on the West Coast of USA.

c) Tourism

The period covering this report saw the arrival of the first ever major group of the naturalists-type tourists to visit Kiritimati. Twenty people of the 'Travellers Century Club' arrived in September for a week long tour of the island. They were offered visits to bird reserves including areas of wildlife interest, a tour of the milkfish culture system, around the island tour and several other sightseeing trips. Other excursions involved visits to see local women at community work activities as well as watching local men at toddy and copra cutting. The group comprised people aged sixty and more and perhaps it is for this reason that the excursions on the whole were succesfully conducted by the two paermanant guides between whom the group was divided. This visit to Christmas Island was an extension to the group's tour of Micronesia that had been organised by Universal Travel Systems of Los Angeles, California. Other visitors before and after had as usual involved individual bird enthusiasts as well as couples mainly from the States. Dr.R.W.Schreiber of the Los Angeles Natural History Museum had also visited on several occasions during the period with a group.

He is expected again with his group in March and possibly again later in 1983. It is obvious that the naturalist type tourism is begining to build up not only in number of visitors taking part but also in the number of visits. Fishermen tourists on the other hand have been flowing more regularly so that tourism on a whole could now be expected to contribute more to the economy. With Air Tungaru now working closely with the Tourism Office we hope visitors could now rely to a better extent on future Air Tungaru itinaries. In March 1983 another major group of twenty (minimum) have been confirmed to visit Christmas Island. This group is comprised purely of birdwatchers. The group is organised by 'Wings Inc.' of Los Angeles, California and arrival dates have been confirmed as 5th March. They are expected to be here until the 14th.

d) Solar Salt

The solar salt project is one of the main areas of development seriously affected by the recent weather. Construction work on the 500 tons per year salt plant began in June. Work was almost half way through when in July the sea rose significantly causing tremendous influx into many of the inland ponds. The site of the project adjacent to the huge lagoon of Manulu was soon covered and in the end submerged completely leaving only few top parts of some completed outer walls projecting above the surface. The huge Manulu lagoon was even filled up full and overflowed into nearby tributaries. It was stated that the flooding would have been avoided had the 3ft. high peripheral wall been completed before the rise in tide and heavy rains. Mr Chester Jenkins, UNIDO Consultant to the project reported that the effect of the weather has had a short-term impact on the programme but long-term operations should not be affected. A visit by Dominion Salt Ltd. executives was expected in November but cancelled due to the suspension of Air Tungaru flights during that month. The visit is now being schedulled to January, 1983. Construction work on the 500 ton plant is expected to resume as soon as conditions permit.

e) Fisheries and Marine Export

Like the solar salt project, fishery is another area of development affected by the rise of the sea. It was reported that about a quarter of the milkfish harvest escaped into the main (open) lagoon because of the overflow of the ponds. Immediate steps were taken to offset the massive influx from several points of inlet but the series of inter-connected ponds in the Milkfish Culture System were filled allowing excessive water to drain many directions and soon in level with the main lagoon. Opening of the dam was no longer necessary in order to attract fish and the harvesting was made difficult. As a result the Fisheries Division had failed to meet export requirements of milkfish since the occurance of the rise. In addition the cancellation of Air Tungaru flights in December also had made exports impossible. The Marine Export Division annual gross sales during the year 1982 was AUS$231,000.00

f) Agriculture

Since July, heavy rains have meant greater production of vegetables particularly English cabbage, Melon and Cucumber. Sales were principally directed to the hotel but surpluses are being sold in Banana and London villages on an alternate basis. Direct sales from the plot meant cheaper and affordable prices. The Agricultural Officer went to Tarawa in October to discuss future funding of the project. In December, a hydroponic unit was started and is so far operating successfully although the heavy rains have caused minor problems with the dilution of the nutrient solution. The scheme will probably take some months before it can be properly evaluated.

g) Copra Scheme

Heavy rainfall since August has meant higher coconut yields but reduction to copra actually produced. In November 94 tons of copra were shipped which represent the amount produced during part of August and the whole of September and October. Before this 294 tons were shipped in August which represent production for the 6½ months period including the first part of August. The total production during the year was 452.23 tons which showed an increase over last years 368.36 tons. The world price of copra has dropped from more that $300.00 per ton at the start of the year to less than $200.00 per ton in November.

h) Settlement of Kiritimati

More lessees have moved out of Government houses to live on their plots and it is expected that all the sixty-three families will eventually come together to form up the entire village. Minor problems aroused recently because some lessees have been given permission to set up temporary businesses (stores) in the villages. This discouraged them to move to their leases. The matter is being looked into and hopefully a solution will be found soon.

i) Dump clearance

A three-men team of the Australian Army have arrived on Kiritimati to organise clearance of the debris which were left from the time of the British and American occupation during the H bomb tests. The team will be here for four months during which time they will be working and teaching local people who are now working with them in cutting, removal and welding techniques. As part of the programme, good metal scrap(non-ferous) will be removed and exported to be re-used. It is hoped that the money received from the sale of the scrap overseas will be sufficient to pay the wages of the workers. Machinery and other equipment have arrived recently and work has already begun.

j) Caroline, Flint and Vostok

The development proposed by Captain Omer Darr on these atolls have not been started. It is not clear why. On the other hand it was revealled from file records just recently that the latest lease licence had expired and it appears that Omer Darr would have to renew his lease agreement for the three islands before proceeding with his development plans. As mentioned in the last report, turtle farming is part of the scheme. Our concern over the project at first was little basically because we are unknowledgeable and inexperienced in that field. The news of the scheme, however, has been a subject of concern by turtle conservationists; Dr. George H. Balazs of the University of Hawaii has expressed his views against the project. He advised that similar projects elsewhere in the past to which he himself had been commissioned to take a consultative study have had the reputation of coming to total failure in the end. Basically, the main argument concerns the biological problems that would be involved and that such a scheme does not in the end, become a means of exploiting wild populations which is of course contrary to existing legislation in Kiribati. This is something that needs to be reviewed while the scheme is being delayed.

k) Fanning and Washington Islands

Representative of the Government of the Republic of Kiribati and Burns Philp met in early January. The meeting resulted in the sale of the two islands for A$1.5 so that Government has finally taken over possession.

l) Penny Bay Resort

Government wrote recently to Architects and Planners Inc. who have expressed continued interest over the project. They are now awaiting the formation of our new Government before finalising their plans.

6. Feral animal control

a) Pigs

Feral pigs are still present in small number on the south-east peninsula. Another six were killed during the period. Of the five shot by the wardens two were pregnant females shot just in time before bearing young. One pig was again killed by lobster fishermen. With the newly introduced 'Control of Animal Order 1982' we hope that the number recruited into the feral population will be very minimal, if any. Our sighting records during the period comparable to our successes indicated a total of about four or five more pigs remain to be cleared from the peninsula.

b) Cats

Feral cats are becoming more and more difficult to get than they were previously. Heavy rainfall which began from August had greatly added to the problem of hunting. Many of the hunting trips were not completed because of the heavy rain

while in some cases some trips were cancelled. To cats the rain was an obstruction to be out feeding under and in fact very few cats were seen during October, November and December. The few sighting records during these rainy months represents sightings at unexpected times of the day such as at mid-day, late morning or early afternoon. The total of sixty-six cats were destroyed during the period. We hope that the continuation of intensive hunting with the newly introduced byelaw will eventually make a significant reduction to the feral cat population.

c) Control of Animal Order 1982

Pursuant to this order, a campaign whereby unwanted domestice animals are collected from every household has been initiated in Banana and London Villages. Such animals include female cats and dogs in addition to all unlicensed pets. The campaign began on 29th November - in Banana by the wardens themselves and in London by the prisoners. The cats were seized using a handled net but in some circumstances the net was not used as the cats were tame enough to be picked up easily. The animals taken were kept in wire enclosures for twenty four hours before being taken away and destroyed. During that time they were fed regularly. As originally proposed, the campaign should commence after the arrival of a Vetenerian officer who should carry out the neutering operation of female cats at the request of their owners. The initial proposal, however failed due to mental illness inflicted on the officer appointed. Alternative arrangements until the availability of the vet. officer has been made whereby female cats acquired after the order came into existence would be surrendered by their owners. Those owned before the order were given special concession : at the owner's wish. It was made clear that we will continue to collect kittens produced by all such females until such time that the animals have been neutered or died after which no more females should be owned. Trapping in the villages was also part of the programme and so far a total of forty five cats have been destroyed. Of these nine were trapped and the rest collected. We are grateful to be able to being loaned seven additional traps by the US Fish and Wildlife team who recently returned from Jarvis via Christmas. These traps have proved more efficient than our own hand made ones. We hope to extend our programme to Poland village in mid or late February 1983.

d) Feral cat control on Jarvis

A programme attempted at eradicating all the cats on Jarvis atoll was launched recently by the US Fish and Wildlife Service. The island is part of the Line Islands being some three hundred miles to the south of Christmas. It is, however under US jurisdiction. The first operation was made in June by a two men team who spent two months on the island camping, hunting and trapping. In the second visit Wildlife Assistant Utimawa Bukaireiti joined the second two men team at their invitation. The second visit, this time lasted a week during which time Utimawa was able to learn some night time hunting tactics. He was also able to learn and share some live trapping techniques which was part of the programme. Such programmes are useful in providing a kind of practical training for us.

7. Education

The course in the second and third term was based on the birdlife and the plantlife of Kiritimati. For both terms, we have compiled the course ourselves since the material provided by the SPC Regional Environmental Programme have been completed last year. In the individual lessons given each species of plants and birds were treated as one lesson topic. The lessons concerned mainly the identification of species; name, colour sex differentiation, breeding season, habitat etc. In the case of plants our teaching was concerned mainly with the names and distribution in relation to the soil type. On the whole, the course was easily understood by pupils. For next year's course, we hope to introduce again the materials from the SPC as most or probably all pupils in next year's class 7 will be new members. Possibly, we will have to repeat the materials every two years.

8. Research

a) The Sooty tern breeding season of June, 1982

There were four main colonies three of which were mapped for the first time. Mapping was done by marking the colonies with stakes at every fifty metres around the edges. Starting from point A the bearing of each stake was then taken with the field compass. The position of point A has to be known exactly in relation to be 1:50,000 scale map of Christmas Island. Using a conversion scale of 1" to represent 50 metres (on an inch graph paper) the bearing of the stakes were then plotted onto graph. The total area of the colony was worked out simply by counting the number of square inches within the shape on the graph which represent the shape of the colony mapped. The area on graph was converted into the 1:50,000" map and the same shape of the colony (smaller though) was plotted exactly from point A. During the mapping particularly after staking, some problems were experienced some two or three days later with the changes to both the size and shape of the colonies. Such changes were brought about as a result of laying which varied within any one colony. This required boundary adjustment not only once but three and sometimes four times. At K site the change occurred when the second colony started peak laying some six or seven days after the first have been marked. The original boundary was adjusted accordingly but during the week lapsed before the adjustment, part of the original colony had become scanty of eggs. Other colonies as well need adjustment but we feared that repeated visits to the colonies particularly at day time might have a similar implication. This forced us to leave further adjustments and eventually the count as well. For the future we should try to think of how better we could do the mapping and the counting.

The areas of the three colonies mapped are:

Cook Island - 10.25 ha
North-west Point - 9.81 ha
K site - 13 ha

Remembering that the colonies varied in shape and size after the first mapping, the final areas at the end of laying would be bigger. The season on the whole had been another successful one for the terns. Large numbers of chicks fledged from each colony.

Evidence of predation was lower than as in previous seasons and perhaps this had resulted in the intensive hunting of feral cats. December 1982, however, brought a turning-point in the breeding cycle of the sooty terns. For some reasons they have been unable to turn up in December and it is believed that the unusual weather since last August was largerly responsible for this.

b) The Wedge-tailed shearwater

It is unfortunate that the censusing of the shearwaters proposed in November had failed due to bad weather. Most of the main colonies were inaccessible because of the flooded roads and tracks. Persistence of torrential-like rainfall at times through the rest of the year augmented the flood making journeys risky and difficult and at other places virtually impossible. Also other plans in November had to be scheduled around with the censusing and other daily commitments. With persistence of bad weather, priority was in the end given to the cat trapping and seizure campaign. It will be interesting to see what happens to the shearwater colonies after the immense rainfall. A check-up will be made as soon as the roads in the central lagoon areas dry out.

c) Survey of the Christmas Island Warbler

Our survey of the Christmas Island Warbler on the Western parts of Christmas Island have now been completed. Unfortunately the result can not be included with the report as the data is still being analysed. We hope to be able to pass a special edition of the result as an addition to this report. The analysis so far dealt with finding the distribution of the warbler with relation to individual plant species. We are also looking at the distribution with relation to canopy height. From these we will go on to look at the distribution with relation to the individual and associated coverage of plants etc. We hope that from all these we should be able to find the distribution pattern and abundance so that we could later on set up detailed study areas and perhaps recomend a Warbler Reserve in future.

9) Wildlife Unit Vehicle

One of the Unit's major requirements in 1983 is the need for a replacement of its present 4WD Toyota Landcruiser. The present vehicle is now deteriorating rapidly particularly in body condition. It is just three years old but like other vehicles on the island it cannot stand the highly saline and corrosive condition of Christmas Island. The engine, by contrast to the main body is still in excellent and reliable condition so that perhaps all that is needed is a new, wheel base including a new body. This Toyota Landcruiser was donated to the Unit in 1979 by the World Wildlife Fund but it actually came in February the following year. It has proved absolutely essential in daily patrols and night time hunting of feral animals most of which were carried out at remote parts of the island. The completion and successes of past research works as well as our education and cat

trapping programmes in the past and at present have essentially been achieved and improved which without the vehicle would have been impossible. Limited funding by the Kiribati Government have forced us to present (with this report) as a matter of appeal the request for a replacement and we hope readers could assist to find or encourage donars.

KATINO TEEBAKI
Wildlife Conservation Unit

Christmas Island Wildlife Conservation Unit Jan-July 1983

f) Turtles

The population of Green Turtles (Chelonia mydas) on Kiritimati is now believed to be larger than had previously been thought. Lobster fishermen reported that at least half a dozen have been seen almost every night during lobstering on the reef all around the atoll. We have ourselves confirmed this several times. A group of three or four turtles could easily be counted at one time on half a mile reef and we estimated that at least 200 turtles roam the coasts of the island. Where on Kiritimati they nest, remains unknown. There were only four beachings reported during the period covered by this report.

g) El-Nino effect on the habitat

Modification of the habitat resulting from lushness and mortality of the flora no doubt contribute to both the success and failure of the breeding activity. At all the Wedge-tailed Shearwater colonies the luxuriance of Sida fallax forms an impenetrable thicket to well over a metre and a half tall. This is also true on the SE peninsula not only to the Shearwater colonies but to former Sooty Tern habitats including many other areas where the shrub tends to occur in large communities. Other types of vegetation such as grasslands, bushes (Messershmidia and Scaevola in particular) have flourished. The most badly affected are the Suriana scrub which occur mainly on the low-lying areas that are liable to flood. Generally this resulted in either too much or barely vegetated habitats so that the birds would have to be rather selective for the most suitable type.

8. Feral Animal control

a) Pigs

Pigs have been seen more regularly than before on the South-east peninsula and a total of ten were killed during the period. Three of these were killed by lobster fishermen and the rest shot by the Wardens.

b) Cats

Feral cats have always been the single most serious problem. The luxuriance of the vegetation after the past heavy rains is most advantegeous to them. A cat escaping into the dense sida shrub is almost a 100% safe. In the Wedge-tailed Shearwater colonies hunting has been made extremely difficult by the lushness of the vegetation. Feral cats are still seen infrequently but we feared that the present situation with the vegetation might give them a chance to increase. To date a total of 31 cats have been shot. Now that the bad weather has gone and that the Unit is fully staffed again we hope to continue smoothly as usual without hindurance to our hunting programme. Next month or probably from September we hope to try some trapping in the wild as part of our continued trapping in the villages. This will require careful planning in order to overcome the various problems that would be involved.

REPORT OF THE WILDLIFE CONSERVATION UNIT

KIRITIMATI, REPUBLIC OF KIRIBATI, PACIFIC OCEAN

1. Report Number 15 — March-August 1985

Recipients of this report are being listed herein for the first time together with their addresses. The idea is to allow them to, if they so wish, communicate consultatively with each other or with the Unit on anything or issue that arises from the report. It is hoped by this that readers would be able to coordinate in making formal approaches which they feel might be done for the betterment of the issue that arises.

Regular issues of the report have been sent to all members of the Advisory Panel as well as to those others interested persons outside and within the country. The Unit will now submit copies of the report to other individuals or organisations where something arises in their connection. Recipients and their full addresses are given at the end pages of this report.

2. New member of the Advisory Panel on Nature Conservation in the Line and Phoenix Islands

Dr A.S. Naviwalla has been officially appointed member of our International Board of Advisers. The appointment was made earlier this year in February. Dr Naviwalla who is Chairman of the Environment Committee, Fish, Wildlife and Environment Conservation Society of Pakistan resides in Karachi. He is the 12th member on the list. His appointment to the Panel has been made on a number of reasons based on his own interest in our conservation programme. From the viewpoint of his location, we are of the opinion that the advisory role of the Panel would be of a more world-wide network. This in turn should benefit the Unit in that it should be more conversant on matters of different global conditions and nature. We thank Dr Naviwalla for his acceptance to membership and we look forward to His contributions towards the advisory function of the Panel.

3. Change of office premise

The Unit moved to an office block at Main Camp near the Captain Cook Hotel in late August. The new premises was formerly the Development Unit's office of the Ministry of the Line and Phoenix Groups to which the move has been necessitated by the administrative rearrangement of that section. The Unit's nearness to the hotel has ensured a closer link with tourists.

The new office, a single building on its own is spacious enough with two extra and larger rooms available for other uses. We have decided to use one of these rooms as a library for the Unit's references presently on hand. The other will be used as an interpretive display center for visitors, school children and the public. In this connection we would like to ask interested readers of this report to kindly send over whatever materials (reference books, pictures, posters, audio-visual equipments, etc) that they could spare or donate for our use and collection. The

new office has given us a hope of being able, one day to conduct illustrated talks as part of our education programme to different sectors of the public. We desire to do this once we are equipped and furnished. Readers are asked to send over as well ideas or suggestions that may help us in this direction. Members of the Advisory Panel are requested to coordinate particular assistance towards this.

4. Third South Pacific National Parks and Reserves Conference

Kiribati was represented at this conference by the Minister for Foreign Affairs and accompanied by the Senior Assitant Secretary of the Ministry of Line and Phoenix Groups - Mr. Komeri Onorio. At the conference, Mr Onorio was able to meet some of the prominent attendees one of whom was a representatives of IUCN Our problem with feral animals which was presented as a report did meet some symphatetic hints toward ways that may help secure funding. The IUCN representative recommended a Party (State Party) membership by Kiribati to the World Heritage Convention as one way to help for the securement of funding for our proposed eradication programme. From the point of view of the cat problem which faces our conservation programme here, membership to the Convention by Kiribati would be an advantage. The Ministry of Line and Phoenix has considered this possibility and the Unit has, on their advise, prepared a Draft Cabinet Paper which, we hope would eventually be presented to Cabinet by the Minister responsible.

5 DEVELOPMENT

a) Tourism and airline

A continous flow of visitors to Kiritimati was seen during the early part of the period. As usual, the visitors had come specifically to fish but we still get the odd numbers taken out to the reserve islets to see the birds for a change. Few individuals had come specifically to do birdwatching. Dr. Schreiber who also visited during the period with a group has undoubtedly contributed much to the bird-visiting effort. The Air Tungaru flight between Honolulu and Kiritimati was maintained on a weekly basis almost throughout the entire period but two flights, however, were cancelled in the latter part for which the reasons were unclear. The air service is expected to resume in the second week of September but it is not known on what basis or for how long.

b) Solar Salt Project

Progress has been made in the past few months on the salt project and Government has recently agreed to the extension of the present scheme (500 ton per annum plant) to 15,000 ton.
This is a small export scheme which has

been opted for to start with on a commercial venture. It is estimated will cost around 2 million dollars. It is noted that the expansion will involve an increase by approximately 30 times the present area currently being used by the domestic plant. Government's option to the 15,000 ton scheme comes out of the three options of that, the 50,000 and 500,000 per year. Aid donors overseas have promised further financial assistance as well as provision of expertise and for the maintenance of the UNIDO consultant Mr Chester Jenkins to be the overall adviser. Government therefore is anxious to proceed with this first stage commercial venture.

a) Copra Scheme

Copra production has been maintained at good levels probably as a result of the reinforcement of the licensed cutters by a large number of public workers who and their families have been cutting copra voluntarily at their leisure times. The copra tonnage for March to the end of July amounted to 706.31. Production figures for August were not availabel at the time of printing of this report. The total tonnage which appeared in the last six month report amounted to 1,087. Looking at the expected average production for March to August, production within this period would obviously show a slight drop. This is not bad as far as the scheme is concerned.

d) Outer Islands-resettlement

Government is currently looking at the possibility of another resettlement scheme after the first trial in Kiritimati (in the form of the new leased village) has come up successfully into existence. For the second trial Government is considering Fanning Island which, like Kiritimati, has been inhabited for long by a number of I-Kiribati people of some 500 in number. Like the long-term residents in Kiritimati the inhabitants of Fanning have more or less considered the island their native homeland where most of them have been born and brought up. They are, therefore most likely eligible to be given the first opportunity to lease but this is not certain yet. Government has expressed the need to settle other I-Kiribati peoples from the main Kiribati group at some of these islands to alleviate the growing problem with 'landless' back in the main group. As yet, it has to be decided whether a combination of settlers from several of the main Kiribati Group with those presently residing on Fanning will be considered to the scheme.

6. Fishing deal with a Russion Company

SOVRYBFLOT, a Russian commercial fishing company applied recently to the Kiribati Government for a permit to fish within the country's 200 mile exclusive economic zone. The application which was not the first of its kind seems to be a matter of political concern in Kiribati. It also seems to be a matter of concern regionally. Obviously there is a fear over the Soviet's possible military penetration into this area which it is assumed might be channelled through the fishing rights. Negotiations between representatives of the company and Government, however, has assured this not to be

the case. The terms of the licence to which the Company has agreed sets conditions which will render the licence void and which may help cautions the possibilities of military activities. On the other hand, the deal, as expressed by Government does not mean any diplomatic relations nor does it mean inter-governmental recognition. Notwithstanding these cautions, however, Kiribati has, of course, no ways or means of seeing that the terms of the licence are complied with so as to see what the Russian Company is actually doing in our waters and perhaps to check as well who else is being or has been fishing legally or illegally if not the Russians alone are or have been doing this for long. From an economic viewpoint the deal with the Russian Company would be more attractive than those past and present deals with other countries. The US$2.4 million which the Company is willing to pay for the licence is more than double what Kiribati would get from any of the present licensed foreign companies. This may indicate that those countries could have paid reasonably more than what they have been paying for their licence. Government is anxious to go ahead with the signing of the agreement but this is subject to finalisation at the Kiribati Maneaba ni Maungatabu next month (September).

7. EDUCATION

a) Environmental Course

Our environmental course during the last six months was based on the history of the Line & Phoenix Islands. Topics given featured discovery, past occupations, periodic visitations, development activities, etc. Other aspects include physical features of the individual island especially size, landscape and geographical distances from each other and in relation to other selected island groups in the Pacific. The idea of this course is to give children an understanding of how these island groups have been linked together through the course of time in their history, what they have in common historically and geographically and how past visitations had sprang up in connection with the growing economic needs of those days. The test given at the end of last term showed a drop compared with last and previous results. Our Teacher Warden, Moiaua Toariri reckoned this to be the result of pupils' effort to concentrate more on their study for the Secondary School entry exam which were in fact held a few days before the test. For next term we are planning to conduct the course combining Banana and London pupils together so as to impute a kind of competition towards the best position which will be rewarded by the offering of prizes. Pupils who did extremely low in the last test will be excluded from the course so as to give them a chance to consider why they have not been accepted. They will be welcomed back to the course the following term at their Headteacher's recommendation.

b) Teaching Booklet for Schools

Translation into Kiribatese of the above booklet has been completed. The Kiribatese version was sent to Dr. Christoph Imboden in England last June. We have not heard anything since then but it is hoped the materials have arrived there and that printing of the booklet will be done soon.

8. Poaching

Two cases of poaching were taken up during the period and are now awaiting court proceedings. One case that concerned the illegal taking away of Sooty Tern eggs by drunken person was revealed during a car accident. The other, over a de-skinned Booby, found in cooler box of fish at the Marine Produce Export Processing Center in Banana. Both cases seems to provide good and sufficient evidences as well as witnesses needed by the Warden and the Police to potentially win over a court hearing.

9. FERRAL ANIMALS CONTROL

a) Eradication Project

Little progress has been made so far towards the project. Ministry of Finance in Tarawa who has just become aware of the aid application has suggested a breakdown of the whole project cost to be determined so as to make funding easier. This has been done and sent back to Finance earlier this month.

b) Feral cats control

Regular hunting has not been resumed yet on a routined basis but control of domestic and stray ones has been maintained. Flashlight headlamps which are used in night-time hunting now need to be replaced and in fact none of our headlamps functions at present. Huntings during the period were carried out mostly at weekends and often after office hours before sunset. A total of twenty-three cats were killed in the wild during the period.

c) Pigs

Extensive hunting efforts in the past and earlier during the period have done much to reduce the number of feral pigs in the wild. Two huge boars were hunted down in June but were not caught. One of them, however was believed to be seriously wounded from the shots and we are of the opinion that it will die eventually. Three pigs shot earlier in the period include one pregnant female. In August another huge boar was hunted and shot at within the vicinity of the Sooty Tern colony south south-east of Artemis corner but escaped. Other places in the wild where we had hunted successfully are now void of of pigs and the marks of their presence is now confined to one spot where we believe some two or three pigs still remain.

d) Domestic cats control

This has been maintained in the villages by means of cage trapping. Caught stray cats were killed instantly and pets released. This village trapping will be maintained even after regular huntings in the wild have begun so that recruits into the wild can be kept at a minimum level till the eradication programme commence.

BIRD NOTES

Sooty Tern

Five colonies of the Sooty Tern nested in June last; Cook Island, near the Tracking Station, south south-east of Artemia Corner, south of Aeon Airstrip, and at 4K' site. The latter three colonies were on the south-east peninsula. Cook Island yielded large numbers of chicks. Most of the chicks, at the time of writing, have fledged and there is good hope for their eventual success. The colony near the Tracking Station was subjected to disturbance largely from the copra cutting activity. Nevertheless it is expected that some 25% of the original nestling population will eventually leave the island shortly. The colony south south-east of Artemia was by far the largest during the season with an area covering approximately nine square kilometres of land. Being amidst the dense Scaevola bush and the Suriana shrub, one would expect considerable predation effect from feral animals. Feral cats still have a heavy toll on the birds especially on the chicks. An extremely large number of chicks have fledged from this colony and we suspect that in the end there would be about fifty to sixty per cent of the chick population to leave the island.

Lesser Frigatebird

In the last season this species shifted back into the Lesser Frigate Lagoon but onto a different islet, just next to the Lesser Frigate islet. At the time of writing the nestlings were in the form of large chicks most of which still had downs.

Masked Booby

This species have been showing an extremely impressive reproduction effort during the last few months up to the end of August. Laying have been maintained continuously at peak levels and nestlings varied considerably between freshly laid eggs to chicks of different age groups.

Tropicbird (Red-tailed)

Peak nesting by the Red-tailed Tripicbird began from mid-March through to late April. They were mostly abundant at the main lagoon islets - especially on the reserve islets of Motu Tabu and Motu Ubua, in the Central Lagoon areas (including the milkfish culture systems) and at several locations on the south-east peninsula.

Crested Tern

Some 700+ of this species nested on Cook Island. Laying began in the last week of March and peaked in early April. The chicks raised have all fledged and now, together with groups of adult birds can be seen roosting or feeding scatteredly and widely over Kiritimati.

KATINO TEEBAKI
Wildlife Unit
Kiritimati

List of recipients of the Wildlife Unit report

Members of the Advisory Panel

1. Dr A.L. Dahl - Corré Rible, 29127 PLOMODIERN, France.

2. Dr D.W. Hall - Environmental Adviser, Overseas Development Administration, Eland House, Stag Place, London SW1E 5DH, England (UK).

3. Dr Christoph Imboden - Director ICBP, 219C Huntingdon Road, Cambridge CB3 ODL, UK.

4. Dr J. Morton Boyd - Director Scotland, Nature Conservancy Council, 12 Hope Terrace, Endinburgh, EH9 2AS, UK.

5. Mr R.S. Home - Carribean and Pacific Department, Eland House, Stage Place, London SW1E 5DH.

6. Dr C.B. Kepler - 248 Kaweo Place, Kula Maui, Hawaii 96790.

7. Dr R.J. Shallenberger - US Fish and Wildlife Service, 300 Ala Moana Boulevard, P O Box 5967, Honolulu, Hawaii 96850.

8. Dr Roger Perry - The Residency, Tristan da Cunha, South Atlanta.

9. Mr Martin C Garnett - Bornhelm Cottage, Chawley Lane, Cumnor, Oxford OX2 9PX, UK.

10. Dr W.B. King - Chairman ICBP (US Section), 871 Dolley Madison Boulevard, McLean, Virginia 22101, USA.

11. Dr D.R. Stoddart - Department of Geography, Downing Street, Cambridge, UK.

12. Dr A.S Naviwalla - Villa Abeda, 47-C, Dhoraji Colony, Near KDA Scheme No. 7, Karachi-5, Pakistan.

Other Overseas recipients

13. F. William Burley - Senior Associate, World Resources Institute, 1735 New York Avenue N.W., Washington D.C. 20006, USA (former Director of Science of the Nature Conservancy International Programme, Massachusetts).

14. Dr G.H. Balazs - US Department of Commerce, National Marine Fisheries Service, P O Box 3830, Honolulu, Hawaii 96812.

15. Dr C.C. Whitlow - Professor of Physiology, Biomedical Research Center, Kewalo Marine Laboratory, University of Hawaii, HI Ahui Street, Honolulu, Hawaii 96813.

16. Dr R.W. Schreiber - Curator of Ornithology, Los Angeles County Museum of ~~Natural History~~, ~~900~~ Exposition Blvd., California 90007, USA.

17. Mr R.A. Anderson - New Zealand Wildlife Service, IAD, Wellington, New Zealand.

18. Mr R.W. Bealea - Fisheries Adviser, EDDP, Private Mail Bag, Suva, Fiji.

19. Martin and Barbara Schwarzschild - 12 Ober Road, Princeton, NJ 08540. USA.

Overseas Organisation

20. The International Union for the Conservation of Nature and Natural Resources (IUCN) - Avenue du Mont Blanc, 1196 Gland, Switzerland.

21. The World Wildlife Fund (WWF) - 1196 Gland, Switzerland.

22. Dr Jeremy Carew-Reid - Regional Ecological Adviser, P O Box D5, Noumea, New Caledonia.

LINE ISLANDS

SIXTEENTH REPORT OF THE WILDLIFE CONSERVATION UNIT

KIRITIMATI, REPUBLIC OF KIRIBATI, PACIFIC OCEAN

SEPTEMBER 1985-FEBRUARY 1986

1. Staff News

Wildlife Warden Katino Teebaki travelled on the MV MOANARAOI in late October 1985 for his home island leave. He would spend several months at home and would resume duty sometime in January or February 1986.

During his absence the unit was runned by his two assistants Noiaua Toariri and myself.

2. National Development Plan 1987-1991

Ministry of Finance in Tarawa, the capital of the Kiribati government had submitted guidelines for the formulation of sectoral plans to all government department and statutory bodies in which written national development objectives detailed. On receiving our copy early this year we looked back into our eradication project mentioned in the last report but the re-application for the breakdown project been done and sent back to Finance early in August 1985.

3. Development of Kiritimati

a) Solar Salt Project

There was a short visit in early September 1985 by the engineering design team selected at Tarawa on August 6. The team examined locations in Manulu Lagoon for the production of 15,000 tons of salt per year average and two sites were chosen as suitable.

Mr Gordon Taylor Engineer Manager of the NZ Government who was also with the team would probably return to Christmas Island with a surveyor to finalize ground layout, plan drawings and estimates that would be in final form for presentation to the Kiribati Government and AID agencies.

The Ministry of Line and Phoenix consider the 15,000 ton too high in view of the lack of a formal marketing survey so the scaling down of the plant capacity would be necessary.

b) Airline and Tourism

The Aloha a weekly flight from Honolulu started its operation three weeks ago carrying thirty to forty tourist sport fishermen mainly.

The plane belongs to Air Tungaru but as before operated by Mrs Carol Farrow replacing the Hawaiian Air also belongs to the same airline and operated by the same person. The idea of this change was to extend the route to Tarawa by a 50 passenger flight but the new flight has not operated this route yet.

Since late last year high flow of tourists came for sport fishing mainly but about 25% of this high flow number been escorted to bird reserves and nesting areas.

Among these visitors was Dr Schreiber who usually came for his scientific research. During his one week stay he took eleven other tourists to the bird islets of Motu Tabu and Cook Island explaining to them bird species there.

Arrangements for birdwatching in reserves made in January this year by the Ministry charging every birdwatcher at US$10.00 and with a minimum length of time on the islet as 2 hrs. Extra hour chargeable to $1.00 per person.

Since then the unit has collected nearly @1,000 from these birdwatchers. The number of birdwatcher charged during the period was about a hundred.

c) Marine Export

The exportation of fish to Honolulu and Nauru was still in progress and the minimum average tonnage sent weekly over the last six months was about 2,000. All types of fish in any size required by these two countries but some type like the milkfish were measured from 1½lbs to 2 lbs.

Over the last six months a slight increase was noticed in comparison to the previous export and the approximate amount of $100,000 been put into the country's revenue.

d) Island Trader Enterprise

A private business owned by Tom Carpenter from Honolulu ceased its operation since the beginning of this year due to its contract's expiration. Local people are now relying on Marewen Xmas CS a public enterprise and other local private businesses that order supplies and other foodstuffs from Central Kiribati and overseas.

4. Animal Control

a) Feral cats: As had mentioned in the last report regular hunting unresumed yet due to the lack of night-time hunting equipment. However cats and pigs hunting done basically in the afternoon and early in the morning during weekdays and weekends. During the period eight feral cats been shot, two of them were ran over by vehicle. Two immature, three adult females and three adult males which were shot near the sooty tern colonies.

b) Feral pigs: There were four adult and three piglets caught at A & K Sites during the last six months. These pigs were chased and caught by church communities doing some sort of picnic in remote areas at the south east peninsular.

From our surveying and sighting record the number and signs of pigs in the wild was very much discouraging, however, the unit would put more effort and provide hunting equipment so that these feral pgis would be finish from the island. We estimated that there were about ten or more pgis still roamed A, K and L. Sites areas.

c) Domestic Animal control

(i) Domestic cat & dogs survey: Cage trapping and handnet catching are our only ways to catch village cats. Thirty cats been disposed during theperiod, twelve caught by hand net and eighteen trapped in cages.

Late in November 1985 surveying was carried out within the three villages of Banana, Te Riiti and London. Stray cats and unlicensed female cats collected during the surveying and new cats were examined.

Pet owners were advised that dog fee would be come up to $4.00 per dog in January 1986 while cat fee would remain the same.

In comparison to the 1984 survey there was a slight drop in the number of dogs and female cats.

5. Education:

Courses in environmental biology were given in a one place combining the two village pupils in one classroom. This was started late last year in order to make the children compete with each other and by this system we noticed their more keen and concentrating on the subject. The last term of 1985's result showed much encouraging and improvements.

Poland primary school which is in the very far end of the island (probably 45 miles from our office) will be checked this year as more people now residing there for copra cutting. The course there been stopped for three years now due to the very small number of pupils in the special class we taught but we assumed this time the number of pupils needed would be over as copra cutter licencees from other villages recruited regularly to this village since late 1985.

Moiaua Toariri who was a teacher warden extracted some of his lesson topics from the SPC Education Hand Book and Education fact sheets on soils, forests, pesticides and conservation. Some of these fact sheets would be sent to our outer island primary schools of Fanning and Washington.

b) Fanning and Washington I made a tour to these two islands on the MV MOANARAOI in October 1985 and I spent about two days on each island. I did public talks with people, surveying nesting areas and discussed with school staffs other possibilities in introducing Biology courses to their pupils like Moiaua did in Christmas Island.

The teachers explained that the children loved and enjoyed the text books and posters from SPC we gave them in 1984 and they asked for more.

The wildlife on both islands did well but domestic animals were not controlled and their growing population would probably go into the wild. The wildlife unit would sent someone to these islands to eliminate these animals. While on Fanning I was able to catch one female dog introduced to the island by Tongan crews of MV SAMI. Three other juveniles from this female dog caught but one escaped. Also one juvenile female dog travelling with me from Christmas caught and taken back with the other three to Christmas and disposed there. Police Constable on Fanning informed about the remaining female dog to seize and dispose it.

In late 1985 government has approved the resettlement on these two islands for both the ex BP employees residing on the island and the rest from either Line and Phoenix Groups or Central Kiribati.

6. Poaching:

It was mentioned in the last report that two cases of poaching been taken up and awaits court proceedings. Court hearing held in October last year and drunken men collecting sooty tern eggs were fined $50.00 each and imprisoned for four months. The other case found innocent.

Another case been put up in December 1985 and awaits now court proceedings. This concerned the two women who were caught during midnight collecting sooty tern eggs at Main Camp Sooty Tern Colony. The event occurred the night after Christmas day and it was the first time to catch women.

7. Sooty Tern Colonies

Cook Is, Disposing Area, Main Camp, A Site, SA30 and Paris were the six successful nesting colonies during the period and the birds in all these colonies would probably leave the island in another week or so. A Site Sooties was the largest colony during this breeding season and it was also a colony with the major signs of pigs and cats. Main Camp Sooties exists for the first time during this season and it was amazing because the birds laid eggs just in the site between the two houses at Main Camp.

The birds during this season was very much larger in numbers than that of last season in June 1985.

8. Closed Areas

Bird Reserves: The North West Point Bird Reserve been opened to the public believing that the birds never came back for a long time but nesting areas during the breeding season would be declared closed areas until the birds fledged.

During the last season of the sooties all the six colonies marked as closed areas and this gave much help to our patrolling programme.

9. Uniform Badges

Fortynine uniform badges received on the 22/1/86 from the NZ Wildlife Service and they are now retained in the office as substitute and souvenirs.

We are very thankful to the NZ Wildlife Service for sending us these badges which will be put on our shirt shoulders to make us look smarter. This is the second time they presented us badges. The first lot was in 1984 not very long after R. Anderson a NZ cat expert left Xmas.

UTINAWA BUKAIREITI
for Wildlife Warden

REPORT OF VISIT TO CANTON ISLAND (KANTON)

BY KATINO TEBBAKI, WILDLIFE CONSERVATION UNIT, KIRITTIMATI

1. Kanton Island was visited by the Wildlife Warden from April to August 1986. The purpose of the visit was to carry out a general survey of the islands flora and fauna with a view to updating the Units knowledge and information of the atoll. As can be seen in the report the visit deserves the purpose in that the writer was able to confirm on:

a) the breeding and other aspects of certain specieis whose previous status have been uncertain.

b) the absence or non-existence of feral dogs which have been reported of the island

c) the status of Green Turtles which are under an early stage of threat from human activities.

The writer wishes to thank the Ministry of the Line and Phoenix Islands for their approval of the visit and it is hoped that similar visits to other islands within these groups can be made should opportunity permits in future.

2. Present situation

Kanton Island which had been a center of military occupation and activities in the Phoenix Groups is now a peaceful port of call for Kiribati ships between Tarawa (the Nation's capital) and Kiritimati (the Line Islands capital). To the yatchmen it is a convenient stepping stone on a southbound or westbound route. No doubt it will become to be regarded as the capital of the Phoenix Group. The withdrawal of the Americans from the island has meant the abandonment of facilities, plants, equipments, etc from the time when it was used (after the second world war) as a civilian airport and subsequently later as a NASA and Military satellite and missile tracking station. Kanton Island was handed over peacefully to Kiribati and since the nation's indepdnence in 1979, the island has been looked after by a handful of I-Kiribati employees who were being stationed as caretakers.

For the Phoenix Groups as a whole, Kanton is undoubtedly a center of consideration for future developments. It has the best anchorage in the whole nation to facilitate the mooring of some 2,000 ton vessel. Among the infrastructures left by the Americans is the one mile long tarmac runway which can facilitate large planes. This runway was in excellent condition at the time of the visit. The tarmac road from the wharf to the airport was also in excellent condition butit continues around the entire perimeter of the island unsurfaced. Other facilities left by the Americans include the hanger (nearing corruption) the hospital, tennis, squash and basketball courts, warehouses and motorpools, a terminal building, open and roofed cinema theatres etc., etc. The plants and equipments include two separate central heavy power-generating plants, radar tracking (satellite and missile tracking) equipments, powerful communication antennas and installations etc.

The I- Kiribati employees stationed on the island as caretakers comprised a Police Sergeant who acts as District Officer for the Phoenix Groups, a meterorological service officer who also do the

postal and radio telecommunications service and the teaching, a nursing officer and a carpenter. Altogether they numbered 14 persons with their children and relatives.

3. Position and weather

On a world scale, Kanton is positioned at 2° 49'S, 171° 40'W. Situated in the equatorial dry belt, the rainfall is low and unpredictable, and there are periodic and severe droughts. In July, however an unusual semi-torential rainfall was witnessed for several alternate days. The prevailing winds are easterly which blow throughout the years. The temperature is as warm as with other islands in the Line groups.

4. Physical feature

Kanton is the most northerly situated of the Phoenix Groups lying about 70 km north-west of Enderbury Island. It is a true atoll enclosing a lagoon which is connected to the ocean by a channel. The lagoon is shallow reaching perhaps 3 metres of depth in certain places, here and there in the lagoon, however, are numerous coral heads and coral patches many of which are subjected to exposition at low tide. Spam island at the lagoon entrance and three others are the only visible man-made features in the lagoon. The island in most places is generally narrow from lagoon to the ocean beach. The widest place in this sence being less than half a Kilometer broad with the narrowest part about 15 meters wide. As with most atolls the beach crest around the entire perimeter of the island is generally high but slopes gently down towards the lagoon. In many places, however, heaps or hills of sand or rubble were visible. These were formed by the Americans during their occupation to form revetments.

Direct from norht-east to southeast the island measures about 9 miles long but the perimeter by road measures approximately 21 miles.

5. Birdlife

a) Species abundance

The birdlife of Kanton is limited in species diversity and abundance. Fourteen species of seabirds were recorded resident. With the exception of the Christmas Island shearwater, all were either confirmed or believed breeding species. The migratory birds observed were the Bristle-thighed Curfew, the Pacific Golden Plover, the wanderling Tattler and the Sanderling.

b) Nesting distribution

The nesting was confiend almost entirely to the South-east corner (Te kabi) of the atoll. Here all except the Brown and Black Noddies and the White Tern concentrated. The two noddy species nest on the three artificial islets at the lagoon entrance. The White Tern occured mainly in and around settlement areas nesting high up in Casuarina equisetifolia as well as in ruined buildings.

c) Population abundance

The seabird population was relatively small compared with other islands that had been visited in the past - in particular Malden. By species comparison and assessment amongst the island's individual species, the Grey-backed Tern and the Red-footed Boby have have significant populations for an atoll with limited habitat and space. To a lesser extent the lesser Frigatebird and the Brown Noddy also have some significance in population. The following is a rough estimate of the individual species population.

Native Species	Estimated Population
Great Frigatebird	50-100 birds
Lesser Frigatebird	200-300 birds
Masked Booby	6 nesting pairs counted on whole island
Brown Booby	200 birds
Red-footed Booby	1500+ birds
Red tailed Tripicalbird	50 birds
Wedge-tailed Shearwater	50 birds
Christmas Shearwater	Only one individual seen flying
Phoenix Petrel	50+ pairs
Sooty Tern	1500-2000 birds
Grey-backed Tern	1500+ birds
White Tern	150-200 birds
Brown Noddy	1000-1500 birds
Black Noddy	1000 birds

Migratory species	Averager per day from 10 different days count
Bristle thighed Curlew	2.8
Pacific Golden Plover	2.4
Wandering Tattler	1.9
Sanderling	1.4

d) Breeding

All seabird species recorded except the Christmas Shearwater were confirmed breeding in Kanton as indicated below:

Species	Breeding
Great Frigatebird	confirmed
lesser Frigatebird	"
Mashed Booby	"
Brown Booby	"
Red-footed Booby	"
Red-tailed Tropicbird	"
Wedge-tailed Shearwater	"
Christmas Shearwater	suspected
Phoenix Petrel	confirmed
Sooty Tern	"
Grey-backed Tern	"
White Tern	"
Brown Noddy	"
Black Noddy	"

Kanton lacked the following birds as breeding speci which do occur in Kiritimati.

Crested Tern
Blue-grey-noddy
White-throated Storm Petrel
Andubon Shearwater

g) Count/estimate of nests and nestlings

The following count/estimate of the nestlings of ea h species were made in late June. In the case of certain species the c nt may be quite accurate as there were no other place on the island hey nest.

SPECIES	TYPE OF NESTLING SEEN	NEST COUNTED	NESTLINGS COUNTED
Great Frigatebird	large downy chicks*	Est. 20+	Only 3
Lesser Frigatebird	Egg	Est. 100+	3 only
Masked Booby	Egg	6	4
Brown Booby	Egg	13	7
Redfooted booby	Egg & young	Est 00	Est 200
Red tailed Tropicbird	Egg & young	5	5
Sooty Tern	a) Young fledged*		5 remained
	b) Egg (following season)	-	20+
Grey-backed Tern	Fledged young and few eggs	-	Est 150+
White Tern	Egg	5	5
Brown Noddy	Egg & young	-	Est 500+
Black Noddy	None	none	none
Wedge-tailed Shear-water	Eggs	21	6
Christmas shearwater	none	none	none
Phoenix Petrel	none	Est 20+	none

* - represents nestling from the season pre ding the writer's arrival on Kanton.

6. a) Habitat

The existence of suitable habitats for the birds w to be found at the south-east regions which include the "Kabi". s is where the least modification from introduced plants and past lldozing activities were obvious. The following habitat types were ide ified:

1) Trees - Messerschmidia argentea
   Casuarina equisetifolia
2) Large shrubs - willow spp.
3) Low shrubs - Suriana maritima
4) Open and partly vegetated grassland/herbland
   - Digitaria pacifica
   - Lepturs repens
   - Beeharvia repens
   - Portulaca lutea
   - Triumfetta procumbens

5) Open unvegetated ground
6) Partly open lepturus grassland - Lepturus repens
7) Coral debris/rubble
8) Roadside dunes
9) Open unvegetated or partly vegetated areas.

Habital No. 6 also exist in low-lying areas on the scarp regionsof atoll.

b) Birds and habitat association

Numbers under habitat types refer to habitat classification under 6 (a).

Habitat types	Bird specieis
(1)	Red-footed Booby and White Tern
(2)	Great and lesser Frigatebird and Red-footed Booby
(3)	Great and lesser Frigatebirds (An important habitat)
(4)	Sooty and Grey-backed Terns
(5)	Brown and Black Noddies and (Grey-backed Tern only on Spam Island)
(6)	Phoenix Petrel
(7)	Brown Booby
(8)	Wedge-tailed Shearwater
(9)	Masked Booby

c) Amount of habitat

The amount of habitat on the whole is generally limited. The mingling of the Sooty and grey-backed Terns on the ground which was observed in April perhaps suggested insufficient habitat. On the other hand the concentration of the majority of the different bird species at the 'Kabi' and its regions may suggest availability of suitable habitats on this part of the island. The Kabi or South-east comer received the least modification from recent human activities. Large-scale bulldozing of land were noticeable on most other parts of Kanton.

7. a) Marine Turtle

Turtles were common sights throughout the duration of the stay on Kanton. They were seen regularly in the lagoon and on the ocean reef at high tide either swimming close to land or appearing on the surface. They also frequent the wharf area regularly coming often so close to land that makes identification easy. Many of those seen within close range were of the Green type. The sighting record at different part of the atoll is indicated on map 4.

b) Nesting distribution

Like the birds, nesting of Green Turtles was confirmed to one particular spot along the south-east regions. This spot, about two miles west of the Kabi (on the northern rim of the island) supported between 20 and 30 suspected nests. The entire extent of the beach westward from theKabi along the northern rim was about two miles long but broken at intervals either by deposits of coral rubbles or base-cemented slabs. Turtles used only one space between these beach/rubble intersections to nest. Certain other parts of Kanton supported good deposits of beach sand particularly the coastal areas of the runway.

Trace of beaching by a turtle on the south rim of the island amongst a mixture of sand and small loose corals were seen but no nesting suspected.

8. Plantlife

a) Native Plants

The native flora of Canton is comprised of the following species.

Trees	Messersdimidia argentea
Large shrubs	Scaevola taccada
	Casuarina glauca
Low shrubs	suriana maritima
Herbs	Digitaria pacifica
	Lepturus repens
	Eragrostis whitneyi
	Potulaca lutea
	Portulaca oleracea
	Boeharvia repens
	Sesuvium portulacastrum
	Cassytha filiformis
	Triumfetta procumbens
	Tribulus cistoides

b) Introduced Plants

A variety of exotic plant species occur mainly in and around settlemtns. A number of these have spread to the remote parts of the island - in particular the willow plant species which can tolerate salt spray and as a result occur widely along lagoon marginal areas over much of the island. The writer identified the following species:

Trees	- Cocos micefera
	- Pandanus tictoria
	- Casuarina equisetifolia
	- Casuarina glauca
	- Terminalia catapa
	- Cordia subcordata
	- Cordia sebestena
	- Guettarda speciosa
	- Callophyllum inophyllum
	- Morinda citrifolia
Shrubs	- Plucles odorata
	- Terminalia spps
	- Willow spp
	- Lantana camara
Grass/Herbs	- Eragrostis amabilis
	- Fimbristylis attolensis
	- Eleusine indica
	- Cenchrus echinatus
	- Euphorbia hirta
	- Euphorbia prostrata
	- Euphorbia heteroplyua

Ornamental plants
- Crinium assiat[illegible]am
- plumeria rubra
- Nerium orleande[illegible]
- Hibscus tilaceus
- Hibiscus rosa-sinensis
- Ipomea tuba
- Ipomea pes - caprae
- Carica papaya

c) Plant Distribution

The bulk of introduced plants grew on the weste[illegible]n p[illegible] of [illegible]e island. This was the most industrialised part of Kanton dur[illegible] bo[illegible] the British and American occupation. Similarly along the roads [illegible]e[illegible]ic plants grew which sprang up in mid July after the rains. [illegible]di[illegible]w plant species which the writer assumed was introduced to [illegible]ve[illegible]d a wind and salt spray 'screen' had spread out to some extent f[illegible]m [illegible]he [illegible]emote areas. At the Kabi for example the shrub for[illegible]d ir[illegible] [illegible]r[illegible] thickets and seldom attract the odd Frigatebirds or R[illegible]-foot[illegible] [illegible] in.

Native plants generally have a widespre[illegible] distribut[illegible]n [illegible]nton but they have been excluded to a certain ext[illegible]t fro[illegible] mu[illegible] [illegible] western regions. The herbaceous communities have a s[illegible]ar [illegible]po[illegible]ion to those on Kiritimati. In many cases, however, Triumf[illegible] procumbens formed part of these plant communities. This plant [illegible]ie[illegible] does not occur on Kiritimati. It is common and wide[illegible]spr[illegible]d e[illegible]t[illegible]nc[illegible]n Kanton may suggest its introduction to th[illegible] is[illegible]d b[illegible] hu[illegible] means.

Typical composition of native herbaceous [illegible]m[illegible]ie[illegible]

A. Portulaca Lutea, Boeharvia repens Di[illegible]t[illegible]ar[illegible] pac[illegible] [illegible]mfetta procumbens and Lepturus repens
B. Boeharvia repens Portulaca Lutea Digitaria pacif[illegible] an[illegible] Lepturus repens
C. Triumfetta procumbens Lepturus repens Digitaria [illegible]fic[illegible]
D. Triumfetta procumbens, Portulaca Lute[illegible], Boeharvi[illegible] Digitaria pacific

9. Feral and domestic animals

a) Dogs

The writer confirmed from the visit of the non[illegible]exist[illegible] of f[illegible]al dogs which have been reported in previous papers. [illegible]re h[illegible] neither been any domestic dog on Kanton until the arrival of [illegible] sh[illegible] from [illegible]rawa in mid July 1986 which brought two pups to the is[illegible]nd. [illegible] w[illegible]r returned to Kiritimati on this ship and di[illegible] not [illegible]ve [illegible] i[illegible]get a record of the sex of the pups.

b) Pigs

Feral pigs were not present in the wild. [illegible]here were [illegible]st[illegible] pigs owned by the families of caretakers on Kanton w[illegible]ich [illegible]e[illegible]e[illegible]e of the visit numbered some twenty animals. These pigs were [illegible] ke[illegible] in pens but were often allowed to roam by their owners. [illegible]hey [illegible]e not posed any problem so far to the environment.

c) Cats

Feral cats exist in the wild but the writer suspected their number to be relatively small. Only five sightings of feral cats were recorded throughout the duration of the visit. Three of the sightings were either of a cat seen running across or alongside the road. The other was of a cat roaming on the beach/reef margin on the ocean side of the runway. The fifth record was in the form of tracks near the south-east comer of the island - seen on the edge of a small colony or burrows (of some 25 birds) of Wedge-tailed shearwater. Evidence of predation by the cat, however, was absent. Each of the four families of employees on the islandownes a male cat. Stray cats were seen in camp areas only.

10. a) Effect on Birdlife

The writer was almost certain of the minimal effect (if any) of feral cats on the birdlife. This was believed by the virtual lack of corpses or bird carcasses which would have b en easily found if predation persist. The writer, however, admitted that hermit crabs which were abundant over all of the island would easily scavenge and consume even the last fragments of any bird carcases that feral cats might leave. A proper survey on feral cats on Kanton is needed before one could present a more accurate information on population, predation etc.

b) Sex and colour of cats on Kanton

Only two female cats were seen on Kanton. These were stray ones as none of the four families of employees on the isalnd own a female. Most of the stray cats seen in and around camp were males. Kittens were never seen throughout the stay. The feral cats seen in the wild could not be sexed. The following colours were recorded:-

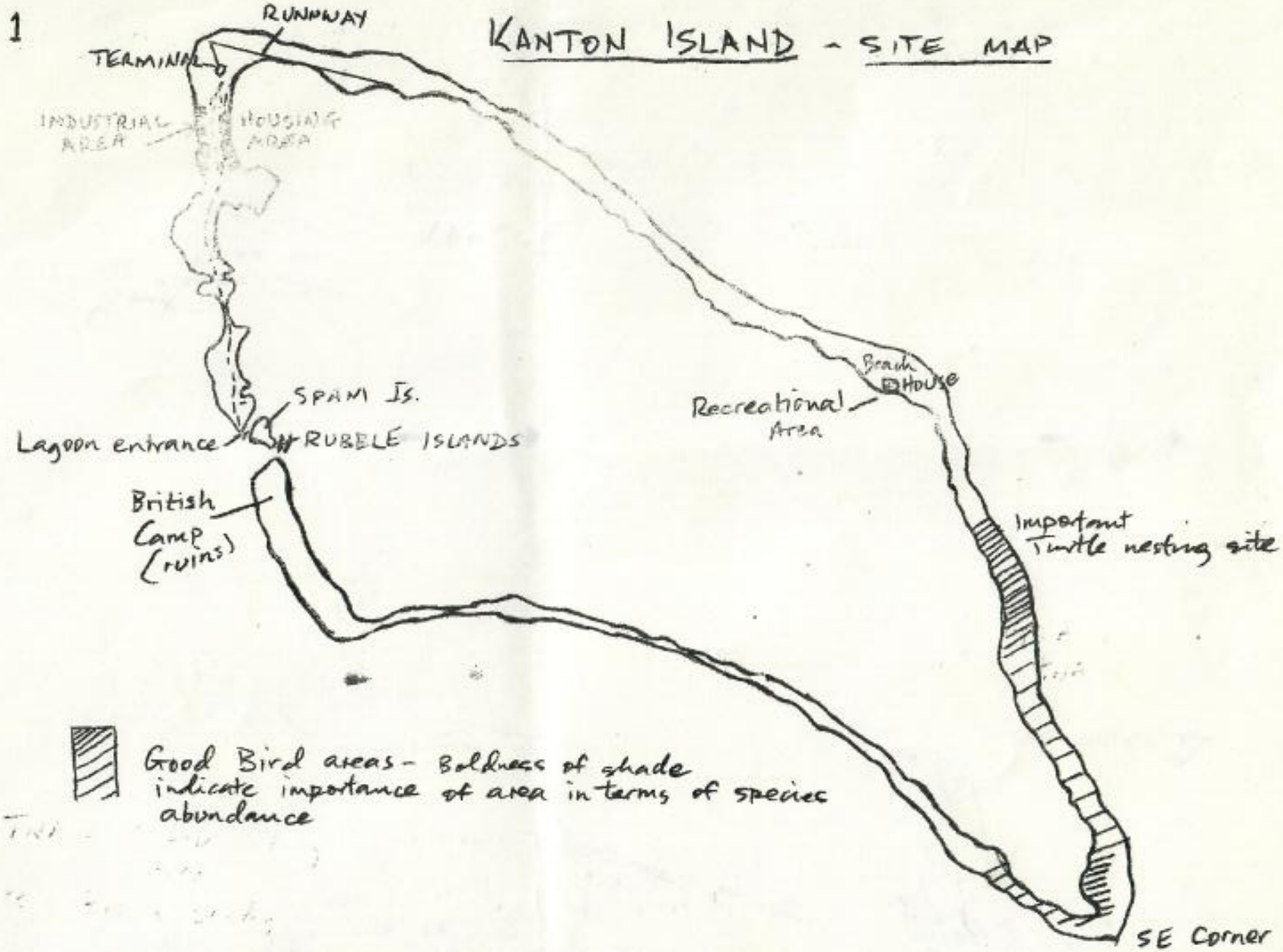
Domestic cats
- a) All black (a)
- b) Black and White (as?)
- c) Black with white spot (AE)
- d) Dilute black (a, d)

Stray cats
- e) Blotched tabby (t+)
- f) stripped tabby (tb)
- g) All black

Feral cats
- h) Orange or giner o/?
- i) All black (a)

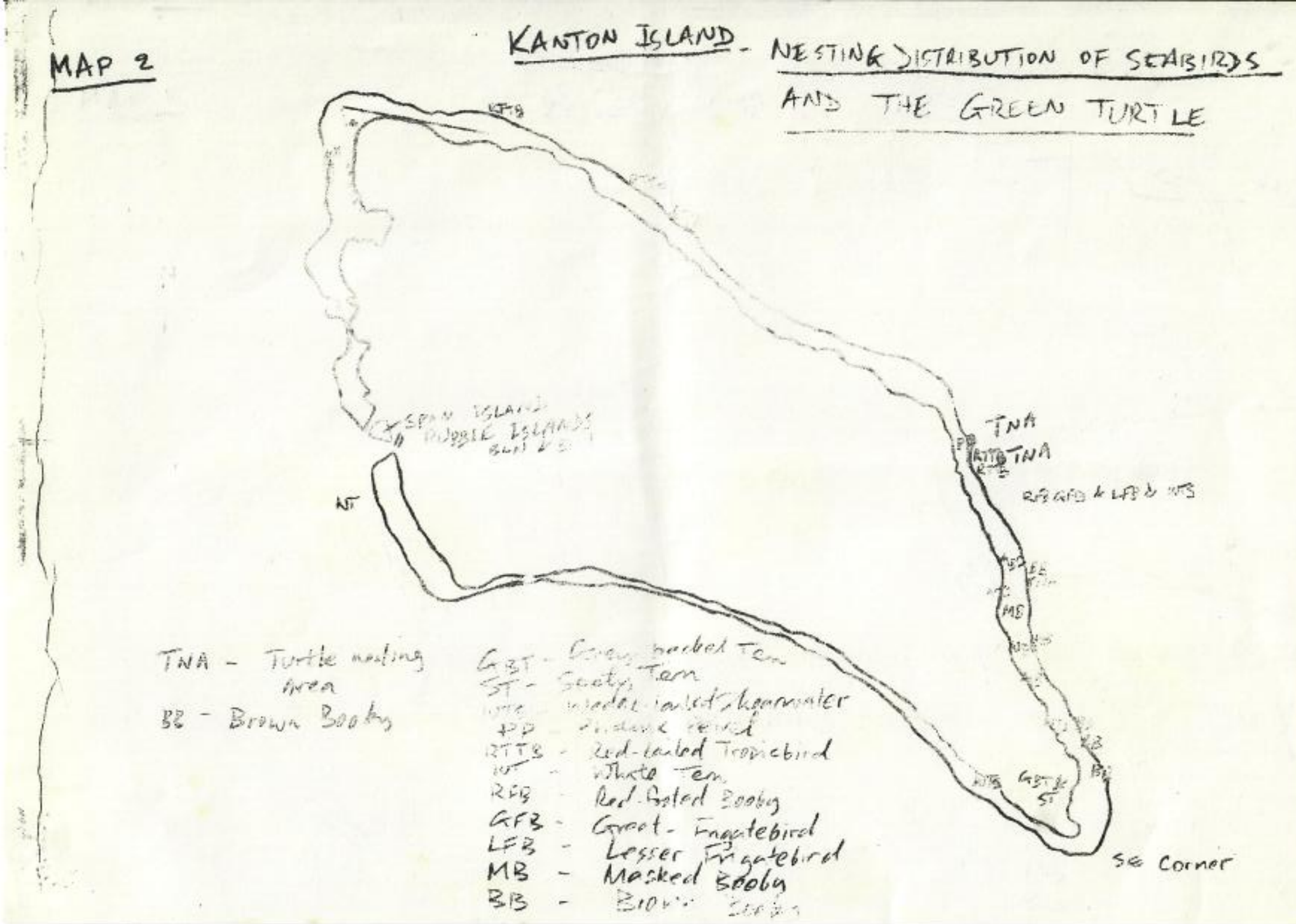
MAP 1

KANTON ISLAND - SITE MAP



MAP 2

KANTON ISLAND - NESTING DISTRIBUTION OF SEABIRDS AND THE GREEN TURTLE



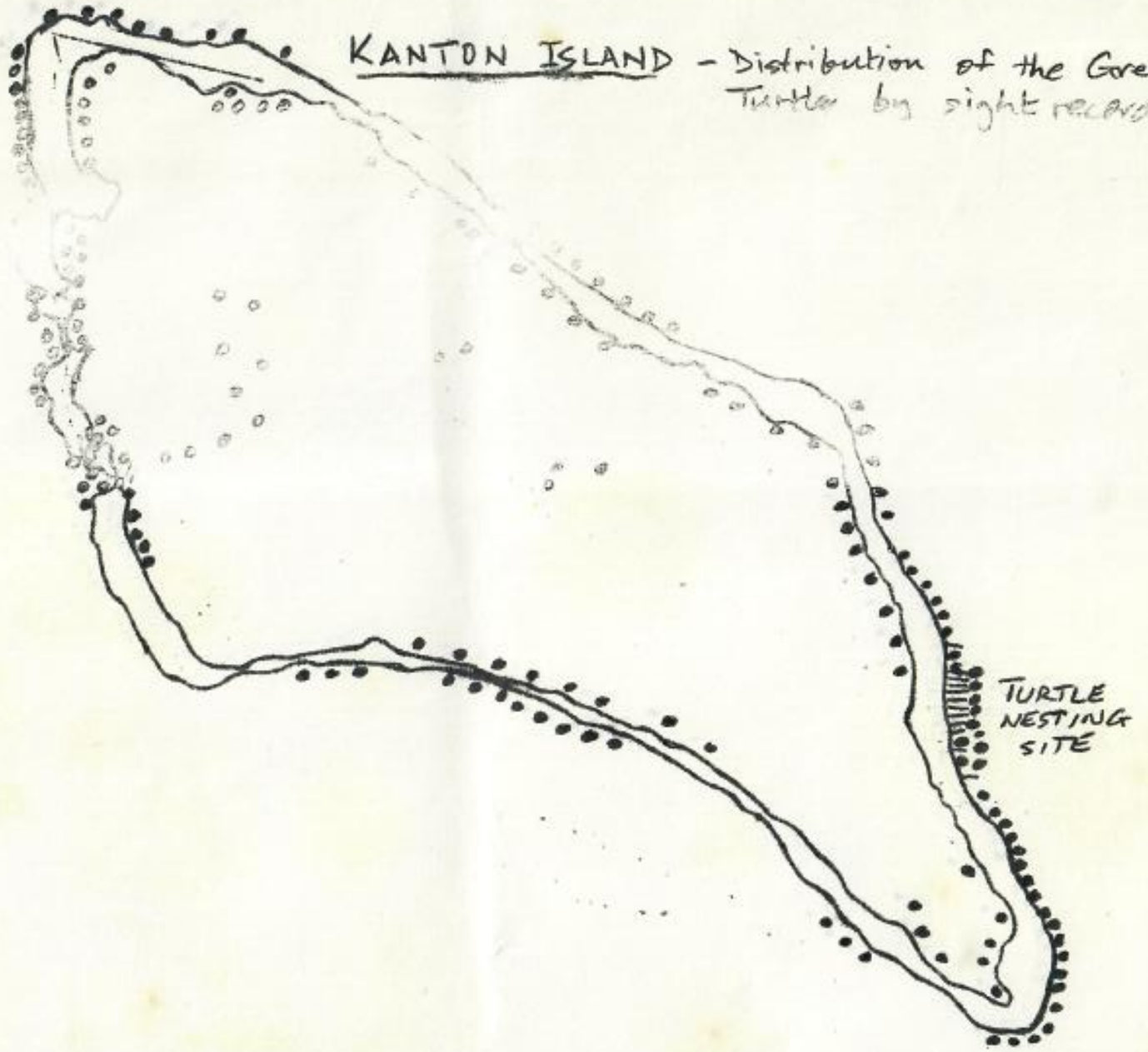
TNA - Turtle nesting area

BB - Brown Booby

GBT - Great-winged Tern
ST - Sooty Tern
WTSH - Wedge-tailed Shearwater
PP - Phoenix Petrel
RTTB - Red-tailed Tropicbird
WT - White Tern
RFB - Red-footed Booby
GFB - Great Frigatebird
LFB - Lesser Frigatebird
MB - Masked Booby
BB - Brown Booby

MAP 4

KANTON ISLAND - Distribution of the Green Turtle by sight recording



By KATINO TEEKAKI'

REPORT OF THE WILDLIFE CONSERVATION UNIT, KIRITIMATI, REPUBLIC OF KIRIBATI

REPORT NO. 17 MARCH - DECEMBER, 1986

It has been made necessary to cover ten months in this report as the result of:

a) the writers' absence from the Unit (late October 1985 to February 1986) in connection with a home leave.

b) a four-month stationing on Canton Island in connection with an updating work on the wildlife (April - July 1986).

c) the writing up of the Canton report on return to Kiritimati and dealing with the paper work that had accumulated during my period of absence.

d) full-time involvement in anti-poaching patrols which began in late October, 1986.

The four-month visit to and stationing on Canton Island immediately followed my return from a home leave. On return from Canton several paper work had to be dealt with. These together with the Canton report took much of the time, before this report could be drafted. On alternate days during the period of writing several fieldwoeks had to be participated in. From October 1986 the Unit connentrated on anti-poaching patrol in conjunction with egg collecting which nedessitated my full time involvement.

2. VISIT TO OUTER ISLANDS

a) FANNING AND WASHINGTON

Teacher Warden Moiaua Toariri visited the Islands in March 1986. Mr. Toariri delivered copies of our first term 1986 course to the schools on each island. He also presented supplementary materials or aids (SPC trial teaching booklet and posters) to each school as well as checking on the progress with previously introduced courses. Law enforcement on the wildlife Conservation Ordinance formed part of the purpose of his visit.

b) CANTON ISLAND

I visited Canton Island in the Phoenix Groups and spent four months there (April to July 1986). The purpose of the visit was to carry out a general survey of the wildlife with a view to updating the Units' knowledge of the islands' Flora and Founa. A separte report of this visit is submitted herewith for additional reading.

3. BIRD NOTE

A rather unusual breeding success by several species was observed during the period. This was was noticed particularly from July when a somewhat super-abundance in both adult birds and nestlings were conspicuously common. Among the reserve islets Motu Ubua had suddenly turned out to be the best in terms of species diversity, abundance and breeding success. Motu Tabu came second and Cook Island third. Ngaontetake fairly matched Motu Ubua in species diversity and Motu Tabu, partly, in species abundance.

Such bredding success was noticed particularly on all Booby spcecies, The Red-tailed Tropicbird, the Christmas Shearwater, the Phoenix Petrel, the Great Frigatebird and the Brown and Black Noddies. No actual counts made on the individual species but we did determine a population estimate in definitive expression as follows:

SPECIES	POPULATION	LACATIONS
Great Frigatebird	Abundant	a) Central Lagoon areas
	Extr. abundant	b) Milkfish Culture system and interior regions east of Central Lagoon areas.
	Abundant	c) Motu ubua and other main Lagoon islets.
Masked Booby	Extr. abundant	a) South-east peninsula
	Abundant	b) Central Lagooon areas and certain areas with Milkfish culture system.
Red-Footed Booby	Extr. abundant	a) Central Lagoon including Milkfish culture system
	abundant	b) Some main Lagoon islets
	Extr. abundant	c) South-east peninsula.
Red-tailed Tropicbird	Extr. abundant	a) South-east peninsula
	Extr. abundant	b) Central Lagoon regions and adjoining Milkfish Culture system.
Christmas Shearwater	Extr. abundant	a) Motu Tabu and Motu Ubua
	Fairly abundant	b) Other nearby islets.
Phoenix Petrel	Extr. abundant	a) Motu Tabu and Motu Ubua
		b) Other nearby islets
Brown Noddy	Extr. abundant	a) Motu Ubua and Motu Tabu
	abundant	b) Cook island
	Fairly abundant	c) Other nearby islets.
Black Noddy	Extr. abundant	a) Motu Ubua
	abundant	b) Cook island and Motu Tabu.

4. THE SOOTY TERN

The following accounts covers the species breeding activity up to peak egg-laying. Five main colonies laid in the December 1986 season: Cook Island, Main Camp, East of Artemia, A site/Aeon airfield and Paris.

The first eggs laid in October (24/10/86) were at Main Camp colony, followed by that at Cook Island on 8th November and Paris two days later. At about the same time, the formation of a colony in aerial display was begining to take shape at a site on the south-east peninsula, but settling on the ground at night. Here the first eggs were laid towards the end of the second week of November, The colony east of Artemia began aerial formation in the last week of November and the first eggs laid in the first week of December.

Peak egg-laying took place in order between the different colonies as follows:

COLONY	DATE OF PEAK LAYING
Main Camp	17 November
Cook Island	18/19 November
Paris	Late November
A site/Aeon airfield	10 December
East of Artemia	11 December

The A site or Aeon airfield colony showed an unusually continous peaking which ended after the first week of January 1987. The eatward extend from A site to well beyond the eastern end of Aeon airstrip made it the largest colony in the season being about ten kilometres long. Its width varied between 50-100 metres at the narrowest to 200-300 metres at its broadest.

BREEDING SUCCESS

It was too early to include notes on the overall reproductive success as the breeding cycle began in November/December. As far as egg-laying isconcerned,

however, the sooty terns have been doing extremely well. This was noticeable especially at the Main Camp, East of Artemia and Aeon airfield colonies where extremely large numbers of both adult birds and eggs were built up at an acceralating rate following peak laying. In all three colonies we noticed the laying of two eggs on one nest as conspicuously common but particularly so at the Aeon airfield colony.

5. THREAT TO THE SOOTY TERN

a) INHUMANE KILLING

The intentional or accidental knocking of birds by vehicles is now at a certain level of persistence. As usual the sooty terns are the most victimised having now the habit of nesting close to or on either side of the main road. In this season (December 1986) a number of birds were killed having been knocked by vehicles at the south-east peninsula colonies. We deduced from the number of dead birds removed daily from the road at each of the peninsula colonies that on average fifty birds per days were killed in this way. We have been assured of the intentional knocking of birds as there were several occasions during the season when the wardens cleaned the road of the dead birds in 5 consecutive days of two consecutive weeks. On each occasion between seventy and a hundred dead birds were removed off the roads giving a minimum total of 5,600 sooty terns killed per month.

6. POACHING

a) LADIES ENTERED POACHING AREA

As mentioned in the last report, we have had the first case of women poaching eggs of the sooty tern. This was the first time since the establishment of the Wildlife Unit in 1977. In the court proceeding which was held after the submission of the last issue, the two women involved were fined A$5.00 each. What led to the women entering the poaching arena might be a clear indication of the courts pliancy.

b) FISH POACHERS FOUND GUILTY ON BIRD COUNT

A criminal case was brought to court in September 1986 over suspected illegal fishing in Government designated fish ponds. This involved three persons but the blame was put on one of them. As it was, the poachers who were pursued and cought during a late night patrol of the ponds by Fisheries staff also had freshly killed birds in their bag confiscated to Police. At a court hearing the magistrates waived the count on illegal fishing on ground of insufficient evidence, but they acused the poacher on his bird count of illegal possession of the birds. He was fined one hundred dollars.

c) LOBSTER FISHERMEN CAUGHT BIRD EGGS

The wardens confiscated a bucket of sooty tern eggs from a lobstering truck during an early morning surveillance on 27 November. This incidence occured in the village of London at dawn and as it happened, it was during the peak of egg poaching conjuncfive with the sooty tern breeding season. Of the half dozen or so returning fishermen on the truck including the driver, none claimed the bucket and the wardens had to escort the truck with the remaining firshermen on it to Police. The police officer who turned up at our request suggested that the only way to make the fishermen disclose the owner of the bucket was to have them kept under police custody. The Sergeant was consulted, however, who advised against the idea and gave the instructions that the fishermen must be questioned individually and released afterward. Over one hundred eggs were being brought in the bucket but we suspected that more had been brought by other fishermen who had been dropped in the lease village prior to the Wardens catch-up with the truck.

This case has been awaiting a court hearing since then.

d) EGG POACHERS CAUGHT ON THE SPOT

Two persons were caught illegally collecting eggs at the most south-east peninsula sooty tern colony on 29 November. The persons were caught by the writer during a weekend patrol which was combined with hunting of feral pigs in the vicinity and interior regions of that colony. It happened that the egg collectors became aware of being approached by the Warden but it was too late for them. Nevertheless they fled leaving their ice chest of eggs. One of them was caught during the chase but the other dissappeared into the bushes.

The presecution made for this case was similar to that at (b) above whereby only one person took the blame before the court. This is absolutely rediculous as in this case both persons ran away leavign the ice chest and the one who was caught confessed in a pure true statement to the warden and the police on what he and his companion (whose name he willingly disclosed) had been doing illegally.

7. ANIMALS CONTROL

a) FERAL PIGS

Over half a dozen feral pigs were hunted down in the wild at different times and places during the period but with not much success. Most of the hunting areas where the animals had consentrated were almost entirely impenetrable with tall shrubs and thickets of SURIANA MARITIMA. Shortage of ammunitions was also experienced during the early part of the period and this contributed to less effort being made at hunting of feral pigs.

b) CATS

Twenty eight cats were killed of which eleven were stray animals caught with handle nets in the villages. The rest were feral animals shot in the wild.

8. EDUCATION

a) TEACHING PROGRAMME

Our teaching programme continued and progressed well during the period. Lesson topics given varied with subjects selectively taken from different materials which include the SPC teaching aids, the newly printed booklet "The Natural History and birdlife of Christmas Island and the Units birdlife and plantlife leaflets.

b) THE NATURAL HISTORY AND BIRDLIFE OF CHRISTMAS ISLAND

The printing of this booklet has been completed and several copies have been received by the Unit. We are most grateful to all t ose who have been involved in or with its production. In particular we thank the ODA for their grant towards the cost of printing.

c) TEACHING MATERIAL ON BIRDLIFE

The Unit is presently designing another teaching phamplet which specifically deals with the birdlife. The intention is to eventually produce it into a booklet, if possible, but as yet, we will have to approach various peoples and authorities about such possibility. The booklet is being designed in the manner of lesson-giving by a teacher so it can be used widely by Kiribati teachers should the need ever come.

9. NEWLY INTRODUCED SPECIES

a) GOATS

Three goats were introduced from Tarawa last April as part of the Agriculture's Livestock rearing trial on Kiritimati. The animals, a female and two bucks are now being captive-bred at the plot near the village of Banana. It is the first time the animal is being introduced to Kiritimati though there had been suggestions deforehand against the idea. Obviously there is still considerations

over the potential of milk-producing from goats which might have, after all, revived the attempt to bring in the animals. Goats are known world-wide to pose serious problems and impact on the wildlife and the environment. Depending on what exactly is the purpose of bringing in the animal and the livestock population, there is concern overthe future of the wildlife and habitat should the trial be left slip past our consciousness.

b) PIDGEONS

Over half a dozen pidgeons were introduced in March by a worker of the Plant and Vehicle Unit. The birds were brought intentionally as pets but they have been released and can be seen now in the village of London. We do not know if they should impose any problem or threat to the wildlife. In any case the act by the person responsible is an example of a deliberate introduction of species into the Wildlife Sanctuary of Kiritimati which need be controlled and scrutinised in order to avoid the risk that may be induded.

10. BASE-STATION DEVELOPMENT

a) WORKSHOP

A new workshop built recently at our request has now been completed. It is built at the backyard of the Units' office at Main Camp. We have used the shop already and the Units equipments are now being stored and maintained in it. We thank the Ministry of Line & Phoenix Groups for their approval and commitment.

b) NEW SIGNBOARDS

We have made a number of new signboards from calvanised metals and wooden stands The idea is to have these availble in good numbers so they can be used whenever and wherever needed. Some of these have been put up on reserve islets to replace the old ones. Some are being installed at critical bird colonies to alert people of the care needed in avoiding knocking or injuring birds with vehicles.

11. GUIDE FEE INTRODUCED

A guide fee of ten Australian dollar has been introduced for a visitor per day who takes a birdwatching tour to the reserve islaets or other bird locations that involve the accompaniment of a guide from the Wildlife Unit. This has been necessary to help meet the guiding expence provided by the Unit which in many case had involved after - office - hours attendance. On the other hand the attendance of a guide means the commital of fuel for over thirty miles and it less than what a visitor would be charged with on other excursions.

Teebaki

KATINO TEEBAKI

13 JULY 1979

LAST U.S Personnel

at CANTON (from L. Taylor)

21 May 79

State + Iverson at Canton

SPC-NMFS/Turtles/WP.7
4 December 1979
Original: English

SOUTH PACIFIC COMMISSION

JOINT SPC-NMFS WORKSHOP ON MARINE TURTLES
IN THE TROPICAL PACIFIC ISLANDS
(Noumea, New Caledonia, 11 - 14 December 1979)

NOTES ON MARINE TURTLES OF REPUBLIC OF KIRIBATI

by
B. Onorio

Introduction

Kiribati, a newly independent republic born on the 12th July, 1979, with (its capital headquarters) at Tarawa, consists of low coral and atoll island groups, the Gilberts group (17 islands), the Phoenix group(8 islands), and the Line Group (8 islands).

Within most of the individual islands are uninhabited small islets or infrequently visited areas around which marine turtles have been noticed, and known to lay eggs. In most of the Gilberts group, where approximately (occupied by about) ninety five percent of the total Kiribati population reside, turtles have traditionally been hunted mainly for its meat. However, at present the turtle fishery in Kiribati is still at subsistence level.

Very little information is available on the extent of turtle resource in Kiribati. Balaz (1975), conducted a preliminary survey of turtle nesting areas on Canton Island in the Phoenix group. Grimble (1972) recorded the traditional values and attitudes towards turtles, however, most of the knowledge about turtles is still with those who hunt for it.

Recently, an investigation was carried out by the Fisheries Division (Kiribati Group) to find out more about turtle species and utilization in Kiribati. A questionaire and identification sheet prepared origionally by USP was used in the survey to interview about fifty turtle fishermen in Tarawa.

This report then is a preliminary attempts to collect and record what is locally known by the various turtle hunters. It is by no means a complete summary and a lot more work is still needed to be undertaken on actual nestings, distribution, feeding area and resource potentials of these islands.

Most of the people hail from different islands in the Kiribati, so information about turtles in other island groups were also obtained. These were supplemented with personal experience and records from the national archives.

History

According to the Gilbertese version of the creation (Sabatier 1977), "Te Tabakea" the turtle was the ancestor and the first of beings in connection with Banaba (Ocean Island). Tabakea was buried beneath Banaba during the creation, hence the general hump shape of the island.

The Kiribati society is divided into exogamous groups. Turtles are considered as one of the totem creatures worshipped by the groups of "Teborauea and Tabakea". No member of a sibbling may eat the totem creature worshipped. The creature is held to be flesh of his flesh. It is also avoided by pregnant women, nursing mothers and also adults at the time of war, as it is supposed to cause cowardise on account of its crawling habit. (Grimble: 1933 - 1934).

Perhaps the first documented historical reference to turtles in Kiribati is that made by Captain Cook after his arrival on Christmas Island in 1777. Bailey (1977) described the highly successful turtle hunt undertaken by Cook's crew to replenish food stores aboard the "Resolution".

Reports of turtle hunting in Kiribati waters appear in log books of other early explorers, Captain Fanning in 1798 mentioned the excellent turtles found in the island which today bears his name. Presence of turtles in waters around Hull Island was reported by the Wilkes Expedition in 1814 (Maude, 1968). Maude (1968) stated however, that turtle shell was obtainable only in limited quantities and that possibly trade in such exotic items declined as the demand for cocconut oil and copra grew. Sabatier (1977) told of spear hunting of turtles at Aranuka Island. In Captain Trainer's voyage in 1831 (Maude, 1965) turtle shell was also taken, the selling price then being $14 per lb. in the United States. Goo and Banner (1963), reported the presence of green and hawksbill turtle in Gilberts waters.

Turtle Species Reported

Identification was made based on the publication "appearance of carapace and arrangement of shields in turtles reported from Fijian waters." (a) and (b) below were positively identified while (c), (d) and (e) were based on actual descriptions. There are at least four common turtle species reported. All of these are called locally as "Te On".

(a) Green Turtle - Chelonia sp.
Local name -"Te On"
Very common, in all island groups, sizes range seen being 15cm to 1 metre length. Found to nest in most of islands.

(b) Hawksbill Turtles - Eretmochely's imbricat

Local name - Te Tabakea, Te borauea

Also common. Size range 60-100 cm (carapace length). Not known to lay eggs in occupied islands (rarely been caught while nesting).

(c) Logger head turtle - Caretta Caretta

Local name - Te on n ae (name for the big loggerhead)

Obtained while nesting and also in gillnet catches. Size range about 60cm to over 1 meter length. Seen at Butaritari, Kuria, Aranuka and Tarawa.

(d) Pacific Ridley - Lepidochelys olivacea

Local name - "Te on mron"

Size range 40 to 60cm. Normally caught by divers and gillnet catches, not so much during egg laying periods. Seen at Butaritari and Kuria.

(e) Leather back turtle - (Dermochelys coreacea)

Most people are unaware of this species in the islands of Kiribati. One case was told from the island of Butaritari. Some fishermen were fishing with hook and line off the reef edges at the ocean side of Tanimainku village. One of the fishermen on one canoe thought he had hooked a big fish when he was suddently pulled out into the ocean, the others came to his aid and tied their canoes one after the other. The turtle pulled six canoes for about an hour, tired out, if surfaces and was tied up and brought to shore for a big feast. The characteristic black skin with seven narrow ridges was noted. The carapas was estimated as about two meters in length.

It was believed to have accidently hit the line and got hooked. This may be the only known case of leatherback turtle.

Distribution

The presence of the marine turtles in all the islands of Kiribati is indicated by earlier reports and observations and the result of the survey.

a) Gilberts Group

Marine turtles have been seen, caught or known to nest in all of the 16 islands (except Banaba). Most of the sightings are by fishermen fishing on the ocean side of the island, in a boat or a canoe. The turtles are seen when moving near the edge of the reef flat, resting in crevices at the slopes of the reef flat edge, or most noticeable is the surfacing turtle making sounds. While fishing off N.W. Betio, Tarawa lagoons edge, an average of 3 turtles surfacing per hour was noted on several fishing days. These were mostly green and hawksbill and the 5th variety turtles. In Butaritari and Kuria and some of the other northern Gilberts, all the four species have been reported.

b) Phoenix and Line Group

Reports from these areas are scanty due to the small population, about 5% of the country's total and being infrequently visited.

Balaz (1975) made a preliminary survey of the nesting sites on Canton Island and noted a high nesting activity of at least 10 nestings per day at one of the 4 sites, by Green Turtles. Reports from a local ships visiting these areas, say, that in most all of the Phoenix group, some numbers of turtles are usually seen roaming unperturbed. Bringing back of barrels of salted turtle meat has been a common practice by crew of the local ships visiting Gardner Island, Hull and Canton Islands.

During the Fisheries Division's one week visit to Gardner Island (June 1978) mating green turtles were seen. Also five turtles were caught easily by chasing in the shallow areas of the reef flat.

In the Line group, very few records were found. It would be expected that these islands would have good numbers of turtles as there is very little disturbances.

In Captain Cook's stay in Christmas Island in 1777 (in Bailey 1977) turtle meat became a staple food during their stay and journey to Hawaii. They once caught 42 green turtles in half an hour.

As Bailey (1977) points out, Cooks successful turtle hunting may have attracted many other ship to Christmas since turtles are now rarely seen.

Some flipper marks have been noticed on the shore of Christmas Island probably indicating nesting activity. Reports from people once living in Line Islands (1963) indicated that sighting of turtles are few. It is possible that nesting activity in this areas are not as high as in the Phoenix group.

Nesting Areas

It is known that nesting females frequent the low sandy beaches far from the villages or at infrequented beaches. In most of these islands in the Gilberts (except Banaba), turtles have been known to nest at same area in each of the 16 islands.

There are however two known areas where nesting turtles frequent in good numbers -

a) "Katangateman" Sandbank - a small sand area few feet above sea level, about 300 km N.E. of Makin. According to fishermen of Makin, vegetation is only creepers and shrubs (mostly Scaevola) no trees. The place was frequented by the Japanese during the war to replenish their meat supplies.

(b) Another sandbank - by Nonouti Island with a habit at similar to the above, was used by the US forces during the war for turtle's meat.

According to some of the elderly people interviewed, Bikar Atoll in the Marshalls has been long known as one of the major turtle nesting ground. Incidently, this place is reported as such by Hendrickson (1972). They also believe that similar areas are abundunt in Kiribati where turtles can nest undisturbed. It is also believed that the turtles go to other areas once their nesting grounds are disturbed.

Regretably, however, indications of the degree of nesting activity in the above areas is not known. From Balaz (1972) a total of 33 turtle tracks were noted from 4 nesting areas. Some tracks noted were ten days old. A total of 170 turtles pits were also noted from the same areas.

It is not clear though whether these tracks were all ascending or also descending tracks. However, indications are that nesting activity of a minimum of 10 turtle nestings per week on Canton Island is possible. Taking the four peak nesting months in April, June and October to December as the expected good nesting seasons. It can be roughly estimated that a minimum of (10 x 4 x 4) - 160 turtles nest yearly in Canton Island. However, if all the 33 tracks are of separate turtles then assuming that all these tracks occur within a 10 day period as mentioned by Balaz, working on similar lines as above, (as with Hendrickson (1972)) a total of 132 turtles nesting can be realised each month or about 132 x 4 (peak nesting months) = 528 turtles nesting that year. This is more than half that of Bikar Atoll (Hendrickson, 1972).

Nesting Season

Turtle nesting activity occurs year round but round the most prolific times are during two seasonal peaks in April and May and on a later peak occuring from October to February.

It is interesting to note that during these peak months, the highest nesting activity occurs during three days after each of the four moon phase (i.e. F.M., F.Q, N.M. and L.Q.)

The October to November peak turtle season is forecasted to the local turtle fishermen by the flowering of the tree "Te Itai" (Callophyllum inophyllum, L.)

CATCHING OF THE EGG LAYING TURTLE (GILBERTS GROUP)

Nesting turtles generally come from the ocean side of the islands to sandy areas at night during spring tides and leaves before dawn in the next high tide. There have been cases where laying turtles comes from the lagoon side, also a turtle crawls up during low tide, however, these are considered rare only. The turtles are caught before leaving the land. Nesting seasons are as indicated above earlier.

A method of catching the nesting turtle is one which has been passed on for generations and mostly within family groups. By this method the exact day and area the turtle will come to lay eggs is worked out from the number and size of eggs and the flipper marks of the turtle when it first come to the beach area.

The turtle flipper marks are usually located first. The types of flipper marks and what they mean to a turtle hunter is told by Tabare* (1976) of Nikunau Island.

There are 3 main types of turtles, recognised from flipper marks

i) "Naeke" - close together flipper marks
This type lays eggs where it first disturbs sand. It then makes large disturbances to cover up the area where eggs have been buried.

ii) "Teimarena" - Literally means - flipper marks are more spaced than above.
This type lays eggs only at the second place disturbed.

iii) "Teiantano-maing" (literally means - left flipper marks are deeper in the sand.)
This type lays eggs in the very last area disturbed.

These could represent three different species of turtles, however time was not permitting in order to find out the corresponding English names.

People who do not know these specific egg pits, go around poking sand with sticks until they get a egg wet end. Others look for marks on the shrubs nearby where the turtle has bitten while laying.

Once the eggs pit is located, the eggs are removed, counted and noted how many days it has been buried. This is indicated by the degree of yolk dissapearance or development of the whitish layer on the egg.

Calculations are made from the egg number and shape, as to when the same turtle will be back to lay more eggs near the area where it left last time.

*In 'Temaribo' (21st October, 1976) - monthly newsheet prepared by Agriculture department (in Kiribati language)

Several versions were told by these people on how the calculations are made.

a) Kanoua of Butaritari (Northern Gilberts)

Turtles normally lay 60 to 100 eggs at a time. If the number of eggs are in the 60x or 80x or 100x, then the turtle will be back at either 8, 10, or 12 days after it left the former lot of eggs.

If the number of eggs is in the 70x or 90x then the same turtle will be back after normally 9, 11 or 13 days. It is important to note the number of days the eggs have been buried and this is known by holding the egg towards the light to determine the degree of whiteness covering the yolk. The egg is marked in on in eight equal sections (8 days) and the degree of whiteness corresponds to the number of days it has been buried. Hence by substraction from the total expected days the day the turtle is expected back is known. The hunter would go at these times and hide in the bush near the area where the turtle left last time. As the turtle comes in or out of the land it is overturned and taken.

b) Batiaua Kobuti of Nikunau Island. (Southern Gilberts).

If number of eggs is 80 or 100 (even) then turtle comes back to the same area in 10 days time. If number of eggs is extra (i.e. 82, 92 or 102) then the extra eggs correspond to extra days as follows:

82 eggs or extra eggs corresponds to 1 extra day so the turtle is expected in (10 + 1) eleven days

4 extra eggs corresponds to 2 extra days etc.

6 extra eggs correspond to 3 extra days etc.

If the number of extra eggs is an odd number then there is usually an oval eggamongst them. To each one of these means an extra day, similarly the day the turtle is expected is worked out.

According to Terurunga, another local writer, if most of eggs are oval then the turtle will come to nest during low tide. Turtles crawling ashore during low tide has also been told by other people interviewed.

There is some differences in the two methods (a) and (b) above however, these may be due to Geographical positions of the islands. Also the experts on this knowledge usually make modifications or hand down bits of information to their family so that they get some turtles but not always.

Catches by the method are on green turtles (60 - 120 cm) and logger head turtles (90 - 130 cm). It is noted that Hawksbill have not been reported to nest in the islands of Butaritari, Tarawa and may be many others.

Indications of numbers, regularity and amounts of catches of nesting turtles is not known.

Catching of Roaming Turtles

In catching turtles in the lagoon and ocean side of the Island, improved methods have been evolved recently with introduction of outboard engine, skiff and monofilment gillnets. However, Tarawa, Butaritari, Kuria, Aranuka, and Nikunau are five of the main areas where turtle fishing using one or all of these methods below are used to a greater extent. In some islands like Beru, majority of people do not normally hunt and eat turtles as they are considered as totem creatures. However, modern influence has changed a lot of attitudes towards the catching and consumption of the animal meat.

a) Gill Netting

This is a fairly recent method mainly done in the Northern Gilberts, and Tarawa. This has now spread to outer islands in the Gilberts group.

Nets are 80 - 120 fathoms long with stretched mesh size of about 50 cm.

These are usually set in the lagoon behind turtle grass ("Te Keang") areas about 6 - 10 feet deep and left overnight. While the nets were are locally sewn on Butaritari, and used to be of "Te Kora" or coconut twine, monofilment (100-120 lbs test strength) has now been found to be superior. The best times for setting the nets are found to be at high spring tides, 3 days after fullmoon. Normal average catches are 2-7 turtles a day. Net can be left for 4-5 days and checked daily, a convienient method of fishing as there is no spoilage.

In Tarawa, at the northern end (Buariki), catches have been up to 5-10 green turtles a day while in southern Tarawa, 1-3 turtles a day of average size 50-90 cm carapace length. Incidently, this coincides with the richer turtle grass concentration at Butariki, north Tarawa and also occurrence of beds of caulerpa sp. seen in the deeper areas at North Tarawa. Less of population disturbance at North Tarawa could also contribute to a generally greater numbers undisturbed roaming there.

A successful catch was made in Butaritari in 1973 was specially reported. It is known by the fishermen that turtles come into the lagoon at night time to feed on the turtle grass beds. They then proceed back at dawn via the southern end tip of Ukiangang village (Auonebe). A net was set

at this point and the turtle kept coming into the net till noon. The day's catch totalled 45 turtles of average sizes 60-90 cm. However, average catches in Butaritari are 3-10 a day when set behind turtle grass areas. Most of species caught in Butaritari are of the first four types described above, with over 50% being green turtles. In Tarawa, most of the catches are green turtles.

b) Spearing or harnessing from a boat or canoe (Te wai)

This is usually done in the lagoons at night especially during clear moonlights, around full moons and new moons. During these periods with incoming tides, the turtles move to the feeding grounds and are not as easily aware of humans as in other times, may be they are affected by the dazzling moonlights.

People of Aranuka Island (Gilberts group) are well known spear turtle hunters. As also told by Sabatier (1977), several canoes with cocomut leaf torches move around the feeding turtles and drive it inshore then it is either speared or one goes in the water and skillfully turn it over and bring it up.

Other hunters with spear do not use torches but recognise the roudish black figure moving slowly. In North Tarawa, this is done at "Biken Amori".

Catches of selected bigger sizes (80-120 mm) of up to 3 green turtles is enough load for the average size canoe.

Speed boats with pressure lambs are now commonly used. Betio (Tarawa), and Abemama are two of the areas where this is done. The dazzled turtle is chased and speared, grabbed or harnessed as it comes alongside the boat. Catches range from 2-5 turtles a day consisting mostly of Green Turtles.

During the 'Van Camp' tuna survey team's stay in Kiribati (1973), the crew use to hunt turtles by the lagoon edge at N.W. Betio. A hook is attached to a bamboo which gets detached as the turtle is hooked. The end of the rope is attached to bouy which people on the boat pull in. Their catches range from 5-10 turtles for 2 hours fishing.

Several people told that turtles are usually baited with grinded ripe pandanus fruit spread at the sea surface. As the turtles comes near they are speared or hooked.

c) Tying or hooking

This is practised in the daytime mostly in theocean side of the islands, but sometimes in the lagoon too. Many turtles usually rest in the

daytime, clinging to rocks, goes into crevices partly exposing their bodies or would be seen crusing along the islands "verander" (the area beyond the reef edge which slopes steeply down into the deep). The "verander" ranges from 3 to 40 metres depth and turtles are taken from all these depths.

Divers go down with a long rope and ties either the neck or the flipper of the resting turtle. The end of the rope is tied to a log float which the turtle pulls until tired. An account of this is also given in Wulff and Bjorn (1977) where the diver spends at least four minutes underwater chasing turtles. Divers like these have undergone special treatments which enable them in the old days to spend unbelievable amounts of time underwater. In Tarawa itself there are at least four skin divers engaged in this method of turtle hunting. On talking to some of these divers, they said that at a glance as they go down they normally see 2-4 nesting turtles amongst the corals. Most of the smaller ones (15-50) cm carapace length) are in the upper areas of the 'verander'. There is no particulary best time to go hunting however, it was noted that there are more roaming or groupings of turtles during the two peak seasons outlined below. Normal subsistence catches on a good day are 2-3 turtles. However, in a particulary good area as in Teaoraereke, Tarawa, catches have been up to 12 turtles per day. Most of catches in the area is of greens, logger heads and pacific riddley. Hawksbill are not generally taken although more tame. This is because of the cultural attachments to it ('Te Tabakea') and also becaume of its nature to bite as it can easily turn its head around.

TARAWA TURTLE FISHERY

To get an idea of the size of the subistence level turtle fishery in Tarawa (urban centre), the number of capable turtle hunters were counted with the help of the fisheries assistant trainees.

An estimate of the capability of the fishery is calculated, below based on the 1978 figures.

Methods	Total number of turtle hunters	Average catch/day in good month	Average days effort/week per good month
Gillnet	12	2	2
Spearing/Harnessing	6	2	1
Skin diver/Tying/hooking	5	2	1
Nesting turtle catching	2	1	?
Total:	25		

Taking only the best times for catching these is in the peak nesting seasons of 4 months per year, with an average effort per good season being in 2 weeks of the month. The estimates of probable catches based on average catches and efforts, can be worked out roughly for each method of catching. It is noted though that in the absence of proper data and survey rough estimates will have to suffice in order to realise the potentials from this fishery which will normally be overlooked.

a) Gillnet

The 12 fishermen are capable of catching 36 turtles/day or 72 turtles/2 days effort in one week.

Considering that this effort can be done at least in 2 weeks of the peak months, hence 144 turtles can be envisaged per good month. This mean then that a probable 576 (144 x 4 month) were taken from Tarawa lagoons in 1978 by gillnet alone.

b) Spearing and harnessing

Here the efforts are more at Betio side. The 6 fishermen can obtain 12 turtles/effort-month. Considering the effort per month being mostly in the month period of the peak nesting seasons.

Hence a 48 turtles in 1978 is realised.

c) Skin Divers

Five of these divers go out at least once in a month in the best 4 month of a year. Taking a low average catch of 2 turtles/day it can be estimated that about (5 x 4 x 2) = 40 turtles were caught.

d) Nesting Turtle

Very few cases were told. In North Tarawa 2 nesting turtles were reported caught in 1978, in Buariki.

The total catch of turtles from Tarawa is estimated in year 1978 as 666 turtles with over 80% catches by gillnets. Increased demand for turtle meat and shield has already shown an increase in effort in all the methods of catching.

FEEDING GROUNDS

Feeding grounds for turtles occur in appreciable quantities in most of the lagoons of islands in the Gilberts group. The common feeding grounds is mostly indicative of abundant turtle grass 'te keang' (Thallassia sp). Such grounds usually occur by the edge of the intertidal sandflats, with 10 to 20 cm of water during very low tides. Turtles come to these areas mostly at

night during high tides, and are hence caught by gillnets at this time.

In Tarawa lagoon, beds of Thallasia sp. occur along the length of the islands, but the big concentrations are towards the Northern end. In the deeper areas, beds of Chaulerpa sp., another known turtle food are also present. Higher catches are reported in these areas near the dense feeding grounds as compared to South Tarawa.

Commonly found in the stomachs of turtles is a spongelike greenish seagrass - locally known as 'Te onga n tari', also sargassum a brownish spiny algae mostly occurring on the ocean side of the islands. Details of the turtle feeding grounds has not been worked out yet.

TURTLE FARMING - A SUBSISTENCE LEVEL FISHERY

Working at subsistence level, it is a common practice for turtles catches, if in excess of normal family requirement, to be left in pools or enclosures until required for feasts and celebrations. In such cases the turtles are fed on:-

a) Babai (cytosperma sp.) leaf
b) Coconut (young soft flesh).
c) Fish (sardines & cut up flesh of fish).
d) Seaweeds (turtles grass, blue green algae)
e) Creeping Grass - Portuluca sp "te boi", "te mtea"

Small turtle, a few days after hatching, have also been kept in small pools of water, and fed mainly on small bivalves ('Te Katura', Mesodesma striata). However, raising of small turtles is not generally favoured as the time and effort spent are thought to be of better utilized for growing bigger sizes.

It is reported that one islander at Tabiteuea, raised a green turtle from 30 cm to about 95 cm on portuluca and coconut for over 5 years.

A small scale turtle farming was reported by A. T. Wainright, VSO working in Fisheries where in a secluded water area made by a causeway joining two ends of islets in Taratai (Tarawa), 50-60 green turtles have been raised in 12 months, the estimates of growth by the farmer are from 15-20 cm to 40-50 cm shell length in about six months. The turtles feeding naturally mainly on young mangrove shoots and algae mat present in the enclosed area.

Considering this rate of turnover, farming of turtles as such may be a profitable occupation in Kiribati, especially with an increasing trend to build more causeways in most of the islands. For this to be a reality though, an adequate supply of seed stock is necessary.

CIGUATERA CASES

Two cases were told from the islands of Nikunau and Arorae where after eating of the fatty tissues of the turtle, most liked by the people, these people vomited with bowels, frothing at mouth, stiffenning of limbs, skin peelin, as if after burning with eventuall death.
The Hawksbill turtle was noted as the ciquatera cause. Many people abandoned the catching and consumption of turtles after these cases. Cooper (1964) also reported of the Arorae Island case with details of ciquatoxic symptoms.

It is interesting to note though that hawksbills (Te Tabakea) are not usually taken by turtle divers and those who follow the advice of the elderly people, as 'Te Tabakea' is considered sacred, (a totem creature) in connection with Gilbertese history. It has served its purpose as well as a deterent for a potentially ciquatoxic animal.

USE OF TURTLE

Turtles are taken for food where the meat and intestines are used. Ways of cooking these, (outline in Temaribo, 31/12/1975) plus other factors shows others who do not normally eat these, to consider catching the turtles. The meat sells at $0.50¢ per lb. at the Local Produce Division Very little is sold as the turtle is usually kept alive until required by each family. However, turtle meat is taken relatively less than fish.

The turtle shield is used primarily for decorations and ornaments. The 40-50 cm shield now sells at $8.00 at the Local Produce Division. Two of the divers in Tarawa go out catching turtles mainly to sell the shield. Kuria island is the main area beside Tarawa where the local produce obtains turtle shields for sale. However, supply is as when demanded.

PREDATION AND LEGISLATION

Quite efficient methods of catching the turtle by man is one of the major predator on the eggs and turtle itself. However, knowledge of catching of nesting turtle is not so widely known. Also people normally prefer fish, only fiarly recently with shift of population to Tarawa, other foreign boats exploiting it, more efficient methods of catching and the growing tendency for export of shield has the increase in effort for turtle hunting been noticed.

Natural predation is reported by (Cross, 1978) where a tiger shark

(Galeocerda curieri) had in its belly a turtle carapace. The other likely predators also found near the nesting sites, migrating to the beach areas in numbers, 3 days after FM are the hordes of the ghost crab 'Te manai' (Cardisoma sp). Present by the beach is the beach crab, 'Te manai' and 'Te mama' (Ocypode ceratophthalma). This is also noted by Balaz (1975).

Birds are also known natural predators to hatchlings. In the Phoenix and Line Groups, thousands of birds nest, and these could contribute to a certain extent on the hatchling predation.

Under the Wildlife Conservation Ordinance 1975, the wild turtle is regarded as being a partially protected animal. None may hunt, kill or capture any wild turtle on land except that they be in possession of a valid written licence.

The traditional practice of catching these makes enforcements of these law difficult. People are aware of the conservation and perpetuation of turtle species and often let the hatchlings go free or let the mother finish laying before taking it.

Tighter measures may have to be taken at a later stage after evaluation of turtle resources especially in potential areas.

Summary

The present size of the marine turtle resource in Kiribati may be envisaged as good considering its current level of exploitation at the subsistence level. However, the future of this resource in some areas may need to be looked at more closely considering the following facts. The population of Kiribati is growing and its move towards urbanisation has resulted in increased demand for animal protein. This increased local market with improved methods of catching marine turtles notably the introduction of monofilament gillnet can be a cause for concern. However, the nature of the people to prefer fish most of the times and turn to meat during celebrations and feasts coupled with traditional attitudes to turtles has helped limit the exploitation of these animals.

Perhaps more attention could be devoted to studying and perhaps improving the traditional turtle farming practiced in some areas of Kiribati to help meet the increased animal protein needs of the country while closely monitoring the turtle resource.

The present global concern for the protection of mass nesting sites and endangered species also justified the urgent need to learn more about the status of the turtle resource in this part of the world so that appropriate

plans can be instituted to insure a long term sustained harvest of this valuable resource.

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Trip Report - Jarvis Island - 19-23 March 1996
With Note from Palmyra and Kanton

Summary: Staff from the Pacific Remote Islands National Wildlife Refuge Complex accompanied the U.S. Coast Guard Cutter *Sassafras* on their voyage through the central Pacific Ocean in March of 1996. We were able to visit and engage in biological surveys at Jarvis Island National Wildlife Refuge, Kanton Island, Republic of Kiribati, and do a brief walk on Palmyra Atoll.

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Objectives: This trip served as the refuge staff's biennial monitoring visit to Jarvis Island National Wildlife Refuge. In addition the itinerary of the *Sassafras* allowed us to make quick surveys of biota at two other central Pacific islands with contrasting climates and management regimes, Palmyra Atoll and Kanton Island. Our specific objectives were:

1. To evaluate the status and condition of refuge wildlife by measuring species composition, population size, and nesting phenology.

2. To check the refuge for indication of alien species introductions, trespass, and toxics, e.g., used batteries.

3. To determine success of cat eradication efforts at Jarvis Island and to monitor subsequent bird recolonization.

4. To repeat pelagic seabird observations done on trip to Howland and Baker Islands the previous year in the same season and over a similar cruise track.

Funding: Funds to support this trip came form the operational budget of the Pacific/Remote Islands National Wildlife Refuge Complex. M.J. Rauzon and K. Broad kindly volunteered their time to conduct the land surveys and at-sea observations.

Vessel: The voyage was made possible by the invitation to ride aboard the USCGC *Sassafras* on its annual trip to American Samoa to maintain aids to navigation and conduct law enforcement activities. The *Sassafras* is a 180 foot buoy tender with good bridge wings for pelagic seabird observation and excellent capabilities for getting close to refuge islands and launching small boats from the deck.

Itinerary:

13 March 1996. 1600.	*Sassafras* departs Honolulu.
14-17 March 1996.	Pelagic bird observations.
17 March 1996. 1700.	Arrive Palmyra Atoll, anchor west of entrance.
18 March 1996. 0800.	Land on Palmyra, survey Cooper-Meng Island.
18 March 1996. 1400.	Depart Palmyra.
19 March 1996.	Pelagic bird observations.
20 March 1996. 0550.	Cross equator
20 March 1996 1000	Land Jarvis Island. Commence surveys.
23 March 1996. 1100.	Depart Jarvis.
23-25 March 1996.	Pelagic bird observations.
26 March 1996. 0830.	Arrive Kanton Island, survey Spam Is., English town, and northwest side of atoll.
27 March 1996. 0700	Survey southwest quadrant of atoll.

28 March 1996 0800	Depart Kanton Island.
28-30 March 1996.	Pelagic bird observations.
30 March 1996. 0630.	Observation of Swains Island from offshore.
31 March 1996. 0800	Arrive Pago Pago Harbor, American Samoa.

Methods: Techniques designed to minimize alien species introductions included freezing of all gear, clothing and packing in clean plastic containers. Tents and bedding are "island dedicated" so used only at Jarvis Island.

The survey of Jarvis was done using standard refuge methods for short monitoring visits. The entire island was covered on foot by dividing the area into sections in which 3 or 4 people could walk abreast in a zigzag pattern. Presence and distribution of plant species was noted and chicks, eggs, and clubs of seabirds counted and staged. Due to the short duration of the visit. we did not take the time necessary to find all tern chick and eggs but simply stated those seen and mapped the general areas of the colonies. All shorebirds were counted. Nightly walks through areas formerly frequented by cats were made using bright flashlights to detect eye shine. Night walks were also made into areas known to have shearwaters nesting. Broad made a dive on the southwest side from reef top to about 80 feet of water.

Results: Weather - There was no precipitation during our stay on Jarvis. Temperatures over the 3 day period ranged from 24.4 C to 35.6 C. During the visit were treated to spectacular nightly views of Hyakutake Comet rising in the east and moving to the west by dawn.

General conditions - The minimal vegetation and low water levels inland indicated it had been very dry preceding our visit although some plants appeared to putting out new growth (*Tribulus, Sida, Eragrostis, and Portulaca*).

Species Accounts -

Plants. No species of plants new to Jarvis were seen on this visit. The following were present in the condition listed:

Lepturus repens - more abundant on the outer beach crest but scattered throughout.

Eragrostis whitneyi - small amount of new growth in flower from many old clumps covered with crystallized salts in interior.

Boerhavia tetranda - we saw both plants with purple flowers and plants with white flowers.

Tribulus cistoides - not in bloom, small leaves sprouting from old dry stumps.

Portulaca lutea - not in bloom, small leaves sprouting from large old stems.

Sesuvium portulacastrum -- not in bloom in most places but some white flowers noted. Plants growing well in thick mats in some parts of the interior.

Sida fallax - Most plants just starting to bear leaves. Some individuals in bloom.

Abutilon indicum - Dead stumps widespread. No active plants found of this species.

Terrestrial Arthropods: Ticks or mites - A small dark grey (approx. 1 mm diameter) tick was seen on Rauzon. Depkin and Flint both received bites reminiscent of tick bites acquired elsewhere characterized by weeping lymph or appearing as a blood blister. Insects were not collected but we observed cockroaches, small gray-black beetles, and small moths frequenting the blooming *Boerhavia*. and *Sesuvium*. *The land hermit* crabs *Coenobyta perlata* were present in small numbers relative to other trips and almost all had good quality *Turbo* shells.

Mollusks: There were fewer *Tridacna* shells on the beach at Jarvis than typically seen at Howland or Baker. The few seen seemed more massive and angular than is typical of *Tridacna maxima*.

Fish: A swimming survey utilizing a "sample of convenience" was conducted along the offshore Western coast of Jarvis (from the boat landing to the SW point). General observations were made primarily in the shallow fore reef community (3-30m) along the outer reef slope. Moving seaward from shore, the reef flat slopes gently into surge gutters, dropping steeply (>70 degrees and at times vertical) to a terrace at about 7m and finally drops steeply into very deep water. The coral cover (a variety of branched and low-covering *Pocillopora*, *Acropora*, *Porites*, and gorgonians) was high on the terrace and drop off with no obvious signs of disease or mechanical damage from storms. Several varieties of fishes from the following families: Gobiidae (Gobies), Labridae (wrasses), Pomacentridae (Damsel fishes), Serranidae (groupers), Blennidae (Blennies), Chaetodontidae (Butterflyfish), Scaridae (Parrot fishes), Carangidae (Jacks), Lutjanidae (Snappers), Holocentridae (Squirrelfishes), Balistidae (Triggerfishes), a single unidentified moray eel (Muraenidae). A small school *of Sphyraena genie* (Barracuda), single *Acanthocybium solandri* (Wahoo), *Thunnus albacares* (Yellowfin Tuna) *one Triaenodon obesus* (Reef Whitetip shark), numerous *Carcharhinus amblyrhynchos* (Grey reef shark), numerous *Carcharhinus melanopterus* (Reef blacktip shark), and a single unidentified Sphyrnidae (Hammerhead Sharks). Numerous *Carcharhinus melanopterus* (Reef blacktip shark) were seen on the reef flat on the East side of the island.

Reptiles: A small unidentified young gecko was seen near the cement pad and refuge sign. A dead female green turtle (*Chelonia mydas*) was found halfway between the beach crest and the water on the south side of the island. Its measurements were: 82cm curve line from the anterior to the posterior end of the carapace, 75cm curve line across the widest part of the carapace measuring to the outside of the perimeter scute, 63cm plastron, 16cm head length, 14.5 head across, 10cm tail, 33cm length of rear flipper and 47cm front flipper (tip of flipper along the front edge to the base of the flipper).

Cause of death unknown. There were no tumors, tags, signs of external injuries, or any evidence of cause of death. Along the same shoreline were a few depressions at the vegetation line that could have been nest pits. Two *Chelonia mydas* (green turtles) were noted on the dive made by Broad on 23 March.

Birds: We confirmed breeding for 12 species of seabirds on the island with an additional 2 species present and probably breeding. There were 4 species of migratory shorebird present. Increases in species known to be vulnerable to cat predation is evidence that cat eradication was successful. Figure 1. shows general distribution of the breeding species on Jarvis. Table 1 provides count totals for each species of bird.

Christmas Shearwater, *Puffinus nativitatis*, (CHSH) - At dusk each day we observed a maximum of 12 individuals in pairs and singles sitting, calling, and courting in *Sesuvium* on the southeast part of the island. They were in an area that had shearwater-sized burrows but no other cover suitable for nesting. Wedge-tailed Shearwaters were seen in the same group of birds. Three burrows checked in the area were empty.

Wedge-tailed Shearwater, *Puffinus pacificus*, (WTSH) - We saw a maximum of 8 WTSH (all dark phase except for light phase individual) in the company of Christmas Shearwaters on *Sesuvium* in the Southeast part of the island. No chicks or eggs were found in 3 burrows checked but we did not check all burrows present, estimated to be about 35.

Audubon's Shearwater, *Puffinus lherminieri*, (AUSH) - A new breeding site for this species was found in the old guano quarry area adjacent to the lake bed. No birds were found in the slab 150 meters south of the day beacon where a few have traditionally nested. Twenty individuals were observed sitting on the surface or in burrows in the *Sesuvium* next to the quarry or in the banks of the guano cuts. One chick was confirmed. Other burrows checked were too deep to determine contents.

Red-tailed Tropicbird, *Phaethon rubricauda* (RTTR) - All of the 13 breeding sites of the RTTR were found under the slabs of coral on the north beach crest. All breeding birds were on eggs and some bird were in very fresh pink plumage.

Masked Booby, *Sula dactylatra*, (MABO) - Masked Boobies were the most numerous of the booby species on the island. They were seen to be in almost all stages of breeding but with a preponderance of chicks stage 6C to 9 (see fig.2). There were numerous pairs (287) and singles (746) standing in the colony but not much male whistle courtship occurring during our visit. Birds were scattered all over the island with slightly higher densities on the outer rim than in the interior. Nine "clubs" were counted and ranged in size from 45 to 233 birds for a total of 1195 birds.

Brown Booby, *Sula leucogaster*, (BRBO) - The majority of BRBO found breeding were on eggs (see fig. 3). One nest found had 3 stage 1 chicks in it. The only BRBO club found had 35 individuals. We found at least 15 birds of this species that had died within the last few months in the colony, perhaps as fully feathered chicks. One Jarvis Brown Booby was killed by being caught on a trolling line behind the *Sassafras* in the morning prior to our pickup. Two other boobies were also hooked but released alive.

Red-footed Booby, *Sula sula*, (RFBO) - Pockets of RFBO were found nesting throughout the island on the minimal dead bushes available. See phenology histogram (fig. 4) for distribution of breeding stages in Red-footed Boobies.

Great Frigatebird, *Fregata minor*, (GRFR) - Great Frigatebirds were breeding in highest numbers on the north side of the lake flats. Figure 5 shows phenology. As with RFBO - most nests were slightly elevated on dead bushes. Some males were displaying and were on nests with fresh nesting material.

Lesser Frigatebird, *Fregata ariel*, (LEFR) - There were 2 colonies of this highly social species. One south of the lake flat was just finishing a breeding cycle with 718 flying juveniles and 20 recently dead chicks of the same age. The other group of about 150 were on the north end was displaying and beginning to lay eggs.

Sooty Terns, *Sterna fuscata*, (SOTE) - There were only 117 active nests at the time of our visit and these were all flying or almost flying young. There were hundreds of thousands of Sooty Terns in pre-breeding behavior - some on the ground during the day but most coming in after 1730 and swirling in huge numbers over the colony in several skeins. This group is probably the largest colony of Sooty Terns in the refuge complex. On the ground were several large areas of abandoned SOTE eggs. These eggs appear to been left early in incubation with no significant embryo development seen and probably were left simultaneously because so many were left unscavenged.

Gray-backed Terns, *Sterna lunata*, (GRAT) - Figure 1 indicates the general distribution of GRAT colonies. Nests were found at all stages but eggs were most common. This is probably due in part to eggs of this species being the easiest stage to find but cover is so minimal on Jarvis that the phenology distribution may be fairly accurate. The total number

of nest found is certainly an underestimate of numbers breeding and appear to have increased since Rauzon surveyed Jarvis in 1991.

Brown Noddy, *Anous stolidus,* (BRNO) - Large numbers of Brown Noddies were incubating eggs but a few chicks were also found. This species had a similar geographical distribution to that of the GRAT, albeit more widespread. The nests of BRNO seemed less elaborate in construction than at some other islands.

Black Noddy, *Anous minutus*, (BLNO) - A single adult was observed standing in the interior alone.

Blue-gray Noddy, *Procelsterna cerulea,* (BGNO) - This species was more numerous than reported in previous trips and noted in most parts of the island. We observed over 100 individuals and found 4 nests all in the egg stage. The majority of the birds were concentrated in *Sesuvium* and *Lepturus* in the northeast quadrant but isolated nests were found in the western wasteland area. The terns used a similar tongue flicking display to the Brown Noddy. Their tongues are a lighter color of yellow. The nests found were bowerlike areas under dead *Sesuvium.* One egg was situated between 2 clumps of *Lepturus* s and one was next to a dead *Abutilon* bush. Measurements of the 4 eggs were:

40.40 X 29.85 mm
38.70 X 27.35 mm
42.20 X 26.75 mm
41.85 X 27.00 mm

White Tern, *Gygis alba,* (WHTE) - Most White Tern activity was concentrated at the day beacon with only a single active nest (stage 5 chick) found sitting on the base of the tower.

Migratory Shorebirds

Pacific Golden Plover, *Pluvialis fulva,* (GOPL) - We saw 84 GOPL, 75 of which were seen in a single flock that arrived the third day of our visit to Jarvis.

Wandering Tattler, *Heteroscelus incanus,* (WATA) - The Wandering Tattlers on the island preferred the beach areas. There were 10 birds seen.

Ruddy Turnstone, *Arenaria interpres*, (RUTU) - We observed only 2 Ruddy Turnstones during the visit.

Bristle-thighed Curlew, *Numenius tahitiensis,* (BTCU) - This species was seen in small groups on the beach and in the interior. Total birds observed during the period was 51. None were banded.

Pelagic bird observations

Pelagic observations were done by Depkin, Rauzon, and Flint, often with the assistance of CDR Douglas Wisniewski, captain of the *Sassafras*. The results of this transit from Honolulu to Pago Pago (see cruise track in figure 6) will be combined with bird observations made by Steve Bailey on the trip of the vessel returning to Honolulu and reported on by Dr. Bailey in a separate document.

Mammals:

Pacific Bottlenosed Dolphin, *Tursiops truncatus* - This species was not observed as we approached the island for the first time but observers on the ship reported large numbers on the south side of the island during their circumnavigation on 23 March 1996. One probable bottlenose, dead and mummified was found on the east end of the island. It was about 8 feet long.

Cat, *Felis catus,* - Rauzon engaged in 5 hours of nocturnal cat hunting focusing his efforts in the guano quarry, the area with formerly the highest cat density. During all surveys the crew was vigilant for scat and signs of cat predation and saw none. The breeding of Blue-Gray Noddies and Audubon's Shearwaters are a good indication that the cat eradication was a success on Jarvis Island.

House mouse, *Mus musculus,* - Mice were not abundant during this visit. The lack of much vegetation probably had depressed numbers somewhat. Rauzon saw 3 individuals and Depkin saw two.

Entrapment Hazards

We turned and opened up 3 barrels that had rusted enough to become entrapment hazards. These were located in the debris area adjacent to the day beacon and at the site of the International Geophysical Year Camp at the southwest point. We also plugged two vent holes in the day beacon with bricks to prevent any entrance by prospecting birds.

Trespass and Contaminants

There were no obvious signs of trespass on the refuge. The signs are all in place and legible although the metal signs had some guano staining. We looked for evidence of batteries associated with aids to navigation and found none though there were several batteries at the IGY site abandoned in 1958.

Health, Safety, and Equipment

All equipment worked well with the exception of the US Fish and Wildlife Service Zodiac. The boat suffered a major structural failure when a large seam split due to dry-rot of the panel. Both the landing and the pickup occurred at the Jarvis camp-site near the day beacon. Due to the failure of the FWS zodiac we were picked up with a hard-bottomed boat belonging to Lamont-Doherty Earth Observatory with our 40 HP motor attached.

The landing area was open for only 2 of the 4 days we were there. When large waves are breaking over the reef the opening has a strong rip as all the water from the area pours out through the opening. This strong current is hazardous for bathers in the area of the opening. We maintained twice daily radio schedules with the ship and had a 406 EPIRB in case we needed to summon help immediately.

Conclusions and Recommendations

The appearance of breeding shearwaters and small terns is a clear indication that cats are eradicated from Jarvis Island. Nevertheless future trips should include surveys to guarantee that cats are indeed gone and shotguns should be taken just in case. It is conceivable that mice could be eradicated, especially at times of drought and low mice population densities. Jarvis Island is increasing in importance for ground-nesting birds as islands of potential are increasingly colonized and abused by human activities. Kanton Island is such an example. With rats and cats present, shearwaters are restricted in distribution to two areas and Phoenix Petrels are extirpated. By training and supporting local Kiribati game wardens at Kanton, seabird populations could be enhanced there.

Acknowledgments

We thank CDR Doug Wisniewski and the crew of the U.S. Coast Guard Cutter *Sassafras* for their willingness to take us to Jarvis Island and their tremendous logistical support and hospitality aboard the ship. We are grateful to Lamont-Doherty Earth Observatory for the use of their small boat that enabled us to leave Jarvis and to survey Kanton after our own zodiac failed.

Appendix I. Palmyra, 18 March 1996

The *Sassafras* anchored at the entrance to Palmyra Lagoon on 17 March 1996. A combination of heavy rain that night and bright lights on the vessel caused a number of Red-footed Boobies to crash land on the deck and lose their food loads. A Black Noddy also landed on the vessel. On 18 March we landed, spoke with Roger, the caretaker, and did a circuit around Cooper-Meng Island. In five hours we surveyed the runway for Sooty terns and Bristle-thighed Curlews. Sooty Terns were not on eggs yet but were starting the swirling phase and the island caretaker, Roger, reported that terns were assembling and landing each evening. Red-footed Boobies were breeding in large numbers on the outer islands but the only 2 nests we had time to visit had a stage 4 chick and an egg. Roger also told us the rats were taking a large number of eggs from the sooty tern colony and requested the USFWS "do something" about the rat problem. . We counted about 30 curlews and examined each one for bands. No banded birds were seen. The runway was overgrown with *Scaevola* and *Tournefortia*. Since the last USFWS survey in 1992 the vegetation on the runway, in the village area, and on the road north of the runway has grown remarkably thick and almost impassable. We collected several specimens of lichens for Dr. Cliff Smith, UH. There were 2 yachts in the harbor and Roger reported that the sale of the island has not been completed. We observed at least 7 chickens, 2 dogs(1 male, 1 unknown), and a single cat (male) all owned by the caretaker . The caretaker was informed of the potential risks of having these animals out there.

Appendix II. Kanton, 26-28 March 1996

We landed at Spam Island, Kanton Atoll, at 1100 on 26 March 1996 (see figure 7). Brown Noddies were the most numerous species and we estimated 2500 birds sitting on Spam and the 3 smaller dredge spoil islands in the area. There were only a few eggs in evidence and no flightless chicks. The species composition of Spam was different last year at the same time of year with more Gray-backed Terns being seen in the evenings. In English town we saw few birds other than White Terns and an occasional Black Noddy and further east to point A on figure 8 we saw no breeding birds. The following morning we motored to the southeast tip and began surveying north and westward. There were numerous Sooty Terns flying over and calling at the tip. No colony was found but the officer in charge of the village says they do breed on occasion down in the south point. In a large Kou (*Cordia subcordata*) we found several fledged young RFBO and WHTE pairs. Moving farther north we discovered a Wedge-tailed Shearwater colony that contained at least 200 burrows, some with calling WTSH inside. A single Red-tailed Tropicbird on an egg was located by Depkin in the southeast. Approximately 1 mile north of the shearwaters we saw Red-footed Booby nests built in thick Scaevola along the lagoon side. In the village we noticed a young RFBO chick (Approximately stage 3). This bird had been taken for a pet. The head of

the village Mr. Teaua Etekiera was interested in our survey and expressed interest in assigning some of the young men in his town warden work. He had spent time at Kirimati and wished to model the system on that of Katino Te'ebaki, the warden there. Another man in town approached us and turned in a bird band (#587-95471). He said he got it in March of 1994 from an injured bird, probably a booby from his description.

We saw chickens, cats, pigs, and dogs in the village and rats (probably *Rattus exulans*) at the southern tip of the island.

The lagoon at Kanton is very clear near the dredge islands but had a bright green algae growth further inside. We observed Black Noddies feeding inside the lagoon at the south end. We also saw 3 different Green Turtles (adult size) inside the lagoon. On the southwest beach we observed one depression that may have been made by turtle nesting activity. Divers on the outside found much more dead coral than they had at Jarvis. Broad saw 7 or 8 *Tridacna maxima* on the 3 dives he made. Unfortunately Coast Guard divers killed three large adults off these in order to collect their shells. Kenny Broad collected a large *Porites* head for study by scientist working on long term temperature and precipitation records for the central Pacific. The divers observed several Green Turtles and 1 Loggerhead Turtle (*Caretta caretta*) on 3 dives made on the north side of the atoll outside the reef.

Depkin observed a Mongolian Plover (*Charadrius mongolus*) on the beach near the pier and Rauzon saw a Semipalmated Plover (*Charadrius semipalmatus*) {Ringed Plover?} at one of the ponds on the south end. The more common migratory shorebirds observed at Kanton were Golden Plover, Wandering Tattler, and Bristle-thighed Curlew.

Appendix III. Swain's Island, 30 March 1996

We stopped for 1 hour but did not land at Swain's Island in the southern Tokelaus. The Island is thickly forested with *Cocos nucifera* and there were hundreds of WHTE and some BLNO flying over the island. Brown Boobies and Lesser Frigatebirds were seen flying by but we were told do not breed there. A dark-phase Reef Heron (*Egretta sacra*) was also seen.

Table 1. Bird numbers at Jarvis Island

FIELD OBSERVATION FORM - PHENOLOGY Island: Jarvis

Date: March 1996 Time: From 20 March to 23 March Observer(s): B. Flint, C. Depkin, M. Rauzon, K. Broad

Weather: Clear, fair Moon: ½ full

SPECIES	EGGS		CHICK GROWTH STAGES														COMMENTS	
	1	2	(1)	(2)	(3)	(4)	(5)	(6)	(6A)	(6B)	(6C)	(7)	(8)	(9)	Total Chicks		S	P
MABO	5	6			1	1	14		5	19	48	44	45	145	333		746	287
RFBO	22					1	4				3	9	2	47	88		128	4
BRBO	5	20	3				2			1	2			7	40		11	
RTTB	13														13		110	
GRFR	109		A-1 6	A-2 18	B 6	C 2	D 1	E	F	G	H	I 99			241		11	3
LEFR	64			A-2 1	B 2							I 24	Primaries 718		809		–	
SOTE								117							117		"zillions" or too many to count	
GRAT	78		3		1	2	3	3							90		–	
BRNO	1230		2	2	1	2	1								1238		–	
BLNO															0		1	
WHTE							1								1		5	
BGNO	4														4		81	75
GOPL															0		84	
RUTU															0		2	
WATA															0		10	
BTCU															0		51	
MUMU															?		2	

Comments: S = Singles in colony
P = Pairs standing together in colony

MABO's in clubs – 1195
BRBO Club 33

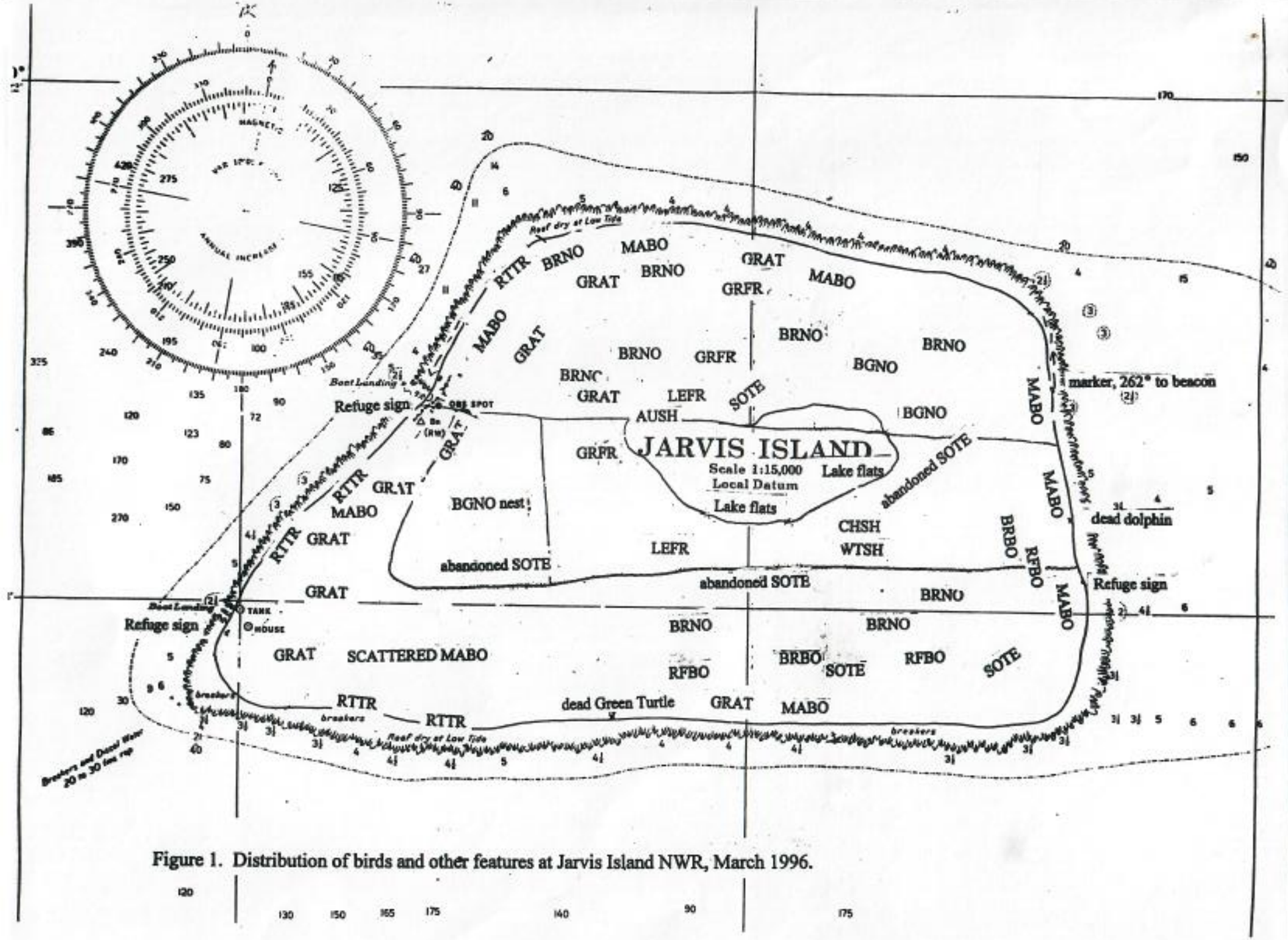


Figure 1. Distribution of birds and other features at Jarvis Island NWR, March 1996.

Figure 2. Phenology of active MABO nests at Jarvis Island in March of 1996.

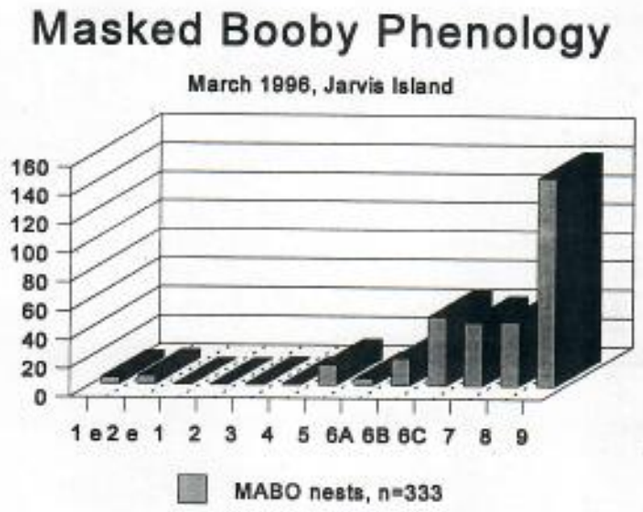


Figure 3. Phenology of active Brown Booby nests at Jarvis Island NWR March 1996.

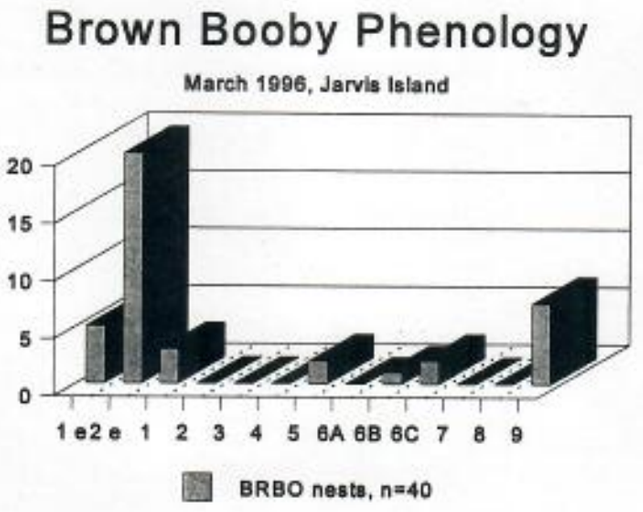


Figure 4. Phenology of Red-footed Boobies, Jarvis Island, March 1996.

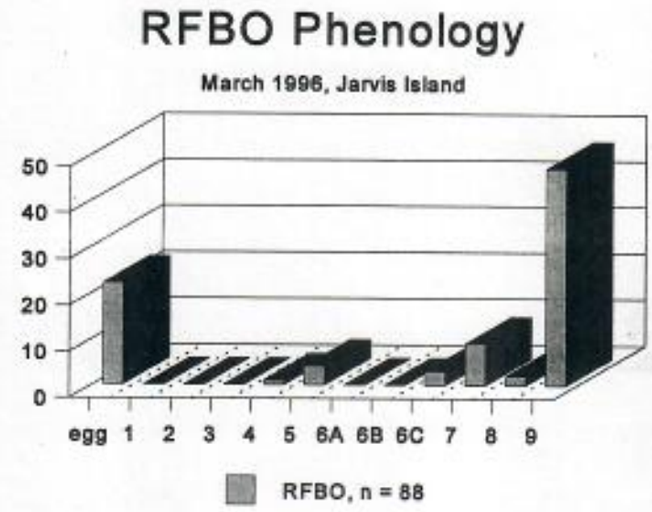
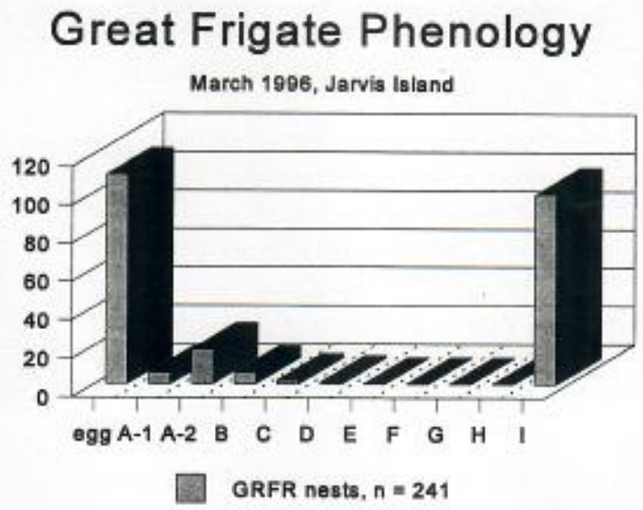


Figure 5. Great Frigatebird Phenology at Jarvis Island, March 1996.



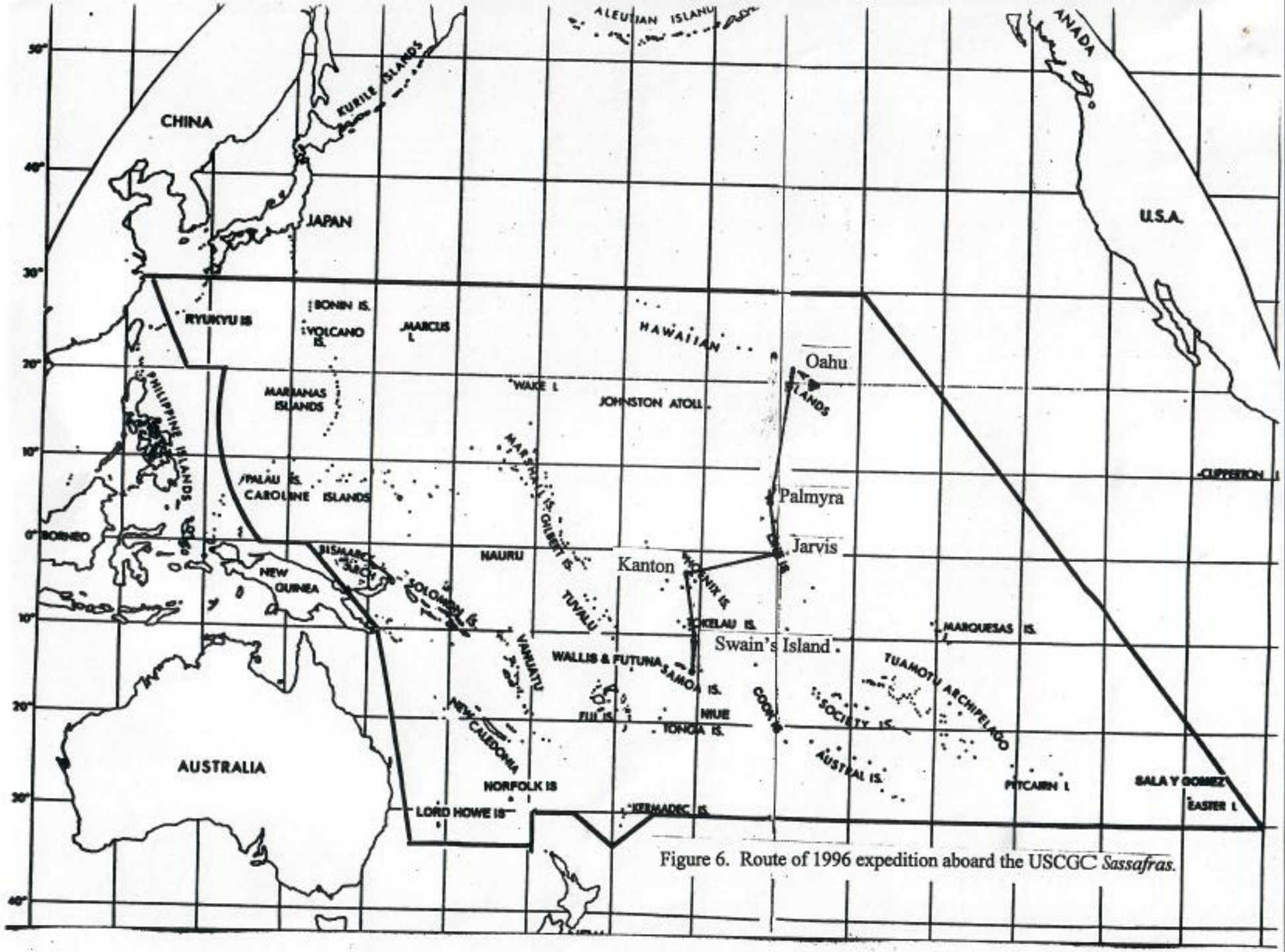


Figure 6. Route of 1996 expedition aboard the USCGC *Sassafras*.

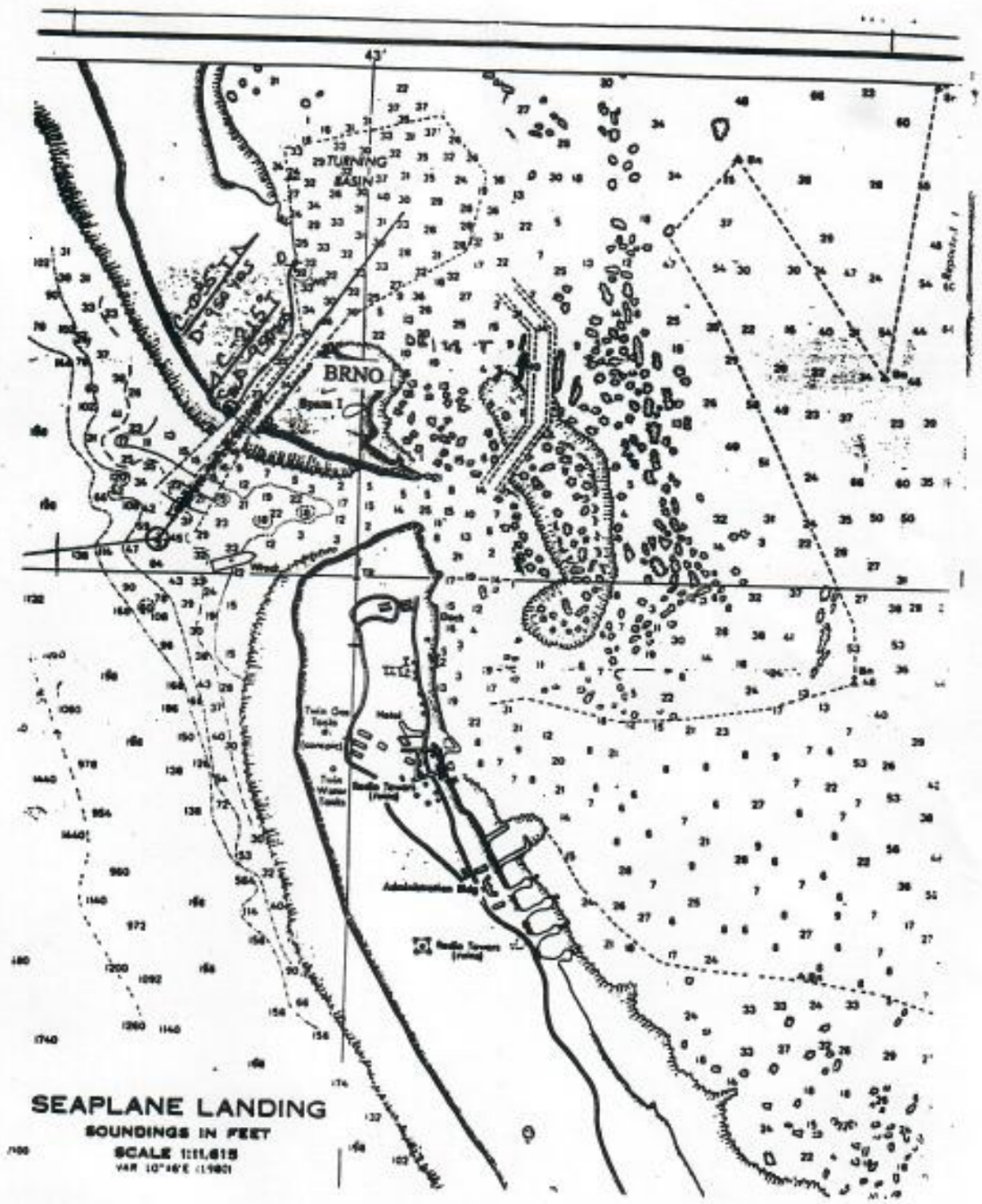


Figure 7. Spam Island and English town, Kanton Island, Republic of Kiribati.

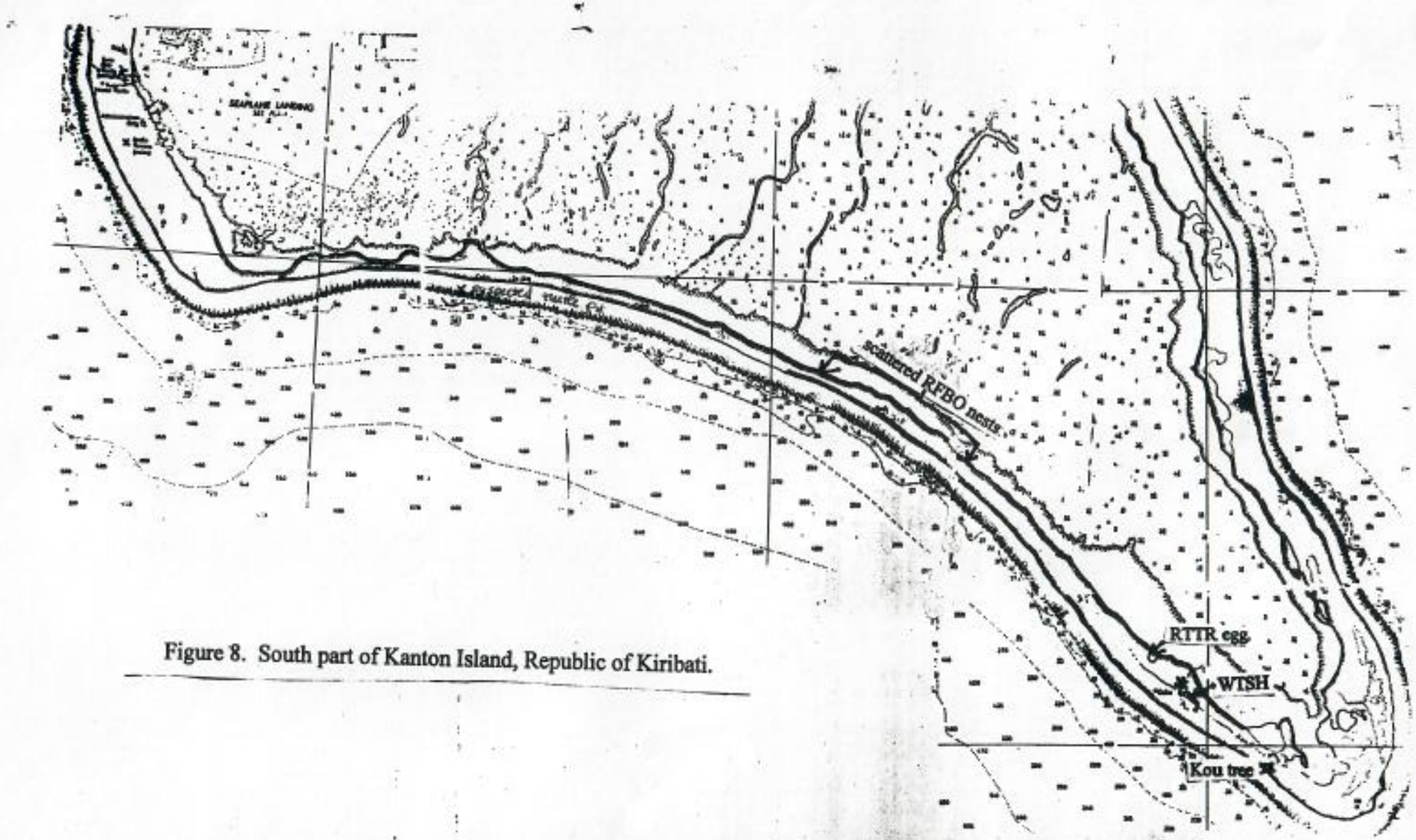
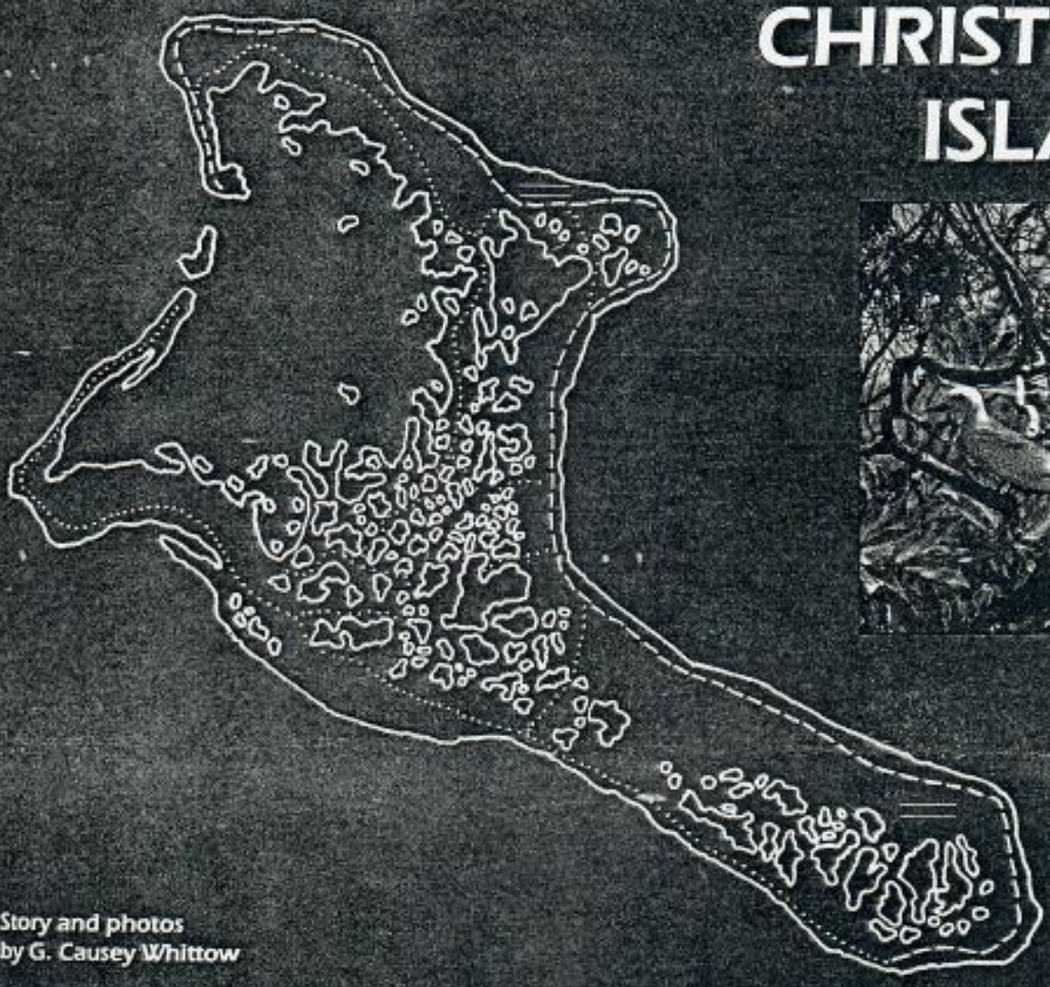


Figure 8. South part of Kanton Island, Republic of Kiribati.

THINGS HAVE NOT BEEN VERY MERRY ON CHRISTMAS ISLAND



Story and photos
by G. Causey Whittow

Thirteen hundred miles directly south of Honolulu, as the frigate bird flies, is the largest coral atoll in the world. When Captain James Cook landed there on Christmas Eve in 1777, he found sea turtles basking on the beaches—but no people. The island was not on his charts, and he recorded in his journal: "As we kept our Christmas here, I called it Christmas Island."

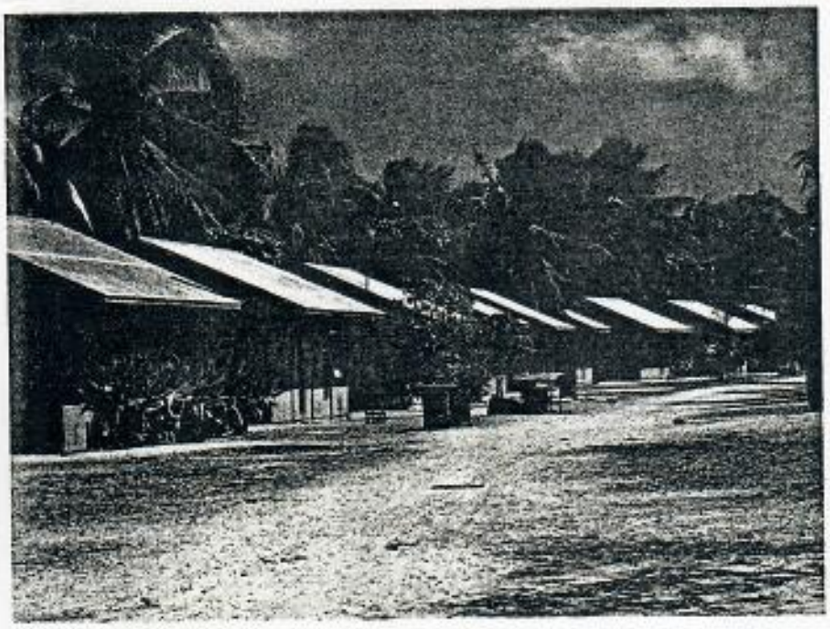
It is possible that Cook was not the first European voyager to sight the island. There is one report by a Spanish mariner of an island named "Acea," sighted during the sixteenth century. It seems likely that this was Christmas Island, for the island is close to the westerly route of the Spanish galleons that sailed between the Philippines and Mexico. The Polynesians seem to have missed the place entirely, except for chance visitations or shipwrecks. Some of Cook's crew noticed evidence of former habitation, and the Bishop Museum's 1924 expedition found adzes, petroglyphs and coral platforms, but ascertained that these and other artifacts were from different periods and suggested different homelands.

The more recent history of Christmas Island has been a chronicle of exploitation and failed enterprises. After Cook had put it on the map, whaling ships used the island as a source of turtle meat, fish and coconuts.

There was a guano operation that fizzled, a pearl shell industry that never got out of the water, an illegal feather enterprise begun by thirteen Japanese trespassers who killed eleven thousand birds in a month, and a brine shrimp endeavor that dried up before the owners could get their feet wet.

Coconuts, however, proved to have potential. Lever's Pacific Plantations planted 70,000 coconut trees, which unfortunately died owing to a severe drought. The company abandoned its investment, after having built copra sheds and cisterns, which survived to serve a later copra industry.

In April 1941, sixteen Gilbertese and Ellice islanders arrived to work a fledgling coconut plantation. They were the forerunners of a Gilbertese population that now numbers well over a thousand. The settlers continued to follow many of their traditional pursuits with life centering around the maniaba, a large platform, open at the sides but roofed over with palm thatch. They have formed three villages



ABOVE: A fisherman lays out his line just off the coast of Christmas Island. LEFT: Beachside shanties are shaded by palm trees.

with the unlikely names of Poland, Banana and London, and exist on a diet of fish, rice and coconut. Christmas is, fittingly, their time of celebration.

The greatest advantage the island offers them, and the visitors who are coming in increasing numbers, is the abundant supply of fish in island waters.

Life on Christmas Island, however, is not always idyllic. The twentieth century intrudes in bizarre ways. At one point during World War Two, 2,428 American military men were stationed there, and they built the landing strip that is in use today.

In 1956, the island had the unfortunate distinction of being chosen as the site for the British hydrogen bomb tests. Three bombs were exploded at a height of 18,000 feet about thirty miles south of the atoll, while the islanders gathered in their maniabas and prayed, with heads bowed, during the countdown. Once the flash, which blinded the large colony of seabirds on the island, was over, they were able to go outside to see the mushroom-shaped cloud, experience the shock waves and hear the roar of the explosion. Between 1962 and 1964 twenty-four more "shots" were staged jointly by American and British forces. Since that time, the island has been declared free of radioactive contamination and life has resumed its former languid ways.

Science again changed the life of the islanders in 1976 when the National Space Development Agency of Japan established a tracking station on the island. Largely to support the station, the twenty-four-room Captain Cook hotel was built, and weekly Air Tungaru flights were inaugurated between Christmas Island, Tarawa in the Gilberts, and Honolulu, resulting in a small but steady stream of tourists.

In 1979, Christmas Island became part of the independent nation of Kiribati, together with the Gilbert Islands and islands of the Line and Phoenix groups.

The tourists who travel to Christmas Island are mainly fishermen and bird-watchers. The excellence of the fishing reflects the relatively small population, and its past history as a largely uninhabited atoll. Jacks, bonefish, snappers and many other fish, including sharks, are abundant, and the southeastern peninsula provides good lobster catches.

Tradewinds cool the thirty-four-mile-long island. Largely flat, its highest point, Joe's Hill, is forty-three feet above sea level. In many parts of the island it is difficult to believe that one is on an island. Savannah-like grasslands stretch away to luxuriant clumps of tree heliotropes, as far as the eye can see. The island is roughly claw-shaped with the two pincers enclosing a lovely lagoon which opens to the ocean. Inland from the lagoon is a mosaic of smaller ponds and lagoons. Much of the western coast is taken up by the Bay of Wrecks, with many hulls bearing silent witness to the treacherousness of the surrounding reefs.

A walk along the quiet roads of the island in the late evening is a reflection of peaceful isolation from the rest of the world. Flitting among the sourbush, the Christmas Island warbler, the only land bird that breeds on the island, provides a surprising counterpoint to the ubiquitous seabirds. At dusk, the land crabs, millions of them, take to the roads.

When Captain Cook arrived on his journey from Bora Bora, it was the island's seabirds that announced the nearness of land. Today the enormous seabird population remains as one of the natural wonders of the place. Eighteen species breed regularly on the island, some of them in prodigious numbers. It has been estimated that during the two breeding seasons, there are no fewer than fourteen million sooty terns in residence—and that's only one species. The Christmas Island shearwater not only breeds on Christmas Island, but has the grace to lay its eggs during the Christmas season.

The island has been the site of a number of important studies of tropical seabirds, one by the Smithsonian Institution. The birds are protected by law, and the three small islands in the lagoon, Cook Island, Motu Tabu and Motu Upua, have been designated sanctuaries with restricted access.

Many people from Honolulu journey to this remote outpost specifically for the bird-watching and the marvelous fishing. And you don't have to get up early for either. There's plenty of both to go around. ALOHA

BIBLIOGRAPHY OF THE LINE ISLANDS, CENTRAL PACIFIC

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The eleven islands of the Line Group lie on both sides of the equator, between 150° and 163° West Longitude, north of the Society and Cook Islands. Kingman Reef, the northernmost, lies 925 nautical miles south by west of Honolulu. The islands from north to south are Kingman Reef, Palmyra I., Washington I., Fanning I., Christmas I., Jarvis I., Malden I., Starbuck I., Caroline I., Vostok I. and Flint I. The total area is 262.15 square miles, and the three largest islands are Christmas (222.7 sq. mi.), Fanning (12.4 sq. mi.) and Malden I. (11.25 sq. mi.)

Christmas Island was discovered by Capt. James Cook, commanding the ships Resolution and Discovery, on December 24, 1777. All except one of the remaining islands were discovered by American and British sea captains between that date and 1825. Vostok Island was discovered by Fabian von Bellingshausen, in command of a Russian expedition, on August 3, 1820. Kingman, Palmyra and Jarvis are American, while the others are under British administration.

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CLASSIFICATION

Ciguatera and Other Marine Poisoning in the Gilbert Islands[1]

M. J. COOPER[2]

AMONG THE ANIMALS that live in the sea are many that may be poisonous to eat; these animals include fish, sharks, crabs, molluscs, and turtles. Of all marine animals the most important are fish, which are for so many people an essential source of food. There are a number of different ways in which teleost fish may be poisonous. Some fish are naturally poisonous; puffers for instance are always toxic. Some species of fish can be poisonous at certain seasons; in Fiji there is a species of sardine which may be deadly poisonous in the later months of the year. A third type of poisoning is found where some fish are poisonous to eat when they are caught on certain reefs or parts of a reef, and yet when caught on other parts of the same reef, or on nearby reefs, are perfectly safe to eat. This type of poisoning, known as ciguatera, is common throughout the tropical Pacific, usually on oceanic islands and isolated reefs.

Ciguatera is not, as many people think, a recent development. Captain Cook, in the journal of his second voyage to the Pacific in 1772–1775, relates how all of his officers who ate "two reddish fish, about the size of bream and not unlike them" were poisoned and the pigs, that were given the offal, died. These fish were taken in the New Hebrides, and Cook refers to an earlier record of poisonous fish in those waters when he remarks that these reddish fish must be the same kind as those mentioned by Quiros, and called by him "pargos." Pedro de Quiros was in the New Hebrides in 1606. However, prior to World War II there were few reports of ciguatera poisoning in the Pacific; cases of poisoning did occur, but unless a stranger to the Pacific was involved little notice was taken. During and after World War II attention was drawn to the problem, as there were many more people in the Pacific who were poisoned by supposedly good food fish, often in areas where toxic fish had been previously unknown.

Although the symptoms of ciguatera poisoning, the species of fish likely to cause it, and many of the areas harboring toxic species have been recorded, several aspects of the problem still remain to be solved. In spite of recent research into ciguatera poisoning an antidote to the poison, a field test for distinguishing a toxic fish from a nontoxic one, the true nature of the toxin, and the cause of the development of ciguatera among fishes have not yet been discovered.

This paper is a review of the history and location of ciguatera poisoning in the Gilbert Archipelago and of the various Gilbertese beliefs about marine poisoning, together with identifications of the species considered toxic by the Gilbertese, and some of the author's opinions on the development, cause, and spread of toxicity.

The Gilbert Islands are a group of 16 atolls lying north and south of the equator; latitude 3° N passes through the most northerly island and latitude 3° S passes a few miles south of the most southerly island. The group lies between longitude 172° and 173° E of Greenwich. From north to south the 16 atolls are Makin, Butaritari, Marakei, Abaiang, Tarawa, Maiana, Abemama, Kuria, Aranuka, Nonouti, Tabiteuea, Beru, Nikunau, Onotoa, Tamana, and Arorae. Atolls are of two distinct kinds, lagoon islands and reef islands. A simple lagoon island consists of a lagoon, a body of fairly shallow water set off from the ocean, according to tradition, by a ring of small islets; in fact, the islets are usually in a chain lying on the weather side of the lagoon, with submerged barrier reefs on the lee side. A simple reef island is a small island with a fringing reef round it and no enclosed body of water. Many islands appear to be a mixture of both types. The total land area was estimated

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by Dr. Rene Catala at 114 square miles. The population in 1947, the time of the last census, was 27,000; in 1958 the Gilbertese population was estimated to be 32,652 (Doran, 1960).

The information presented here was collected during the period 1953–1962 while the author was resident in the Gilbert and Ellice Islands Colony with her husband, who was an administrative officer with the Gilbert and Ellice Islands Colony Government. Residence was maintained for varying periods of time on Tarawa, Christmas Island (in the Line Islands), and Ocean Island; personal visits were made to all the Line and Phoenix islands, including Washington Island, and to almost all of those in the Gilbert group. During this time the author learned the Gilbertese language, which permitted her to gather information directly from the islanders.

In the course of a study of the scientific equivalents of the Gilbertese names for fish it was found that while some names would encompass all members of a whole family of fish, other names were restricted to a single species, and some names defined the development stages of a generic group. Through the initial study of Gilbertese names for fish, the author became interested in Gilbertese traditions and customs associated with fish, and finally in an investigation of fish toxicity in the archipelago.

The intimate association of the Gilbertese with the sea, almost their only source of dietary protein and fat, makes them reliable givers of factual information about fish poisoning. This dependence upon the sea means that every adult member of a community must have a basic knowledge about the reefs and the fish species around his island, particularly in the area of his village. Although in recent years the traditional dependence on fish as a major source of food has been lessened to some extent by introduction of imported foodstuffs, the detailed knowledge of environment has been preserved and is still known by the elders of the Gilbertese community who are the traditional custodians of natural lore. These "old men"—the term in Gilbertese is traditionally one of respect—have proved to be the most fruitful source of information when dealing with the history of fish toxicity. Younger men, active fishermen, have provided information on the species caught and the areas fished.

Due to the restricted nature of the Gilbertese diet, there are very marked preferences for certain species of fish. Fish considered to be very fatty or greasy are greatly sought after, because the Gilbertese at times develop a craving for animal fats. These sought-after species include *Lutianus bohar, Letbrinus variegatus, Acanthurus xanthopterus, Epinephelus fuscoguttatus, Cephalopholis mineatus, Myripristis* spp., *Chanos chanos,* and Muraenidae spp. The larger these fish, the more tasty they are considered to be. Some of these species have been found to be toxic, even dangerously so, in certain areas in the Gilberts. But even if a species is known to be toxic, there comes a time when the Gilbertese find it impossible to resist the temptation of a good fatty meal. This craving for animal fats is not restricted to the Gilbertese. Harry (1953) relates that the islanders of Raroia Atoll, in the Tuamotus, were unable to resist eating certain species of fat fish even when they knew that these species were toxic, and that as a result there were frequent cases of poisoning. Population pressure, together with particular food preferences, forces the Gilbertese to continue sampling a known toxic area. On account of this, a fairly accurate picture of the evolution of toxicity in an area may be obtained.

Considerable information was collected from Gilbertese visiting Tarawa, from assistant medical officers (graduates of the Fiji School of Medicine), and from officers and crews of the various ships operating in the colony. This information was later checked by the author, who was able to visit all the "toxic islands" with the exception of Tabiteuea and Arunuka, and by her husband, whose duties took him to all the Gilbert Islands. A special visit was made by the author to Marakei to obtain a more detailed picture of a toxic area than was possible when surveying the group as a whole.

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The population statistics were taken from the "Report on Tarawa Atoll," by E. Doran (1960); the land areas are taken from "Report on the Gilbert Islands: Some Aspects of Human Ecology," by Rene L. A. Catala (1957). The rainfall figures were kindly given me by the New Zealand Meteorological Service, Laucala Bay, Suva. The maps, except that of Onotoa, are adapted from admiralty charts. The Fiji Government Printer gave great assistance in preparing the maps of Nikunau and Tabiteuea. The map of Onotoa was adapted from P. E. Cloud's map, based on aerial surveys (Atoll Research Bulletin 12, 1952).

Above all, the greatest acknowledgment and thanks are due to the many Gilbertese old men and women, fishermen, and the "general public," who patiently discussed for endless hours just "fish."

SYMPTOMS OF CIGUATERA POISONING IN THE GILBERTS

Ciguatera poisoning is regarded as an occupational hazard by the Gilbertese, especially by those who have lived all their lives in a toxic area. As a result, they consider ciguatera poisoning to be a "Gilbertese sickness," and they prefer to treat such sicknesses with their own remedies, as opposed to what they consider to be imported "European illnesses," for which European medicines are logically more suitable. Gilbertese do not normally go to a medical officer when poisoned by a fish, except on rare occasions when the victim is obviously on the point of death. Colony medical officers, therefore, do not see or record many cases of fish poisoning. Although mild cases of poisoning are very frequent on some islands, medical department records are relatively few.

The following sequence of symptoms of ciguatera poisoning has been collected from talks with several assistant medical officers and colony dressers (male nurses trained at the Colony Central Hospital, Tarawa). At first, several hours after eating a toxic fish, there is nausea, followed by vomiting and severe stomach pains, which may be accompanied by diarrhea and fever. There is tingling of the arms and legs followed by numbness and a heaviness of the limbs, which may lead to complete loss of coordination or even to paralysis. The sense of balance is lost. In severe cases there may be great thirst. Intense itchiness is followed by peeling of the skin. Finally, in fatal cases the victim lapses into coma and dies.

The following case histories were taken from the assistant medical officer stationed on Betio, Tarawa. He, his wife, mother-in-law, and two teenage boys were poisoned in March, 1962. He caught a small *Lutianus bohar* on the Betio lagoon reef. The fish was cooked and eaten on his return home, but no symptoms of poisoning appeared until 12 hr later. The five people involved ate varying amounts of the fish and had different symptoms.

The assistant medical officer and his wife ate only a little of the fish. His symptoms, which appeared about 10 PM, were nausea but no vomiting; his legs tingled and then felt numb; next morning the cement floor felt like ice to his bare feet and he was "very shivery" in the wind, but far too hot out of it. He managed to work for half the day, but then he felt too ill so went to bed. Next day he was better, the symptoms had all gone, but on the third day the tingling sensation in his legs returned and persisted for several days. His wife suffered nausea, vomiting all night, and a severe stomach-ache. She stayed in bed the next morning and complained of numbness in her arms and legs all day. She recovered by the second day, except for a shivery feeling and an intensified tingling in her legs every time she put her hands in water. These feelings persisted for about a week.

The old woman, the mother-in-law, ate more fish than the preceding two. She suffered from nausea, vomiting, and a severe stomach-ache all night. Next day and the day after, the vomiting and stomach-ache continued; she complained that she could not walk, her legs felt heavy, and

she remained lying on her mat. By the fourth day she could walk again, but she vomited and complained that her legs felt tingly for a week, by which time she was well enough to travel to another part of the island where she considered she could get more expert treatment. It is possible that her vomiting was aggravated by her own home-made medicines.

One of the boys ate but little of the fish; he suffered from nausea during the night, and the next morning his legs tingled but he was able to go to work. The other boy finished the fish, and in doing so ate far more than the others. He was taken ill about 2 hr before the rest of the family, at about eight o'clock, with nausea, vomiting, severe stomach-ache, and a fever of 102 F. The assistant medical officer did not realize that it was ciguatera poisoning until the others became ill as well, so at first he treated the boy with penicillin for appendicitis. The boy vomited all night, as well as having acute diarrhea and pain. The next day he was still ill, with fever, nausea, vomiting, and diarrhea; he lost his sense of balance, his legs were powerless, and he remained on his bed. By the third day he had completely recovered; he returned to work and suffered no lingering symptoms or after-effects.

The three adults were in agreement on certain symptoms; they all say that one of the first signs, which at the time they did not realize was the start of an attack of poisoning, was a funny feeling in their noses, as if the air passages were enlarged and they could breathe more freely. They also agreed that the numbness in their legs persisted for several days, and that water on their skins caused shivery feelings, as well as making their legs tingle again.

Another man who was poisoned by a *Lutianus bohar*, also in March, 1962, from the Betio, Tarawa, toxic reef, said that he had nausea and vomiting, but he complained that the most persistent symptom was a feeling of numbness and swelling of his lips and tongue. This sensation, together with pins and needles in his legs, persisted for about 10 days.

It has not yet been proved whether the severe poisoning caused by large Muraenidae is true ciguatera or is caused by a different, although perhaps allied, toxin (Banner *et al.*, 1960; Helfrich, 1961; Bouder *et al.*, 1962). The Gilbertese consider it to be ciguatera poisoning but very much more severe than that from other fishes. They say that moray eels grow large, have voracious appetites, and are able to eat so many smaller toxic fish that they become deadly from the stored toxin. It has been proved that ciguatera toxin is passed along the food chain, at least for toxic *Lutianus bohar*, which when fed to a previously nontoxic *Acanthurus xanthopterus* Cuvier and Valenciennes, made the flesh of the latter toxic (Helfrich and Banner, 1963). In the Gilberts large moray eels may be deadly poisonous but only when caught in an area in which other species of fish are toxic. Outside these areas large moray eels are a popular food fish (see section on Nonouti). In 1961 two men died after eating part of a large moray eel caught on the Betio, Tarawa, toxic reef. The eel was cooked in the usual manner, without gutting or cleaning, and the family went to the cinema without eating any of it. While they were away two men, an old man and a young one, ate part of this eel. When the family returned from the cinema they found both men very ill, with violent vomiting and severe stomach-ache. They were both taken to the Betio hospital, in charge of the assistant medical officer, where the old man lapsed into a coma and died at 2 AM the same night. The younger man lived for a week, but the only symptoms remembered by the assistant medical officer were that he suffered intense itchiness, that his skin peeled away, and that finally he went into a coma and died.

The following history was supplied by an assistant administrative officer who was poisoned by an eel on Canton Island, in the Phoenix Islands, in 1947. The eel, a big, black moray, was caught in the lagoon and cooked and eaten by six men. True to normal practice, it was not gutted before being cooked. Of the six men who ate the eel, only this one man was poisoned; the others were completely unaffected. He was a newcomer to Canton Island and was given the choicest part of the eel, the fatty part from the belly, whereas the others ate only the meat. About half an hour after eating the eel, he began to feel very ill. At first he felt very cold in the wind, so he moved out of it, and then felt far too hot. Then he felt as if he were standing on the bows of a ship in a rolling sea; this was

followed by a severe pain high in his stomach, accompanied by violent vomiting and diarrhea. He lost his sense of balance, his legs became powerless, and he just lay on his bed, suffering from acute pain in his stomach for a week. After this time the pain in his stomach eased, and he felt that perhaps he was not going to die. During the second week, although he suffered from intense itchiness, he began to feel much better and slowly regained his sense of balance. When he left his bed, he said, he almost had to relearn to walk. By the third week he was very much better, the itchiness finally having subsided with the flaking away of the skin from all over his body. This was the first time that this man had been poisoned, and he thought that it was because he was a newcomer to the island and had not had time to build up an immunity to the poison. The other five men, who ate the eel with him, had been living on Canton Island for some months, and considered that they had become partly immune to toxic fish during the time they had lived there. At that time, 1947, mild cases of ciguatera poisoning on Canton Island were not infrequent.

SOME GILBERTESE REMEDIES FOR CIGUATERA POISONING

Gilbertese have a variety of herbal remedies for ciguatera poisoning but, apart from an emetic, it is doubtful if any of them is of real value. If a fish has already been eaten and is then thought to be toxic, the best thing is to get rid of it. An emetic may be made from the juice of a commonly found spurge, "te tarai," *Euphorbia atoto* (Forst). A few drops of the milky sap are squeezed into a small drinking coconut and this, when drunk, usually has the desired effect.

One of the oldest remedies may be made from the fruits of the Indian mulberry, "te non," *Morinda citrifolia* (Linnaeus). Three unripe fruits are crushed with three ripe fruits and mixed with the juice from a drinking coconut; sometimes only three unripe fruits are used. This very bitter concoction is one dose, which may be repeated when needed.

A newer but very popular remedy on the more northern islands may be made from the buds of the seedless breadfruit tree, "te bukiraro," *Artocarpus* sp. One terminal bud is finely chopped, put in a cloth, and squeezed with about half an inch of rain water in a mug until all the juice is extracted. This must be drunk immediately, and is one dose. It may be repeated as often as necessary. Another new remedy is made from the fruits of the papaya, *Carica papaya* (Linnaeus). Several unripe fruits are chopped and crushed and the milky sap extracted. This is added to an unspecified amount of rain water; the mixture must be boiled and taken as soon as it is cool enough. This is again one dose and may be repeated when required.

Finally, a very popular medicine for many ailments, including ciguatera poisoning, may be made from the fruits of the saltbush, "te mao," *Scaevola frutescens* (Mill); an indefinite number of ripe fruits are gathered, and the bitter juice from them is squeezed into a drinking coconut. This dose may be repeated when it is thought to be needed.

SOME GILBERTESE OPINIONS ABOUT CIGUATERA POISONING

Gilbertese opinions as to the cause of toxicity in fishes vary from island to island, and even between individuals. On Abemama, Nonouti, Tabiteuea, Onotoa, Beru, and Nukunau the islanders say that the fish have been toxic since a vessel was wrecked on the reef which is toxic at the present time, and blame the wrecks for the toxicity. On Tarawa the war with its resulting bombs, increase in shipping and in rubbish of various sorts dumped in the sea, is blamed for the violent increase in toxicity which began in about 1944. On Butaritari the increase in shipping and above all the rubbish dumped by the ships during the war is thought to have caused the poisoning there. All these islanders agree with Randall (1958), who found that on many islands wrecks were cited as the location of a toxic reef, and that rubbish dumped in the sea was often blamed for toxicity. Randall's hypothesis (1958) that toxicity may be caused by an alga that is the first alga to grow on a new substrate appears at first sight to be borne out by these Gilbertese statements. Wrecks, rubbish, and bomb craters all form new surfaces in the sea.

On Marakei, where toxicity suddenly appeared in 1946, the people blame a certain kind

of alga. They say that their fish became toxic when this alga, which they had not seen before, began to grow on the now toxic reef. This alga, a blue-green *Schizothrix calciola* (Agardh) Gomont,[5] grows on top of fine algae already growing on the reef (see section on Marakei). If this alga should be associated with toxic conditions, then this upholds Randall's hypothesis (1958) that a fine, blue-green alga might be one of the basic causes of toxicity in fishes.

Many Gilbertese believe that certain people are immune to fish poison, and many even eat a toxic fish without harm. It is commonly said that there have been occasions when a family group has partaken of a large fish, and some of them have been severely poisoned, others not at all. However, neither the amount of fish nor the parts eaten are taken into consideration. A little-known belief which still lingers, especially among the older people, is that of family totem fishes. It is almost impossible to find out very much about this belief, as the Gilbertese are very loathe to talk about it. When discussing toxic fish with Gilbertese it should be realized that some older people still consider that certain families may be magically affected by certain species of fish.

Some Gilbertese think that the toxin is concentrated in the liver and guts of a fish, and that the viscera may be toxic when the flesh is not. This idea has been confirmed by Halstead and Bunker (1954). Other Gilbertese think that the toxin is concentrated in the blood, and that if the throat, guts, and large blood vessels are ripped from a still living *Lutianus bohar* then that fish will be safe to eat. Banner *et al.* (1963) report that large specimens of *Lutianus bohar* killed, filleted, and frozen within half an hour of catching proved just as toxic as specimens kept for several hours after death. In spite of these ideas the Gilbertese do not usually bother to clean or gut carnivorous or small fish before cooking them. It is considered a waste of time to gut such fish as *Lutianus bohar* or species of Muraenidae, as the Gilbertese say the guts are too small to bother about. It is customary, however, to clean and gut certain herbivorous fish such as *Mugil* spp. or *Kyphosus* sp.

Randall (1958) mentions that if a person who is recovering from an attack of ciguatera poisoning eats a reef fish he may experience a return of certain symptoms. He suggests that therefore the fish must contain toxin at a level sufficient to raise the toxin in the eater to the threshold level, but not sufficient to affect people who have not been recently poisoned. The Gilbertese people agree with this contention, but maintain that *all* fish will accentuate the neurologic symptoms in someone who is recovering from ciguatera poisoning, including species that have never been known to cause ciguatera, for instance flying fish.

The Gilbertese have the usual superstitions, proved false by Banner *et al.* (1963), that flies will never settle on a toxic fish, that a silver coin will turn black if it is cooked with a toxic fish, and, one superstition that appears to be peculiar to the Gilbertese, that grated coconut will turn bright green if baked inside a toxic fish. A more promising method of testing for a toxic fish occasionally practiced is to give one of the household cats a sizable piece of the suspect fish; if the cat is not ill in a few hours then the fish is not toxic. Another, probably more frequent "test," is for one of the family to act as guinea pig and eat some of the fish, although this is not considered foolproof because people react differently to the toxin. It is customary in toxic areas for old people to eat part of a large fish first. Later, if no symptoms of poisoning develop, the rest of the family will finish the fish. Experienced residents of toxic areas never allow their children to eat doubtful or uncommon fish until several hours, preferably a night, after it has been tried by the older members of the family.

This custom makes most puzzling the statement of Cavallo and Bouder (1961) and of Bouder *et al.* (1962) that ciguatera poisoning was a primary cause of infant mortality on Sydney Island (which the author visited in 1953). Sydney Island, in the Phoenix group, had no indigenous population prior to 1939, when it was settled by Gilbertese from the southern Gilberts, but had at times been worked for guano and copra. It is a most unfertile, drought-stricken atoll, the enclosed lagoon being too salty to sup-

[5] This alga, originally identified as *Plectonema terebrans* (Bornet and Flahault) by Dr. Franci Drouet, has been assigned to the above species by Drouet. See Drouet, 1963, Ecophenes of *Schizothrix calciola*, Proc. Acad. Nat. Sci. Phila. 115(9):261–281.

port marine life. The whole population suffered severe protein deficiency, certainly due in large measure to the toxicity of the reef fish, which deprived the settlers of their natural source of animal protein. This general deficiency undoubtedly contributed to the infant mortality referred to above. The population of Sydney Island was evacuated to the Solomon Islands in 1958, the island having been found unsuitable for permanent settlement.

EVOLUTION OF TOXICITY IN THE GILBERTS

In the Gilbert Islands the evolution of toxicity of an island seems to follow a pattern. When toxicity first appears in an area only a few fish caught on a small patch of reef are found to be toxic. Within a few months many more fish become toxic, the toxicity is more severe, and the area where toxic fish are caught extends over some of the neighboring reefs. Within a short while (on Marakei about 2 years), nearly all species of reef-dwelling food fish and the roving carnivores that normally prey on them have become very poisonous. After some years have passed (on Marakei about 10), the toxicity begins to decrease. Small specimens of certain species become safe to eat; this improvement appears to start at the periphery of the toxic area and gradually works its way toward the center. The small fish of a species become safe to eat before the large ones of the same species, and the "safe" size becomes progressively larger; certain species become safe to eat before others. Eventually a stage is reached when all fish are being eaten, although sporadic cases of poisoning may still occur; at this stage the Gilbertese do not admit to having a toxic area on their island. It is not known whether a reef, once "poisoned," ever becomes completely free of all toxic fish, but from accounts collected in the Gilberts it seems highly unlikely. The reefs appear to go into a "quiescent stage" when only an occasional large specimen of *Lutianus bohar, Promicrops lanceolatus* (specimens of 200–300 lb are sometimes landed, but they are very uncommon), or of Muraenidae may cause poisoning. The toxicity may flare up again, when the cycle will be repeated, and it appears that, until a valid field test for toxicity has been discovered, any fish caught in a known toxic area should be regarded with suspicion.

Unfortunately, due to the rapidity with which toxicity increases, it has not been possible to determine either the order in which species become toxic, or the first species to become toxic. However, at the height of toxicity most members of the following families or genera of fish are toxic: Acanthuridae, Balistidae, *Caranx* spp., Cirrhitidae, Holocentridae, Lethrinidae, Lutianidae, Mugilidae, Muraenidae, Scaridae, Serranidae, and Sphyraenidae; certain Mullidae may be toxic, and Labridae are also probably toxic, especially the larger ones, but information on this family is lacking, as the Gilbertese do not like their taste and prefer not to eat them.

As the toxicity declines, amongst the first fish that become safe to eat are the Holocentridae, Mugilidae, Cirrhitidae, Mullidae; the smaller species of grouper, *Epinephelus merra,* and allied species and *Cephalopholis urodelus;* small specimens of *Lutianus kasmira* and *L. vaigiensis.* On the other hand, some species remain toxic far longer than others, and among the ones that may remain toxic for many years are the following: *Acanthurus xanthopterus, Ctenochaetus* spp., *Lutianus bohar, L. semicinctus, L. monostigma, Lethrinus variegatus, Epinephelus fuscoguttatus, Cephalopholis argus, C. mineatus, Variola louti, Plectropomus truncatus, Promicrops lanceolatus,* large *Caranx* spp., *Scarus* spp., large *Sphyraena* spp., large Muraenidae. *Monotaxis grandoculis* and *Gnathodentex aureolineatus* may also remain toxic, but these fish are not at all common. More and more species become safe to eat, but *C. mineatus* and *P. truncatus* are particularly slow, and *E. fuscoguttatus* even slower to improve. Finally the reefs enter the quiescent stage with only a few species, *Lutianus bohar, Promicrops lanceolatus,* and large Muraenidae, remaining potentially toxic. Large *Sphyraena* sp. have been found to remain very toxic in the vicinity of a toxic area, which in the Gilbert Islands may be almost anywhere in the colony.

WINDS AND CURRENTS

Throughout the Gilbert Islands the prevailing winds are the trade winds, blowing from the northeast, east, or southeast, with an occa-

sional stronger wind blowing from the north, usually after a period of calm. The prevailing ocean current is from the southeast; this current splits on coming to an atoll, sending a very strong current sweeping northward up the eastern side, with a much slacker current being deflected round the southern tip and up the western side. The effect of these winds and currents on the atolls is very marked. On the eastern weather sides there is constant heavy surf, while on the western lee sides calmer seas prevail. The "land" of the atolls is often more developed on the weather side than on the lee. This is especially noticeable on the larger lagoon islands, which have islets all along the weather sides, while the lee remains a mass of barrier reefs and shoal patches (as in Butaritari, Abaiang, Tarawa, Maiana, and in particular Arunuka, Nonouti, and Tabiteuea). The main anchorages on all the atolls are on the western lee sides, and, in the case of lagoon islands, so are the main ship or boat channels into the lagoon.

Between the months of October and March, there may be gales from the west bringing heavy rain, but several years may pass without any westerly weather developing. In years of heavy or continual westerly winds, an ocean current may develop from the southwest; the Gilbertese believe that a change in current actually precedes a severe westerly gale. During this westerly weather, big seas develop on the usually calm western sides, heavy surf breaks on the barrier reefs and may even sweep right across the lagoons. These westerly gales do not normally last for more than a few days, but they may blow up without warning and may be the cause of an occasional shipwreck, even in these days of motor vessels (as at Nikunau, in 1955).

DETAILS OF TOXIC AREAS BY ISLANDS

Makin

Makin (in U. S. Sailing Directions, Little Makin or Makin Meang) is the most northerly of the Gilbert Islands. It is small, about 2.8 square miles in land area, with a population in 1958 of 1,130. Annual average rainfall is 107 inches, which makes it one of the wettest islands in the Gilberts. Toxic fish are unknown to the Makin people. Although Makin is classed as a reef island, it is unusual in having a shallow lagoon on the eastern side of the island. On the western or lee side there is a narrow fringing reef, which at low tide is covered by about 4 ft of water; this reef drops away suddenly and steeply to deep water. Vessels may anchor only during exceptionally calm weather, and even then they must moor onto the edge of the reef.

In 1956 this narrow lee reef was a mass of luxuriant corals, with deep sandy-bottomed surge channels lined with many species of corals and a large and varied population of fish. In November, 1961, this magnificent reef was found to be completely changed; the corals were broken and the surge channels full of the debris, and there were not nearly so many fish. Enquiries showed that this very extensive damage had been caused by an exceptionally severe gale accompanied by heavy seas just before Christmas, 1960. However, no toxic fish have yet appeared.

Butaritari

Butaritari (in U. S. Sailing Directions, Makin Atoll) is a large lagoon island in the northern Gilberts with a land area of some 4.5 square miles and a population in 1958 of 2,118. It is the wettest island in the group, with an annual average rainfall of 125 inches. Poisonous fish were first reported from Butaritari after World War II. Small ships may enter Butaritari lagoon, which is large, through a passage in the southwest by Kotabu Islet, but large ships must remain outside the lagoon. During the war many ships were anchored in the passage and there are wrecks both here and inside the lagoon. About 25 years ago the "St. George" was wrecked in the lagoon opposite Ukianang village; and nearby the "Alexis" was bombed and sunk by the Japanese a couple of years later. No toxicity followed the earlier wreck, nor appeared for some years after the latter. The remains of a crashed Catalina flying boat are still to be seen near Butaritari village.

The toxic area, which is in the southeastern part of the island (Fig. 1), extends from a point somewhere between Butaritari village and Ukianang village inside the lagoon southward through the South Channel by Kotabu, thence to the northwest along the fringing and barrier reefs both inside and outside the lagoon, as far as Tukurere Islet. This toxic area is composed of

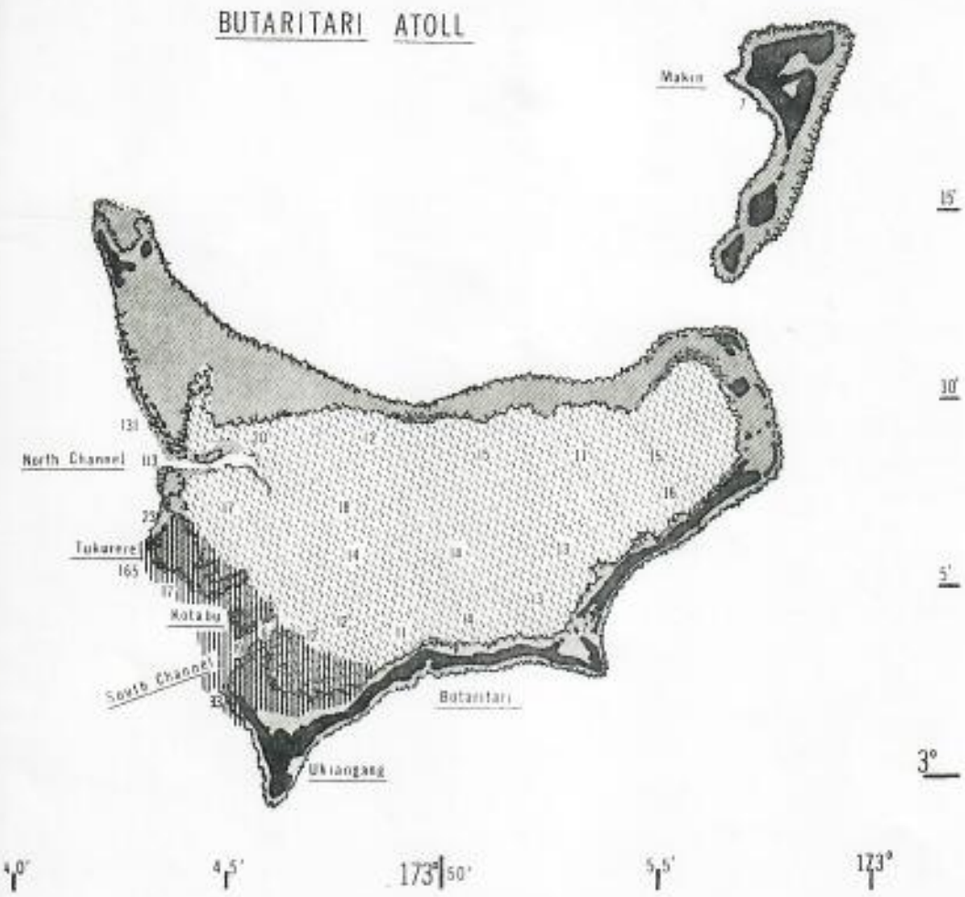

FIG. 1. Map of Butaritari Atoll.

sandy-bottomed lagoon opposite Ukianang village, deep water in the passage and anchorage outside, and living coral on the reefs.

Toxic fish were first reported from Butaritari about 1947–1948, and one of the earliest recorded cases of poisoning was the crew of the London Missionary Society's vessel, "John Williams VI." They caught a number of *Acanthurus xanthopterus* in the lagoon anchorage near Ukianang and, having had no previous experience of poisonous fish in Butaritari, they ate them. So many of the crew were poisoned that the vessel was unable to sail on time.

It is not known when the toxicity began to clear, but by 1956 there was already a great improvement in the condition of the reefs around Kotabu and Tukurere, where many species of fish were safe to eat. The toxicity took much longer to clear in the lagoon by Ukianang, the South Passage, and anchorage. The "John Williams VI" was again involved in a case of poisoning in 1956, but this time it was the European passengers and the captain of the ship who were very severely poisoned by an unidentified fish. The health of one of the passengers was so seriously affected that he was forced to resign from his work.

By 1959 all species of fish, with the exception of large *Lutianus bohar* and the Muraenidae, were again being eaten in all toxic areas. By 1961 the Butaritari people claimed that they were free of poisonous fish, except for an occa-

sional specimen of *Lutianus bohar* or an exceptionally large *Promicrops lanceolatus* or muraenid. However, early in 1962 the crew of the Sacred Hearts Mission ship, "St. Teretia," were poisoned by a barracuda (*Sphyraena* sp.) said to be about 3.5 ft long, which they had caught just outside the South Passage.

Marakei

Marakei is a small lagoon island in the northern Gilberts, lying some 60 miles to the northeast of Tarawa. The lagoon on Marakei is shallow, although full of fish, and is connected with the sea by only two passages, one on the southwest and one on the east. Both passages are very shallow and almost dry at low spring tides. There are seven villages; the largest is Rawanawi, in the northwest, which is also the Government Station where the medical dispensary and wireless station are situated. The Sacred Hearts Mission maintain a school at Rawanawi with two resident sisters and a resident parish priest, who were most helpful in this survey. There are two anchorages. The main one, for ships up to 150 tons and usuable only during east to southerly winds, is off Rawanawi, where there is a boat passage through the fringing reef. This anchorage, although poor, is better than the more southerly one by the western lagoon entrance.

A more detailed survey of the toxic fish problem was made on Marakei than on the other islands. Marakei was chosen for a variety of reasons, the most important being that the start of the toxicity in 1946 was recent enough to be clearly remembered by the Marakei people and it was said that they knew which alga was responsible. The population on Marakei, about 1,790 in 1958, is rather large for the size of the island, which is a mere 3.94 square miles in land area, and it is one of the most densely populated islands in the group. Although Marakei is not one of the "drought" islands, the rainfall, averaging 79 inches a year, is not high, and the people are accustomed to finding a large proportion of their food from marine sources. Thus, when the reef fronting the main village, Rawanawi, the most heavily populated area of a heavily populated island, suddenly began producing toxic fish, the Marakei people were very hard hit by the loss of a good proportion of their food supply. They were forced by the need for protein food to keep sampling this reef, in an effort to find out just what they could eat without fear of poisoning and what was too toxic. In this way a good local knowledge of the behavior of the toxicity on this reef was gradually amassed by the older people of Marakei.

The toxic reef on Marakei is the fringing reef on the west or lee side of the island (Fig. 2), extending from the vicinity of the village of Rawanawi southward to the village of Buota.

FIG. 2. Map of Marakei.

The reef flat is narrow, with a few very shallow tide pools and small boulders. It is covered with fine algae and has a greenish aspect. Just below low water mark (see Fig. 3) where the reef never dries out, there is a belt of red-colored algae. Beyond this the reef drops a little and is covered with a dense growth of millipore coral. Between the stands of coral there are deep sandy-bottomed channels, whose sides are lined with a great variety of marine life. There are a few red algae between the branches of the millipore coral, and some brilliant green species on the floor and sides of the channels; in places there

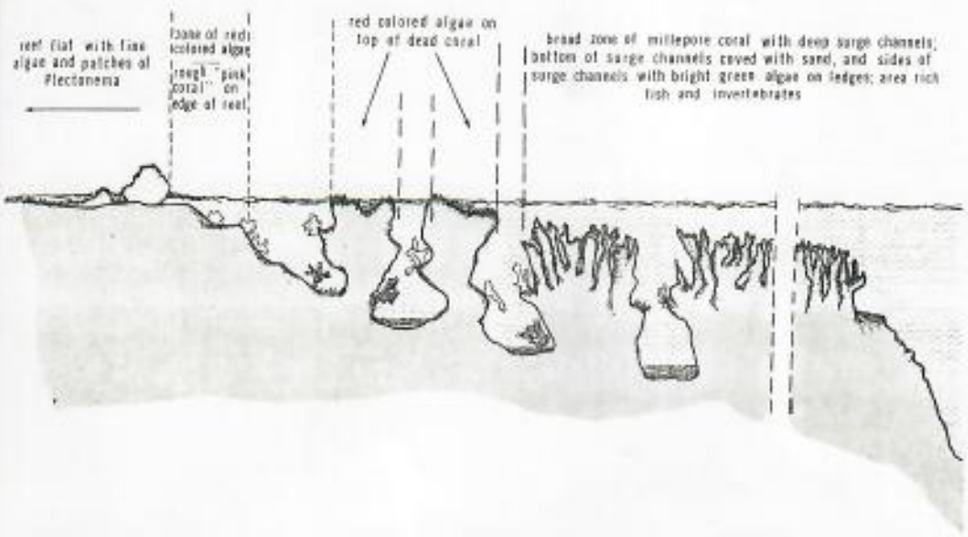

FIG. 3. Diagrammatic sketch of toxic area of reef at Marakei, water at low tide; depth of top of submerged heads of millepores about 4 feet below low tide level. "Red-colored algae" are mostly *Laurencia mariannensis*.

are dead coral pinnacles which reach almost to the surface, and the tops of these are covered with red algae. On the whole there was little algal growth below low water mark compared with the quantity on the reef flat. Beyond the belt of millipore coral, the reef face drops away fairly steeply to deep water. Many fish of different species were swimming above the coral, in the channels, and over the edge in the deeper water.

With the exception of tetraodonts and diodonts, toxic fish were unknown on Marakei prior to 1946. In that year a few fish caught on the reef near Rawanawi were found to be poisonous. By 1947 the affected area had spread southward along the reef as far as Buota, and many more fish were found to be toxic. By 1948 "all" fish were said to be toxic in some degree, when caught anywhere along this reef. Although the Gilbertese say "all" fish were poisonous, there were a few species, chiefly pelagic and oceanic, that were not affected, but it was not safe to eat most reef-dwelling or reef-hunting species. Many people were poisoned but few died, the only remembered deaths being the very old people and those already debilitated by disease. The Marakei people were forced to discontinue regular fishing on this reef, although they continued to collect octopus and other molluscs, none of which became toxic.

When toxic fish first appeared the Marakei people, having had no previous experience of toxicity, did not know what was making them ill. As more fish became toxic and the intoxications increased in severity, they realized that the fish had become poisonous; they were exceedingly angry and surprised, and immediately sought around for a reason. At first many people blamed the medical dresser, saying that he had fouled the reef with old medicines and dressings. Even to this day the Marakei people are loath to go to any medical officer when poisoned by a fish.

Another idea, a usual one throughout the Gilberts in an unknown, unpleasant situation, was that someone was making black magic and had poisoned the reef. The blame for this was put on a Maiana man who had been imprisoned on Marakei by the Marakei Island magistrate. Some people blamed a party from Butaritari, who arrived on the Sacred Hearts Mission ship, "St. Teretia"; they brought with them some alumi-

num from the wrecked catalina in Butaritari lagoon. Aluminum is a highly prized metal in the Gilberts, used for making combs; when the visitors landed on Marakei they were swamped in the boat passage and the aluminum was swept onto the reef. Although an attempt was made to recover it, some metal remained on the reef, and this metal was thought to have affected the fish.

Other people blamed "the Americans," in particular "an American ship which came to Marakei, grounded on the reef at Rawanawi, and when the tide came in again, left." Enquiries at Tarawa showed that a United States L.S.T. had made several trips to Marakei from Tarawa sometime in 1945 or early 1946, to load thatch and wood for the new houses that were then being built on Tarawa. At that time toxic fish were a serious problem on Betio, Tarawa, and this L.S.T. was based on Betio.

The "old men," on this occasion a specially called-together group of experienced fishermen as well as the usual village elders, aver that when the poisoning started they noticed a change in the appearance of the reef flat fronting Rawanawi. They say it appeared to have *tan-tan*, a Gilbertese word used to describe lichens and also certain fungus diseases of the skin. This *tan-tan* was caused by a brown-colored alga of a kind which they had never seen before. The alga began as a small circular patch growing on top of existing algae, sand, or stones, and as the patches grew larger small pieces broke away from the center. As in *tan-tan*, or fungal skin infections, this alga first appeared as a few small patches but spread rapidly, and then gradually died away until only a few patches were left, as at the present time. The "old men" say that this alga first appeared at Rawanawi, and spread along the reef to Buota; they insist that they have never seen it on any other reef on Marakei. This alga was clearly seen on the reef flat at low tide; it is orange-brown in color and grows in circular patches which may be picked up together with the underlying algae. At high tide vast numbers of acanthurids graze along this reef, and appear to nibble at this alga in turn with the other fine varieties on the reef flat. This alga has been identified by Dr. Drouet of the Philadelphia Academy of Science as the blue-green alga *Schizothrix calciola* (Agardh) Gomont.

Unfortunately the "old men" could not remember which species of fish was first noticed to be toxic, but they agree that a specimen of *Cephalopholis argus* was responsible for one of the earliest cases of severe poisoning.

The "old men" said that they continued to eat *Albula vulpes* (Linnaeus), *Chanos chanos*, and one unidentified species of Mullidae, together with flying fish—luckily very plentiful off Marakei—tunas and other deep-sea fishes, and of course fish from the other reefs and the lagoon. Strangely enough, one of the most popular and safe species, provided it was cleaned correctly, was puffer fish.

By 1962, although there had been a great improvement in the condition of the reef, many fish were still toxic. The fish population had increased enormously during the many years' rest, and the Marakei people (whose population had also increased) were not able to resist the easy fishing and disregarded the risk of being poisoned. Cases of poisoning were frequent and became an accepted part of Rawanawi village life.

Abaiang

Abaiang (in U. S. Sailing Directions, Apaiang Island) is a lagoon island just north of Tarawa, with a land area of 11 square miles, a population in 1958 of 3,234, and an annual average rainfall of 83 inches. There is a large lagoon, deep in parts, with an abundance of fish. Small vessels may enter the lagoon but larger ones must remain outside. There was no increase in shipping during the war.

Poisonous fish have never been reported from Abaiang; its people claim that this is entirely due to the efficacy of their magic.

Tarawa

Tarawa, the headquarters of the Colony Government, is a large lagoon island with a land area of 7.5 square miles. The population in 1958 was 6,982 Gilbertese and 141 expatriates; this includes some 1,500 on Betio, a small islet in the southwest. There is an annual average rainfall of 70 inches. Poisonous fish have been known on Tarawa for as long as anyone can remember. The lagoon is large, with extensive barrier reefs on the western side, in the midst of which is the main deep-water entrance to the

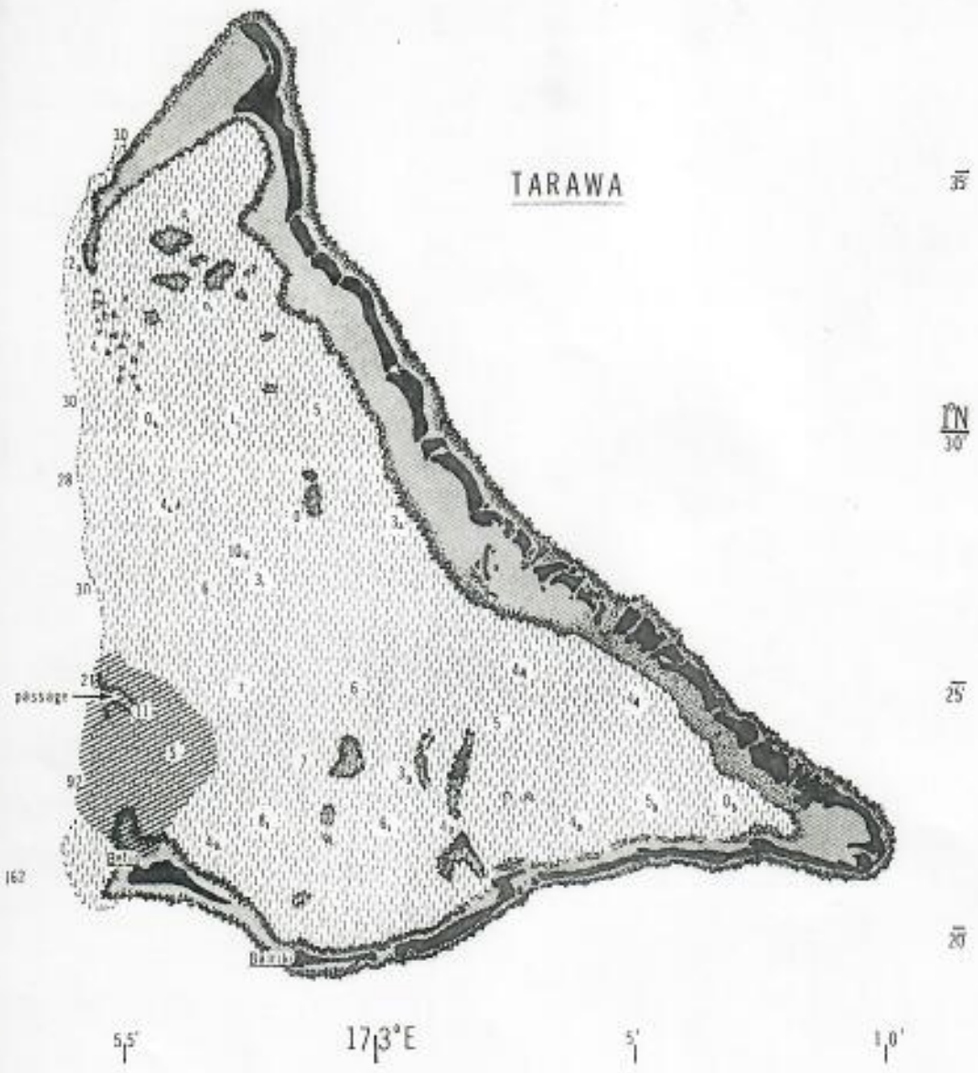

FIG. 4. Map of Tarawa.

lagoon. The anchorage, which is in the southwestern part of the lagoon, is an excellent deep-water anchorage and small ships may anchor very close to Betio. Tarawa, and in particular Betio, may be remembered as the site of the World War II Battle of Tarawa in 1943.

The toxic area on Tarawa (see Fig. 4) is situated in the southwestern part of the atoll. It is centered round the reef which runs north from the west end of Betio, and includes the deep water on the ocean side of the reef and the deep-water entrance which marks its northern extremity. Part of the reefs bordering the other side of the entrance, the ship passage inside the lagoon from the entrance to the anchorage and the parts of the lagoon bordering this passage, and the lagoon beach west of Betio are also toxic.

This toxic area includes deep water, a sub-

merged barrier reef, living coral, sandy areas, and a fringing reef flat that dries out at low-water springs. During normal weather conditions seas are slight on these reefs, but at times of westerly gales heavy surf develops. A very strong current sweeps out over the toxic area from the lagoon during the ebbing tide.

It is not known when poisonous fish first appeared on Tarawa. According to Gilbertese tradition, Betio was notorious for being the place where strangers dare not eat fish for fear of being poisoned. Among the old people the idea is held that toxic fish always have been, and always will be, found on this reef—it is part of the natural order of things. However the war, with the resultant increase in shipping, bombs, wrecks, rubbish, and surplus war material dumped on the reef, is blamed for the violent increase in toxicity in the late forties and early fifties.

There still remains about Betio much of the wreckage of the invasion of 1943, but these wrecks are not well correlated with the toxic areas. Thus landing craft left stranded, now rusted out and disintegrating, are present not only on the toxic reef flat but also on the edges of the inshore reefs all along the lagoon side of the island. Other war wreckage may be found in the deeper parts of the toxic section of the lagoon, but is also found in the nontoxic areas.

FIG. 5. Map of Abemama.

Finally, although there is a large quantity of ammunition and other materials to be found on the toxic reef flat, there is a considerably greater amount on other reefs which are not toxic. At various times from 1944 to 1963, coral heads have been blasted from the main lagoon entrance and passage to Betio, and from the seaplane alighting area near Bairiki; the former area is toxic, the latter is not.

There are several well-remembered cases of poisoning from before the war, mostly attributed to *te maneku*, large spotted grouper (probably *Epinephelus fuscoguttatus*) and red snapper (probably *Lutianus bohar*). However, the first recorded case was that of an elderly Australian shipmaster in 1944 (Halstead and Lively, 1954) who ate a red snapper. This is commonly thought to have been the start of the toxicity on Tarawa, whereas it was merely the first time it had been brought to the notice of the outside world. It was, however, the start of the resurgence of poisoning.

From 1944 onwards the toxicity increased rapidly, until nearly all the food fish caught in the toxic area were poisonous. The Betio people ceased to fish that area. In about 1956 a slow amelioration began, and by 1960 the reef was considered safe enough for fishing to be generally resumed. In 1961, although sporadic cases of poisoning still occurred, the reef was considered to be clear of toxic fish, and all species were being eaten. A few recorded cases of poisoning since 1958 are as follows:

1958 A Betio woman died after eating an 18-inch *Epinephelus fuscoguttatus*. I personally investigated this case, as the woman was the wife of a fisherman employed by me. This fisherman had brought this grouper to my house, where he was told it was a toxic fish and was sacked on the spot. He then took the fish home to his wife, who ate it and died.

1959 Several people ate a large *Lutianus bohar* and two of them were mildly poisoned.

1961 Two men died after eating a large moray eel. (See above, under Symptoms.)

1961 Two men were mildly poisoned by a *Lutianus bohar*.

1962 A man was mildly poisoned by a *Lutianus bohar*.

1962 The assistant medical officer stationed on Betio and his family were poisoned by a *Lutianus bohar*. (See above, under Symptoms.)

1962 Two children were mildly poisoned by an *Epinephelus fuscoguttatus*.

Maiana

Maiana is a lagoon island just south of Tarawa. There is a land area of about 10.2 square miles, a population in 1958 of 1,359, and an annual average rainfall of 62 inches. Maiana lagoon is fairly large but very shallow, navigable by the smaller colony vessels at high spring tides only. Toxic fish have not been reported from Maiana.

Abemama

Abemama (in U. S. Sailing Directions, Apemama) is a lagoon island in the central Gilberts. It is a fertile island, 6.5 square miles in land area, and has an annual average rainfall of 57 inches. The population in 1958 was 1,341, but settlers from the overpopulated southern islands have increased it. There is a large lagoon with two deep water entrances through the reefs on the western side. Toxic fish have been found in both these passages for many years. (See Fig. 5).

The northernmost toxic area is around the Western Passage; it comprises the passage itself, the reefs both inside and outside the lagoon around the point of "land" (in fact, a reef flat known as Te Tutongo) on the north side of the passage, and the reefs around the islet of Abatiku on the south side of the passage. A vessel owned by Burns Philip and Co. was wrecked on Te Tutongo about 1917, and the poisoning is said to date from this time. Parts of the engines of this vessel are still visible on Te Tutongo at low tide, and the Abemaman people think that some fish will remain toxic until all the ship's remnants have disintegrated. The condition of the reefs around the islet of Abatiku began to improve about 1947; and in December, 1961, both there and in the passage, an occasional *Lutianus bohar* or *Epinephelus fuscoguttatus* were the only fish found to be poisonous. On the reefs around Te Tutongo some acanthurids were still poisonous, as well as the above species.

The southernmost toxic area comprises the South Passage and the reefs around the islet of

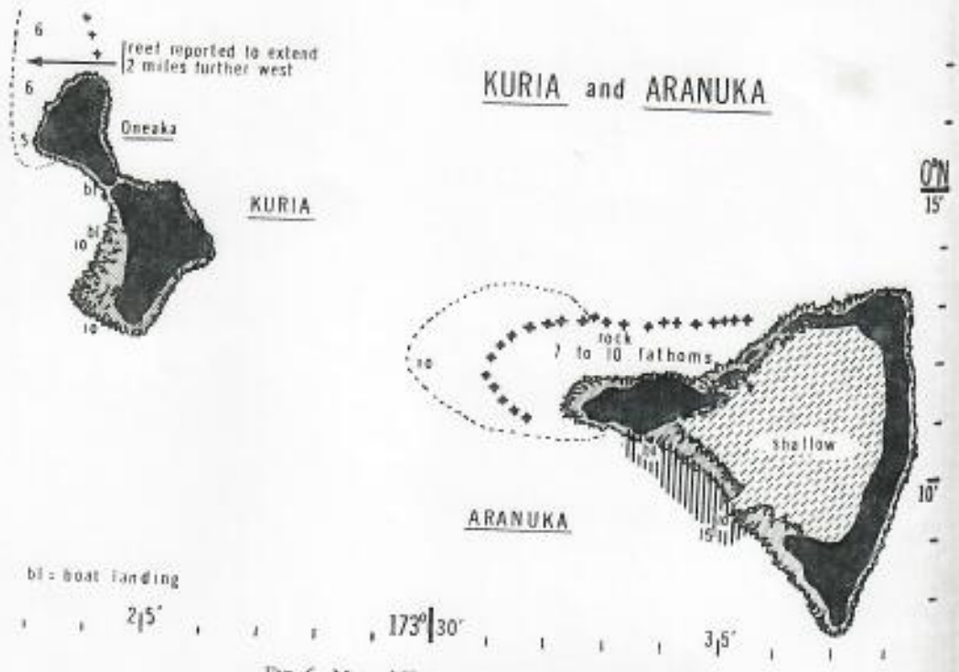

FIG. 6. Map of Kuria and Arunuka [Aranuka].

Bike, to the south of the passage. A ship remembered as "Te Tambou" sank in this area some 60 years ago and is blamed for the start of the poisoning. An occasional extra-large specimen of *Lutianus bohar* or *Epinephelus fuscoguttatus* are the only species to have caused poisoning here for many years.

Although these two areas are so close together, the islanders maintain that there has always been a stretch of reef between them which has been free of toxic fish.

Before the war large *Caranx* spp., which were often caught by ships' crews in the deeper water off the passages, were said to have been especially poisonous. During World War II many ships were anchored in both these passages, but there does not seem to have been any increase in the toxicity.

In 1961 details were collected from different old men, including the island magistrate, who swore that eels had never been toxic on Abemama. This is contrary to the information collected in 1958, when the author was told that large eels were poisonous in both toxic areas. It is possible that the small and comparatively wealthy population of Abemama is not forced to fish for eels in these localities, and that they and the new settlers have forgotten the last time someone was poisoned.

Kuria

Kuria is a reef island, 5 square miles in land area, in the central Gilberts, with a population of 541 in 1958; the annual average rainfall is 55 inches. There are two islets, joined and surrounded by extensive reefs. Toxic fish have not been reported from Kuria.

Arunuka

Arunuka is a lagoon island in the central Gilberts, with an annual average rainfall of 53 inches. The lagoon is full of coral heads and is not navigable except by launches. Ships must anchor by the entrance to the lagoon on the west side of the island. (See Fig. 6.)

The population of Arunuka, a mere 571 in 1958, is very small for the size of the island, which is nearly 6 square miles in land area. Many of these people are settlers from the overpopulated southern islands. These settlers do not

know the reefs around the island, nor the traditions associated with fish on Arunuka. This and the fact that the small population finds plenty of fish in the lagoon for all their needs, mean that there is a lack of local knowledge concerning the outside reefs. In fact, the present Arunukans maintain that there are no poisonous fish on the island. However, many people, all members of ships' crews, have been poisoned at Arunuka; the fish have been caught either in or somewhere near the anchorage, or on the reefs on the north side of the anchorage by an uninhabited islet. It has not been possible to find out the exact positions of the reefs that are considered to be toxic, and those marked on the map of Arunuka are tentative only. It is definite, however, that toxic fish have not been found inside the lagoon.

It is not known when fish became toxic on Arunuka, but between 1929 and 1937 many species are reputed to have been dangerous to eat. Just before World War II two members of the crew of the Burns Philip vessel *Moamoa* ate a large *Epinephelus fuscoguttatus* which had (probably *Epinephelus fuscoguttatus*), and were severely poisoned. Another time, according to one old Arunukan, a whole village went out communal fishing and caught "over one hundred big grouper," of which only one fish was poisonous, and the unlucky family who consumed it were very ill.

Despite the Arunukans' ideas to the contrary, all the ships' crews still consider that large *Lutianus bohar, Epinephelus fuscoguttatus,* and Muraenidae are toxic when caught in or near the anchorage. In January, 1962, the crew of the Co-operative vessel "Aratoba" were poisoned by a large *Epinephelus fuscoguttatus* which had been caught by the reefs on the north side of the anchorage.

Nonouti

Nonouti is a lagoon island in the southern Gilberts, with a land area of nearly 10 square miles and a population in 1958 of 2,143. There is an annual average rainfall of about 50 inches. Poisonous fish have been known on Nonouti for many years. Ships may enter Nonouti lagoon, which is large, north of Autaken reef (see Fig. 7), but the passage is not easy and many ships' masters prefer to remain at anchor just south of Autaken reef and work the island by boat. The toxic area is around this southern anchorage and includes the neighboring reefs. There are no toxic fish inside the lagoon.

The "old men" of Nonouti told us that they could not remember a time when fish were not toxic on this reef—which memory probably dates back 50 years to 1910—but that they remember hearing that a vessel was wrecked there in 1890, and that this was the start of the poisoning in the area. The Gilbertese name for this area, *Te Tamni* (not on the Admiralty charts), was derived from the name of the wrecked ship. The Nonouti people are not quite certain which species are still toxic there because, from long-standing custom, they do not fish on those reefs. However, crews of all ships do fish in the anchorage, and they say that in 1948 and 1949 very many fish were toxic on these reefs and that by 1958 only a few species remained poisonous. In 1962 *Lutianus bohar,* all large Muraenidae, and any particularly large groupers (Serranidae) were the only fish they considered still remained toxic.

Eels are very plentiful on Nonouti, and a specialty of the island is dried eel. Eel traps are set in the deep water of the lagoon and boat passages. The large eels which are so caught are cut into pieces and dried in the sun. The resulting rather smelly, very greasy pieces of fish are sold for a remarkably high price to the Chinese on Nauru. The "old men" say that, as long as the eels are taken only from the lagoon and boat passages, they are not toxic, and that by customary law no Nonouti fisherman would dare to trap eels outside the lagoon.

Tabiteuea

Tabiteuea (in U. S. Sailing Directions, Tapiteua), the largest of the Gilbert Islands, with a land area of 19 square miles, is a lagoon island in the south. The population in 1958 was 3,266, and the annual average rainfall is 47 inches. There is an extensive area of reefs and shoal patches lying to the west of the southern portion of Tabiteuea. These reefs are not shown on the Admiralty chart, as the survey of Tabiteuea is not yet completed. Somewhere among these reefs is a shoal patch known on Tabiteuea as Takoronga Inanon, which at times is large enough to be covered with a growth of *Scaevola frutescens,* and at other times is a mere sandbank

awash at high tide. The reefs all around this islet harbor toxic fish, and the area is extensive enough to include the entrance channels into south Tabiteuea (see Fig. 8).

A vessel of some sort is said to have been wrecked on Takorongo about 1919, and the poisoning dates from that time. Although many fish remained very toxic for many years, occasional fishermen continued to visit the area because there were so very many fish there that the temptation was great enough to risk poisoning. Men who had dived there said that the ribs and keel of a vessel are to be seen near Takorongo, and that other remains are scattered over the area.

In 1958 many species still remained toxic off Tabiteuea, although the Tabiteueans considered that there were fewer than there had been. By 1962 still fewer species were considered toxic, but it was not possible to obtain details of which

FIG. 7. Map of Nonouti.

FIG. 8. Map of Tabiteuea.

species remained poisonous. In December, 1961, both the mate of the colony vessel "Moanaroi" and a passenger, Mr. H. R. Cooper (husband of the author), were mildly poisoned by an unidentified fish caught in the entrance passage to south Tabiteuea.

Beru

Beru is a lagoon island in the southern Gilberts, with a land area of 8.15 square miles. The population in 1958 was 1,968 and the annual average rainfall is 49 inches. Until recently, the headquarters of the Gilbert Islands Mission of the London Missionary Society was located there. Toxic fish have been known on Beru for as long as anyone can remember. Ships cannot enter the lagoon, which is very shallow with extensive sandbanks at low tide and is considered to be silting up. (See Fig. 9.)

There are three anchorages on Beru, one in the south, off the village of Taboiaki, which was in use many years ago. In about 1936 a boat passage was blasted at Espiegle Anchorage in central Beru by the London Missionary Society and this became the main anchorage. The boat passage has gradually silted up, and the southern and northern achorages have been used more than Espiegle Anchorage in recent years. It is around the southwestern anchorage that toxic fish are found, opposite the village of Taboiaki. This area is a leeward fringing reef and does not include any part of the lagoon.

The Beru people say that long ago a New Zealand ship was wrecked on this reef, and that the poisoning dates from that time. They say that at times many species may be toxic, at other times only a few, but that this variation appears to follow no rules. Beru is a dry, poor island and population pressure forces the people to continue to fish this reef in spite of the risk of severe poisoning.

The poisoning caused by toxic fish on Beru appears to be more severe than on other islands. The staff of the London Missionary Society report that cases of poisoning among their students—many of whom were from other islands—were often severe enough to cause paralysis. In the late thirties several people became ill after eating a *Lutianus bohar* and were taken to the London Missionary Society's headquarters, where two men died. (This is a well-remembered incident, as the victims were all Roman Catholics.) Other deaths are remembered and red snapper (probably *Lutianus bohar*), *te ingo*, is blamed for most of them.

In January, 1962, the Beru people said that there were far fewer fish toxic than in 1958,

FIG. 9. Map of Beru.

FIG. 10. Map of Nikunau [Nukunau].

and that they were eating everything except large Muraenidae and the uncommon, enormous *Promicrops lanceolatus*. However, they said that they were taking a risk, and that any specimen of *Lutianus bohar*, *Epinephelus fuscoguttatus*, or *Cephalopholis mineatus* could be poisonous.

Nikunau

Nikunau is a reef island in the southern Gilberts with a population in 1958 of 2,011 and a land area of about 7 square miles. Although the average annual rainfall on Nikunau is the same as Onotoa's, 44 inches, and differs only by a few inches from several other islands, it appears to be a much drier island and is subject to severe droughts. Poisonous fish have been known on Nikunau for a very long time.

The toxic area is on the western or lee side of the island (see Fig. 10), and stretches along the fringing reef from the village of Tabutoa in the north to the village of Manriki in the south. Between these two villages is the village of Rungata, the Government Station and main anchorage. There is a boat passage through the fringing reef in front of the village. The reef flat is alga-covered and there are luxuriant corals in the deeper water.

A vessel is said to have been wrecked on the reef by Rungata village at some time in the past, and the poisoning dates from that wreck. The Nikunau people say that the poisoning began at Rungata, but spread north and south along the reef. After a while it began to recede and the reefs near Manriki and Tabutoa have always produced fewer toxic fish than those in the center by Rungata. At one time very many species were toxic, but by January, 1962, all species, except large Muraenidae, were being eaten; the occasional large specimen of *Lutianus bohar* may still cause mild poisoning.

In 1955 the Sacred Hearts Mission ship, "St. Teretia II," driven on to the reef by a very local westerly current and wind, was wrecked opposite Rungata village. However, this accident appears to have made no difference to the toxicity of the reef.

Onotoa

Onotoa is a lagoon island in the southern Gilberts with a land area of 5.21 square miles and a population in 1958 of 1,542 people. It is another dry island subject to drought and having an average annual rainfall of 44 inches. Poisonous fish have been known on Onotoa for many years. The toxic reef is in northwest Onotoa, is known as Aontebeba (see Fig. 11), and is considerably smaller than other toxic areas in the Gilbert Islands. There are three anchorages outside the lagoon on Onotoa, and the toxic reef lies just to the north of the northernmost anchorage. A ship is said to have been wrecked on Aontebeba during a southwesterly gale, and the poisoning dates from that time. It has not been possible to discover when this wreck took place; it was, however, a very long time ago.

Onotoans say that at one time very many species of fish were toxic on Aontebeba, but that their numbers have declined and the reef has been considered to be clear of toxic fish for some years. However, Onotoans still will not eat large Muraenidae caught there and admit, though somewhat reluctantly, that the occasional large *Lutianus bohar* is still found to be mildly poisonous.

Tamana

Tamana is a very tiny reef island in the southern Gilberts; the land area is a mere 2 square

miles, the population in 1958 was 1,142, and the average annual rainfall is 48 inches. There is a poor anchorage on the western side of the island, opposite the only village. Toxic fish have never been reported from Tamana.

Arorae

Arorae is a small reef island and the most southerly of the Gilbert Islands. There was a population in 1958 of 1,551 and a land area of 5 square miles. There are three anchorages, all described as poor. Toxic fish have never been reported from Arorae, and both the Tamana and Arorae people are most indignant at the idea that either island could ever produce a toxic fish.

The fringing reefs on Arorae are wide, especially in the north and south. A ship is reputed to have been wrecked on the southernmost tip of Arorae, but there is no sign of any remains.

Ocean Island

Ocean Island, lying 160 miles west-southwest of Tarawa, is not in the Gilbert Archipelago although it is a part of the Gilbert and Ellice Islands Colony. Ocean Island is a higher island than the low atolls of the Gilberts, and has an annual average rainfall of 68 inches. It rises to 265 ft, and beyond the fringing reefs drops abruptly to great depths. The fringing reef is rather different from those of the atolls, being composed in places of much rougher rocks; there are steep cliffs of very sharp weathered rock and few sandy beaches. There are, as on the atolls, deep surge channels in the edges of the reefs. There are deep pools on the reef flat, joined by tunnels in the reef, and living corals grow luxuriantly in these more protected waters. There is a very large fish population, composed not only of reef dwellers, but also of oceanic and deepwater species.

Ocean Island has large deposits of phosphates which have been worked since the early 1900s. Phosphate-loading vessels tie to moorings laid in very deep water. There is an old boat harbor with a wide deep passage through the reef on the western side which was blasted out of the reef in 1904. Since then a large new harbor has been built on the southeastern side, entailing extensive blasting of the reef. There is much cement and iron work on the reef, both in use and in the process of disintegrating from the old and new cantilever piers.

All rubbish is thrown over a chute on these cliffs, to fall on the reef beneath; from there it is slowly washed away by high tides. Sewage is pumped out over the reef. The "Ocean Trader" was wrecked sometime ago on the southeast side, and was followed in 1952 by the "Kelvinbank," which went on the reef on top of the remains of the previous vessel. The wrecks are still there, slowly disintegrating. During normal trade winds, blowing from the northeast through southeast, there is heavy surf on the eastern side of the island, but westerly weather is apt to cause heavy seas to beat all round the coast.

In spite of all this reef damage extending back over 60 years, no poisonous fish have ever been reported from Ocean Island.

Discussion

Of the 16 islands in the Gilbert Island archipelago, 10 have toxic reefs where certain species of fish have been poisonous for varying lengths of time. These "toxic" islands are Tarawa, Abemama, Aranuka, Tabiteuea, Beru, Nonouti, and Onotoa, lagoon islands, and Nikunau, a reef island, on all of which some fish have been toxic for many years; on Butaritari and Marakei, toxic

FIG. 11. Map of Onotoa.

fish have appeared only comparatively recently. The remaining six islands, Abaiang and Maiana, lagoon islands, Makin, Kuria, Tamana, and Arorae, reef islands, have no history of toxic fish.

The toxic area on all these islands is in the same relative position on the atoll; that is, each toxic area is on the sheltered lee side, either in the northwest, west, or southwest. This finding does not agree with Brown (1945), who reports that in the Bahamas the windward, exposed areas are more likely to be toxic than the leeward, sheltered ones. On a few islands part of the lagoon is toxic, but in no case is the toxicity confined to the lagoon; no non-navigable lagoon has any toxic reefs. Randall (1958) suggests that a body of water set off from the ocean by reefs may be more likely to contain toxic fish than more open water. In the Gilberts, although all the toxic reefs are in reasonably sheltered areas, there is a steady but not powerful ocean current, as well as currents caused by ebbing and flowing tides constantly washing over them.

The islands of the Gilberts vary from wet toxic Butaritari (125 inches) and dry toxic Nikunau (44 inches), to wet nontoxic Makin (107 inches) to dry nontoxic Tamana (48 inches). There is no island in the Gilberts with a fresh water stream, nor is the rainfall ever heavy enough to cause run-off.

Wrecks are often cited as the location and cause of a toxic area (Randall, 1958). In the Gilberts, on no less than seven toxic reefs out of eleven, wrecks are given as the reason for the start of the toxicity. Of these seven wrecks only one may still be seen (on northern Abemama); the rest are merely remembered. Within the last thirty years there have been five authenticated wrecks, two at Ocean Island, two at Butaritari, and one at Nikunau, none of which appear to have had any effect on the areas concerned. The Nikunau reef was already toxic when the wreck occurred, but the toxicity was not increased. The two wrecks at Butaritari occurred within a couple of years of each other, during the Pacific war, but the toxicity was not reported from Butaritari until some years later. It should be noted that all the wrecks referred to are in or very near anchorages or passages to navigable lagoons.

Again, heavy reef damage has been suggested as a possible factor in the chain of events leading to toxicity (Randall, 1958). Yet damage to the Makin lee fringing reef (by storm), to Beru lagoon reef (by blasting), and to Ocean Island reefs (by continual blasting and workings) produced no change in toxicity. Of particular interest is Beru, where the fringing reef downcurrent from the blasted area was already toxic. However, on Tarawa there was a resurgence of the toxicity following the Battle of Tarawa with its reef damage, wrecks, and heavy casualties on the reefs, all of which must have produced at least a temporary change in the ecology of the reef areas around Betio.

Vessels not only anchor in the usual cargo-working anchorages, as at Tarawa, Butaritari, Arunuka, Onotoa, and south Nonouti, where all these anchorages are in toxic areas, but, as may not be generally realized, vessels planning to enter a lagoon often must first anchor outside, in the entrance, or even in the passage itself, to await the optimum angle of the sun's rays before navigating the unmarked channels through the reef patches. In these days of radar and depth indicators this approach is not so vital as it was a few years ago. It has been found that these anchorages at lagoon entrances and in reef passages are frequently toxic, as at Tarawa, Abemama, Butaritari, and Tabiteuea. Nonouti is an island with a very difficult entrance into the lagoon, and many ships' masters prefer to work the island from the southern anchorage (which is toxic), or to wait there before attempting to navigate the entrance which is to the north of Autaken reef. Nikunau and south Beru have rather poorer anchorages than the islands so far mentioned, but nevertheless vessels do anchor off these places to load cargo and, once again, these anchorages are toxic.

Fanning Island, often quoted in papers on ciguatera (Randall, 1958; Banner et al., 1960), is another example of an atoll where the anchorage is toxic. In fact P. F. D. Palmer is quoted by Randall (1958) as saying that the areas where fish were toxic were only where the ships anchored. Randall continues to say that in the Line Islands where toxic fish appeared large ships had previously been anchored. The toxic area on Palmyra is also near the channel entrance (Banner et al., 1960). The toxic area on Christmas Island in 1953–54 was in and around the anchorage by the main lagoon entrance; since that time it has extended southward a con-

siderable distance (Helfrich, unpublished data).

It is of interest that, with the exception of Abaiang, islands which are free of toxicity have the worst anchorages and are islands where vessels must often drift while working cargo (for instance Makin, Kuria, Tamana, and Arorae). Marakei, another island with a very poor anchorage, is toxic, but it has been suggested that the cause of toxicity was an L.S.T. which was able to "land" on the reef. Abaiang, an island with excellent anchorages for small ships inside the lagoon, is near enough to Tarawa for vessels to time their arrival so that they may enter the lagoon at daylight without anchoring in the entrance. Larger vessels, infrequent at Abaiang, must drift off the island. Maiana, another nontoxic island very close to Tarawa, has a very shallow lagoon, navigable only by the smaller colony vessels (length about 50 ft) at high spring tides. All cargo and copra is worked on Maiana by these vessels or by larger vessels on the drift.

Washington Island, in the Line Islands, so often cited as one which is inexplicably free of toxic fish (Randall, 1958; Banner et al., 1960; Bouder et al., 1962), under normal conditions has no anchorage. Continual, heavy surf beats all around the atoll. Cargo, copra, and passengers must be moved in surf boats, while the vessel being loaded drifts some way off the island.

From evidence in the Gilbert and Ellice Islands Colony, it would appear that shipping may in some way be associated with the spread of toxicity. Allen (1953) discusses the large part played by ships in the world-wide distribution of a variety of marine invertebrates. He suggests that, as well as invertebrates, certain algae, in particular *Enteromorpha intestinalis* (Linné) and *Ulva lactuca* (Linné), may owe their almost universal distribution to ships. There is a minimum number of new organisms, he says, that must be introduced to start a new population, and concludes that in Australia harbors are the logical place for this to happen. In the Gilbert Islands there are no harbors, but merely anchorages; and it may be noted that all the most frequently used anchorages (lying outside lagoons) in the Gilbert Islands are toxic. Perhaps this means that there is a particular organism found in and around these anchorages which is not found elsewhere in the Gilbert Islands. If wrecks are indeed "the cause" of toxicity, perhaps the wrecked vessels were carrying this organism, which then spread along the reef.

OTHER TYPES OF POISONING

Sharks' Liver Poisoning

The liver from large sharks is thought to be potentially poisonous throughout the Gilberts, whether the shark is caught in a lagoon or in the ocean. The Gilbertese have a great liking for shark flesh, considering it more digestible than the flesh of other fish. In particular they like the liver; sometimes this is made into a kind of sausage, using the shark intestines as the casing. Not all large sharks have toxic livers; certain species are more likely to be toxic than others. According to the Gilbertese the most dangerous species are the tiger shark, *Galeocerdo cuvieri* (Lesueur), and the "white tipped lagoon shark" (possibly *Triaenodon obesus* [Ruppell]), but they say that any exceptionally large shark may have a toxic liver.

The different assistant medical officers consulted say that there appears to be no difference in the symptoms caused by sharks' liver poisoning and those caused by toxic teleost fishes; their list of symptoms for sharks' liver poisoning is the same as that described under ciguatera poisoning. However, the poisoning caused by toxic sharks' liver is extremely rapid and severe; the victims often become comatose after suffering from severe vomiting, stomach cramps, and diarrhea. There are no Gilbertese remedies for sharks' liver poisoning other than those given for ciguatera.

It has been considered that sharks' liver poisoning may be due to an excess of Vitamin A (Lonis, 1950). However, in 1949 samples of sharks' livers from the Gilberts were analyzed for Vitamin A content with a view to starting an industry. The report stated that there was insufficient Vitamin A to make commercial extraction worthwhile. The Vitamin A content of livers from several species of sharks from various areas in the tropical Pacific was also investigated by the U. S. Fish and Wildlife Service in 1949; none were found to contain enough to be used as a commercial source (unpublished report).

The traditions associated with sharks' liver poisoning vary slightly from island to island, but

inhabitants of all islands, with the exception of Abaiang, agree that the liver of large sharks can be very poisonous. The Abaiang people maintain that their magic prevents sharks from having toxic livers in the same way as it prevents their fish from producing ciguatera; they are not really believed by other islanders, who ridicule them, but not within their hearing. The Marakei people say that sharks caught at night are more likely to have poisonous livers than those taken during the day. Arunukans, Abemamans, and Butaritarians say that a toxic liver is always longer than a nontoxic one and has one lobe doubled back underneath itself. Others say that a toxic liver is darker than a nontoxic one or has dark spots on it. There are the same superstitions as there are for toxic fish; i.e., flies will not settle on a toxic liver, a silver coin is blackened, or grated coconut turns green when cooked with a toxic liver.

Several people died on Beru in 1957 after eating some tiger shark liver; again in 1960 and 1961 people died on Tabiteuea, poisoned by liver from the same species.

Shark flesh has never been reported to be toxic in the Gilbert Islands.

Poisoning by Tetraodont and other Plectognath Fishes

Puffer fishes, species of the family Tetraodontidae, are rather uncommon in the Gilberts, although on certain islands in other parts of the colony, particularly Fanning Island, they are very plentiful. Puffer fish poisoning is well known to the Gilbertese who, on the whole, do not especially like to eat these fish. Nevertheless, there are many people who do eat them; and they say that, provided the fish is skinned and gutted and the ovaries are removed immediately while the fish is still alive, the flesh will not be poisonous. Sometimes, despite these precautions, a puffer may still be deadly. On Maiana a large blue puffer fish, probably *Lagocephalus lagocephalus* (Linnaeus), which was taken at sea on a bait for flying fish, severely poisoned all who ate it, killing two, in spite of being "correctly" cleaned when it was caught.

Porcupine fish, Diodontidae, are considered far too toxic to risk eating. The toxin is thought by the Gilbertese to be concentrated in the ovaries, and they say that "even if only one egg is broken" the fish will be deadly. Sharp back puffers, *Canthigaster* spp., are also known to be deadly poisonous, but these little fish are too small to be used as food; *Canthigaster solandri* (Richardson) is the only species of any interest to the Gilbertese, as this species is used for fighting in the same way as are the Siamese fighting fish.

Trigger fish, Balistidae, are eaten whenever caught, but the majority are not particularly liked. Large specimens of *Prendobalistes flavimarginatus* (Ruppell) or *Rhinecanthus aculeatus* (Linnaeus) are considered to be more tasty than other kinds of Balistidae. These fish do not appear to be toxic all the time, and the Gilbertese say that they have always eaten them with impunity. Trigger fish may be very poisonous, however, in a ciguatera-producing area, but only when the outbreak of poisoning is at its height.

File fish, Monocanthidae, are not at all liked as food fish, but are occasionally eaten and do not appear to cause poisoning. The flesh of *Aleutera scripta* (Osbeck) is described as being rather bitter, but this fish was eaten in times of famine and does not have the reputation of being poisonous.

Hallucinatory Mullet Poisoning

The heads of certain species of mullets, Mugilidae, and of certain species of surmullets, Mullidae, have the reputation of causing a mild form of poisoning, described by some Gilbertese as a "madness," by others as a "forgetfulness," or "sleepiness." It was very difficult to get Gilbertese to admit to any knowledge of this form of poisoning. Fuller inquiries showed that the heads of certain of these fish were eaten with the full expectation and possible enjoyment of the hallucinations or dreams which followed.

Helfrich and Banner (1960) reported that in Hawaii this form of poisoning is restricted to certain localities and times of the year. Sufficient information was not obtained from the Gilbertese to be able to decide if this was true in the Gilberts or not.

It may be of interest to note that the Gilbertese consider two more species of fish capable of causing a "madness" or "forgetfulness" form of poisoning, *Epinephelus corallicola* (Cuvier

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and Valenciennes) and *Abudefduf septemfasciatus* (Kendall and Goldsborough). These fish are customarily eaten only by the old people—who are forgetful anyway. It was not possible to find out if these fish were at times genuinely "toxic," or merely considered so on account of their habits.

Scombroid Poisoning

There is no evidence of any scombroid poisoning in the Gilbert or Ellice islands. This type of poisoning appears to be caused by a bacterium (Kawabata et al., 1956), which may be found in the flesh of certain scombroid fishes. This microbe reacts on certain chemicals in the flesh of the fish when too long a time is allowed to elapse between catching and cooking the fish. The reaction is quickened by tropical temperatures. In the Gilberts scombroid fishes of various species are frequently caught early in the morning and left in the sun, and later the flesh is salted for consumption the next day. No poisoning has been reported, and it is thought that the scombroid fishes inhabiting this part of the Pacific are not infected with the specific bacterium (Banner, personal communication).

"Castor Oil" Fish Poisoning

On a few islands where the sea is very deep, close to the shore is found the castor oil fish, *Ruvettus* sp. Although this is a favorite food, it has the reputation of causing poisoning from the purgative properties of the oil in its flesh (Fish and Cobb, 1954). The choicest part of the fish is considered to be the roe, which is boiled whole, but the flesh is eaten as well. If the fish is cooked soon after catching, no "poisoning" results. However, the Gilbertese, and in particular the Ellice people, are well aware of its purgative properties; indeed, if there is a prolonged shortage of them, perhaps due to rough seas, the amount of epsom salts sold by the stores increases to quite staggering proportions.

Clupeoid Poisoning

During the time that the author was in the Gilberts, clupeoid poisoning was unreported. However, in November 1962 two children are reported to have died and other people have been taken ill after eating "sardines" (*te tarabuti*) caught off Betio, Tarawa. No details are known, except that there were two separate catches involved.

Some years ago at Bairiki, Tarawa, a woman died after eating what was described as "sardines" (possibly *Harengula* sp.). This woman was the only person taken ill among a number of people who ate the catch. At the time she was blamed for her own death, as she threaded her fish on an old piece of corroded brass wire before cooking them, instead of using a piece of coconut midrib: it was considered that she had died from copper poisoning.

Turtle Poisoning

The hawksbill turtle, *Eretmochelys imbricata* (Linnaeus), is considered to be deadly poisonous throughout the Gilbert and Ellice islands. It is not generally eaten, but occasionally one will be eaten in error, either in mistake for the green turtle or by someone who does not know the hawksbill's reputation.

The poisoning caused by the hawksbill is very severe, and the Gilbertese describe it as being similar to ciguatera but very much worse. It is so rare for anyone to eat this turtle, and so to be poisoned, that none of the assistant medical officers who were consulted had ever seen a case. The details of the following cases were supplied by eye witnesses on whom the severity of the poisoning had made an everlasting impression.

On Arorae, about 15 years ago, a group of people ate a hawksbill turtle. All of them became very ill and five of them died. Their symptoms were described as follows: vomiting; very severe stomach ache, and diarrhea; their skin was "very hot to touch; they were very thirsty, but something was wrong with their mouths and they were unable to drink; they were unable to move their arms and legs; finally, their skin peeled off as if they had been cooked." One man was so severely poisoned that he is said to have died less than a day after he ate the turtle, but even in that short time he peeled. The others died at various intervals, the longest surviving about a week.

The symptoms in a more recent incident on Tabiteuea involving an unknown number of people were described as follows: vomiting; severe stomach ache, and diarrhea; gradual paralysis; flaking skin, leaving great sores, especially

Summary of Toxic Conditions in the Gilbert Islands

ISLAND TYPE		Butaritari Lagoon		Marakei Lagoon		Tarawa Lagoon		Abemama N. Lagoon		Abemama S. Lagoon		Arunuka Lagoon		Nonouti Lagoon	Tabiteuea Lagoon		Beru Lagoon		Nikunau Reef		Onotoa Lagoon	
ANNUAL AVERAGE RAINFALL (IN INCHES)		125		79		70		57		57		55		50	47		49		44		44	
YEAR TOXICITY COMMENCED		About 1948		1946		Unknown; resurgence 1944–		Unknown (1917?)		Unknown (more than 50 years)		Unknown; but resurgence 1929–37		Unknown (1890?)	Unknown (1919?)		Unknown (more than 40 years ago)		Unknown (more than 40 years ago)		Unknown (more than 40 years ago)	
SPECIES TOXIC IN YEAR STATED	COMMONEST VERNACULAR NAME	1958	1961	1958	1962	1958	1962	1958	1962	1958	1962	1958	1962	1962	1958	1962	1958	1962	1959	1962	1958	1962
Holocentrus spp. (Gunther)	Ku			+																		
Myripristis spp. (Cuvier)	Mon			+																		
Epinephelus merra (Bloch), and allied species	Kuau			+											?							
E. corallicola (Cuv. & Val.)	Kuaurang			+		+		+							?							
E. fuscoguttatus (Forskål)	Maneku	+	L+	+	+	+	L+	+	+			+	L+	L+	+	?	+	L+	+	?	L+	?
Cephalopholis argus (Bloch & Schneider)	Nimanang			+	+	+		+	?						+	?	+					
C. miniatus (Forskål)	Nrekereke	+		+	+	+		+	?						+	?	+	+				
Plectropomus truncatus (Fowler)	Rekimoa	+		+	+	+		?	?			?	?	?	+	?	?	?	?			
Variola louti (Forskål)	Bukinakeiau	?		+	+	+		+							+							
Promicrops lanceolatus (Bloch)	Bakati	L+	L+	+	+	L+	L+	L+	L+	?	?	?	?	?	?	+	+	L+	?	L+	?	?
Caranx spp. (undetermined species)	Tauman, Aurua	?		+	L+	L+		L+						?	L+		?					
C. lugubris (Poey)	Aongo	L+		+	+	L+		L+						?	L+	?	?					
Acanthurus spp. (undetermined species)	Riba	?		+	+	+		+	+			?	?	?	?	?	+					
A. triostegus (Linnaeus)	Koinawa			+											?	?						

(undetermined species)											+	
A. triostegus (Linnaeus)	Koinawa		+						? ?			

ISLAND TYPE		BUTARITARI Lagoon	MARAKEI Lagoon	TARAWA Lagoon	ABEMAMA N. Lagoon	ABEMAMA S. Lagoon	ARUNUKA Lagoon	NONOUTI Lagoon	TABITEUEA Lagoon	BERU Lagoon	NIKUNAU Reef	ONOTOA Lagoon
ANNUAL AVERAGE RAINFALL (IN INCHES)		125	79	70	57	57	53	50	47	49	44	44
YEAR TOXICITY COMMENCED		About 1948	1946	Unknown; resurgence 1944–	Unknown (1917?)	Unknown (more than 50 years)	Unknown; but resurgence 1929–37	Unknown (1890?)	Unknown (1919?)	Unknown (more than 40 years ago)	Unknown (more than 40 years ago)	Unknown (more than 40 years ago)
SPECIES TOXIC IN YEAR STATED	COMMONEST VERNACULAR NAME	1958 1961	1958 1962	1958 1962	1958 1962	1958 1962	1958 1962	1962	1958 1962	1958 1962	1959 1962	1958 1962
A. lineatus (Linnaeus)	Katawa		+ +	+					? ?			
A. xanthopterus (Val.)	Mako	?	+ +	+	+ +					+		
Ctenochaetus spp. (*striatus* and *strigosus*)	Ribabui	?	+ +	+	? ?				?	?		
Aprion virescens (Val.)	Awai	?	+ +	+					+			
Lutianus vaigiensis .... (Quoy & Gaimard)	Bawe		+									
L. monostigma (Cuvier)	Baweina		+						+			
L. bohar (Forskål)	Ingo	L+ L+	+ +	+ L+	+ +	L+ L+	+ L+	L+	+ L+	+ L+	L+ L+	L+ L+
L. gibbus (Forskål)	Ikanibong		+ +							+		
L. semicinctus (Quoy & Gaimard)	Tinaemea	?	+ +	+	+ ?				? ?	?		
Lethrinus spp. (undetermined species)	Rou		+ ?	?					? ?			
Scarus spp.	Inai	?	+ +	?	+ ?				+ ?	?		
Sphyraena sp. (unidentified species)	Nunua	+ L+	+ +	+ L+	L+ L+	L+ L+	L+ L+	L+	L+ L+	L+ L+	L+ L+	L+ L+
Mugil spp. and other mullets	Aua		+ +									
Muraenidae	Rabono	+ L+	+ +	L+ L+	L+ ?	L+ ?	L+ L+	L+	L+ L+	L+ L+	L+ L+	L+ L+

\+ Denotes a species which may be toxic.
L+ Denotes a species in which large specimens only are potentially toxic.
? Denotes a species about which there is insufficient information on its toxicity.

The author would like to point out that the above list refers to the more common toxic species in the Gilberts. To discuss the degree of toxicity of all possible species is beyond the scope of this paper.

on the mouth, lips, and in the armpits; intense thirst, but due to the condition of the mouth, inability to drink; finally, the victims died, described as being unable to breathe.

The green turtle, *Chelonia mydas* (Linnaeus), is eaten throughout the Gilbert Islands and has not been implicated in any poisoning.

It should be noted that the hawksbill turtle is primarily a carnivore (Loveridge, 1946), preferring crabs and molluscs, although in captivity they will eat fish as well as seaweeds. On the other hand, the green turtle is primarily a herbivore, grazing many hours a day on beds of *Thalassia* (Loveridge, 1946, citing Deraniyagala, 1939). In captivity the green turtle may prefer animal food (Loveridge, 1946). In the Gilberts young green turtles are sometimes kept until they are large enough to eat, being fed almost exclusively on fish.

The hawksbill and green turtles were and still are Gilbertese family totems. Members of the families concerned will often maintain that all turtles are poisonous.

Invertebrate Poisoning

Several species of crabs are considered by the Gilbertese to be deadly poisonous, but very few species of crabs are commonly eaten. *Te kukua*, *Zozymus aeneus* (Linnaeus), is reported by Banner and Randall (1952) to be deadly poisonous on Onotoa; although Tarawa people would agree that it is toxic, this species is eaten on Arorae, Beru, and Nonouti. Another species, *Carpilius convexus* (Forskål) generally considered to be poisonous, is similar to a commonly eaten species, *te ntababa*, the red-eyed crab, and in the dark may easily be confused with it, especially by an inexperienced fisherman. Another with the reputation of being deadly poisonous is an uncommon small black and green or yellow crab. Because of its size it would never be taken for food; but it is said to have been used by the practitioners of black magic to poison their victims. However, the Gilbertese are reluctant to discuss such practices and the crabs involved.

In September 1961 a Bairiki, Tarawa, woman died after eating crabs. The crabs had been collected by torch fishermen on the Bairiki reef. When they returned they flung the whole catch on the ashes of a fire, an unusual procedure, boiling being the usual Gilbertese method of cooking crabs. It is said that the woman, being greedy, did not wait until the crabs were fully cooked, but grabbed them half-cooked from the fire and ate them. She was taken ill, removed to the Colony Central Hospital, and died. The assistant medical officer who dealt with the case described her death as being due to acute allergy poisoning. As it was dark when the crabs were cooked and eaten, identifying the species responsible was not possible.

Molluscs are not considered to be toxic by the Gilbertese on any island. Banner and Randall (1952) stated that the Onotoans reported that large tritons, *Charonia tritonis* (Linnaeus), were toxic; however, they could find no specific case of intoxication from this snail (Banner, personal communication). The large conch, *Strombus* sp., has been reported as toxic from certain areas in the Bahamas (Randall, 1958), but apparently this mollusc is not found in the Gilberts. The blood-mouth conch, *Strombus* sp., is one of the most common shellfish in the Gilberts. Vast numbers are collected and eaten, either raw or cooked, but so far none have caused any poisoning. Both small and large spider conches, *Lambis* spp., found on the algae-covered reef flats as well as in deeper water, are commonly eaten by the Gilbertese, but have never been reported toxic. The commercial trochus, *Trochus niloticus* (Linnaeus), is not found in the Gilberts, but smaller *Trochus* spp. are not uncommon; although these are eaten when collected during general gleaning on the reef, they are considered somewhat small for food. Turban shells, *Turbo* spp., are eaten and are commonly used for bait. These snails are picked up on the reef, broken open, a piece is bitten off and put on the hook, and the rest is eaten raw at the time. Cowries of various kinds are found throughout the Gilberts, but are never eaten by the Gilbertese. Many varieties of pelycopods are eaten without any causing illness.

The Gilbertese, surprisingly enough, do not make as much use of the various seafoods on their reefs as do many islanders in the Pacific. Sea urchins, again reported by Randall (1958) as causing a ciguatera-like poisoning, are not eaten by the Gilbertese.

During the Japanese occupation some varieties of seaweeds were eaten by the Gilbertese, but as soon as food supplies returned to normal

ISLANDS THAT ARE FREE FROM TOXICITY

ISLAND	MAKIN	ABAIANG	MAIANA	KURIA	TAMANA	ARORAE	OCEAN ISLAND
TYPE	Reef	Lagoon	Lagoon	Reef	Reef	Reef	High, reef
RAINFALL	107"	83"	62"	55"	48"	56"	63"
ANCHORAGE (outside lagoon)	Very Poor	Poor	Nil	Poor	Very Poor or Nil	Poor	Moorings only

this ceased. No information is available, therefore, as to the toxicity of any alga in the Gilbert Islands.

SUMMARY

The Gilbert Islands were surveyed for fish poisoning, using local Gilbertese as informants. The following observations were made:

1. Ten out of 16 Gilbert Islands have fish that cause ciguatera.

2. The toxic areas are all found on the western lee sides, and are usually confined to open sea reefs and anchorages in this area, seldom penetrating into lagoons.

3. There is a definite evolution of toxic conditions over the years, with a few species being initially toxic, almost all reef fish being toxic at maximum, and, in the final stages, only large eels, certain snappers, and groupers remaining toxic. This cycle appears to take at least 8 years.

4. Of the other fish in the archipelago, the liver of some sharks, the heads of some mullets and surmullets, the "castor oil fish," and some sardines all have reputations for varying degrees of toxicity. In addition, the hawksbill turtle is also reported to be toxic. At least the shark's liver and the hawksbill turtle produce symptoms somewhat similar to those of ciguatera.

5. Of the invertebrates, only two species of crab and one species of gastropod have been said to be toxic; no other crustaceans or molluscs were considered as being toxic.

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The Discovery of the 1960 Sharp Pacific Islands

106. Early Encounters with the Phoenix Islands

In 1794 the British ship *Arthur*, Henry Barber being the captain, made a trip from New South Wales to the north-west coast of America. An Arthur Island, seen in this passage, was in due course shown in nineteenth-century charts. As late as 1871, Findlay's *Directory* stated that Arthur Island, placed by Arrowsmith in latitude 3° 30′ S., longitude 176° 0′ W. required confirmation as to existence and position.[1]

No land in fact exists in the precise position given for Arthur Island. McKean Island in the Phoenix group, which is in the stated latitude but some 1¾° to the east of the stated longitude, is the most likely candidate for identification with this island.

The name Phoenix was given to the group by Wilkes of the U.S. Exploring Expedition of 1838–42 at a time when its geography was still imperfectly known,[2] a Phoenix Island having been reported in the area. The Russian hydrographer Krusenstern, in a note published in 1834, said on the authority of the French explorer Tromelin, who crossed the Pacific in the *Bayonnaise* in 1823, that the position of Phoenix Island was latitude 3° 42′ S., longitude 170° 43′ W., and that Arrowsmith's latitude for Phoenix Island was 0° 12′ too far north.[3] Jeremiah N. Reynolds, in his report of 1828 to the U.S. Navy Department on discoveries by American whaling vessels,[4] gives the position of a 'Phenix Island', described as small and sandy and 3 miles in circumference, as latitude 2° 35′ S., longitude 171° 39′ W. Records of American whaling voyages refer to American whaling ships called *Phenix* and *Phoenix* prior to Reynolds's report in 1828.[5] Reynolds also

[1] Stackpole, E. A., *The Sea-Hunters* (Philadelphia–New York, 1953), p. 375, citing *Albany Sentinel*, 29 Aug. 1797; Findlay, A. G., *A Directory for the Navigation of the Pacific Ocean* (London, 1871), p. 665.

[2] For references to Wilkes in this section, Wilkes, C., *Narrative of the United States Exploring Expedition* (Philadelphia, 1845).

[3] Royal Geographical Society, *Journal* (London, 1837), pp. 407–8; Krusenstern, A. J., *Supplémens* (St. Petersburg, 1836), pp. 158–9.

[4] For references to Reynolds in this section, Reynolds, J. N., Report of 1828, in Doc. No. 105, House of Representatives, Navy Department, 23rd Congress, 2nd Session (Washington, 1835).

[5] Starbuck, A., *History of the American Whale-Fishery*, in Appendix to the Report of the Commissioner for Fish and Fisheries for 1875–6 (Washington, 1878).

says that 'Birney's Island in lat 3° 30′ long 171° 30′ W and Sidney's Island in lat 4° 25′ long 171° 20′ W discovered by Captain Emmert will be found on the charts'. He gives this as a comment on a position for a Sidney's Island as latitude 4° 30′ S., longitude 171° 20′ W., which is listed by him in juxtaposition to two unnamed islands in latitude 3° 14′ S., longitude 170° 50′ W. and latitude 3° 35′ S., longitude 170° 40′ W. respectively. In another place he gives another position for a Sidney's Island as latitude 4° 29′ S., longitude 171° 20′ W. These positions for two unnamed islands and two Sidney's Islands were evidently derived by Reynolds from information secured by him about contacts by American whaling ships independently of Emmett. Captain Emmett, of the British vessel *Sydney*, was presumably associated with Captain James Birnie, a contemporary shipping man of London and New South Wales; Tromelin found Sidney's Island again in 1823 and gave its position as latitude 4° 26′ 30″ S., longitude 171° 18′ W.[1] Two islands reputed to be rediscoveries of Emmett's islands but of doubtful longitude were seen by Obed Starbuck (see section 97).[2] Enderbury Island (a corruption of Enderby's Island), reported by Captain James Coffin of Nantucket in 1823 while in command of the British whale-ship *Transit*, is shown in early nineteenth-century charts in latitude 3° 10′ S., longitude 171° 10′ W.[3]

When these data are compared with the actual geography of the south-eastern sector of the Phoenix Islands, comprising Phoenix, Birnie, and Enderbury Islands, the impossibility of deciding who discovered which of these three islands, and when, becomes apparent. The positions of the modern Phoenix, Birnie, and Enderbury Islands, all of them small, are respectively latitude 3° 43′ S., longitude 170° 44′ W., latitude 3° 35′ S., longitude 171° 32′ W., and latitude 3° 8′ S., longitude 171° 8′ W. Tromelin's position for his Phoenix Island corresponds almost exactly with the position of the modern Phoenix Island, but whether Arrowsmith's data for the previously reported Phoenix Island are sufficient to differentiate it from Birnie is open to question. The position for Reynolds's 'Phenix Island' corresponds neither to the modern Phoenix nor the near-by Birnie or Enderbury, being in

[1] Krusenstern, A. J., *Supplémens* (St. Petersburg, 1836), pp. 4, 12; Appendix to Bigge's Report, in McNab, R., *Historical Records of New Zealand*, vol. i (Wellington, 1908), pp. 458–69.

[2] Stackpole, E. A., *The Sea-Hunters* (Philadelphia–New York, 1953), p. 375.

[3] Krusenstern, A. J., *Supplémens* (St. Petersburg, 1836), pp. 158–9; Bryan, E. H., *American Polynesia* (Honolulu, 1941), p. 58.

fact 11 miles north of Canton Island, the visible land of which is 8 miles long and over 20 miles in circuit, as compared with the description of 'Phenix Island' as small and sandy and 3 miles in circumference. The precise identification of the two unnamed islands listed by Reynolds in this area is also doubtful, as is the identification of the islands reported by Starbuck. One or other of the Sidney's Islands in these data may have been Hull, since Sydney and Hull lie east and west of each other in latitude 4½° S. and longitudes 171¼° and 172½° W. respectively. All that can be said is that Emmett apparently discovered Sydney, and that the first firm reports of Phoenix and Enderbury would appear to have been made by Tromelin and Coffin respectively.

Wilkes established the locations of the modern McKean, Hull, Birnie, and Enderbury, seeing each of them in turn, and heard from a French turtle-hunter on Hull that Sydney was some 60 miles to the east.

Howland Island, the northernmost of the Phoenix group, is said to have been discovered by Captain George B. Worth, of the Nantucket whaling ship *Oeno*, about 1822, being called Worth Island.[1] It was placed on the charts under the name Howland Island following a contact in November 1827, by Daniel McKenzie of the American whaling vessel *Minerva Smith*, who placed it in latitude 0° 47′ N., longitude 176° 35′ W., and gave it its present name.[2]

New Nantucket, as we have seen (see section 97), was the name given to Baker Island by its discoverer Obed Starbuck, of the American ship *Hero*, in 1823.

Mary Balcout's Island is described in Reynolds's report as being in latitude 2° 47′ S., longitude 171° 58′ W., surrounded by a reef 20 leagues in circuit, with only four openings where boats could enter. The English hydrographer Norie, in his map of 1825, lists a Mary's Island,[3] which may be identical with Mary Balcout's Island, being virtually in the same position. Reynolds also gives the position of a Barney's Island as latitude 3° 9′ S., longitude 171° 41′ W., described as having a lagoon 20 miles in circumference. Several masters

[1] Bryan, E. H., *American Polynesia* (Honolulu, 1941), p. 46.
[2] Stackpole, E. A., *The Sea-Hunters* (Philadelphia–New York, 1953), p. 374.
[3] Ibid., p. 375.

and owners named Barney are listed in records of American whaling voyages.[1]

The position given for Mary Balcout's Island is precisely that of Canton Island, the north-easternmost of the Phoenix group. While nothing like the size indicated, Canton is larger than any of the other islands in the vicinity. Its sides are broached by several openings, although only one is in fact negotiable by boats.[2] Barney's Island, from the size of the lagoon, would also appear to have been Canton, although the stated latitude is somewhat south of Canton.

Late in 1825 Captain Joshua Gardner, of the American whaling vessel *Ganges*, found an island named by him Gardner's Island, the position given being latitude 4° 30′ S., longitude 174° 22′ W.[3] Wilkes found an island described by him as being in much the same position as the Kemin's or Gardner's Island of the charts.

The positions given for Kemin's or Gardner's Island are almost precisely that of the modern Gardner Island, a relatively detached member of the Phoenix group.

107. Curé Island

In 1827 Captain Stanikowitch, of the Russian vessel *Moller*, found a small, low, dangerous island, placed by him in latitude 28° 27′ N., longitude 178° 23′ 30″ W. The Russian hydrographer Krusenstern suggested that this was the same as Curé Island, a previous vaguely reported discovery.[4]

This was the modern Kure Island, in the north-western sector of the Hawaiian Islands.

[1] Starbuck, A., *History of the American Whale-Fishery*, in Appendix to the Report of the Commissioner for Fish and Fisheries for 1875–6 (Washington, 1878).
[2] *Pacific Islands Pilot*, vol. ii, p. 472.
[3] Stackpole, E. A., *The Sea-Hunters* (Philadelphia–New York, 1953), p. 378, citing *Nantucket Inquirer*, 8 Dec. 1827.
[4] Krusenstern, A. J., *Supplémens* (St. Petersburg, 1836), pp. 109, 161.