THE SOUTH PACIFIC COMMISSION FISHERIES NEWSLETTER

Editors: J. Crossland and
R. Grandperrin
South Pacific Commission
P.O. Box D5, Noumea Cedex
New Caledonia

No. 19 November 1979

CONTENTS

GIANT CLAMS IN TONGA UNDER STUDY

J.L. McKoy
Fisheries Research Division
P.O. Box 19062
Wellington, New Zealand

INTRODUCTION

Concern over the possible overexploitation of the valuable giant (tridacnid) clam resource in Tonga resulted in a four-month (December 1978-March 1979) preliminary study of these clams under the New Zealand Bilateral Aid Programme. The aim of this study was to investigate basic biological and population parameters and to make recommendations for conservation and management of the fishery.

As in many other areas in the Pacific, giant clams in Tonga have long been taken from reefs as part of subsistence fisheries. However, in recent years a commercial fishery has developed there, resulting in steadily increasing pressure on the stocks of clams, especially in areas close to centres of population. Most clam fishing is done around the island of Tongatapu. Estimates of minimum landings were 24 t in 1974, increasing to 153 t in 1978 (estimated whole weight, including shells; based on Tongan Fisheries Division statistics).

Four species of giant clams are found in Tongan waters. *Tridacna maxima* is the most common (about 94 per cent of landings). It lives partly buried in the coral in shallow reef areas and grows to about 300 mm in shell length. *Tridacna derasa* is the largest species in the area (up to 525 mm long) and makes up about five per cent of landings by number and probably 10-15 per cent of landings by weight. *Tridacna derasa* had not been recorded from Tonga before, despite the fact that its shells are commonly used to decorate graves and gardens. It is found mostly on sandy areas, near reefs in all depths down to about 30 m.

The attractive *Tridacna squamosa* makes up about one per cent of landings around Tongatapu but it is much more common in the sheltered waters around Vava'u. It lives in similar habitat and depths to *T. derasa* but seems to prefer less exposed conditions.

Hippopus hippopus has been recorded from Tonga, but during this study only dead shells were found. It seems likely that this species, which lives in very shallow reef areas and on reef flats, has been fished to such an extent that it is now quite rare in Tonga.

RESULTS

Growth

The short period of the project did not allow a thorough study of growth rates but a start was made by tagging 150 specimens *in situ* using a special underwater epoxy resin. Continuing measurements of the tagged clams will be done by Tongan Fisheries Division technical staff who assisted with the study.

Little information is available from any area on growth of *T. derasa* and *T. squamosa* but data from McMichael (1974) for growth of *T. maxima* on the Great Barrier Reef were available and were used for preliminary estimates of mortality rates. *Tridacna maxima* is a slow-growing species, taking approximately five years to reach 100 mm in shell length. Large specimens of 250-300 mm are probably well over 50 years old.

Reproduction

Tridacnids are hermaphrodite, developing first as males and then as females. Eggs and sperm in fully mature individuals are produced in adjacent follicles in the gonads. Tridacna maxima in Tonga mature as males at about 55 mm (two and a half years?) and 50 per cent are fully mature (producing both ripe eggs and sperm) at about 105 mm (five years?). All were fully mature at more than 140 mm long.

A small sample of T. squamosa indicated that 50 per cent of this species were fully mature at about 200-250 mm in shell length. All were mature when longer than 300 mm. All of the T. derasa examined were spent and size at first maturity could not be estimated.

In Tonga spawning of T. maxima and T. squamosa probably occurs during late summer (February-April) while T. derasa probably spawns in early summer (November-January).

Mortality estimates

Estimates of total annual mortality (Z) were made from size frequency distributions from field and market samples combined with McMichael's (1974) growth data, for T. maxima only. Calculations using two different methods produced estimates of Z ranging from 0.17 (16%) to 0.27 (24%).

These estimates seem fairly low. However, as a result of the method of fishing it is likely that the major component of these estimates is natural mortality (i.e. not due to fishing). In many cases new areas are fished each day so that a large part of the sample brought into the market comes from previously unfished areas. The effects of fishing are therefore not distributed evenly over the whole population as most models for estimating Z require.

MANAGEMENT OF THE FISHERY

It is unlikely that the giant clam resource, particularly around Tongatapu, can withstand the fishing pressure it is presently receiving. The demand for clam meat is still considerably greater than the supply, and loan schemes for fishermen for the purchase of boats and outboard motors have increased the pressure markedly over the last few years. Fishermen are now having to travel to reefs at increasingly greater distances from Tongatapu to obtain reasonable catches. The development of export markets in Samoa may result in greater pressures on the relatively untouched areas in the Ha'apai and Vava'u groups.

Recommendations made to the Tongan Government for management of the stocks included a range of measures depending upon the choice of management objective. If the choice is to manage this fishery on a sustainable yield basis, the suggestions include a size limit (at around 115 mm shell length for T. maxima) and several measures aimed at controlling and then reducing fishing effort.

Some form of commercial cultivation of giant clams was considered, but rejected, primarily on the grounds of the poor economic prospects for cultivation of these slow-growing species, at least at the present time.

REFERENCES

McMichael, D.F. 1974: Growth rate, population size and mantle colouration in the small giant clam *Tridacna maxima* (Röding) at One Tree Island, Capricorn Group, Queensland. *Proceedings of the International Coral Reef Symposium* 2 (1): 241-254.

McKoy, J.L. 1979: The biology, ecology, exploitation and management of giant clams (Tridacnidae) in the Kingdom of Tonga. Report to the NZ Ministry of Foreign Affairs under the NZ Bilateral Aid Programme, 86 pp.

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SPAT PRODUCTION AND CULTURE OF THE GREEN MUSSEL MYTILUS VIRIDIS IN FRENCH POLYNESIA

AQUACOP[1]
B.P. 7004 Taravao
Tahiti
and
Daniel de Gaillande
Service de la Pêche
B.P. 20 Papeete
Tahiti

INTRODUCTION

With the aim of developing the culture of shellfish in the South Pacific, CNEXO and the Fisheries Service of French Polynesia are endeavouring to establish a hatchery for bivalves. CNEXO (Fig.1) is concentrating on spat production and pregrowth, the Fisheries Service on the growing-on stage. Besides testing the local oyster species which has a slow growth (more than two years), CNEXO has also tried the Japanese oyster, *Crassostrea gigas*. The latter does not appear well adapted to tropical conditions, not being resistant to high temperatures, nor to the annelid, *Polydora*. Recent trials have therefore concentrated on the Philippines green mussel *Mytilus viridis* (often called *Perna viridis* or *Mytilus smaragdinus*). Unlike the Japanese oyster the green mussel is a tropical species; it is also resistant to *Polydora*.

This report records trials made in 1978.

SPAWNING AND LARVAL CULTURE

Spawning

The first spawning was obtained from brood stock imported from New Caledonia in February 1978. This stock had been introduced there as spat originating from the Philippines. Subsequent spawnings were from mussels raised later on at CNEXO. The brood stock are kept in $15m^3$ ponds with effluent water from the penaeid shrimp culture ponds circulating through them. This water contains a varied phytoplankton flora (diatoms, chlorellas) resulting from the pellets fed to the shrimps, and their faeces. The brood stock appears to mature practically all the year in sequence with the phytoplankton blooms.

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1. AQUACOP: Aquaculture division of the Centre Océanologique du Pacifique, Centre national pour l'exploitation des océans (CNEXO). Algae and molluscs: J.L. Martin, O. Millous, Y. Normant, D. Gillet, O. Lemoine. Nutrition: A. Lefèvre, P. Vilmorin, J.J. Laine, L. Mu, J.M. Guesne. Water control and treatment: J. Calvas, B. Couteaux, J. Bonfils, J.Y. Robert. Pathology: J.F. Le Bitoux, S. Robert. Crustaceans and fish: P.J. Hatt, M. Jarillo, J.P. Landret, J. Goguenheim, F. Fallourd, O. Avalle, J. Moriceau, D. Lacroix, S. Brouillet, R. Galzin, H. Pont, D. Amaru, V. Vanaa, A. Bennett, D. Sanford. Technology: J.F. Virmaux. Aquaculture programme co-ordinator for the tropical zone: A. Michel.

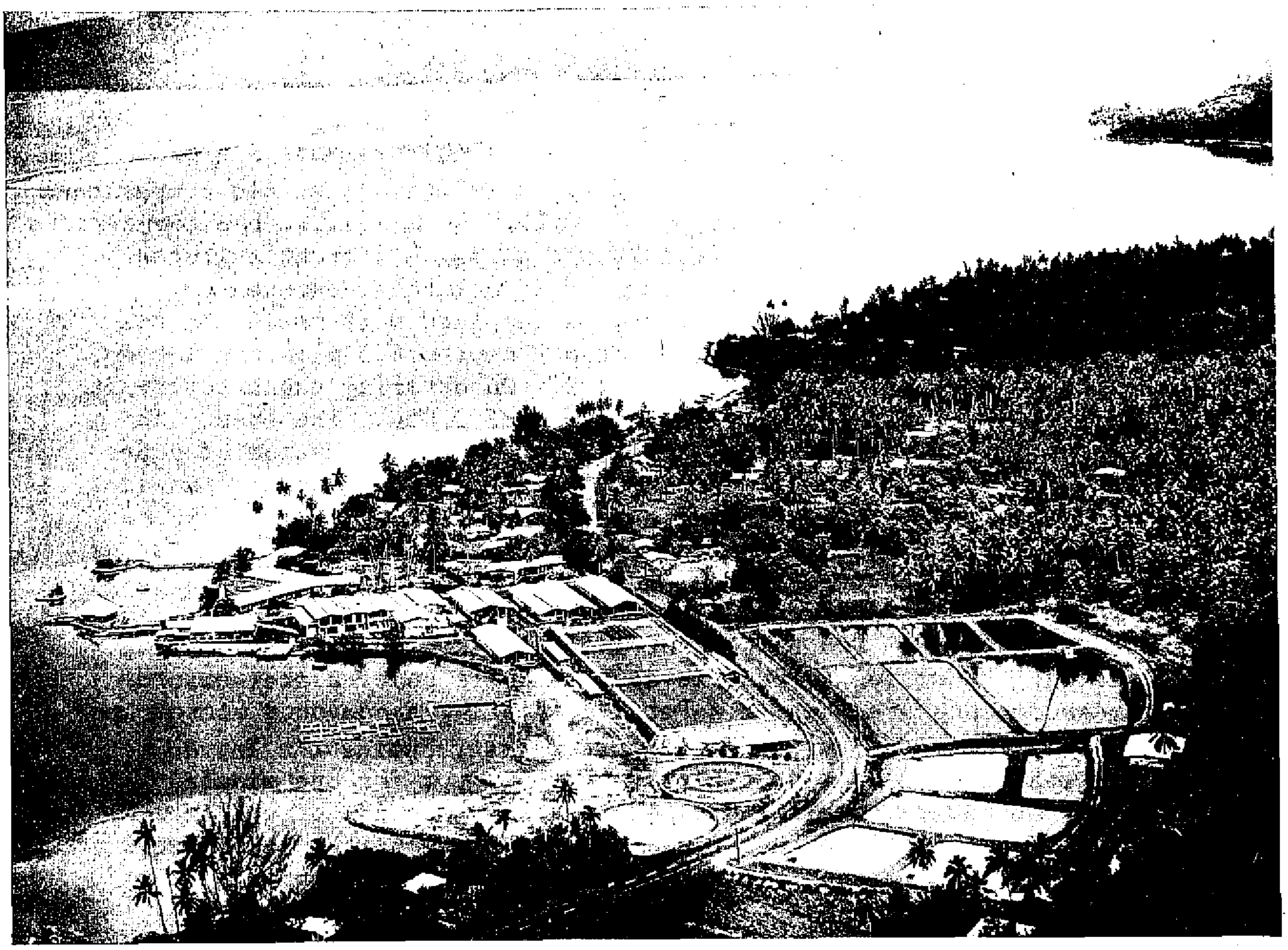

Fig.1: Site of the CNEXO aquaculture station at Taravao, Tahiti. (Photo, A. Sylvain)

The maturity index is judged from sacrificed specimens: sex unrecognisable, gonads distinguishable, gonads beginning to invade the mantle, gonads completely filling the mantle. Mature animals are stimulated by thermal shock. For that purpose they are placed in a vat fitted with a heat exchanger at the bottom. The water is progressively heated from 20°C to 34-35°C. Usually the first shock is sufficient to initiate spawning. The males release their genital products first, followed a little later by the females. After spawning has begun each animal is isolated so that the white sperm and the orange eggs are collected separately. Fertilisation is achieved simply by adding sperm to the receiver containing the eggs. The process is monitored under a microscope so as to obtain the maximum fertilisation rate while avoiding polyspermy. The polar globule is emitted rapidly (five minutes).

The fertilised eggs are filtered through a 100 µ sieve so as to retain any faeces of the brood stock and other matter. They are then incubated in one of the larval culture vats. The trochophore larva appears 10 or 12 hours after fertilisation, the D larva[1], 24 hours after fertilisation. The next day the D larvae are distributed in the hatchery vats so as to achieve densities of 2000-5000 larvae per litre. These densities are later reduced.

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1. Stage 1 veliger larva, in shape like the letter D.

Larval Culture

The hatchery established at CNEXO for the culture of oysters is constructed so that temperature elevation is limited during the day. To ensure an effective thermo-regulation, the larval culture vats are made with a double wall. Lagoon water, which has a relatively stable temperature (25.5-29.5°C) circulates within the double wall. As a result, the temperature in the vats has only varied from 26.5-28.0°C during different cultures, and the daily variation has not exceeded 1°C. A bubbler ensures oxygenation and stirring of the water. The hatchery is supplied with fresh and sea water. The sea water, which is pumped from a depth of 5 m in the lagoon, has a salinity of 35-36‰ and a pH of 8.2. On entering the hatchery it passes through two filters, one of 5µ and one of 0.05µ. The supply of sea water and the draining of the vats is done through a system of pipes and sluices made of PVC. The water in the vats is changed every two days. To do this, the larvae are collected on sieves of different mesh sizes, the mesh size being a function of the age and thus the size of the larvae. The vat is cleaned with fresh water and soap, rinsed and refilled with water. The larvae are decanted into 10 l buckets; this is done by rinsing in filtered sea water. Two samples of 1 ml are then taken for counting and measuring. Counting is done in squared cells under a stereomicroscope; measurements are made in a Petri dish using a compound microscope fitted with a micrometer eyepiece. Before redistributing the larvae in the vats, a washing in a hypochlorite bath (3 ppm for one minute) is sometimes necessary to eliminate all risk of a massive growth of ciliates which are fatal to cultures. Every day the filter boxes are cleaned with fresh water and then dried. The internal plumbing of the hatchery is also drained, for ciliates and numerous bacteria grow in pipes where water remains. The culture water is treated with sulphadimerazine (4 mg/l).

Larvae are fed unicellular phytoplankton. Two species, *Isochrysis* sp. and *Monochrysis lutheri*, are used in equal proportions of 25,000 cells each per ml. On settlement this quantity is reduced to half (12,500/ml) and *Skeletonema costatum* is added at a rate of 50,000/ml. On the appearance of the first pediveligers, about 15 days after the beginning of culture, black polythene nets are hung in the vats to act as collectors. They are placed around the central stream of bubbles so that the planktonic larvae are trapped there. They creep around, then attach themselves by their byssus. The collectors remain in the vats for about a week, the time necessary for the settlement of all the larvae. Only *S. costatum* is then distributed at will. Recently *Monochrysis* and *Skeletonema* have been discontinued and the whole culture carried out with only two species: *Isochrysis* sp. and *Chaetoceros gracilis*.

Algae are produced in two air conditioned algal rooms, one at 20°C for the temperate species and the other at 25°C for the tropical species such as *Isochrysis* sp. The base stock is kept in test tubes and is re-inoculated every week. Conway's culture medium is used, with the addition of vitamins and aeration augmented with CO_2 (0.5%). Cultures from these stocks are made by successive augmentation of the volume to 250 ml, 5 l, 20 l and 200 l. Each stage lasts four days, that is 16 days in total.

PREGROWTH STAGE

The nets, to which are attached the spat, are suspended from pieces of wood placed around the edges of the outer rectangular ponds. Effluent water from the shrimp culture ponds flows through these ponds ($15m^3$ in size) as in the case of the brood stock. A regular addition of Chaetoceros ensures better survival and growth. This circulation is carried out from the pond to the surface so as to avoid sedimentation of organic material and the loss of spat during the draining of the ponds for routine cleaning. The drying out resulting from emptying is a critical phase, not well tolerated by young spat during the early days. It is, however, essential to acclimatize the spat progressively to emersion because it must be transported dry to the growing on sites. The pregrowth stage lasts around one month. During the whole of this period the spat remains very mobile and a large proportion falls from the nets, creeps around and attaches to the bottom of the pond. The stripping operation is done manually. The spat is thus sent to mussel farmers in a free state, which leaves to them the choice of attachment procedure and appropriate culture method.

During 1978 the five trials realised produced six million young mussels. Survival during pregrowth was around 90 per cent. Spat is sold at 200 French Pacific francs per thousand (US$2.63) which is equivalent to 0.01 French francs each; in comparison, spat of the oyster C. gigas is sold in France at 0.03 FF each at a size of 2-3 mm and at 0.08 FF at 7-8 mm. The cost of production obviously depends on the size at which the spat is sold.

GROWING-ON STAGE

The growing-on stage has been carried out by the Fisheries Service in two plankton-rich lagoons around high islands: at Papeari in Tatutu lagoon (3.5 ha, mean depth 0.4 m) on the island of Tahiti; and at Utoroto lagoon (21 ha, mean depth 1 m) on Raiatea in the Leeward Islands of the Society Group. At both these sites the physico-chemical and biological parameters have been carefully recorded.

Different attachment substrates have been tested: bamboo, various woods, plastic mesh bags, polyethylene rope, branches of the coral Acropora covered in a rubber solution, and reinforcing rod. Despite being immersed in sea water for two or three weeks a certain toxicity appears to come from the local bamboo, although this is the material generally used in the Philippines. The plastic bag technique is too laborious to be used; on the one hand three different sizes of mesh are needed, depending on the size of the mussels, and on the other hand, stocking can only be at a low density because of rapid clogging. Although they are originally wedged between the strands, mussels attach feebly to the polyethylene rope. Attachment to Acropora proved satisfactory but this technique was abandoned because of the great amount of hand labour involved during the stripping process. During all these trials it appeared that the young mussels had a tendency to migrate onto the reinforcing rod supports used to brace the site. It was finally this material which was used.

It was still necessary to achieve attachment without major losses. Spat is mobile and moves around more easily when it is small; after three months the tendency to move around ceases. The trials were carried out with spat less than 10 mm. It was thus necessary to use an envelope of a type which would keep the young mussels close to the supports long enough for them to become permanently attached, and at the same time one which would degrade in the course of time so as not to hinder the mussels' development. Several types of paper and nylon mesh were tested; the former were too fragile, the latter too resistant.

It was finally tube gauze for bandages of hydrophilic cotton, 10 cm wide (tube around 3 cm diameter), which was used (Fig.2). The gauze is sufficiently porous to allow the penetration of water, therefore food, and it degrades in about 10 days. Using this method attachment was achieved almost without loss (Fig.3).

At the present time attachment of young mussels is simplified as follows: the spat is placed in large trays, covered with a metal gauze with a fine mesh (1.5 mm). After they have been acclimatised for 8-15 days constantly immersed, reinforcing rod is put into the trays so that the mussels can attach themselves naturally. The technique of attachment using cotton gauze is used for the ones which do not grow well.

Finally, it is necessary to protect the cultures against their principal predator, the crab Scylla serrata. To do this the reinforcing rods (length 1.2 m) were placed through the meshes of the netting of a protective cage (Fig.4). Each rod carries 200-300 mussels, making a total of 10,000-15,000 per cage of $1m^3$ (2.0 x 1.0 x 0.5) containing 50 rods. This method is suitable for small-scale trials but is too laborious for large operations. In the future it appears that a simpler solution will be to enclose the whole pen with a wire lattice. This will also make it easier to clean the meshes, as it is more convenient to scrub large flat surfaces than cumbersome cages, which are difficult to remove.

Fig.2: Mussel spat being placed in tubes of cotton gauze around reinforcing rod. (Photo D. de Gaillande)

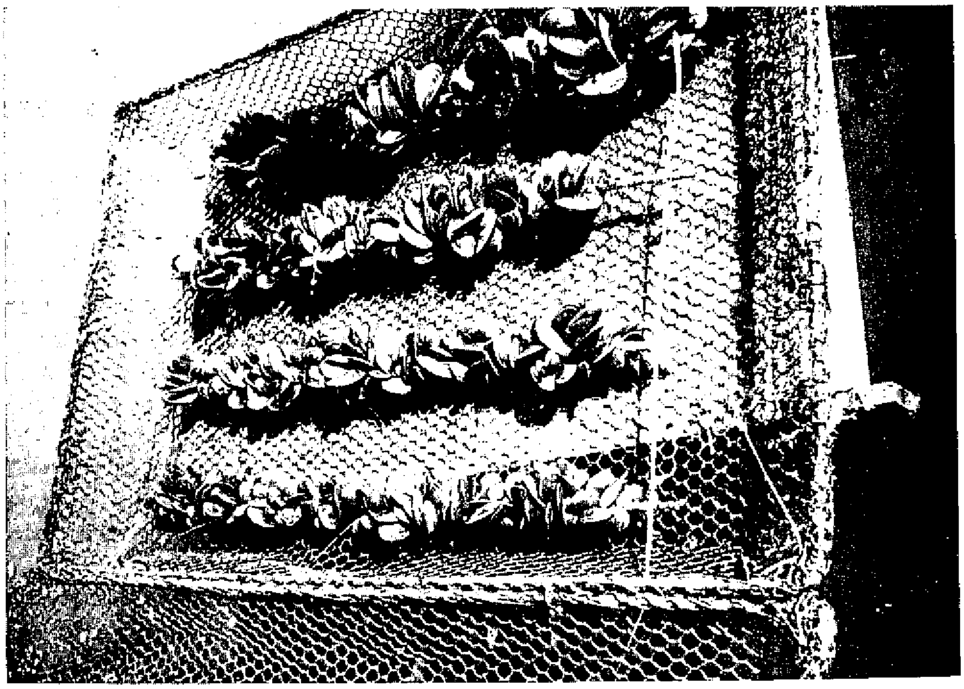

Fig.3: Young mussels attached to reinforcing rod supports. (Photo D. de Gaillande)

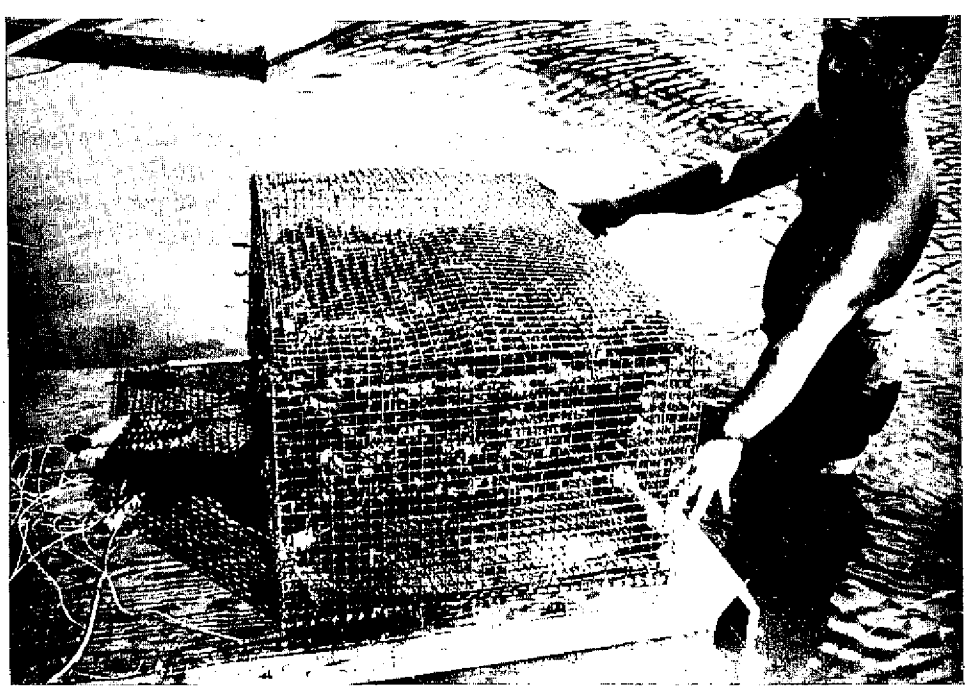

Fig.4: Protective cages used for growing-on stage of green mussel culture. (Photo D. de Gaillande)

During some of the trials certain adverse meteorological conditions (extreme heat, strong rain) enabled limiting parameter values fatal to the mussels to be determined: water temperature 35°C (optimum 27°C); salinity 10‰ (optimum 30‰).

It should be noted that these trials were carried out in permanent immersion. This method has the advantage that the mussels can feed 24 hours out of 24, and thus can grow more rapidly. Growth will obviously be a function of phytoplankton density. A concentration of 10^4 cells/ml appears to be a suitable average value which will give rapid growth, provided that the nutritive value of the phytoplankton is adequate. One can expect a certain growth of epibiota on the shells, but a single washing with a jet of water at harvesting has proved sufficient to remove this.

In the early batches, growth was shown to be very rapid, a weight of 15-20 g and lengths of 65-70 mm being attained in 6-8 months. Under average conditions it appears that harvest at a commercial size of 25-30 g can be almost complete after one year of culture.

The lagoons of high islands appear favourable for mussel farming because they are rich in nutrient salts derived from run-off and rivers, and thus also rich in phytoplankton. However, their shallow depth can cause difficulties during periods of heavy rain or high temperatures.

DISCUSSION AND CONCLUSIONS

With its present facilities CNEXO can produce several million young mussels for culture per month. Assuming 10 months of production a year, a commercial hatchery of the size of CNEXO's would be able to provide 20-30 million mussels per year to producers. This amount is in fact two or three times the actual market in French Polynesia, which would be of the order of 100 t per year.

It appears that in suitably chosen sites the culture of the green mussel in French Polynesia is perfectly practicable. Small investment and reduced labour requirements must be factors favourable to the development of this activity, whose profitability will be substantiated in 1980. Carried out as a small operation, at the family or partnership level, and complementing traditional fishing and farming activities, the culture of the Philippines green mussel could be of particular interest to the people of the Leeward Islands. Favourable sites are currently being recorded.

Several aspects of mussel culture still remain to be precisely determined. In addition, this operation is new, beginning only in 1978. It is essential to keep in mind the numerous disappointments encountered during the fruitless attempts to acclimatise the Japanese oyster in the tropics. Moreover, it is still difficult to predict what the response will be in the local market or possible export market, to this product new to the region.

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FISHING SHOWS PROMISE AT YAP

James Crossland

Paul Mead, experienced master fisherman, recently completed a highly successful stay in Yap with the SPC Deep Sea Fisheries Development Project. From 38 trips, usually only of a few hours duration and fishing under difficult conditions, he and his team of Yapese fishermen landed a creditable 1,605 kg of trolled fish, 888 kg of bottom fish and 174 kg of flying fish.

Yap Island in the Western Carolines lies at 9°30'N 138°10'E and is the administrative centre for the district of the same name. The island, roughly triangular in shape, is 22 km long and 9 km at its widest point and is fringed by a reef extending 1-2 km offshore. Several passages through the reef lead to sheltered inlets, the most important of which is Tomil Harbour, site of the main settlement, Colonia.

Fishing in Yap has traditionally concentrated on the reef and the sheltered harbour waters, using gill nets for rudderfish, emperors and rabbitfish. A few fishermen venture outside in outboard powered dinghies to troll for pelagic fish, or to spearfish for the schools of humpheaded parrotfish. In the past the Yapese used large arrow-shaped fish traps built of stones to impound fish on the falling tide. These traps, now mostly in disrepair, are a conspicuous feature on the reef as one comes in to land at Yap airfield. Despite the Yapese interest in fishing there is often a shortage of fish on the island, particularly at the times when the trade winds blow strongly. The aim of the Deep Sea Fisheries Development Project was to introduce new methods and encourage the exploitation of the resources outside the reef.

Fisheries activity is administered by the Marine Resources Division. Closely allied to Marine Resources and working from the same building on the waterfront is the Yap District Fishing Authority, which is perhaps best described as being the commercial arm of the Government fisheries service. The Fishing Authority with its staff of fleet manager, fishermen, diesel mechanic and refrigeration engineer, operates two boats used for commercial fishing, runs a fishmarket, and provides ice to fishermen.

The boat initially used by the project was a 7 m planing hull motor launch belonging to the Fishing Authority. Wide in the beam and powered by a 56 hp Volvo Penta sterndrive unit, it proved a roomy and stable platform for fishing, but after making 21 fishing trips it had to be slipped for repairs. The Fishing Authority's second vessel, an 8 m fibreglass whaleboat, was then overhauled and extensively modified. Originally built for the US Navy in 1940, it is virtually unsinkable and its 22 hp Yanmar diesel uses only half a gallon[1] of fuel per hour for a top speed of seven knots, and half that at trolling speed. Fitted with two hand reels, trolling outriggers on both sides, spotlights for night fishing, and with space for two ice boxes forward, it proved a versatile fishing unit, although a trifle wet in head seas.

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1. 1 U.S. gallon = 4.4 1

The best catch rate so far obtained by any of SPC's bottom fishing programmes was achieved in Yap. Fishing the outer reef slopes down to 300 m depths, using wooden handreels fitted with monofilament nylon, wire terminal rigs and tuna circle hooks, the project achieved a catch rate of 7.3 kg per reel per hour fishing. The catch comprised 20 different species. Also caught were about 60 sharks (not included in the catch figures because they were unsaleable), the largest a 3 m tiger shark.

Although demonstrating deep-bottom fishing techniques was the basic aim of the project, and although it proved successful, for much of the stay conditions were unfavourable for this method. For best results deep-bottom fishing requires the boat to be anchored, which cannot be done if the wind is too strong or from the wrong quarter. Also a problem in Yap are the strong tides and currents which flow along the island following the edge of the reef. At times they not only make it impossible to position a boat in the desired fishing spot, but threaten to carry it into the breakers.

During the times when it was possible to go out but not to bottom fish, and at all times in transit, trolling was carried out. The most successful technique was trolling at 3-4 knots with several hundred metres of line out and a flying fish for bait. This method gets the line well below the surface and gives a better chance of catching the deeper-swimming pelagic fishes. Eight species were caught by trolling, of which yellowfin and large dogtooth tuna (averaging just under 13 kg each) were the most important.

A third fishing method successfully tried was night fishing with lights and hand nets for the flying fish which abound around Yap. The whaleboat, with its low freeboard and open deck forward, was ideal for this. With two men netting, an average catch of 7.8 kg per hour was achieved; with improved gear and more experience an even better catch rate would be possible. Some of the catch was kept for bait, the rest was sold at the fishmarket; usually all of it was gone within half an hour of being landed, such was the demand for this prized fish, and also for the needlefishes which made up an important by-catch.

As well as investigating the fish resources around Yap Island itself, Paul Mead flew to Ulithi Atoll, some 80 miles to the north-east, to demonstrate the use of the handreels. In the short time available the local fishermen quickly adapted themselves to this method. Fishing was extremely good and from four trips 369 kg, mostly of bottom fish, was landed. Sixty-seven miles south of Yap lies another atoll, Ngulu. Two trips were made to Ngulu in the whaleboat, trolling there and back and bottom fishing at the island. The first round trip lasted 36 hours, used 16 gallons of diesel and produced 274 kg of fish; the second took 42 hours and 18 gallons of fuel for a catch of 326 kg.

The Yapese have a tradition of seafaring dating back many years to the days when their empire extended hundreds of miles to the east, and canoes set out regularly on the 250 mile journey to bring back stone money from the limestone caves of Palau. Several of the 15 fishermen trained during the project's stay showed that this tradition and the necessary skills have not been lost. The fish are there, the fishermen can catch them, the boats can be built[1] - fishing at Yap could well make an important contribution to the local economy in the next few years.

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1. Manno Buchoitil and Filig Tagal, the Fishing Authority's two boatbuilders, built an FAO design 8.6 m Alia catamaran in three weeks during the project's stay.

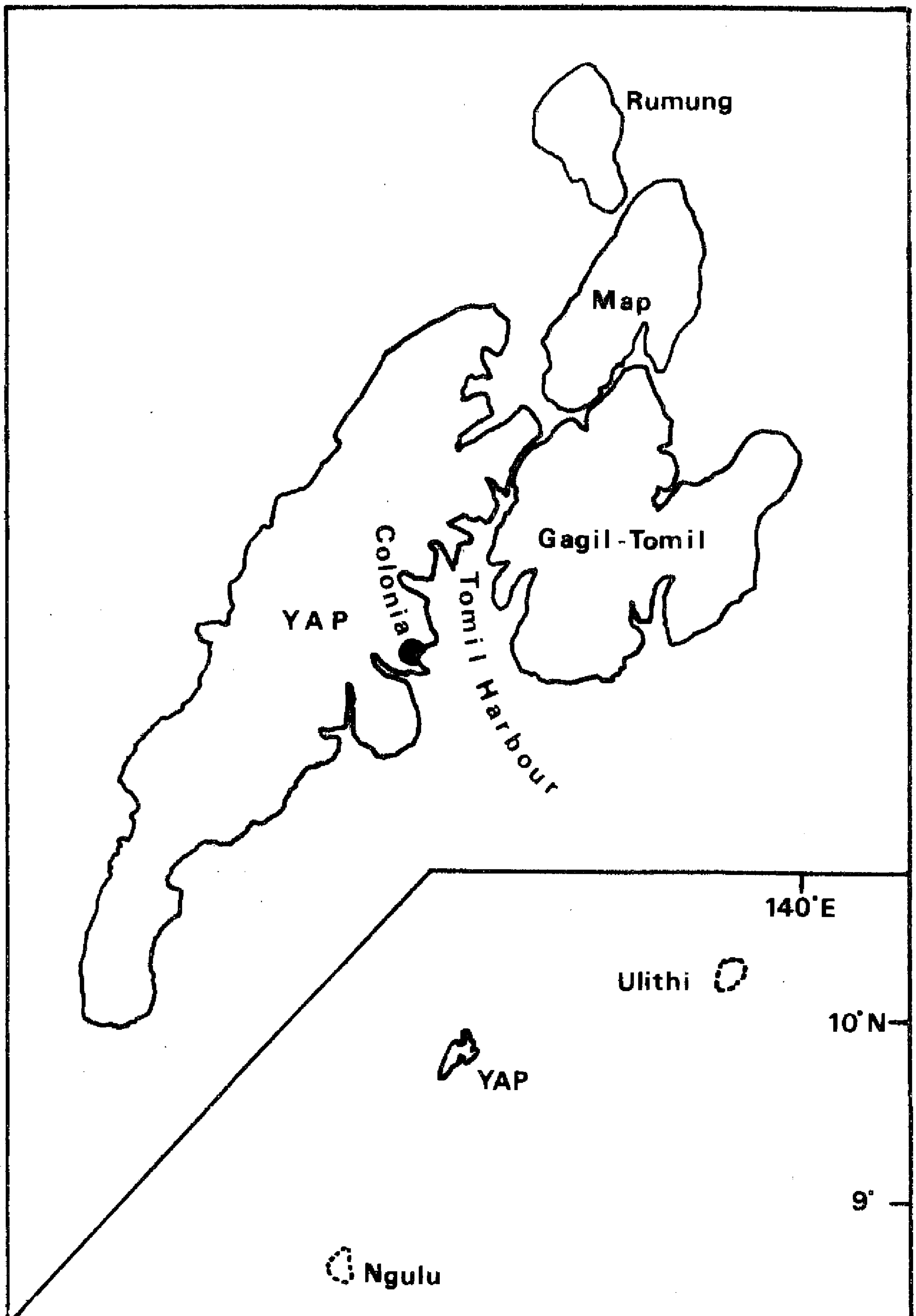
Rumung
Map
Gagil-Tomil
Colonia
Tomil Harbour
YAP
140°E
Ulithi
10°N
YAP
9°
Ngulu

Fig.1: Yap

BECHE-DE-MER IN NEW CALEDONIA: WEIGHT LOSS AND SHRINKAGE DURING PROCESSING IN THREE SPECIES OF HOLOTHURIANS

Chantal Conand
Centre ORSTOM B.P. A5
Noumea, New Caledonia

INTRODUCTION

The fishery for sea cucumbers for processing into bêche-de-mer (trepang) was a profitable activity in several islands of the tropical Pacific during the last century and early in the present one. It is now experiencing a revival.

In New Caledonia, where the reef and lagoon area occupies roughly 19,000 km^2, this fishery could contribute to a diversification in the revenue sources of the coastal population. Training courses have been organised by the Territorial Development Service to teach fishermen the treatment processes employed in Fiji. Sampling carried out during these courses and during processing trials by an exporter enabled the lengths and weights of the three most commercially valuable species to be recorded. The reduction in these parameters was calculated for the principal processing stages (boiling, smoking and drying).

While awaiting processing the sea cucumbers were kept in containers of sea water. Shrunken or eviscerated specimens were excluded from the sampling. Lengths were measured dorsally from mouth to anus using a flexible ruler.

RESULTS

1. Microthele nobilis (teatfish or mammy fish)

(a) The white teatfish

This is a large variety, characterised by pairs of large lateral papillae of which there are usually six. Colour can vary from brown to creamy white, variably speckled. The body wall may be up to 2 cm thick. In New Caledonia it occurs near reef passes in depths below 5 m.

(b) The black teatfish

This variety is dark coloured and has less well developed papillae and anal teeth than the white variety. It occurs in shallower water amongst beds of turtle grass and on the coral sand of the reef slopes. Its body wall may be up to 2 cm thick.

Measurements given in Tables 1 and 2 show that the white variety is larger (mean length 52 cm, mean weight 4.2 kg) than the black (37 cm, 1.7 kg). However, the latter variety is more abundant in New Caledonia and is easier to collect.

Table 1. Changes in length and weight during processing of the white teatfish (sample size = 13)

	Initial state	Boiling (1 hour)	Smoking (48 hours)	Drying (168 hours)
Length (cm)				
Minimum	39	27	20	20
Maximum	64	39	30	29
Mean	52	33	24	23
% of initial length	-	63	46	44
Weight (g)				
Minimum	1750	950	240	230
Maximum	6100	1780	630	470
Mean	4220	1230	340	320
% of initial weight	-	29	8	8

Table 2. Changes in length and weight during processing of the black teatfish (sample size = 70)

	Initial state	Smoking (48 hours)	Drying (192 hours)	Drying (248 hours)
Length (cm)				
Minimum	25	14	13	12
Maximum	59	30	24	24
Mean	37	20	19	19
% of initial length	-	54	51	51
Weight (g)				
Minimum	800	50	50	45
Maximum	3750	650	340	320
Mean	1730	223	170	150
% of initial weight	-	13	10	9

2. Thelenota ananas (prickly fish)

This species is recognisable by its reddish colour and large papillae grouped in twos or threes on the dorsal surface. Its body wall may be up to 2 cm thick. It can be collected on the reef slopes down to a depth of about 15 m.

Table 3. Changes in length and weight during processing of the prickly fish (sample size = 13).

	Initial state	Smoking (48 hours)	Drying (192 hours)	Drying (240 hours)
Length (cm)				
Minimum	47	20	15	15
Maximum	78	36	33	33
Mean	58	24	22	22
% of initial length	-	41	38	38
Weight (g)				
Minimum	2400	150	85	85
Maximum	9500	750	480	460
Mean	4000	290	186	184
% of initial length	-	7	5	5

3. Actinopyga echinites (deep water redfish)

This is a brown coloured species with numerous papillae; its dorsal surface is usually covered with a film of sand. It is found in great abundance on the reef flats where its ease of collection makes it suitable for exploitation despite its smaller size and thinner body wall (1 cm) than the preceding species. It survives well out of water.

Table 4. Changes in length and weight during processing of the deep water redfish (sample size = 40).

	Initial state	Smoking (48 hours)	Drying (160 hours)
Length (cm)			
Minimum	14	-	7
Maximum	29	-	11
Mean	19	-	9
% of initial length	-	-	47
Weight (g)			
Minimum	160	-	15
Maximum	725	-	65
Mean	330	-	37
% of initial weight	-	-	11

DISCUSSION

Tables 1-4 show clearly that there is a considerable reduction in length and weight of sea cucumbers during processing. The length of the dried product is important in determining the price realised for bêche-de-mer. After a preliminary sorting by species, bêche-de-mer are graded by length, colour and smell. The biggest specimens obtain the highest price. The length of the dried product is equal to approximately half the initial length for M. nobilis and A. echinites and slightly less for T. ananas.

It is interesting to compare these results with those from studies in other parts of the Pacific. Table 5 shows that dry weight compared to initial weight varies in the different studies. Weight loss in the teat-fish was only 58.6 per cent according to Parrish (1978), 75-89 per cent according to Howell and Henry (1977) and around 90 per cent for the other authors. These differences may derive from the sampling methods - sample sizes and size frequencies being different. Another possible reason is the variable length of the drying period (2-4 days). In New Caledonia prolonged drying enables a very dry and thus a good product to be obtained.

Table 5. Lengths (L) and weights (W) of dried bêche-de-mer as a percentage of the live animal from different studies in the Pacific (n = sample size)

	Microthele nobilis			Thelenota ananas		
	n	L	W	n	L	W
Crean (1977) Solomon Islands	5	51.8	6.8	-	-	-
Howell and Henry (1977) Trust Territory of the Pacific Islands	10	-	11-25	1	-	11
Parrish (1978) Queensland, Australia	8	-	41-4	64	-	8.2
Conand (1979) New Caledonia	white phase 13	44	8	18	38	5
	black phase 70	51	9			

SUMMARY

This study on sea cucumbers in New Caledonia has provided data on the average sizes of four varieties of economic importance and on the reduction in their length and weight during processing. In general 12 kg of live sea cucumbers are needed to produce 1 kg of bêche-de-mer. The length of the finished product represents approximately half that of the living animal.

REFERENCES

Crean, K. 1977 : The bêche-de-mer industry in Ongtong Java, Solomon Islands. The South Pacific Commission Fisheries Newsletter 15 : 36-48.

Howell, R. and Henry, M. 1977 : Dried sea cucumber processing. Report Marine Resources and Development, Truk District, Trust Territory of the Pacific Islands.

Parrish, P. 1978 : Processing guidelines for bêche-de-mer. Australian Fisheries 10 (17) : 26-27.

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SOUTH PACIFIC COMMISSION PROJECT ON FISH POISONING

A. THE CHAIN OF EVENTS IN CIGUATERA FISH POISONING

T. Kuberski
Epidemiologist, South Pacific Commission

What causes ciguatera fish poisoning? Scientific evidence gathered in the past few years suggests that a dinoflagellate, *Gambierdiscus toxicus*, may be the primary source. This microscopic organism, which lives around coral and is frequently found associated with bottom-fixed algae, is ingested with the food of many small and intermediate sized fish which feed on the sea bottom and off coral reefs. Familiar examples of these fish consumed by man are parrotfishes and surgeonfishes.

The dinoflagellate toxin (ciguatoxin) becomes incorporated into the flesh of these fish, making them dangerous for human consumption. However, small fish generally contain comparatively low amounts of toxin and as a general rule poisoning is less likely to occur with small fish than large predatory ones such as groupers, snappers, jacks, barracudas, emperors and moray eels. These species prey on the small bottom-feeding fish and become contaminated with ciguatoxin. Large fish contain larger amounts of toxin, because they concentrate the toxin acquired from numerous smaller fish. In this way the toxin produced by the dinoflagellate gradually moves up the food chain, eventually reaching a concentration in certain fish which makes them toxic to man (Fig.1). Ciguatoxin can be found in both the flesh and the entrails of fish and cannot be removed by salting, washing or cooking. Not every fish of a certain species will be toxic. Toxicity is dependent on the distribution in nature of relatively large quantities of the toxin-producing dinoflagellate and the kinds of fish through which it enters the food chain.

It is difficult to assess the size of the fish poisoning problem in the South Pacific accurately because many cases are never recorded. However, several thousand cases of fish poisoning in Pacific Islanders do get reported to the South Pacific Commission every year and the indications are that ciguatera is increasing. This may be related to changes in the environment which are conducive to the growth of the micro-organisms producing ciguatoxin. These organisms appear to increase rapidly in areas of the sea that experience sudden, drastic changes, either natural or man-made. Such things as an unusually heavy rainfall, the building of a new wharf or a channel through a reef, wrecks, or dredging in areas where these micro-organisms exist only in small quantities will frequently be followed by a great upsurge in their numbers. This eventually results in an increase in the number of toxic fish. Following the appearance of toxic fish, recognized human fish poisoning may not be evident for months to years after the increase in the toxin-producing dinoflagellates. The complicated manner in which the different varieties of fish become toxic has made recognition of the association between human fish poisoning and this small organism very difficult. Further studies are needed before all the facets of ciguatera fish poisoning can be understood.

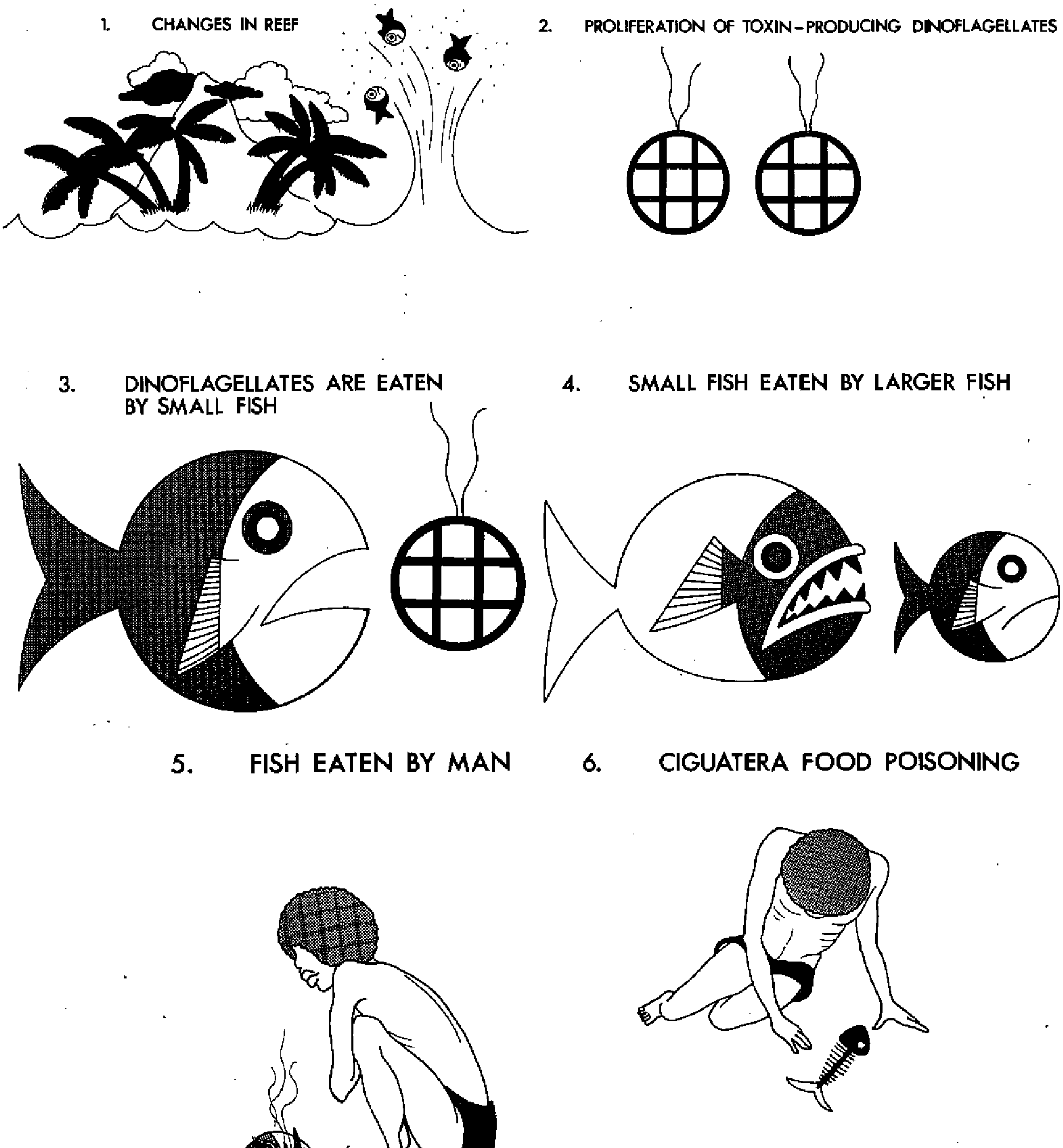

Fig.1: The chain of events in ciguatera fish poisoning

B. CLINICAL OBSERVATIONS ON 3009 CASES OF CIGUATERA FISH POISONING

R. Bagnis[1], T. Kuberski and S. Laugier[2]

Clinical observations on ciguatera fish poisoning were collected in 1964-1977 on 3009 patients from several South Pacific Island groups. Patients generally presented with neurologic symptoms such as numbness and tingling of the hands, cold things feeling hot to touch, dizziness and difficulty with balance. In addition, they commonly had gastrointestinal symptoms such as diarrhoea, abdominal pain, nausea and vomiting. Patients with this illness usually developed symptoms less than 24 hours after the ingestion of fish and most patients (76.8%) developed symptoms in less than 12 hours. Significant differences in certain symptoms were noted between Melanesian and Polynesian ethnic groups, suggesting a susceptibility difference or a difference in the nature of the toxin found in different areas of the Pacific. Being poisoned multiple times by ciguatera appeared to result in a clinically more severe illness than disease observed in patients experiencing ciguatera for the first time.

Table 1. Distribution of 3009 cases of ciguatera fish poisoning by age and sex; percentages shown in brackets.

Age-group (years)	Male	Female	Totals
not recorded	107 (6.0)	59 (4.8)	166 (5.5)
0 - 9	77 (4.3)	68 (5.6)	145 (4.8)
10 - 19	131 (7.3)	140(11.4)	271 (9.0)
20 - 29	398(22.3)	297(24.3)	695(23.1)
30 - 39	478(26.8)	311(25.4)	789(26.2)
40 - 49	338(18.9)	178(14.5)	516(17.1)
50 - 59	172 (9.6)	111 (9.1)	283 (9.4)
60 - 69	72 (4.0)	49 (4.0)	121 (4.0)
≥70	12 (0.7)	11 (0.9)	23 (0.8)
	1,785(59.3)	1,224(40.7)	3,009

Table 2. Period of time between ingestion of fish and the development of signs and symptoms in 3009 cases of ciguatera fish poisoning.

Period of incubation (hours)	Number of patients	Percentage of patients
<12	2,222	76.8
12-24	552	19.1
>24	118	4.1
Not recorded	117	

1. Louis Malardé Medical Research Institute, Papeete, Tahiti

2. SPC.

Table 3. Frequency of certain signs and symptoms in 3009 cases of ciguatera fish poisoning.

Sign or symptom	Percentage of patients with findings
Numbness and tingling of hands	89.2
Numbness around the mouth	89.1
Burning or pain to skin on contact with cold water	87.6
Joint pains	85.7
Muscle pains	81.5
Diarrhoea	70.6
Weakness	60.0
Headache	59.2
Chills	59.0
Abdominal pain	46.5
Itchy skin	44.9
Nausea	42.9
Dizziness	42.3
Difficulty walking	37.7
Vomiting	37.5
Sweating	36.7
Shaking	26.8
Dental pain	24.8
Neck stiffness	24.2
Watery eyes	22.4
Skin rash	20.5
Pain on urination	18.7
Salivation	18.7
Shortness of breath	16.1
Low blood pressure	12.2
Inability to move arms or legs	10.5

Table 4. Days in bed for patients with ciguatera fish poisoning. Out of 3009 cases, 1013 (33.7%) were bedridden.

Days in bed	Number of patients	Percentage of patients
1	161	27.2
2	218	36.9
3	91	15.4
4	40	6.8
5	30	5.1
6	13	2.2
7	6	1.0
⩾ 8	32	5.4
Not recorded	422	

Table 5. Blood pressure and pulse measurements in 3009 patients with ciguatera fish poisoning.

A. Systolic blood pressure (mmHg)	Number of patients	Percentage of patients
Unobtainable	5	0.2
< 80	41	1.7
80 - 100	311	12.9
> 100	2,048	85.2
Not recorded	604	

B. Pulse (per minute)	Number of patients	Percentage of patients
Unobtainable	6	0.2
< 60	324	13.4
60 - 85	1,833	75.6
> 85	263	10.8
Not recorded	583	

C. PROGRESS IN RESEARCH ON FISH POISONING

J. Laigret
Louis Malardé Medical Research Institute
Papeete, Tahiti
French Polynesia

Since the last meeting of the South Pacific Commission Ad Hoc Advisory Group on fish poisoning the two major aims of research at the Louis Malardé Institute have been to monitor and control ciguatera outbreaks more effectively, and to develop a method (or apply methods developed elsewhere) for the direct assay for ciguatoxin in fish. The main results of this work are summarized hereunder.

RESULTS

In regard to the biological origin of ciguatera, the dinoflagellate discovered in the Gambier Islands has been confirmed, both ecologically and biochemically, as a causal agent. It was initially classified under the genus Diplopsalis but has proved to be of an entirely new genus. It was finally named Gambierdiscus toxicus (Adachi and Fukuyo, 1979). Data recently collected by Bagnis (in press) in the West Indies suggest that the causal agent of ciguatera is probably the same in all areas where it occurs. The environmental factors which cause these marine organisms to multiply abundantly from time to time are beginning to be understood. There is evidence, for example, that an increase in the dissolved phosphate content of the sea is one factor that contributes to the increase of dinoflagellates.

Gambierdiscus toxicus is now being successfully grown in the laboratory, but only one part, maitotoxin (MTX), of the two major components of the toxin complex involved has been obtained in relatively large quantities. We have been able to demonstrate that this water-soluble substance can be secreted by other benthic dinoflagellates, particularly those belonging to the genera Amphidinium and Prorocentrum, which coexist with G. toxicus in the natural environment. These two dinoflagellates can also be grown in the laboratory. However, production of the more important pathogenic substance, ciguatoxin (CTX), which is not water soluble, has been very difficult. Only G. toxicus can produce it in the laboratory and only in very small amounts and under certain conditions. The culture should contain bacteria but no other species of dinoflagellate. The presence of bacteria in the culture medium has been found to facilitate the production of both CTX and MTX, suggesting that G. toxicus requires organic substances of bacterial origin for optimum growth.

A study of the respiratory and cardiac effects of CTX and MTX on rats and cats administered toxin experimentally has confirmed hyperactivity of the cholinergic (parasympathetic nervous) system in these animals.

We have used the radio-immunoassay technique developed by Hokama et al. (1977) from the University of Hawaii to test for ciguatoxin in fish tissue. We used this test on fish which had been clearly demonstrated as either safe to eat or toxic for man but were not able to confirm its accuracy. According to the Hokama test, 85 to 90 per cent of all fish would be rejected as unsafe. In order to understand the reasons for these discrepancies, we undertook a study of certain factors capable of interfering with immunological reactions. Our results showed that some of the antisera assumed by Hokama et al. to contain ciguatoxin antibodies actually had no specificity, thus no true antigen/antibody reaction against ciguatera was demonstrated. This has constituted a major obstacle to the development of a practical test for application in the near future.

DISCUSSION

Thanks to impetus given by the SPC, research work conducted in co-operation by French, United States and Japanese laboratories in the Pacific, has achieved very real progress in the last few years. Discovery of the causal agent of ciguatera was a major result of this co-operation. Though the radio-immunoassay test proved disappointing, research undertaken to determine the reasons for the failure has brought to light unknown ciguatoxin properties which are likely to be of practical use in the future. The pre-requisite for any immunochemical approach to the development of a test suitable for testing of fish for human consumption is a good understanding of the chemical structure of ciguatoxin. This will require a comparatively large quantity (several mg) of CTX in its purest form. Future work must therefore include a study of the mechanisms of large-scale production of the substance in nature and in the laboratory, and production of large quantities of toxic fish extracts. We have already begun this work in collaboration with Professor Yasumoto of Japan and plan to continue it under SPC auspices.

REFERENCES

Adachi, R. and Fukuyo, Y. 1979: Bulletin of the Japanese Society of Scientific Fisheries 45(1): 67-71.

Bagnis, R. (in press): Caraibe Medical.

Hokama, Y., Banner, A.H. and Boylan, D.B. 1977: Toxicon 15:317-325.

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THE NELSON POLYTECHNIC FISHING CADET COURSE FOR PACIFIC ISLANDERS, 1979.[1]

James Crossland

Fisheries hold the key to economic advancement for many countries in the Pacific, but their proper development requires trained manpower at all levels. As part of its marine resources programme SPC is actively engaged in training fishermen. This is done both through its own projects, such as the Deep Sea Fisheries Development Project, and by providing funds and arranging training with other organisations. In June 1979 nine young Pacific Islanders sponsored by SPC successfully completed an 18-week fishing cadet course at Nelson Polytechnic, New Zealand.

The Pacific trainees were nominated by the fisheries departments of their home islands in response to a circular letter from the SPC Fisheries Adviser.[2] Those selected were Gerald Billings from Fiji, Solomona Aleta, Iona Tinielu and Petelo Vulu from Tokelau, Lale Fehoko, Penieli Finau, Tavake Noko'akifolau and Vailele Taukitoku from Tonga, and Fatulolo Vave from Tuvalu. Funding for the course, provided by the New Zealand Government and the Commonwealth Foundation, covered all travel, accommodation, subsistence, clothing and equipment expenses and also a pocket money allowance.

With its course for fishing cadets Nelson Polytechnic has established itself as New Zealand's leading training institute for fishermen. The course was originally designed for young New Zealanders with some previous fishing experience. It combines lectures and practical work at the Polytechnic with periods of sea time on a variety of fishing boats. The basic plan of the course was not changed for the Pacific trainees but was adapted where possible to make it more relevant to fishing in the tropics. For example, sea time concentrated on experience with boats using lines and set nets rather than trawlers, and in the engineering section outboard motor operation and maintenance were stressed.

The trainees arrived in Nelson during the first week of February and were taken in charge by Captain Paul Rendle, the Polytechnic's Nautical Tutor and director of the course, and Captain Alastair Robertson, Fishing Technology Tutor. After being shown around the Polytechnic and being issued with protective clothing and sleeping bags the trainees travelled to Greymouth for their first period of sea time. Greymouth lies on the west coast of the South Island and is the centre for a small fleet of tuna vessels. With the assistance of Mr Gary Burke of Talleys Fisheries, berths were found for all trainees on local boats. Despite some rough weather all gained useful experience in the trolling techniques used for catching albacore. The trainees would have preferred to spend the initial period of the course at the Polytechnic but if this had been done they would have missed the tuna season which is usually over by the end of February.

After a month on the boats the trainees returned to Nelson for a period of lectures and practical work. During this time they attended Polytechnic daily from 8.30 a.m. to 4.30 p.m. Subjects studied were practical netting and seamanship, welding, navigation and chartwork, safety at sea, engineering (outboards and diesels), first aid, electronic aids (echo sounders, radar, etc.) and marine science. All the trainees

1. This article is an expanded version of one written for the South Pacific Bulletin (4th quarter 1979) under the title "SPC sponsors fishing trainees".

2. Sent to all British Commonwealth countries in the region.

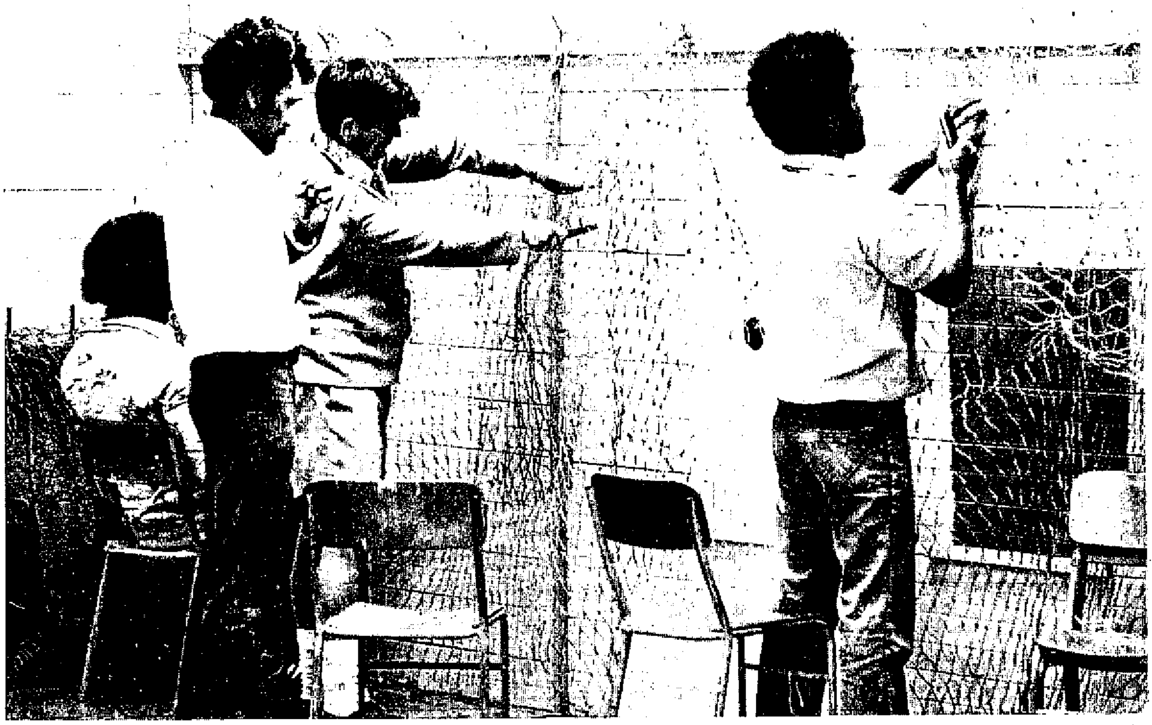

Fig.1: Captain Alastair Robertson instructs Vailele Taukitoku, Iona Tinielu and Solomona Aleta in practical net repairs. (Photo: Nelson Polytechnic)

worked well and enjoyed this part of the course. Chartwork was a favourite subject, particularly as Captain Rendle had procured charts of the trainees' own islands for their practice exercises. As well as studying hard they integrated well into social activities, making good use of their guitars and the volley ball courts.

During April a second period of sea time was completed. Trainees were divided into two groups. One group was based at Motueka, a small town not far from Nelson, where they worked on fishing vessels carrying out long-lining, set netting and other small-scale fishing methods. The other group assisted on a mussel farm in Pelorus Sound, also close to Nelson. Easter recess coming in the middle of this period provided a suitable time for the two groups to change over. Thanks to the co-operation of fishermen at Motueka and the staff of Talleys Fisheries, this practical training was very successful. The enthusiastic support of Mr Henry Buchanan and Mr Alister Lash, joint managers of the mussel farm, ensured the success of that part of the venture.

Gerald Billings spent the period before Easter following a useful programme of visits and experience kindly arranged by Mr Val Hinds, former SPC fisheries officer, and now Assistant Director with New Zealand's Fisheries Management Division. This included a spell at the National Fisheries Control Centre, where foreign fishing in New Zealand's 200-mile zone is monitored. After Easter Gerald joined the research vessel James Cook for a two-week voyage.

After this second period of sea time the trainees spent two weeks as observers in processing factories at Motueka and Nelson. They were involved in a full range of experiences in the factory situation, with emphasis on quality control.

The trainees returned to the Polytechnic on 14 May for the final four weeks of the course. This period enabled the planned syllabus to be completed, and during the last week the trainees each produced a written report on the course. All nine were successful in obtaining a Polytechnic Course Completion Certificate, a First Aid Certificate and a Restricted Radio Operators Licence. The course concluded with a social evening on 7 June and an award ceremony the next day.

Was the course a success? The trainees thought so - "very worthwhile", "great value", "very good and helpful", "I am looking forward to another similar course" - were some of their comments. Mr George Pringle, principal of Nelson Polytechnic, was also very pleased with the way it went: "Regarding the course, generally it was highly successful and apart from some initial homesickness, they were a very happy group". Our own assessment at SPC is that the whole exercise has been well worthwhile and with the co-operation of Nelson Polytechnic it is intended to offer a similar course in 1980. Preparations for this are already in hand and a letter inviting nominations was sent to fisheries officers of Commonwealth countries on 14 August 1979. The course is not restricted to government fisheries staff; private fishermen are also welcome. However, any application should come through the local fisheries officers. Candidates should be 17-25 years old, have a minimum of two years secondary education (preferably to the level of the New Zealand School Certificate), and have fishing experience.

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Cahiers de l'Indo-Pacific

We have received the following information from the editor of the above journal. Since January 1979 the Cahiers du Pacifique has a new title Cahiers de l'Indo-Pacifique. This quarterly publication is devoted to general oceanology and island ecology. Each issue contains about 100 pages.

Contributions are accepted in French, English or German, with the title being given in two languages, one of which must be English. Figures and photographs are accepted on condition that they do not exceed one third the number of pages of text. Each author receives free 25 offprints of his article. Manuscripts are now being accepted.

Annual subscription (overseas)

350 French francs (approximately 6,700 French Pacific francs or US$86). Subscription enquiries should be addressed to:

Le Président de la Fondation Singer Polignac
43 Avenue Georges Mandel
75016 Paris
France.

RECENT SOUTH PACIFIC COMMISSION FISHERIES PUBLICATIONS

Bour, W. and Galenon, P. 1979: Le développement de la pêche thonière dans le Pacifique ouest.[1] Occasional Paper No.12, 35 pp.

Crossland, J. and Grandperrin, R. 1979: Fisheries directory of the South Pacific Commission region.[2] Number 1, 47 pp.

Eginton, R. and James, R.H. 1979: Report on the South Pacific Commission outer reef artisanal fisheries project in Solomon Islands, 5 April 1977-31 January 1978, 11 pp.

Fusimalohi, T. 1978: Report on the South Pacific Commission deep sea fisheries development project in Niue (3 July-31 August 1978), 7 pp.

Josse, E. et al 1979: Croissance des bonites à ventre rayé.[1] Occasional Paper No.11, 83 pp.

Kearney, R.E. 1979: Skipjack survey and assessment programme. Annual Report for the year ending 31 December 1978[3], 15 pp.

Kearney, R. and Hallier, J.P. 1978: Interim report of the activities of the skipjack survey and assessment programme in the waters of Wallis and Futuna Islands (4-31 May 1978). Preliminary Country Report No.7, 12 pp.

Kearney, R. and Hallier, J.P. 1978: Interim report of the activities of the skipjack survey and assessment programme in the waters of Western Samoa (6-14 June 1978). Preliminary Country Report No.8, 10 pp.

Kearney, R. and Hallier, J.P. 1978: Interim report of the activities of the skipjack survey and assessment programme in the waters of American Samoa (31 May-5 June, 15-21 June 1978). Preliminary Country Report No.9, 9 pp.

Kearney, R., Hallier, J.P. and Kleiber, P. 1978: Interim report of the activities of the skipjack survey and assessment programme in the waters of Tuvalu (25 June-4 July 1978). Preliminary Country Report No.10, 9 pp.

Kearney, R. and Gillett, R.D. 1978: Interim report of the activities of the skipjack survey and assessment programme in the waters of the Gilbert Islands (5-25 July 1978). Preliminary Country Report No.11, 11 pp.

Kearney, R., Gillett, R.D. and Whyman, D. 1979: Interim report of the activities of the skipjack survey and assessment programme in the waters of the Trust Territory of the Pacific Islands and Guam (26 July-15 August, 2 October-15 November 1978). Preliminary Country Report No.12, 14 pp.

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1. Also to appear in English
2. Also to appear in French
3. This publication and all the Preliminary Country Reports are also available in French.

Kearney, R. and Gillett, R.D. 1979: Interim report of the activities of the skipjack survey and assessment programme in the waters of Tokelau (19-23 November 1978). Preliminary Country Report No.13, 8 pp.

Kearney, R., Hallier, J.P. and Gillett, R.D. 1979: Interim report of the activities of the skipjack survey and assessment programme in the waters of French Polynesia (6 December 1978-3 February 1979). Preliminary Country Report No.14, 17 pp.

Kearney, R., Gillett, R.D. and Hallier, J.P. 1979: Interim report of the activities of the skipjack survey and assessment programme in the waters of the Cook Islands (24 November-5 December 1978, 4-11 February 1979). Preliminary Country Report No.15, 9 pp.

Mead, P. 1978: Report on the South Pacific Commission deep sea fisheries development project in American Samoa (28 March-2 July 1978), 13 pp.

Mead, P. 1979: Report on the South Pacific Commission deep sea fisheries development project in the Kingdom of Tonga (3 June-20 September 1978), 12 pp.

South Pacific Commission 1979: Report on ad hoc meeting of the expert committee on tropical skipjack (4-8 December 1978), 5 pp.

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