THE SOUTH PACIFIC COMMISSION FISHERIES NEWSLETTER

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COMMON BOTTOM FISHES CAUGHT BY SPC FISHING PROJECTS

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During the period 1974-78, SPC bottom fishing projects operated at many places in the South Pacific. The fishing method employed was drop-lining, using both electric reels and wooden hand reels. Considerable information has been accumulated on the distribution of the fishes caught. This article presents a brief summary of the depths (Table 1) and bottom types (Table 2) where the different species were caught. The three bottom types described here (Fig. 1) are common throughout the Pacific; there are many combinations and variations of these three.

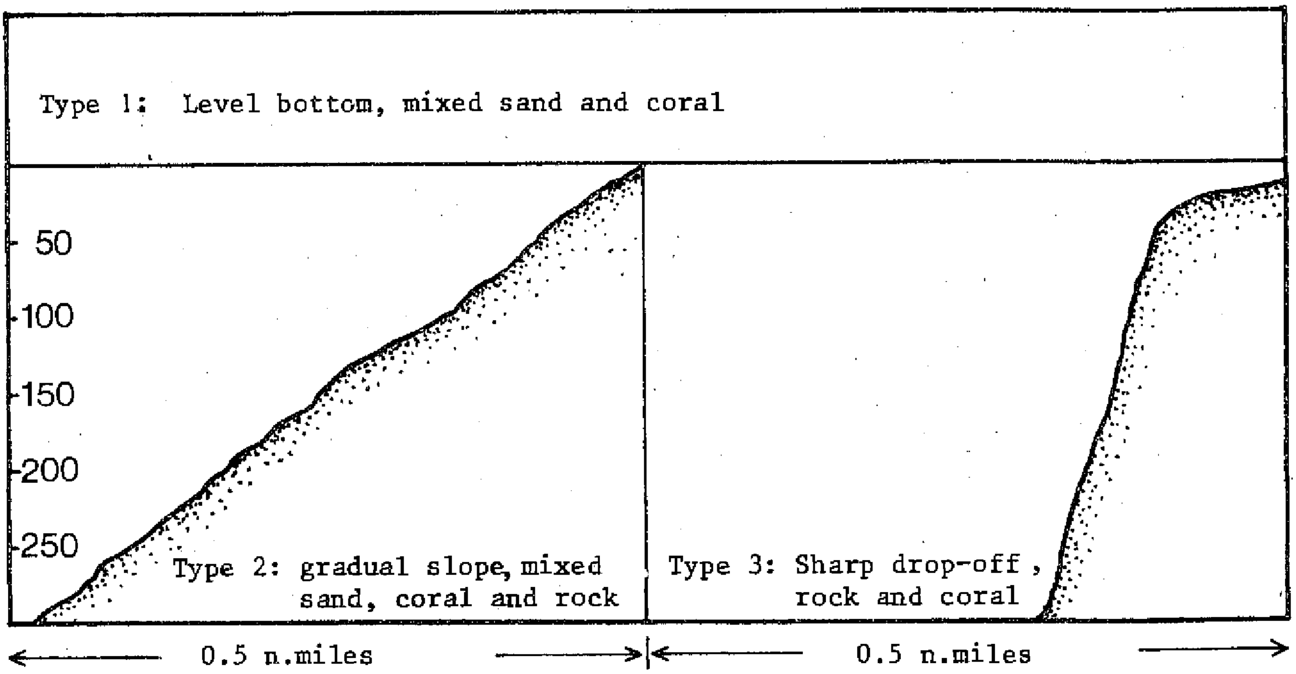


Fig. 1: Common bottom types found throughout the Pacific. The depth scale is in metres.

Except for Lutjanus sebae, the species listed here are the more common ones caught by the SPC bottom fishing projects. The depths and bottom types given for each species are those in which the species was most frequently found, but there are many exceptions. For example Pristipomoides spp. have been caught in depths from 75-295 m on all types of bottom, but are most abundant on bottom types 1 and 2, in 130-205 m.

Notes

(1) The depth information quoted in this article naturally reflects the depths fished by the projects. The depths quoted for the deeper-living species should not necessarily be regarded as the maximum depths at which they occur.

(2) The families of fishes shown here follow Nelson, J.S. (1976): Fishes of the World, John Wiley and Son, New York, 416 pp.

In general, greater numbers of smaller fish are found in the upper part of a species depth range and fewer, larger fish are found in the lower part of the range. The best fishing is usually somewhere in between.

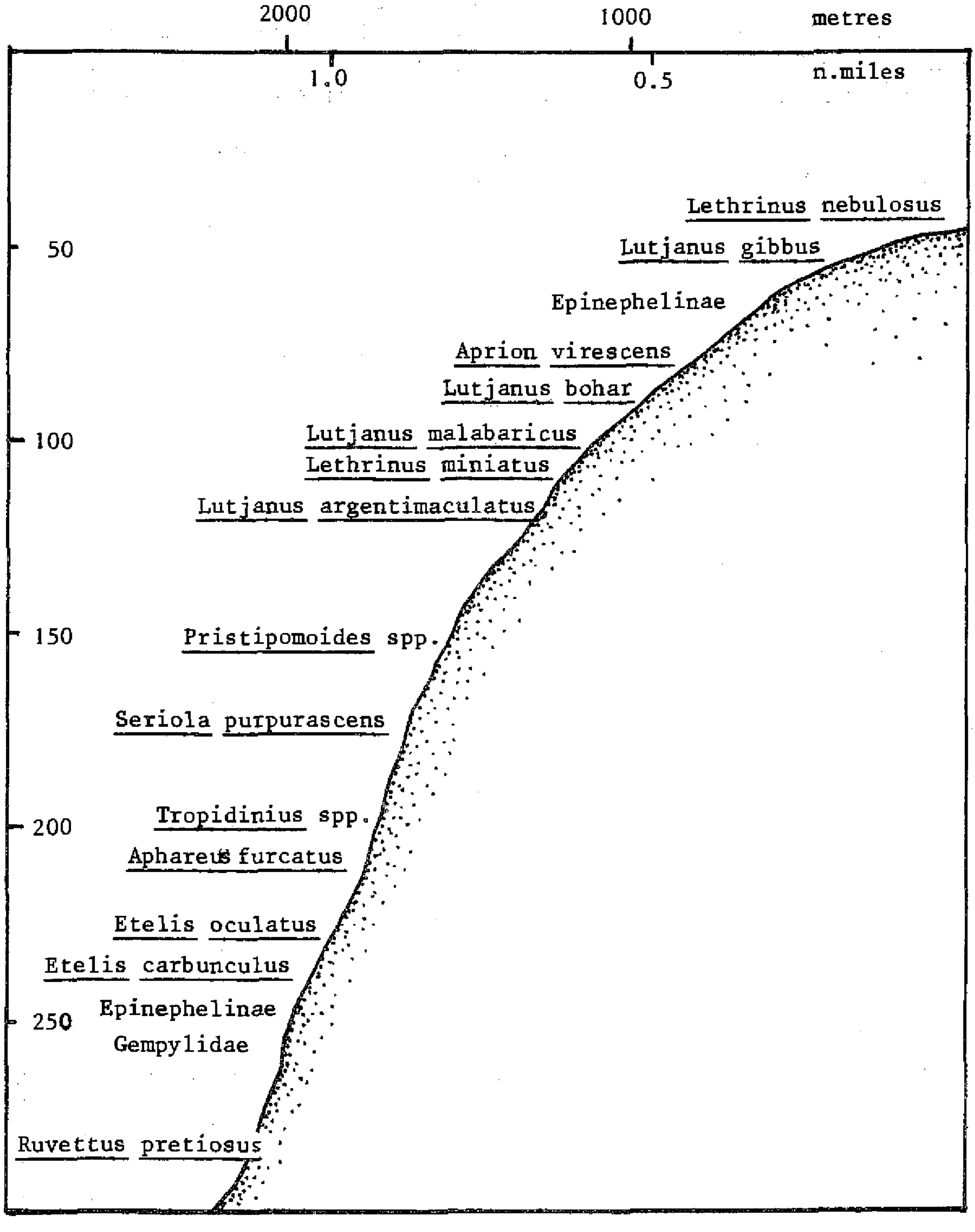


Fig. 2 : Schematic representation showing the approximate depths (in metres) at which the principal bottom species are found.

Table 1: Common species of bottom fish caught during SPC fishing projects 1974-78 at various places in the South Pacific, and the depths (in metres) at which they were taken.

	Malekula N. Hebrides	Asau W. Samoa	Aitutaki Cook Is.	Funafuti Tuvalu	Gizo Solomon Is.	Tutuila A. Samoa	Tonga
SERRANIDAE							
Subfamily Epinephelinae	40-335	40-370	20-335	20-370	55-335	40-295	30-295
CARANGIDAE							
Seriola purpurascens	95-165	110-205	130-240	20-165	110-240	150-220	165-240
Unidentified	20-295	20-220	0-185	0-185	55-240	40-220	30-220
LUTJANIDAE							
Aphareus furcatus	165-250	165-280	130-260	130-280	165-220	130-260	55-240
Aprion virescens	30-165	40-185	45-165	20-150	55-185	40-110	30- 95
Etelis carbunculus	240-370	140-410	150-370	140-335	220-295	230-280	205-315
E. oculatus	-	140-280	150-280	165-240	205-240	185-260	165-260
Lutjanus bohar	20-165	40-185	45-185	20-165	55-240	40-205	30-165
L. argentimaculatus	55-165	40-185	45-150	20-150	55-240	40-165	30-165
L. gibbus	55- 95	40- 95	45-150	20- 55	55- 75	40- 55	40- 55
L. malabaricus	75-205	75-220	-	-	55-240	40-165	130
L. kasmira	55-205	55-205	45-185	20-165	45-240	40-260	30-260
L. sebae	140-165	-	-	-	150-185	-	-
Pristipomoides spp.	95-205	75-280	95-295	95-295	110-240	75-205	110-260
Tropidinius zonatus	165-220	165-280	110-280	110-280	130-280	110-280	165-390
T. argyrogrammicus	165-220	165-280	110-280	110-280	130-280	110-280	165-280
LETHRINIDAE							
Lethrinus miniatus	75-150	65-185	20-150	20- 95	55-110	40-165	30-150
L. nebulosus	-	-	-	20- 55	-	40- 55	30-110
SPARIDAE							
Unidentified	110-185	55-205	55-205	20-165	45-165	40-185	30-205
SPHYRAENIDAE							
Unidentified	20-130	20-130	20- 45	20- 40	55-240	40-130	30- 75
GEMPYLIDAE							
Ruvettus pretiosus	260-335	185-410	75-370	75-410	-	110-295	165-335
Unidentified	150-370	110-410	40-410	55-410	-	110-280	95-295
SCOMBRIDAE							
Gymnosarda unicolor	20-150	0-240	20-240	20-165	55-205	40-260	30-240

Table 2: Common species of bottom fish caught during SPC fishing projects, the types of bottom on which they were caught, and observations on their distribution. For key to bottom types see Fig. 1.

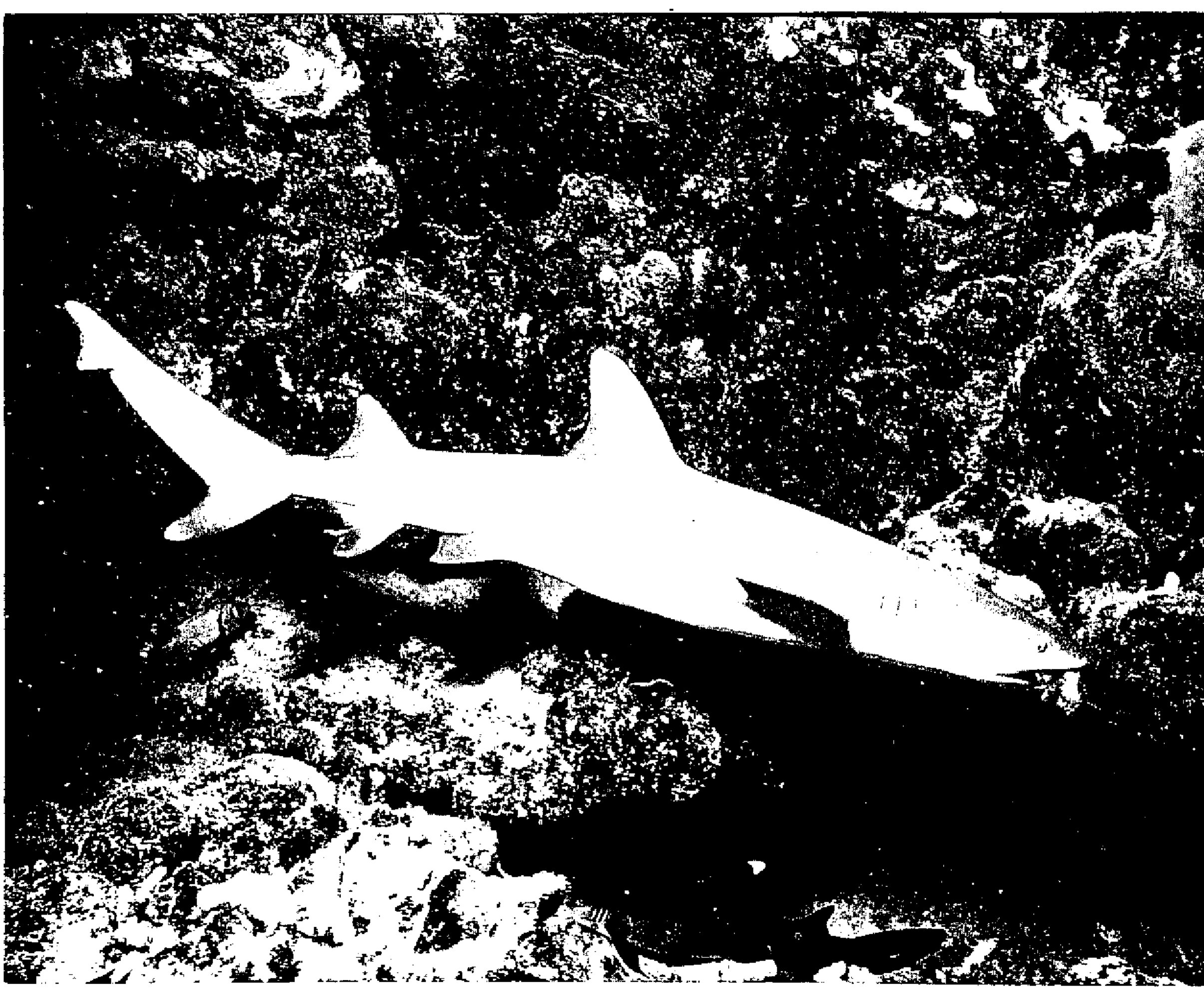
Species or family	Bottom type	Observations
Epinephelinae	2, 3	Rock or coral bottoms. Many species
Seriola purpurascens	3	Commonest in 165-205 m
Carangidae	1, 2, 3	Many species
Aphareus furcatus	2, 3	Commonest in 165-240 m
Aprion virescens	1, 2, 3	Favours coral bottom in 40-110 m
Etelis carbunculus	1, 2, 3	Commonest on 1 and 2, in 240-295 m
E. oculatus	3	Commonest in 185-240 m
Lutjanus bohar	2	Commonest in 40-165 m
L. argentimaculatus	2, 3	Favours areas near mangroves and rivers
L. gibbus	1, 2	Shallow banks or large lagoons
L. malabaricus	2, 3	
L. kasmira	1, 2, 3	Wide-ranging; commonest on 2, in 130-250 m
L. sebae	2, 3	Western Pacific, near large islands
Pristipomoides spp.	1, 2	At least three species
Tropidinius zonatus	1, 2, 3	
T. argyrogrammicus	1, 2, 3	
Lethrinus miniatus	1, 2	Commonest in 75-165 m
L. nebulosus	1, 2	Shallow banks or in large lagoons
Sparidae	1, 2	Three or four species
Sphyraenidae	2	At least six species
Ruvettus pretiosus	3	Commonest in 260-335 m, on dark nights
Gempylidae	3	Commonest in 130-280 m, on dark nights. Two species.
Gymnosarda unicolor	2, 3	Largest fish (45-70 kg) caught in 185-260 m

THE WHITETIP REEF SHARK

Knowledge on the biology of the whitetip reef shark Triaenodon obesus, one of the three most common sharks on coral reefs of the Indo-Pacific region, has been reviewed by Dr John E. Randall of the Bernice P. Bishop Museum, Honolulu. [1]

This comparatively small shark (it grows to a length of 1.6 m and a weight of 27 kg) is normally not dangerous to man. It gets its common name from the conspicuous white tips to its dorsal fins and the lobes of the caudal fin (see photograph). Its specific scientific name, obesus, is not really appropriate as, apart from pregnant females, it is a slender species.

The whitetip reef shark is very broadly distributed, being known from the east coast of Africa (including the Red Sea), the Indian Ocean, northern Australia, right through Oceania, and in the eastern Pacific from the Galapagos Islands and Panama. The whitetip is a bottom-dwelling species, found in or very close to coral reefs. It is good at moving among crevices and is frequently observed resting in caves. Observations by Dr Randall and by others have shown it to be



The whitetip reef shark Triaenodon obesus (Photo Nathan Bartlett)

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1. Randall, J.E. (1977). Contribution to the biology of the whitetip reef shark (Triaenodon obesus). Pacific Science 31 (2): 143-164.

relatively sedentary, and one individual was observed to make the same cave its home-base for several months. Between 1968 and 1971 a tagging programme under the control of Dr Randall marked 124 whitetips at Johnston Island. Seven recaptures were obtained after periods ranging up to two years, with a longest distance moved of 2.9 km. Whitetips must, however, be capable of occasional long distance movements, given their widespread distribution.

These sharks are active predators, feeding mainly on fishes, and mainly at night. Out of 56 stomachs examined by the author, 33 were empty, 17 contained the remains of reef fishes, four had eaten octopuses, and four both fishes and octopuses. Growth rates measured from the tagging programme varied from 2.1 - 4.2 cm/yr. This is a slow growth rate, even for sharks (which are generally believed to be slow growing). Dr Randall estimated that large whitetips must be at least 25 years old.

Female whitetips begin breeding when they reach a length of around 1 m, producing their young alive, in litters of one to five. Males mature at a smaller size (82 cm was the smallest observed).

Although the whitetip is not generally aggressive, it has been known to attack divers after being provoked. Probably a greater threat to man is the possibility of ciguatera poisoning from eating this shark. Its liver is often highly toxic, and in some areas, its flesh also.

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TESTING CULTURED MOLLIES AS LIVE BAIT FOR TUNA FISHING ABOARD THE SPC SKIPJACK TAGGING VESSEL, HATSUTORI MARU

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It is generally agreed that limited bait supplies prevent further expansion of skipjack (*Katsuwonus pelamis*) pole-and-line fisheries in the central and western tropical Pacific. American Samoa has been culturing alternative bait, notably mollies (*Poecilia mexicana*), since 1974. However, until recently not enough bait could be produced to test under fishing conditions. In January 1978, the *J-Ann*, a 22 m live bait pole-and-line vessel from the U.S. west coast, was chartered by the Pacific Tuna Development Foundation to test cultured mollies in American Samoan waters. These trials tested about 1.5 million mollies under actual commercial fishing conditions. The *J-Ann* obtained a baitfish to tuna ratio of 1:10. This ratio is considered to be poor under commercial conditions; the Hawaii commercial baitfish to tuna ratio is around 1:23. However, neither the captain nor crew had ever fished in tropical waters before and the vessel was not equipped with a spray system.

In June 1978, the South Pacific Commission skipjack tagging vessel, *Hatsutori Maru*, called at American Samoa to test mollies once again. The vessel, a 42 m Japanese style sampan, fished with mollies around American Samoa for several days but fishing was very poor. The seas were rough, the water temperature was around 28°C, and the tuna would not respond to either mollies or wild bait. It was therefore decided to load the vessel with mollies, and head north towards Tuvalu and the Gilbert Islands.

On 21 June, the Hatsutori Maru left Pago Pago and steamed for two days towards Funafuti in the Tuvalu group. The water temperature increased to over 29°C and the wind died considerably. Fishing was resumed on 25 June using mollies alone. On that day, over 1,000 skipjack and yellowfin were tagged. Fishing was conducted around Funafuti and north towards the Gilbert Islands until 5 July, when all the remaining bait was depleted in a "sundown" school. Over 3,000 skipjack and tuna were tagged. Overall, including American Samoa, 80 schools of tuna were chummed and 30 schools (38 per cent) were fished.

The commercial venture of the J-Ann chummed 1,834 kg of mollies and caught (including trolled fish) 17,542 kg of tuna for a 1:10 ratio. The tagging effort of the Hatsutori Maru, chummed 479 kg of mollies and caught 10,236 kg of tuna for a ratio of 1:21 (trolled fish are not included). Scientists involved in the SPC skipjack survey and assessment programme have determined that the fishing power of the Hatsutori Maru under commercial conditions is 3.47 times greater than the fishing power of the vessel under tagging conditions. Therefore, under commercial conditions the mollie to tuna ratio obtained by the Hatsutori Maru could have been expected to be 1: 73, an exceptional catch by any standards. The Hawaiian pole-and-line bait to tuna ratio of 1: 23 is achieved using the anchovy *Stolephorus purpureus*, considered the best bait-fish by most Hawaiian fishermen.

While the Hatsutori Maru was in Funafuti, considerable quantities of wild bait, the round herring *Spratelloides delicatulus*, were captured. During the fishing trials, the wild bait was chummed from the bow and the mollies from the stern and vice versa on alternate days. Twenty-one schools were chummed in this fashion; nine of these responded and were fished.

In five schools, more tuna were tagged on mollies than on sprat. More tuna were tagged on sprat in four schools. From the nine schools, 515 tuna were tagged on mollies versus 386 tagged on sprat. These results indicate that mollies are at least as good as round herrings which are considered excellent bait by most knowledgeable pole-and-line fishermen.

Several times during these trials, lures modified with dark mahimahi (dolphin fish) skin were tried next to standard lures (chrome with white and red feathered squids). The modified lures seemed to work much better than the standard lures, perhaps because they were more similar to the dark colour of the mollies. Several schools were chummed with small mollies which averaged around 27 mm standard length and weighed 0.7 g (the normal ones averaged 36.2 mm SL and 1.5 g). There were no differences in behaviour or catchability of the two size groups. Schools seemed to react the same whether the smaller or larger mollies were used, even when schools were chummed with a mixture of the two groups.

The mollies were held aboard the Hatsutori Maru for over two weeks and were fed straight fish meal during this time. Up to 2 July, the average daily mortality was 0.44 per cent. Between 2 and 5 July mortality increased significantly and about 71 per cent of the remaining mollies died during this period. This is believed to have been caused by either rancid fish meal or nutritional deficiencies in the straight meal diet. The latter is the suspected cause of the mortality because mollies fed with both fishmeal and a complete fish food (Ralston Purina, "Trout Chow") were held with less than one per cent mortality for over a month during the J-Ann trials.

The results of these trials aboard the Hatsutori Maru show that mollies are acceptable live bait for skipjack and yellowfin tuna and may even be better than some wild baits, such as the round herring Spratelloides delicatulus. The hardiness of the mollies will allow presently limited day fleets in many island groups to extend their range by giving them the efficiency which they presently lack because of the fragility of wild bait. Mollies are easily cultured, and if small mollies are shown to be as effective as larger ones, production rates can be increased significantly. Also, modification of the squid lures to resemble the dark-coloured mollies may improve catch rates significantly; this aspect warrants continued research paralleling the development of this new baitfish resource.

Reference

Bryan, P.G. (1978). On the efficiency of mollies (Poecilia mexicana) as live bait for pole-and-line skipjack fishing: fishing trials in the tropical central Pacific. Office of Marine Resources, American Samoa Government, Pago Pago, American Samoa. Technical report on project No. 4-35-D, 45pp.

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FISHERIES AT NIUE

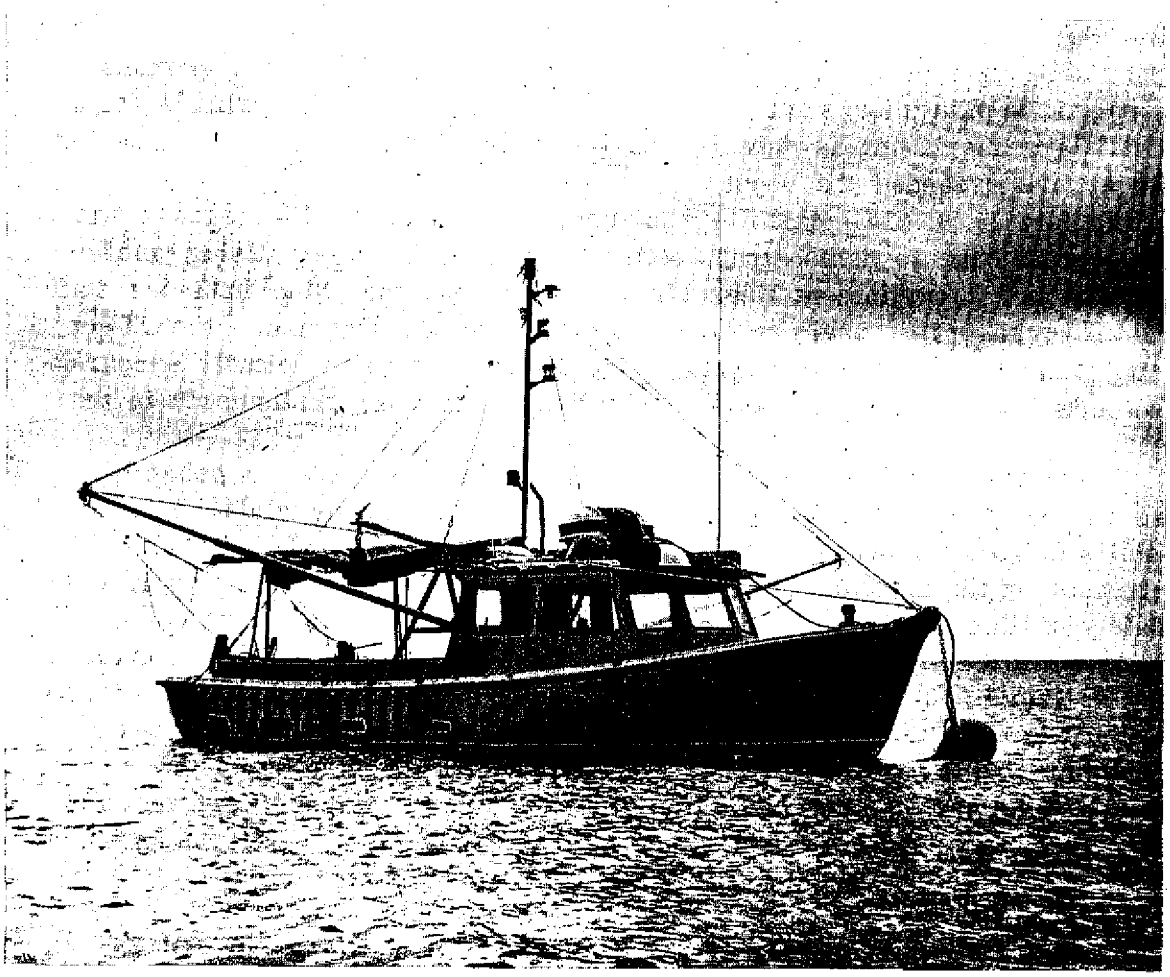
J. Crossland

Like many other Pacific islands Niue is a net importer of fish products. Last year fish imports amounted to 54 t (value NZ$60,000) of which about a third was frozen whole fish or fillets and the remainder was canned fish. Local catches are estimated to be about 20 t annually. The policy of the Niue Government is aimed at reducing reliance on overseas supplies, and eventually replacing them with locally caught fish. It will not be an easy task, because fishing is a difficult and hazardous business at Niue, and suitable fishing areas are limited. This has not deterred the fisheries staff, who with the help of a New Zealand aid scheme have made a sustained effort over the last 18 months to boost catches. For the first time ever a regular supply of fresh fish has been available to the public.

Nuie rises almost straight from the ocean depths, with no lagoon and a fringing reef at the most only some 10 m wide. Depths of 100 m are reached within 0.5 km of the shore, or even closer in some places. There is no harbour or inlet of any kind around the 75 km coastline. The newly acquired fisheries vessel Nukulafalafa, ties up to a mooring buoy near the pier in Alofi Bay. In periods of bad weather it must be lifted out of the water and moved high enough to be clear of the seas which break over the pier.

Until recently fishing around Niue was carried out solely by a fleet of one-man canoes. These craft are small and light enough to be carried up and down the cliff tracks by one man. They fish a few hours at a time, mainly for pelagic species - skipjack, wahoo, dolphin fish, yellowfin tuna and others - which occur around the island. Some excellent photographs of the traditional Niuean canoes can be found in an article by Val Hinds,[1] former SPC fisheries officer. Many of these canoes remain in use but they are increasingly being replaced by aluminium dinghies (usual size about 4 m) powered by outboard motors. These craft, roomier and faster than the canoes and usually trolling two or three lines, have enabled better catches of surface fish to be made; at times they are also used for handlining for bottom fish.

Fishing at Niue entered a new phase in 1977 with the arrival of a New Zealand aid project. The project was led by Nick Dryden of the New Zealand Ministry of Agriculture and Fisheries, and brought with it the 8.3 m, diesel-powered Nukulafalafa, plus a variety of fishing gear. Mr Dryden began fishing operations in July 1977 and tried various methods: trolling, bottom and pelagic longlining, handlining, and floating and bottom gillnetting. Trolling was found to be the most productive method. Six lines could be worked at one time, two



Niue's new fisheries boat Nukulafalafa at its mooring in Alofi Bay

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1. Niue Island, buttress against the ocean. South Pacific Bulletin 21 (2): 24-26 (1971)

each from booms on the sides, and two from the stern. Both lures and dead-baiting with flying fish and jack mackerel were used. The most important species caught, wahoo (pa'ala), showed marked seasonal fluctuations in abundance, being most plentiful in the late winter - early spring (August and September), with other good catches in late summer and autumn (February-May). Skipjack was next in importance to wahoo; it too was seasonal, and provided the main-stay of fishing over the summer with peak catches in December and January. In the eleven-month period July 1977 to May 1978 the total catch of all species was 8,051 kg. When it is considered that much unproductive time was spent in exploratory work, a figure of 10-15,000 kg for a year's fishing is not an unrealistic target for the Nukulafalafa.

During Mr Dryden's eleven months of exploratory fishing at Niue four local fishermen were trained in all aspects of the fishing methods used, the practical details of boat handling, boat maintenance, coastal navigation, basic meteorology and safety on board. Fifteen local fisherman were also taken out for fishing trips. After the departure of Mr Dryden, command of the Nukulafalafa was taken over by Archie Moana, Niue's Fisheries Officer. Mr Moana has spent a period of fishing training in Nelson, New Zealand; he is also a trained diesel mechanic, a very important asset when your vessel is the only one of its kind for hundreds of miles around (an outboard motor is carried for emergencies).

Fish caught by the Nukulafalafa are cut up into pieces of approximately 2 kg, packed in plastic bags and held in a freezer until enough is available for a market. The marketing is done by the fisheries section, and the demand has so far always exceeded the supply.

In July 1978, SPC Master Fisherman, Tevita Fusimalohi, began a two month stay in Niue to demonstrate bottom fishing techniques. Using wooden hand reels and monofilament lines Mr Fusimalohi and the Niue fisheries staff carried out a series of trials in depths down to 300 m. Catches, although not high in comparison with some parts of the Pacific, were sufficiently encouraging[1] to make bottom fishing a useful alternative to trolling, particularly in the off-season for pelagic fish.

What does the future hold for fishing at Niue? Catches of pelagic fishes can be increased with a greater utilisation of the Nukulafalafa. Recently, two shifts to work the boat were introduced. A second boat would be a help, not only because of the increase in catching power, but because it would greatly add to the safety of Niue's fishermen. It remains to be seen if bottom fishing can develop further, and if the stocks can withstand sustained fishing pressure. As for foreign fishing in Niue's 200-mile zone, this is very small. An analysis by W. L. Klawe[2] of the Inter-American Tropical Tuna Commission for the SPC of the catches of tunas and billfishes by foreign vessels in the economic zones of the member countries of the SPC showed that within Niue's zone[3], the catches were very low - between 1972 and 1976 the highest annual total was only 289 t. Little is known of

1. A full report on the project is in preparation at SPC, and will be published shortly.
2. Estimates of catches of tunas and billfishes by the Japanese, Korean and Taiwanese longliners from within the 200 mile economic zone of the member countries of the South Pacific Commission. Occasional Paper No. 10: 41 pp. SPC, September 1978.
3. The zones used in this study were estimates only.

the concentrations of pelagic fishes in the area around Niue, but the resources are thought to be small. The visit of SPC's skipjack tagging vessel Hatsutori Maru in 1980 may provide some information.

Nearly every Niuean considers himself a fisherman. This popular interest in fishing, plus the sound advice and leadership of the Fisheries Division, offers the best hope for increased catches in the near future.

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REPORT ON A DEEP-WATER FISHERIES SURVEY IN THE NEW HEBRIDES
(31 July - 4 August 1978)

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In October 1977, the ORSTOM[1] research vessel Vauban carried out a survey of deep-water fishery resources around the Torres Islands on behalf of SPC. From 31 July - 4 August 1978 a second cruise for SPC was made by the Vauban, this time to the central islands of the New Hebrides. Participating in this cruise were research scientists P. Fourmanoir and P. Rancurel of ORSTOM and R. Grandperrin, SPC Fisheries Adviser.

The initial intention was to carry out trial fishing with bottom longlines on deep-water sea mounts. These sea-mounts, isolated by great surrounding depths, are situated near the islands of Efate and Erromango. Three plateaus shown on the chart "New Hebrides Geological Survey" - ORSTOM (Efate - Erromango) were chosen for investigation. One of these (18°25'S, 168°30'E) is at a mean depth of 100 m with depths of 1000 m around it; the other two (18°12'S, 168°45'E and 18°50'S, 168°24'E) are more limited in area and have depths over them of 300 and 400 m. Another sea-mount (22°29'S, 168°03'E) marked on chart No. 4844 of the Marine Hydrographic Service was also to be investigated.

These sea-mounts, situated close to inhabited areas, were considered interesting not only biologically, but also from the practical aspect, as they could have significant potential for commercial fishing.

EQUIPMENT

Three kinds of lines were used:

(1) A standard longline consisting of a backbone (mainline) of 6 mm tarred rope, 120 m long, carrying a spliced eye every 2 m; 50 cm snoods of monofilament nylon or steel wire were clipped into the eyes at the time of shooting the line. Size 4 or

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1. Office de la Recherche Scientifique et Technique Outre-Mer

5 circle hooks were used. Each end of the line had a 10 - 15 kg weight attached, and one end had a buoy line.

(2) Japanese type longline consisting of a backbone of 6 mm kuralon kept 20 m from the sea bed by 1 l floats placed every 30 m; from these 20 m vertical nylon lines with 1 kg weights were attached. Four or five nylon snoods, 80 cm long with terminal hooks, were attached to each vertical line, starting 1 m from the bottom. This line is recommended for use in areas of uneven bottom.

The lack of 1 l floats and their replacement by 4 l floats made this line inefficient during trials carried out in 200 m depth off Efate.

(3) Vertical longlines. These consisted of a line buoyed at one end and kept in contact with the sea-bed by a chain at the other. The end of the line carried a series of steel wire snoods with No. 4 circle hooks attached.

RESULTS

The sea-mounts at a depth of 390 m shown on the Hydrographic Service chart could not be located despite a zig-zag search lasting almost two hours. It would appear that their positions are doubtful.

A decision was taken to conduct a trial with the standard longline in 350 m on hard bottom off Undine Bay, to the north-west of Efate. Night fishing between 2100 and 0500 hours yielded an hourly catch of only a few small deep-water sharks (Centrophorus, Squalus). After 0600 these sharks were abruptly replaced (still in the same fishing spots) by the deep snappers Etelis oculatus and E. carbunculus. Considerable numbers of these were caught (23 on one 80-hook line).

The sea-mounts between Efate and Erromango were searched for and found on the second day of the cruise. Unfortunately unfavourable weather and the state of the sea near the sea-mounts did not permit any fishing. One line which was shot was carried away by the current and waves but was fortunately retrieved. The vessel was forced to return to a more sheltered fishing area to the north-west of Efate without carrying out any fishing.

A series of trials with the standard longlines and the Japanese longlines was made on a slope to the west of Moso Island, at depths of 200-450 m. Small deep-water sharks (the same kinds as at Undine Bay) were caught in large numbers through the night and up until dawn. The most common species caught at night, Centrophorus scalpratus, is notable for the large size of its squalene-rich liver. On the other hand no Etelis spp. were observed during the morning fishery.

It is interesting to note that numerous remains of skipjack, Katsuwonus pelamis, and of Decapterus were recorded from the stomachs of the small sharks caught. This shows that skipjack occurs on the bottom, and that this active fish has as one of its predators a small, apparently slow-moving shark. Hexanchus vitulus caught in the same depths also contained skipjack in their stomachs.

Fishing in shallower depths (200 m) by day, using the Japanese longline, yielded three species of Pristipomoides, (P. multidens, P. flavipinnis, P. filamentosus) and two species of Paracaesio.

Deteriorating weather conditions obliged the vessel to return to the shelter of Emau Island, in Undine Bay, where a trench 400 m deep extends along the south-west coast. Lines fished on the edges of this trench in 350-385 m yielded numerous Etelis. The sea bottom was much more uneven and rocky than that to the south of Moso, which probably explains the different population.

In spite of the change to the programme because of weather this short exploratory cruise showed:

(1) That there is an abundant population in rocky, uneven bottom areas of the two Etelis spp. caught during day fishing.

(2) That there is a considerable population of Centrophorus scalpratus on both rocky and soft bottom areas, available to night fishing. A fishery for this species, as in Australia, could be directed to exploiting both its flesh and its liver oil (squalene).

The lines used in this survey were intentionally simple; they could be made up and used locally at a very low cost.

Table 1: Kinds and numbers of fishes caught

Etelis oculatus	17	Mustelus manazo	5
Etelis carbunculus	34	Galeorhinus sp.	2
Centrophorus scalpratus	50	Hexanchus vitulus	2
Squalus megalops	13	Pristipomoides spp	11
Squalus sp.	21	Others	9

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POPULATION ECOLOGY OF COMMERCIAL BECHE-DE-MER (ECHINODERMATA: HOLOTHUROIDEA) IN FIJI

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DISTRIBUTION AND ABUNDANCE

Surveys were carried out by the author on several barrier reefs near Suva in order to learn more about the habitat requirements of commercial species of bêche-de-mer. It was hoped in this way to understand why some reefs are rich in commercial bêche-de-mer, whereas on other reefs, the commercial species are rare.

Methods: The survey was carried out by free-diving along the lagoon edge of the reefs between low-water mark and a depth of 10 m (mean water). Deeper areas were not examined because the study was designed to survey bêche-de-mer stocks accessible to local villagers, who lack formal diver training and are usually unable to dive deeper than 5 m.

In the detailed study of the Suva and Levuka reefs, a random-survey technique was used. Diving stations were selected by running the boat parallel to the inside of the reef at constant speed, and anchoring at random time intervals. At each station the depth and type of habitat were recorded, and a count was made of bêche-de-mer falling within a circular sampling area of 10 m radius, centred on the anchor. Thirty dives were made within 2 km sections on each of the two reefs.

Short visits were also made to three other barrier reefs (Beqa Reef, North and South Astrolabe reefs) to check the conclusions reached as a result of the main study.

Results: This work showed that there is a clear link between the abundance of teatfish Microthele nobilis, the most valuable species, and the abundance of turtle grass Syringodium isoetifolium. On Suva Reef, there are extensive turtle grass beds and teatfish are abundant (catch per unit effort figures ranged from 12-20 teatfish per man hour). Levuka Reef, by contrast, has no turtle grass and teatfish are so rare that only 43 specimens could be located in ten days of searching. On Beqa Reef and North and South Astrolabe Reefs conditions were found to be similar to those on Levuka Reef.

Turtle grass is probably abundant on Suva Reef because of land-derived nutrients brought down by the nearby Rewa River. The other reefs studied are not influenced by any substantial land run-off. It is hypothesised that teatfish feed on detritus derived from turtle grass.

The survey also showed that white-phase teatfish are most abundant on Suva Reef whereas black-phase teatfish are more numerous on the other four reefs. Black-phase teatfish were found mainly in sand channels among patch reefs of living coral. On the reefs studied, this type of habitat was found only in shallow water, from low tide level down to a depth of two metres. Black-phase teatfish are frequently found partially hidden under ledges.

Two other commercial species, prickly redfish (Thelenota ananas) and black-fish (Actinopyga miliaris) were found in the same habitat as the black teatfish, but were everywhere less abundant than black teatfish. The non-commercial Bohadschia argus was also located in the same areas. Other commercial species, Actinopyga lecanora (stonefish), A. obesa (redfish) and A. echinites (deepwater redfish), were found only as isolated individuals so that no conclusions could be drawn about their habitat requirements.

A very large holothurian, commonly weighing 6-7 kg, was located in groups of a dozen or more, always on the fine sand of the upper margin of the lagoon slope. This giant animal has been identified as Thelenota anax (Clark), a species previously thought to be very rare. Historical sources indicate that this animal was once in great demand as bêche-de-mer. If a market still exists for this species, it is certainly common enough to make diving for it worthwhile.

Three other species (none of which appear to have any present commercial value) occur in the same habitat. They are Bohadschia marmorata (moonfish), B. bivittata (brown sandfish) and Holothuria axiologa (elephant's trunk fish).

REPRODUCTION

Evidence to date is consistent with the hypothesis that the teatfish breeds throughout the year. Spontaneous spawning of the teatfish was observed in a tank environment on 14 September 1978. Since Mortensen (1938) described the teatfish as spawning during the time of his visit to the Red Sea (i.e. in the Northern Hemisphere) in mid-June to mid-September, there is reason to believe that spawning can occur throughout the year. In addition, it has been found that samples from the same population of similar sized teatfish may contain individuals with vastly different gonad indices.

Spawning has now been observed in three species of bêche-de-mer, Microthele nobilis, Actinopyga mauritiana, and Halodeima atra. Spawning behaviour was similar in all cases with both males and females raising their front ends which were then slowly waved from side to side. Clouds of gametes were emitted in bursts from pores just behind the feeding tentacles. Since bêche-de-mer are able to spawn even though males and females are not in physical contact, it is hypothesised that a pheromone is responsible for triggering spawning behaviour If this is the case, spawning aggregations (as occur in many starfishes) may occur in the wild. However, so far only an isolated individual (a female H. atra) has been observed spawning in the natural environment.

ECOLOGY OF JUVENILES

A major breakthrough has been achieved in our understanding of the life history and ecology of Microthele nobilis with the recent discovery of the habitat of the juveniles of this species. On 22 February 1979 numerous young teatfish less than 1 cm in length were discovered clinging to the bases of stems of turtle grass (Syringodium isoetifolium), It was noted that all were associated with a pink calcareous alga which encrust the bases of the turtle grass stems. Juvenile M. nobilis are also common on Halimeda sp., a green alga common in turtle grass beds. It is hypothesised that the free-swimming larvae have a specific settling response to either turtle grass or algae. It is hoped to investigate larval settling behaviour under laboratory conditions. Strong tidal currents which periodically sweep through the turtle grass beds are probably responsible for transporting the young teatfish to deeper areas below the turtle grass beds where the large adults live. All young seen so far have been white-phase individuals.

In addition small black bêche-de-mer of the genus Actinopyga have been located under stones associated with muddy sand and work is underway to establish whether these are juvenile blackfish (Aotinopyga miliaris).

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THE TUVALU BECHE-DE-MER PROJECT: QUARTERLY REPORT, AUGUST 1978

Elisala Pita
Fisheries Officer, Fisheries Division, Tuvalu.

The project officially started on 29 May 1978 when the necessary equipment arrived from Fiji. This included a 15 ft 6 in. boat, two outboard motors, diving gear and some lines and hooks.

Five labourers were recruited to do the fishing and processing of bêche-de-mer. Work started with the construction of a smoking kiln. The kiln consists of a fire compartment from which the smoke goes through a concrete tunnel into an enclosed smoke house made of sheets of corrugated aluminium. There are two shelves on each side of the kiln.

Resource Survey: The first month was spent identifying areas in the lagoon where the commercial species were present. The presence of other species was also noted. In each area visited samples were collected by divers equipped with goggles. These samples were test processed.

In the second month (July) fishing was concentrated in the areas identified. However, fishing was not carried out very intensively because the results of test marketing overseas were still awaited. Hence the catches varied; 20-50 teatfish (Microthele nobilis) per trip were collected. Catches were affected by the weather During bad weather fishing is quite difficult because the water becomes too turbid for the bêche-de-mer to be seen.

To date a total of 38 trips have been made in 12 weeks, and 1122 teatfish have been landed.

Processing: The technique used is as follows. The bêche-de-mer are placed in boiling water in a drum cooker and cooked for 30-45 minutes. They are then gutted, cleaned and smoke-dried in the kiln. The product is well dried after 4½ days, the dry weight being approximately seven per cent of the original weight. So far no sun-drying has been carried out as it was not considered necessary after the above drying time in the kiln.

Not all the bêche-de-mer processed were first grade. Some were spoiled inside, some were open-slit, and others had holes in them. The open-slit ones were soaked in water for half a day, and then dried. Some become closed again, but not others. So far about 600 lb of dried bêche-de-mer are ready for marketing.

Marketing: One 10 lb sample has been sent by airfreight to a buyer in Honolulu; an answer is expected soon on the quality and prices achieved for our sample. Other buyers, in Fiji and American Samoa, are interested. Some of the product will be sent to the Fiji Fisheries Division on the next ship.

A preliminary grading system has been established, as follows:

(1) 1st grade, 7-8 inch length
(2) 2nd grade, 6-8 inch length
(3) 3rd grade, <6 inch length

Operation Costs (to date): 12 weeks (30 May-29 August 1978).

				$A
1.	Wages	: 5 labourers at $17.60/week	=	1056.00
2.	Petrol	: 9 drums x 44 gallons = 396 gallons at $2.45/gallon	=	970.20
3.	Oil	: $1/week	=	12.00
		Total expenses (excluding depreciation and shipping)		2038.20

<u>Daily Costs</u>		$A
Wages : $0.44/man/hr for 5 men	=	17.60
Petrol : 10 gallons at $2.45/gallon	=	24.50
Estimated total daily cost (including oil, shipping and depreciation)	=	50.00

<u>Daily catch rate required to cover expenses</u>

Price/lb/dry weight for 1st grade	= $F2.50 = $A2.60
∴ dry weight required	= 50/2.60 lbs
	= 20 lbs dry weight
	= 285 lbs wet weight
Average wet weight of bêche-de-mer	= 4.84 lbs
∴ Average catch/day required	= 285/4.84
	= 58.9
or approximately 60 bêche-de-mer	

So far a daily average of 30 teatfish has been caught, half the required numbers. This could be increased by intensive fishing once the results from test marketing in Honolulu and Fiji are available.

<u>Analysis:</u> From the results so far it is fairly difficult to estimate the resources; once bêche-de-mer are fished commercially an estimate of the resources will be easier. It is hoped that with a good price overseas revenue would be sufficient to cover expenses. The processing is going along smoothly, with only a small amount of spoiled product. It is hoped to build more smokers and increase the volume that can be processed in a day.

* * *

FISH SILAGE: A PLACE IN THE PACIFIC?

J. Crossland

BACKGROUND

The technique of acid ensilage is a method of preserving waste fish, and turning it into a product suitable for feeding to stock, mainly poultry and pigs. The product - fish silage - was defined by Tatterson and Windsor (1974) to be "... a *liquid product made from whole fish or parts of fish that are liquefied by the* action of enzymes in the fish in the presence of an added acid."

The manufacture of fish silage was first developed more than 50 years ago. Since then it has been produced on a large scale in Denmark for a number of years (25,000 t in 1972), and also in Poland (7,000 t/yr in recent years). Other European countries produce it in smaller amounts, and recently an increasing amount of research has been carried out in the United Kingdom.

The process of making fish silage is basically simple. The waste fish is minced and put into containers. Sufficient acid is then added to ensure that putrefaction does not occur (about 2.5 - 3.0% by weight of 100% acid is needed); the acid must be mixed thoroughly with the fish. The acids commonly used are sulphuric (a mineral acid), formic (an organic acid), or a mixture of the two. The process of ensilage then occurs naturally. The time taken depends on the type and freshness of the fish, and the temperature. The fresher the fish and the warmer the mixture, the faster is the process. Under tropical conditions the whole process takes about two days. The only tricky part of the operation is getting the amount of acid right - sufficient to preserve the silage - but avoiding excess, which adds to the cost, and in the case of mineral acids makes the addition of a neutralising agent necessary before the product can be fed to stock. Properly manufactured fish silage has a storage life of many months.

Fish meal is the common product made from waste fish, but it is not suitable for small-scale production because of the high capital costs involved, and the need for trained engineers and other technical staff. Fish silage, on the other hand, can be made in any quantity - as little as one drum at a time; the process can be quickly learned by unskilled labour; and the capital outlay is minimal. The basic equipment required consists of a grinder for macerating the fish, a pH meter, a supply of drums or other containers and a balance for weighing the ingredients.

Disadvantages of silage compared to meal are that it is bulkier and more costly to transport, and that its protein content is only about 20-25 per cent of that of meal. The latter is an important consideration when evaluating the comparative costs of the two products, although there is some compensation in the greater energy component of silage, which must be added to a fish meal diet.

THE SOLOMON ISLANDS FISH SILAGE PROJECT

In 1975 the Solomon Islands Government made a request to the Ministry of Overseas Development, London, for technical assistance in setting up a fish silage project. As a result Mr J.P. Jones was sent out for a year's assignment to work on experimental silage production. The purpose of this review is to give a brief description of the main results and an up-to-date record of the present situation; the full report (Jones 1977) contains the detailed results and all the technical information.

The project had as its initial aim to assess the value of silage as an animal feed and the possibility of producing it on a village level basis. If the assessment was favourable, the manufacture of silage would reduce the need for importing stock feed and provide a basis for future livestock development.

A prefabricated hut, 40 ft x 12 ft on a concrete base, housed the project. It was sited close to the Solomon Taiyo tuna processing factory at Tulagi, Florida Islands. Operations began in December 1975, utilising waste fish from the factory. At that time about 5 t of waste was produced daily. Most of it (80%) was cooked waste, consisting of heads, bones, guts and flesh trimmings; the remainder was uncooked heads and guts. Until the arrival of the project this waste had been dumped at sea, incurring considerable expense to the company.

Initial work concentrated on investigating and refining the ensilage technique to suit local requirements. Trials were made using both sulphuric and formic acid, separately and in mixture, and at different concentrations. These experiments showed that formic acid alone, at a minimum concentration of 2.5 per cent (100% acid) was the best. Reasons for this were that it was easier to work with one acid alone; formic was cheaper than sulphuric, and more suitable for preserving cooked waste, which requires high acid levels if mineral acids are used.

Production by the project amounted to 0.25 t per day, made in 25 kg batches. The silage, which contained 20 per cent crude protein, was transported in 44 gallon drums to Honiara where it was stored for 10 days and then fed to pigs in a series of controlled trials. These trials began in April 1976 under the direction of an animal nutritionist, Dr Morgan, also from the Ministry of Overseas Development. Factors investigated were weight gain, palatability, carcase appearance, and taint. Results showed that fish silage was a suitable substitute for the fish meal and protein concentrate which had previously been used to supplement the pigs' diet.

By the end of the project's one-year term (December 1976) the production of silage was ready to go onto a commercial basis with an estimated output of up to 2 t/week. Production costs of wet silage (using formic acid alone) were estimated at $35/t; of this, acid cost $15 and fish waste $13. A selling price of around $60/t was proposed. At that time alternate sources of protein were priced at $270/t for pig concentrate, and $300 for fishmeal; both were imported commodities.

Recent news from Mr Jones, now a senior fisheries officer with the Solomon Islands Ministry of Natural Resources, indicates that the project was producing on a commercial basis at $1\frac{1}{2}$ t/week up until June 1978, but that production has now stopped. Several factors contributed to this. Transport facilities capable of shipping 44 gallon drums between Tulagi and Honiara broke down. A change of management in March 1978, together with understaffing, resulted in low production and a poor product. The result of this was that pig farmers had to supplement their protein feed base with imported fishmeal, and it became more attractive and reliable for them to change to a feed based entirely on imported materials. However, it is hoped that silage production will start up again soon, and according to Mr Jones "Interested parties have been contacted and a new consortium will hopefully ensure that a cheap pig feedstuff will again be available to serve both small and large piggeries in the islands".

RESEARCH ON FISH SILAGE IN AUSTRALIA

Research on fish silage recently started in New South Wales as a co-operative project between the State Fisheries Service and the Department of Agriculture. The objectives of the programme are basically the same as those of the Solomon Islands project: to determine the practicality and economic feasibility of producing fish silage under local conditions, and to study its nutritional value as a pig food. Mr Terry Gorman of the State Fisheries Service is in charge of the silage production and Dr Ted Batterham of the Agricultural Research Centre, Wollongbar, of the feeding trials.

The project has been programmed to comprise four stages. Stage one involves the technical details of producing an acceptable product from the locally available waste fish - fish and prawn offal, and unmarketable species such as sharks, rays, frostfish. The raw material is minced using a hammer mill or mechanical meat chopper and treated with 3.5 per cent of 85 per cent formic acid. Depending on temperature the mixture takes 2-10 days to mature.

Stage two involves feeding trials at Wollongbar. Particular attention is being paid to the possibility of fishy taints and oily fat developing in the carcases of the pigs. So far this has not proved to be a problem, but in any case it can easily be avoided by withdrawing silage from the diet a few weeks before slaughter. Another problem is the possible accumulation of mercury in pigs fed a sustained diet of silage. Many fish, particularly some sharks, accumulate mercury and this may be further concentrated by the pigs. Tests are to be made on the livers of such pigs to see to what extent this has occurred.

Both stages one and two have proved trouble free. Stage three involves the preliminary assessment of the economic feasibility of production and usage. Stage four, large scale production of silage, is dependent on stage three.

CONCLUSIONS

The projects discussed above seek to utilise fish wastes produced in insufficient quantities to support a fish meal plant. In both cases the production of silage has produced few technical problems, and silage has proved an acceptable and nutritionally valuable pig food. However, those advantages are not enough on their own. The marketing side - transport, quality control, and continuity of supply - is just as important. In Solomon Islands this has broken down (temporarily it is hoped); in New South Wales research on it has not yet been completed. If such difficulties can be overcome, fish silage appears to have a future in many parts of the Pacific region.

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NEWS FROM TONGA

W.A. Wilkinson
Fisheries Officer
Nuku'alofa
Kingdom of Tonga

Interesting new developments have been taking place in the Kingdom of Tonga. Two fishing centres were officially opened in October 1978. The smaller of the two, sited at Vava'u, has been built with funds donated by the Australian Government. It consists of an office block for the Fisheries Officer and staff, a workshop for the repair of engines and fishing gear and a cold room, housing a block ice-making machine, capable of producing 800 kg of block ice a day. A well laid out laboratory is also included. The centre is situated on the fore-shore adjacent to the harbour jetty in Neiafu, an ideal site for providing an extension centre for fishermen.

A similar facility is planned for Ha'apai, again funded under Australian aid. Construction will begin this year.

Also completed is a much more sophisticated Mariculture Centre at Sopu, on the main island of Tongatapu. This has been donated by the Japanese Government under its Technical Co-operation Programme. The most up-to-date wet and dry laboratory facilities are included, fully equiped for molluscan and finfish culture. The facilities will be used initially to expand the Kingdom's mollie live bait programme and undertake a tridacnid clam survey.

Offices include an audio room, conference room and a dormitory block to house visiting scientists. The centre is fully equipped with scientific equipment making it possibly the best equipped fisheries research centre in the Pacific. Recruitment of a Research Director is now in hand. He will be supported by volunteers from the U.S.A. and Japan. Training of local staff will be a priority. The Centre was handed over officially to the King of Tonga by the Japanese Ambassador from Wellington on 5 October 1978. Many other distinguised Japanese guests attended the opening ceremony, indicating Japan's great interest in this area, as far as fish is concerned.

In general Tonga has had a progressive year's development. There were excellent long-line catches mainly of albacore (about 60% of total catch). Foreign exchange earnings for 1978 already exceed $150,000. A record 3.7 t was recorded in one day's fishing in July. The price of albacore has increased to US$1,460 a tonne. Unfortunately, frozen bait (Cololabis saira) has also increased in price, from US$9.50 per 10 kg case to US$14.50.

A team of German consultants has completed a wharves and fisheries study on behalf of the European Economic Community. This includes a fishing boat harbour, fish market, boat-building facility, training centre, and a 200 ton-capacity cold store for frozen tuna. A reclaimed foreshore area adjacent to Faua Harbour has been selected as the site. Work is expected to commence in early 1979.

Development of the artisanal fishery will be supported by funding from the Foundation for the Peoples of the South Pacific. This will include infrastructure facilities such as ice-making machines and transport of fish from the remoter island groups to the main market in Nuku'alofa. This area has been neglected in the past and at present, due to the lack of these facilities, only sufficient fish for immediate subsistence needs are being caught. As elsewhere in developing fisheries trained extension workers are essential. The need to train fishermen in the simple practicalities such as maintenance of outboard and inboard engines, care of catch, use of ice, repair of fishing gear, introduction of new techniques, are all prerequisites for the development of the local fishery. Emphasis will be placed on this aspect in the more isolated fishing communities in the Ha'apai and Vava'u groups, where this type of assistance is most needed.

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SPC SKIPJACK SURVEY AND ASSESSMANT PROGRAMME: BRIEF SUMMARY REPORT TO 31 JANUARY 1979

J.P. Hallier
SPC Fisheries Research Scientist

PROGRAMME FUNDING

The total contributions received from the donor governments to 31 December 1978 were approximately US$1,801,000. A breakdown of these contributions is as follows[1]:

Country	Contribution		Approximate US$ equivalent
Australia	A$	533,000	603,000
France	Fr.F	1,229,000	270,000[2]
United Kingdom	£	52,500	120,000
Japan	US$	348,000	348,000[3]
New Zealand	NZ$	240,000	235,000
United States of America	US$	225,000	225,000

1. There are significant differences in the contributed amounts because some countries have already paid their second year contribution to the programme while others have not yet completed the first year's contribution

2. In January 1979, an additional payment of Fr.F. 400,000 was received from France.

3. The Japanese contribution in the first year was the payment of a three-month charter (US$168,000); in the second year Japan made a money contribution (US$180,000).

SURVEY AND ASSESSMENT RESULTS

July 1978 - January 1979: At the end of June 1978, the survey vessel Hatsutori Maru was in the waters of Tuvalu; she completed the survey of Tuvalu during the first days of July before proceeding to the Gilbert Islands and then the Trust Territory, where the first year of the programme was completed on 14 August, in Saipan.

The Hatsutori Maru arrived in Japan on 21 August for overhaul and refit prior to the commencement of the second year on 2 October 1978.

Results of the first year of the programme: The results of the first year were better than anything we could have hoped for: 50,500 skipjack and other tunas were tagged and released, exceeding the target originally set by 20,500 (68 per cent).

Tagging, baitfish survey, and research work were successfully carried out in the 12 different countries and territories visited. Because major tagging efforts had not previously been made in the waters of most of these countries and territories, the SPC skipjack programme should provide a major advance in the understanding of tuna migrations and stock structure in the region. The data already collected concerning tuna and baitfish occurrence and biology are considerable. A total of 18,920 buckets of bait were caught (28.4 t) in 238 hauls during 152 nights in 95 different stations. During 1,634 hours spent searching and fishing 1,239 schools were sighted; of these 681 were chummed and 322 (47 per cent) responded positively. From these 322 schools, 7,056 skipjack and 813 yellowfin were accurately measured (fish on deck), and several tens of thousands were roughly measured, tagged and released. Blood samples were taken from 3061 fish from 20 different schools in 9 different countries.

October 1978 - January 1979: The second year of the programme started in Guam and the Trust Territory. In mid-November the vessel left Majuro in the Marshall Islands for Tokelau, and later proceeded to the Northern Cook Islands (Suwarrow, Penrhyn), before arriving on 7 December in Papeete, French Polynesia, where she stayed until the end of January. Twelve thousand and sixty three skipjack and other tunas have been tagged in the second year, bringing the total to 62,500. This is more than the target originally set for the first two years of the programme, with six months of the second year still remaining.

Tag recoveries: To date almost 1,700 recaptures have been reported. Of these about 80 have been recaptured in the waters of a different country from that in which they were tagged.

Data processing and analysis: A computer file containing the release and recapture information has been maintained. We have also begun to acquire computer files of commercial catch and fishing effort in the region. A Hewlett-Packard 1000 computer is due to be delivered to SPC headquarters in March 1979, and will make it possible to begin analysing the results to date with a view to assessing the stock structure and migration of skipjack.

FUTURE SCHEDULE

In February 1979, the Hatsutori Maru concluded the second part of her survey of the southern part of the Cook Islands (Rarotonga, Aitutaki) and proceeded to New Zealand[1]. The survey of Niue has been postponed. After a month in New Zealand the Hatsutori Maru will go to Australia and then Papua New Guinea. The schedule from June 1979 has not yet been finalised.

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Erratum: The article "Influence of currents on the production of tropical seas: consequences for fisheries" by R. Grandperrin which appeared in Fisheries Newsletter 17 contains an error in Fig. 2. In the legend the "east setting current" should be shown as "west setting" and the "west setting current" as "east setting".

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1. On 2 March 1979 in New Zealand the tagging team set a new world record for the number of skipjack tagged in one day - 3,600.