THE SOUTH PACIFIC COMMISSION FISHERIES NEWSLETTER

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THE 1979 SPC FISHERIES MEETING

SPC's Eleventh Regional Technical Meeting on Fisheries, which was held in Noumea from 5-10 December 1979, was attended by about 50 participants and observers including representatives from 14 countries and territories. In recent years the Fisheries Meeting had been held early in the year; the 1979 meeting was fixed for December so that any recommendations arising from it could where necessary be incorporated into the Commission's proposed work programme, which is put forward to the Planning and Evaluation Committee in May of each year.

The meeting unanimously elected Mr Harry Kami of Guam as Chairman and Mr Brendan Dalley of Kiribati as Vice-Chairman. It began by reviewing progress of all aspects of SPC's activities in the field of coastal fisheries.

The Deep Sea Fisheries Development Project has visited 10 countries and territories since its inception in March 1978. This project, which introduces new fishing methods for deep bottom fishes, has revolutionised artisanal fisheries in many places. Catch rates have, without exception, been much higher than those achieved by traditional fishing techniques. In October 1979 a third master fisherman was appointed to meet the demands for this project; the team now comprises Mr Tevita Fusimalohi, Mr Paul Mead and Mr Pale Taumaia, each working independently at different locations.

Mr Mark Gentle, SPC bêche-de-mer specialist, reported on his research on commercially valuable species of bêche-de-mer. Mr Gentle, who is funded by SPC and works in conjunction with Fiji's Fisheries Division, has been carrying out his studies since August 1978. The meeting then heard from Mrs Chantal Conand of the ORSTOM Centre, Noumea, also working on bêche-de-mer, and who has co-operated closely with Mr Gentle. Following an interested discussion on bêche-de-mer, the meeting recommended that a detailed survey of marketing opportunities for this product be undertaken.

The meeting heard a report on fisheries training funded through the SPC regular budget and through outside sources arranged by SPC. This included courses on bêche-de-mer processing, training in aquaculture and the sponsoring of nine Pacific Islanders to a specially arranged 18-week fishing cadet course at Nelson Polytechnic, New Zealand, in 1979.

The meeting considered information services on fisheries. Reports produced since the previous meeting have included those on the Outer Reef Artisanal Fisheries Project (two), the Deep Sea Fisheries Development Project (five) and the Turtle Project; amongst other documents the first edition of the Fisheries Directory of the South Pacific Commission Region also appeared in 1979. The meeting recommended that in addition to the *Fisheries Newsletter* and other useful publications, SPC disseminate information on films dealing with fisheries training and development.

The meeting then heard reports from representatives of FAO/UNDP, the Southwest Fisheries Center (Hawaii), ORSTOM, CNEXO, the University of the South Pacific and the fisheries departments of Australia and New Zealand, who described their organisations' fisheries programmes. Many of the topics discussed were illustrated by films, slides and videotapes, which were greatly appreciated.

Four seminar sessions were held during the meeting. The first dealt with research on deep bottom fishes, with Mr Richard Uchida of the Southwest Fisheries Center, Hawaii, acting as consultant. Deep bottom resources are beginning to be developed in many places in the Pacific and their importance was recognised by the meeting when it recommended that SPC study the effects of the development of fishing on them. It also recommended that countries collect catch statistics on deep bottom fishes.

The second seminar session concerned aquaculture, with the main emphasis on mollusc culture (particularly the Philippines green mussel) and the raising of live bait for tuna fishing. The meeting recommended that SPC stimulate regional co-operation in aquacultural matters such as training, the distribution of desirable species, the supply of fry and spat, and the dissemination of information. On 8 December participants visited the CNEXO aquaculture station and three private oyster, mussel and shrimp farms on the west coast of New Caledonia.

The third seminar reviewed the use of floating objects to attract fish. Several participants reported on trials in their own countries. The meeting felt that despite some technical problems, floating objects made it easier to catch fish and thus reduced fuel consumption, as less time was spent in searching for fish. The last session considered the use of teledetection and aerial surveys for locating surface swimming tunas.

The final day of the meeting was devoted to the Expert Committee on Tropical Skipjack which reviewed and discussed SPC's skipjack survey and assessment programme. The meeting recognised the need for a centralised information service on tunas and recommended that until this was established all countries collect statistics on the standardised forms which are already available[1]. Dr George Habib, tuna biologist with New Zealand's Fisheries Research Division and Dr Jacek Wankowski of Kanudi Fisheries Research Laboratory, Papua New Guinea were consultants to the Expert Committee meeting.

The Fisheries Meeting was directed by the SPC Fisheries Adviser, Dr René Grandperrin, assisted by Mr James Crossland, Fisheries Assistant. Dr Robert Kearney, Skipjack Programme Co-ordinator, directed the Expert Committee on Tropical Skipjack.

WORKSHOP ON MARINE TURTLES

A Workshop on Marine Turtles in the Tropical Pacific Islands was jointly convened by the South Pacific Commission and the U.S. National Marine Fisheries Service (NMFS) at SPC headquarters from 11-14 December, immediately following the Eleventh Regional Technical Meeting on Fisheries.

Six of the seven species of marine turtles in the world are known from the SPC region: the green turtle *Chelonia mydas*, the flatback *C. depressa*, the hawksbill *Eretmochelys imbricata*, the loggerhead *Carreta caretta*, the leatherback *Dermochelys coriacea* and the olive ridley *Lepidochelys olivacea*. In many parts of the world, including the Pacific, the numbers of turtles have declined, The workshop, which was attended by 38 participants and observers, was called together to review the state of knowledge on marine turtles in the region and to formulate guidelines for future management, research and conservation of the species.

Three well-known experts on marine turtles - Mr George Balázs of the Hawaii Institute of Marine Biology, Professor Archie Carr of the University of Florida, USA, and Dr Peter Pritchard of the Florida Audubon Society - were consultants to the workshop. The consultants provided an introduction to the workshop with a brief review of the biology and status of the different species. It was apparent that there are large gaps in our knowledge of the life histories of all the species.

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1. See: *Ad hoc* Meeting of the Expert Committee on Tropical Skipjack, 4-8 December 1978. Report. SPC, January 1979.

The workshop then went on to discuss the distribution, abundance and known nesting areas of the various species in the member countries of SPC and the neighbouring regions. Other topics to be covered were the importance of turtles in traditional life, for commercial purposes and for subsistence. The workshop reviewed regulations on marine turtles presently in force in different places and discussed the difficulties of enforcing them. The topic of turtle farming was also considered and reports were presented on the SPC turtle project in the Cook Islands (which terminated in 1977), the Australian Government project in Torres Strait, and the Western Samoan project which raises young hawksbill turtles for release at sea. It was the feeling of the meeting that turtle farming was not a practical proposition for the Pacific Islands at the present time.

After much lively discussion the workshop made a series of recommendations for future action. It recommended that research be carried out on the hawksbill turtle whose survival is threatened by the world demand for tortoise-shell. Other recommendations concerned the need to establish turtle breeding sanctuaries in the Pacific Islands, the expansion of conservation, education and research programmes, and a proposal for a Pacific turtle tagging programme. It was pointed out that SPC could not undertake basic reasearch work itself, however it could contribute in other ways and the workshop recommended that SPC circulate information and develop basic educational materials on turtles.

A total of 15 working papers was produced for the workshop, together representing a considerable body of knowledge, much of it covering areas where there was previously little or no information. The workshop also benefited from several relevant papers from the World Conference on Sea Turtle Conservation, held shortly before in Washington, D.C., USA and kindly brought over by Mr Balazs.

The workshop was directed by Dr René Grandperrin (SPC) and Mr Richard Shomura (NMFS) and was chaired by Mr Harry Kami of Guam.

REPORT ON PALAU'S TROCHUS HATCHERY PROJECT

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INTRODUCTION

For several decades, the top shell, *Trochus niloticus* (Fig. 1), has been one of Palau's most important marine export products. Valued for its nacreous shell and edible meat, this large, herbivorous snail is a conspicuous component of the outer reef surf zone, and it is easily harvested by free diving. As early as the 1950s, evidence of serious overfishing of Palau's trochus population (McGowan, 1956) necessitated the implementation of a series of strong conservation measures. Currently, the trochus collecting season is restricted to one month or less per year, and shells smaller than three inches (76 mm) may not be taken. In addition, 16 sanctuaries have been designated, from which collection is prohibited.

As a further means of ensuring conservation of this resource in Palau, biologists at the Micronesian Mariculture Demonstration Center (MMDC) (Fig. 2) have developed techniques for rearing larvae and juveniles on a large scale. The aim of this project is to use hatchery-reared juveniles as seed for restocking depleted reef areas. The initial success of this effort is notable since many previous attempts to induce spawning and raise larvae have failed. Early unsuccessful attempts to culture larvae were reported by Moorhouse (1932) in Australia, and by Rao (1937) in the Andaman Islands.

Recent work by B. Smith (personal communication, 1979) at the University of Guam Marine Laboratory demonstrated that spawning could be induced by means of potassium chloride injection; however, this technique was abandoned since it yielded inviable embryos. Subsequently, A. Hillmann of MMDC induced spawning by using hydrogen peroxide injection; again, all embryos produced developed abnormally.

With our discovery that adults spawn in captivity on a year-round, monthly cycle, it has become unnecessary to induce spawning by artificial means. We have found that adults survive very well (97 per cent per month) and reproduce repeatedly when held in flowing seawater tanks of 5,000 to 100,000 l capacity. Since the tanks are outside in full sunlight, the walls and floors support a rich growth of green filamentous algae and other algal forms, on which the trochus feed.

METHODS

Ordinarily about 50 adults are held in 5,000 l tanks and up to 200 animals are held in 100,000 l tanks. Beginning three days before the new moon, water flow to the tanks is turned off during the evenings. The trochus usually spawn within a few days of each new moon, starting at about 8.30 pm. After spawning, adults are removed to other tanks. Developing embryos (Fig. 3A) are provided with aeration for eight days. Settlement and metamorphosis of most of the larval population occurs from 3-8 days (Fig 3 B, C). After this period the water is again turned on, and the system is left undisturbed for 2-3 months. During this time juveniles feed on algae growing on the walls and floors of their tanks. At 2-3 months of age the young trochus can be swept up with a broom and transferred to other tanks or to the field.

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1. Present address: East West Center, Box 1623, 1777 East West Rd, Honolulu, Hawaii 96848.

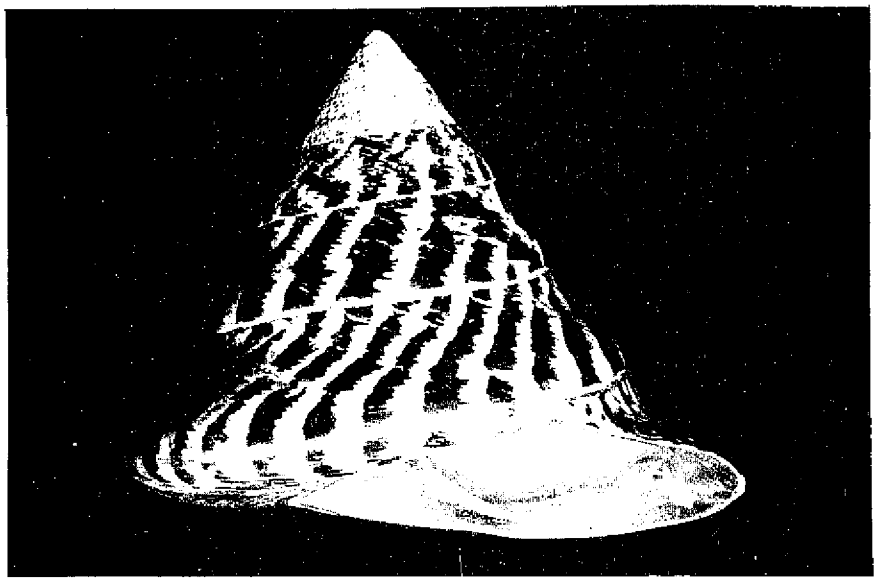

Fig. 1: Adult *Trochus niloticus,* 102 mm in shell diameter.

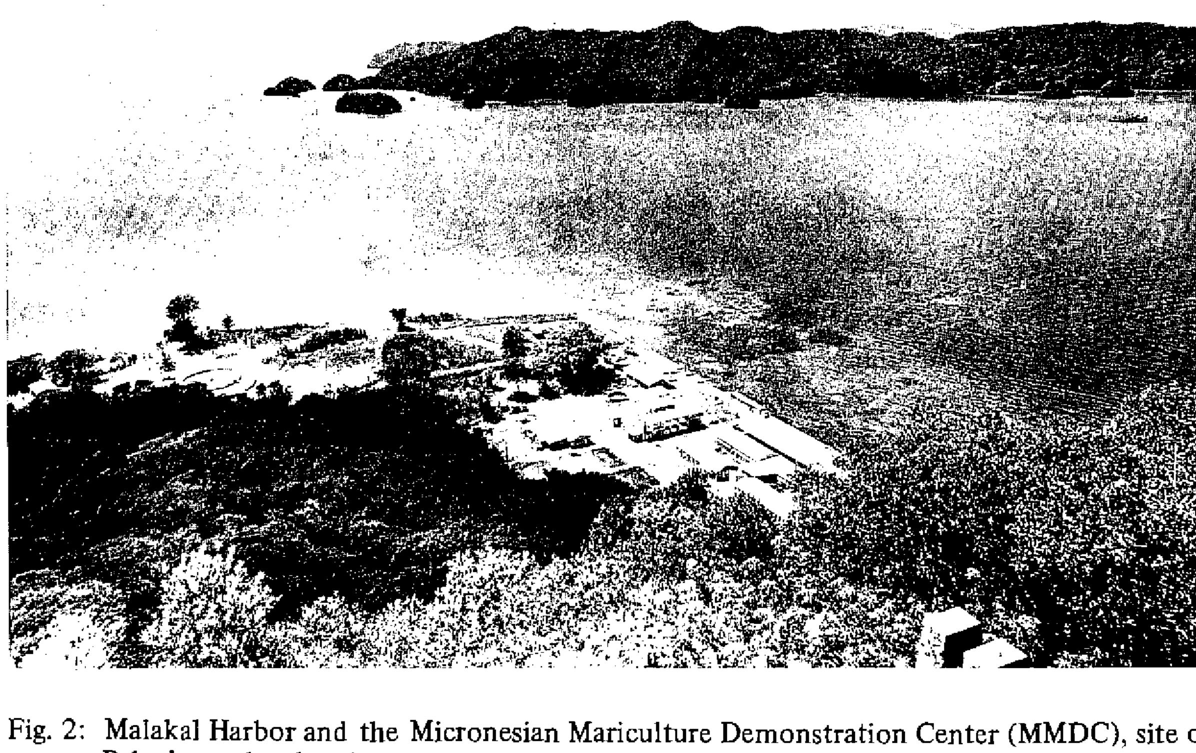

Fig. 2: Malakal Harbor and the Micronesian Mariculture Demonstration Center (MMDC), site of Palau's trochus hatchery.

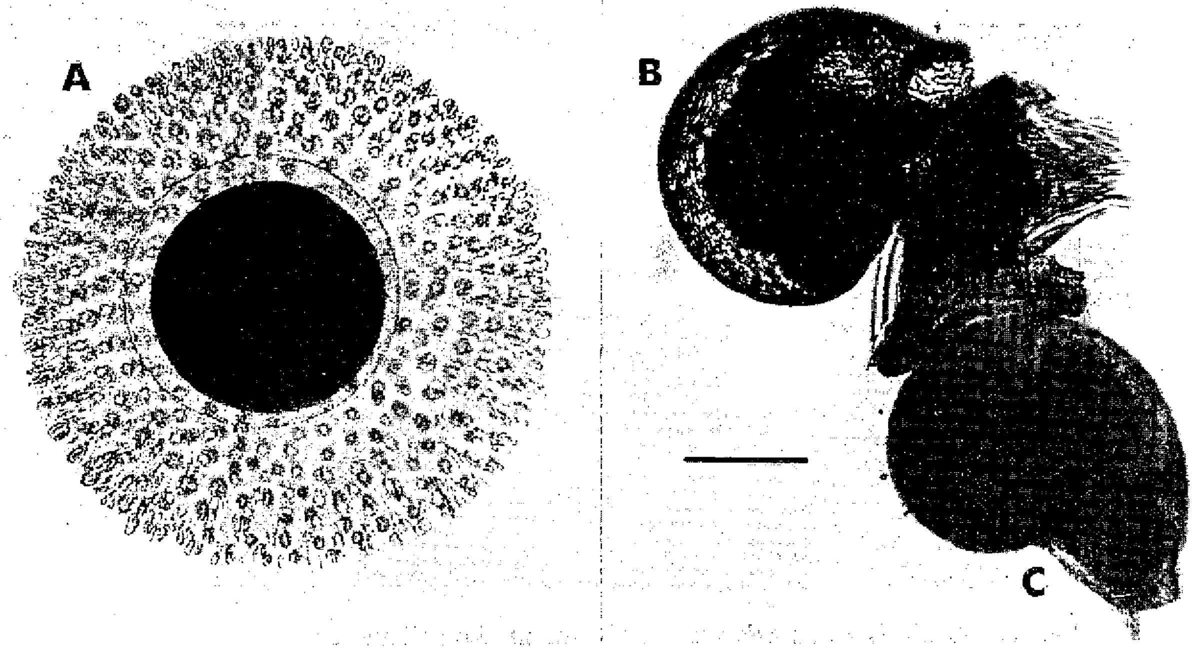

Fig. 3: *Trochus niloticus* fertilized egg (A), and day 3 veliger larvae (B and C) just before settlement and metamorphosis. Scale bar = 100 microns.

Fig. 4: Hatchery-reared *Trochus niloticus* juveniles 4 months after fertilization.

RESULTS AND DISCUSSION

Using this technique we have reared batches of up to half a million juveniles. Survival from egg to metamorphosed juvenile exceeds 50 per cent in large outdoor cultures and 85 per cent in small laboratory cultures. In outdoor tanks, survival from egg to 2 months of age is about 20 per cent and from egg to 4 months of age about 10 per cent. Juveniles in the system grow at an average rate of 2 mm/month and a maximum rate of 4 mm/month during their first 4 months after fertilization (Fig. 4). We consider these survival and growth rates to be surprisingly high in view of the simplicity and low maintenance requirements of the system.

In summary, hatchery culture of *T. niloticus* is now technically feasible, due in large part to the following biological characteristics of the species:

1. Adults in captivity spawn on a predictable schedule;
2. Larvae are lecithtrophic (yolk-eating) and require no additional feeding during the planktonic period;
3. The larval planktonic period is comparatively short;
4. Larvae appear resistant to bacterial necrosis and ciliated protozoans;
5. Juveniles are herbivorous and grow well on algae occurring naturally in our tanks.

The culture system we have developed for trochus is perhaps unique in that no water filtration, antibiotics, or supplemental foods are required at any point in the process. In view of these considerations, we expect that development of similar hatcheries may be possible on other Pacific islands. Alternatively, trochus seed produced at one or more facilities could be air-freighted to other districts for planting.

Our current research objectives include:

1. Determination of hatchery production capacity, based on tank space and water availability.
2. Identification of size-specific juvenile mortality rates in the natural environment.
3. Release and monitoring of hatchery-reared juveniles, beginning in sanctuary areas.
4. Continued investigation of life-history characteristics, with emphasis on reproductive and developmental aspects.

Finally, we are interested in establishing correspondence with other workers involved in trochus harvesting, management, or research.

ACKNOWLEDGMENTS

This work has been supported by the Resource Systems Institute of the East West Center, Honolulu, the Hawaiian Malacological Society and the Division of Marine Resources, Trust Territory Government of Micronesia. Special thanks are extended to the staff of the Micronesian Mariculture Demonstration Center and the Palau Marine Resources Division.

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THE TROCHUS FISHERY IN NEW CALEDONIA

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Trochus *(Trochus niloticus)* is a reef-dwelling gastropod of the tropical Indo-West Pacific region. It is exploited for its shell, which is used for mother-of-pearl and has been exported from New Caledonia since the beginning of the century. Fishing for it is done at low tide on the reefs or by free diving in depths of 1-5 m. The meat is extracted after boiling and is usually discarded. The shells are cleaned and dried and forwarded to Noumea where they fetch an average price of 26,000 francs CFP (US$356) /t. In Noumea they are cleaned again and graded before export to Europe (54 per cent) or Japan (41 per cent) at an average price of 45,000 francs CFP (US$616) /t. The shell is used for making buttons (Fig. 1) and, to a lesser extent, for fancy jewellery and curios. The waste portions of shell are crushed and the powder is used for making paints and nail varnish. Although only 0.5 per cent of buttons in the world are made from mother-of-pearl, there is a current annual demand of the order of 6,000 t of unprocessed trochus shell.

In 1978, New Caledonia exported 1,900 t of trochus, which was more than 30 per cent of the world production. In value, it was the territory's most important non-mining export. It is very often the only source of revenue for tribes in the north and north-east of New Caledonia. There are no exploitable trochus stocks in the Loyalty Islands or the Isle of Pines. The main quantity harvested comes from the west coast (Fig. 2). On the west coast, as far north as Voh, the fishermen are Tahitians or Europeans; further north, on the east coast, and in the south, the fishermen are Melanesians. The large tonnages in the last few years (Fig. 3) are due to the long period known as the 'mining boom' during which the fishery was at a very low level or non-existent and the stocks thus had time to build up.

The Noumea ORSTOM centre has studied the growth of trochus by tagging the shells (Fig. 4) and recapturing then over a period of 18 months.[1] Growth of trochus is quite fast for the first 2-3 years (up to a size of 8 cm), then it becomes very slow. It takes 10 years for trochus to attain a size of 12 cm (base diameter). Large trochus (over 11 cm) made up the bulk of the landings in 1977-1978. Landings for 1979 can probably be maintained above 1,000 t, but with the risk of contributing to a sharp drop in the early 1980s.

Fig. 1: Button blanks cut from trochus shells.

1. A report on this work is in preparation.

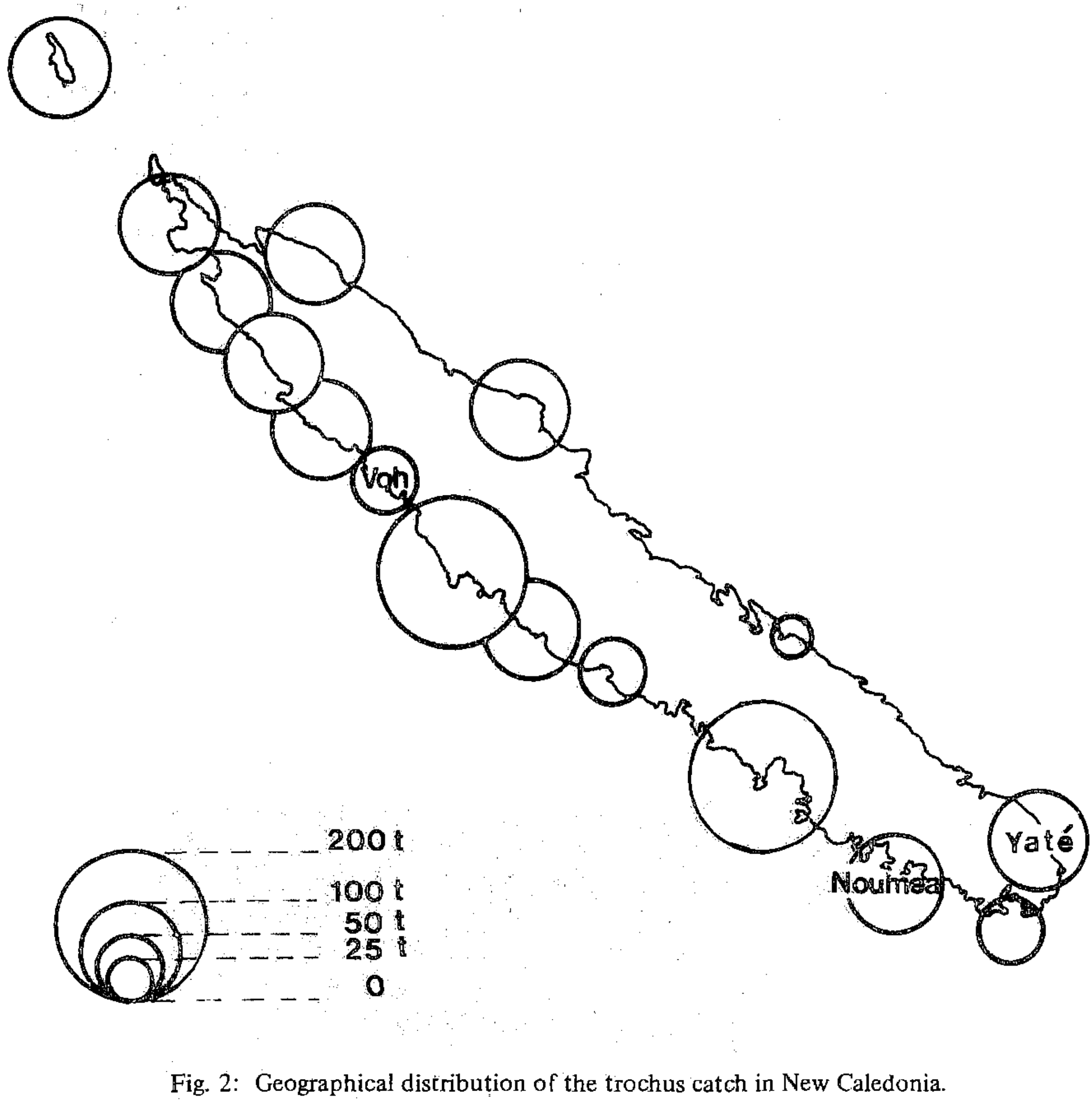

Fig. 2: Geographical distribution of the trochus catch in New Caledonia.

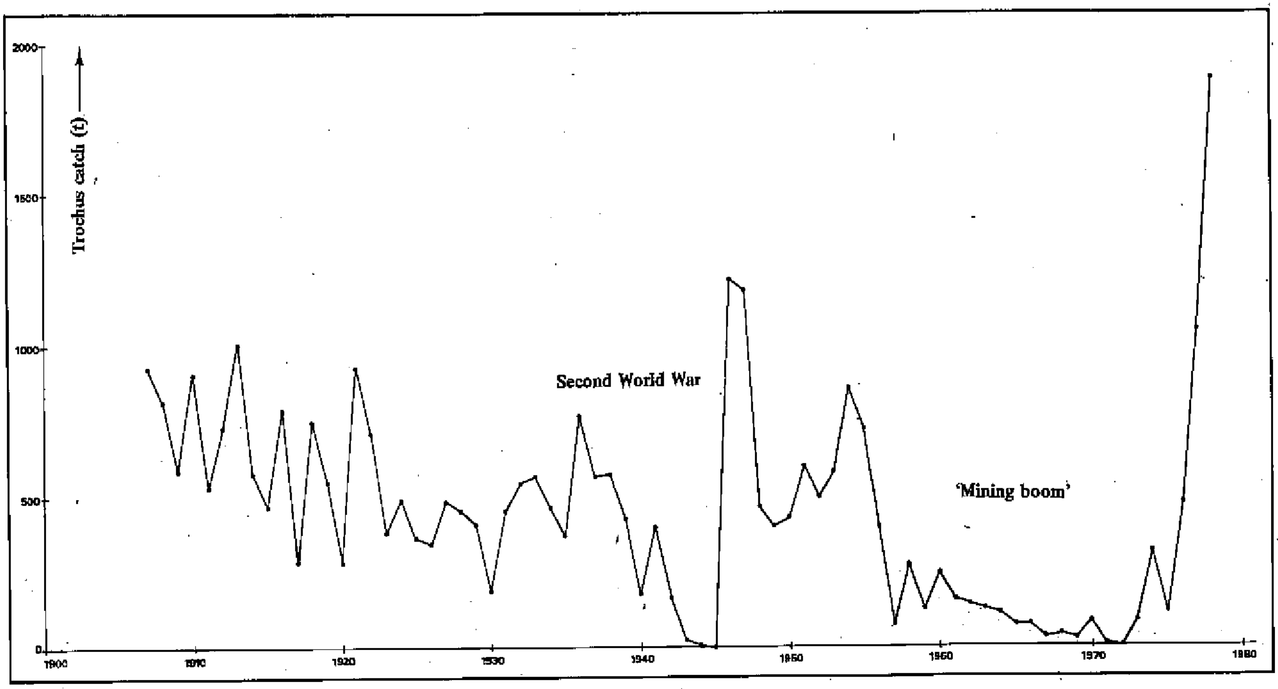

Fig. 3: Trochus exports from New Caledonia, 1907-1978.

Fig. 4: Tagged trochus for growth studies.

At the present time fishing for trochus is permitted throughout the year for persons holding a licence. Licences, issued by Affaires Maritimes, are free. Only trochus with a diameter of 8 cm or greater can be taken. At this size, trochus have already begun to reproduce, as sexual maturity is attained at 6.5-7 cm. Small specimens (6-10 cm) are most valued on the European market. The shell from large individuals (12 cm and above) is not of good quality (too thick and encrusted with calcareous algae). Some countries have a regulation restricting the capture of trochus to those between 6 and 12 cm; reproduction is then assured by the very large individuals. The lower tonnage harvested is compensated for by the better quality of shell from young specimens. The adoption of such a regulation could be considered for New Caledonia but would cause problems on certain reefs. For example, in the south (Unia, Yaté, Touaourou, Goro) the populations are already overexploited and all trochus are caught before reaching 9 cm. If a new regulation (as above) were introduced, the reproductive stock would no longer be safeguarded and it would be necessary to reseed the reefs with several tonnes of mature trochus taken from the lagoon on the west coast.

With the present state of the stocks it does not appear necessary to change the fishing regulations. It is certain that the 1977-78 tonnages cannot be maintained, however, the New Caledonian reefs should be able to continue to produce 1,000 t/year (17 per cent of world consumption) without overexploitation, provided the catches are evenly distributed throughout the lagoon.

AUSTRALIAN ASSISTANCE TO DEVELOPMENT OF FISHERIES IN THE SOUTH WESTERN PACIFIC[1]

The past decade, and in particular the past five years, has witnessed the emergence of a number of independent states in the south-western Pacific region and this has impressed upon the Australian government the need for a recognition of its responsibilities to such states in the development of their economies. A number of Australian government leaders, notably the Prime Minister and the Foreign Minister, have stated publicly that the government is mindful of these obligations and the increased levels of developmental assistance over this period bear testimony to this awareness.

In a general aid context the Australian commitment to the region has risen dramatically since 1976. Funding on a bilateral basis for various island programmes during the period 1976/77 to 1978/79 increased some 400 per cent over the previous three year period to A$63 million and allowance has been made in this year's budget for a further increase of 33 per cent to take Australia's commitment to the region for 1979/80 - 1981/82 to A$84 million. At the moment Australia is undertaking some 130 projects with a total value of $74 million in the South Pacific. The expenditure target for the current year has been set at $28 million and provision has been made for an annual review of such expenditure. This commitment does not include provision for aid to Papua New Guinea, which holds special significance for Australia and commands an independent appropriation in its own right.

In addition to this bilateral package, contributions are also made on a multilateral basis, such as the contribution to the SPC budget, and through the Defence Co-operation scheme.

Turning specifically to fisheries commitments you will be aware of Australia's support for the operational costs of the Commission and its support of the SPC skipjack programme over the past three years. As the skipjack programme has now been extended for a further 12 months, the Australian commitment will be extended for that period at 40 per cent of its past contributions, i.e. $100,000 for that period.

Australia also contributes substantially to the running costs of the Forum Fisheries Agency (FFA) and as in the case of SPC, funding is at the level of one third of the operational budget.

Australia sees both the SPC and FFA performing important roles in the determination of the South Pacific future and will continue to channel funds through these bodies to ensure that valuable work programmes can be undertaken and satisfactorily completed without unnecessary financial pressure.

Bilateral assistance in the development of fisheries has, so far, been limited. One particular programme of interest has included the building of cold storage facilities and other facilities on Vava'u in Tonga and the provision of a refrigerated fishing vessel in an attempt to both improve the methodology of local fishermen and provide a basis for the expansion of the local industry. To date this project has cost $287,000. Port development at Nuku'alofa at a cost of $8.5 million and the construction of a deepwater wharf at Funafuti estimated at $1,360,000 will also contribute to the expansion of this undeniably vital industry.

Within the context of fisheries surveillance Solomon Islands took delivery of a 16 m inshore surveillance patrol boat on 1 May 1979 and its effectiveness has already been ably demonstrated. The package, which included the vessel itself, spare parts, a limited training programme and the technical assistance of an Australian naval officer for the initial three months of its operation, cost $850,000.

1. Paper prepared by the Department of Primary Industry, Canberra and presented at the 11th SPC Regional Technical Meeting on Fisheries, Noumea, 5-10 December 1979.

Early in 1980 a team of experts from various Australian departments will be undertaking a survey throughout the member states of the South Pacific Forum as a means of accurately assessing the civil coastal surveillance requirements of these states and will be recommending to the South Pacific Bureau for Economic Co-operation, FFA and the individual states concerned the actions it sees necessary.

Whilst direct aid to individual states to assist in the development of their fisheries appears limited, Australia sees its financial obligations lying in the first instance with the multilateral bodies such as SPC, FFA and the various agencies within the FAO framework. This ensures that a harmonised approach to regional problems, which are for the most part reasonably consistent, is adopted. The individual needs of individual coastal states will not, however, be neglected.

The proclamation of 200-mile fishing zones by states within the region could result in significant economic benefits provided that the fish resources within the zones are utilised to maximise economic and other benefits for these states. Organisations such as the South Pacific Commission and the Forum Fisheries Agency have important contributions to make to our knowledge and management of the resources within these zones, and you can be assured that Australia is prepared to give its moral and financial support to the activities of the Commission and similar bodies.

DEEP BOTTOM FISHING IN NEW CALEDONIA

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INTRODUCTION

Deep bottom fishing can be considered to begin at a depth of 120 m, and to end around 400 m with the disappearance of the economically important species.

On the main island of New Caledonia and at Ouvea, where the lagoon waters are filled with fish, the need to fish outside the barrier reef has not yet been felt. At Lifou and Mare, where deep water is close to shore, deep bottom fishing is occasionally carried out in depths averaging 180 m.

For several years there has been a fall-off in the sale of lagoon fish. The purchasing power of the consumers has decreased and the fear of eating toxic fish[1] is becoming increasingly great amongst those coming from France. Deep water fishes, which are of excellent quality and are never toxic, offer an opportunity to improve fish sales and to develop fishing activity.

The deep water fishes are represented by a small number of families and species, the dominant ones being the deep water snappers (Etelidae[2]). Descriptions of the species, information on their habitats resulting from fishing trials on the ORSTOM vessel *Vauban*, and details of the fishing methods used, are given below.

DEEP WATER FISH SPECIES

ETELIDAE (Deep water snappers)

(a) Genus *Pristipomoides*

The six species of this genus differ in colour and by the shape and number of scales; their fin counts are the same: D.X, 11, A.III, 8. This formula is also the same for the other genera: *Etelis, Tropidinius* and *Aphareus.* Concerning the lateral line scales, *P. multidens* has 50-52; *P. flavipinnis, P. filamentosus* and *P.* sp. have 60-62 and *P. sieboldi* and *P. auricilla* have 70-72.

Descriptions of the three most important species follow:

Yellow jobfish *(P. flavipinnis)*

The upper part of the head is marbled in pink-lilac and yellow-olive. The lateral line and the pectoral fin are yellow. The caudal fin is pink with a yellow margin. There are large yellow spots on the membrane of the dorsal fin. Its habitat is between 150 and 300 m and it lives permanently at the bottom. Maximum weight 3 kg.

Rosy jobfish *(P. filamentosus)*

The dorsal and ventral profiles are symmetrical. On capture the colour is white tinged with pink or violet, slightly silvery. The caudal fin has a red margin, particularly bright in the fork, and it is this characteristic which most quickly distinguishes it from the yellow jobfish. The other fins are tinged with yellow-pink.

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1. Because of ciguatera.
2. Often classified as sub-family Etelinae of the Lutjanidae.

This species is found from 40-250 m, the optimum depth being 150 m. Unlike the preceding species it may leave the bottom, forming schools which follow the macro-plankton. It can reach 6 kg but averages slightly less than 2 kg.

Large-scaled jobfish *(P. multidens)*

It can be identified by its large scales, of which there are 50 along the lateral line, by the purplish-red colour veined with yellow on top of the head, and by a yellow line under the eye. It is caught at an average depth of 260 m outside the reef on the west side of New Caledonia and around 220 m to the south of the Isle of Pines where the slop is gradual. Average weight 4.5 kg.

(b) Genus *Etelis*

Short-tailed red snapper *(E. carbunculus)*

This species is a vivid orange red. The point of the lower lobe of the caudal fin is white. It has a robust shape, short tail and powerful canine teeth. It is caught between 230 and 440 m, most commonly around 320 m.

This is the largest of the deep water snappers and can reach 30 kg. About ten specimens over 18 kg have been taken in New Caledonia, but 6-8 kg is the usual size caught.

Long-tailed red snapper *(E. oculatus)*

This magnificent fish is cherry-red in colour, slender in form, with very elongated lobes to the caudal fin. Its dentition is weak. It is taken between 300 and 450 m. In weight it can reach 15 kg, but two thirds (by weight) of catches comprise specimens from 6-9 kg.

Outside the reef on the west of New Caledonia the average proportions of the two *Etelis* species (by weight) have been two thirds *E. carbunculus* and one third *E. oculatus*. The ratio is reversed on offshore banks, particularly those between Ouvea and Lifou and to the south of the Isle of Pines.

The two *Etelis* species are sold at a high price in Japan and Hawaii. In Reunion the price per kilo is 60F (1090 francs CFP or US$15). Being excellent food fishes and never toxic, as mentioned earlier, they could be sold at 400 francs CFP (US$5.50)/kg in Noumea.

(c) Genus *Tropidinius*

This genus is represented by two species, *T. zonatus* and *T. argyrogrammicus*, known as flower snappers. They are only of interest as indicators of favourable sites for *Etelis* as they are found between 250 and 400 m. The larger of the two, *T. zonatus*, is magnificently coloured with eight parallel bands alternately golden-yellow and vivid pink. It does not exceed 1.5 kg.

(d) Genus *Aphareus*

The small-tooth jobfish, *Aphareus rutilans*, with its large tail, is a fast swimmer. Its lower jaw is very long and projecting; it feeds on small prey. It lives near the bottom at an average depth of 150 m. It is taken irregularly with the best places seeming to be the sea mounts of the Loyalty Islands. Its weight can reach 10 kg.

SERRANIDAE (groupers, rock cods)

Epinephelus morrhua

Body greenish-brown marked with three or four darker brown encircling bands (longitudinal), sometimes with lines composed of dots. Small specimens are found from 140 m, the adults, which reach 6 kg in weight, as deep as 320 m.

Brown-spotted reef-cod *(E. chlorostigma)*

The whole fish is covered in very small, closely spaced hexagonal spots which are olive-green to ochre-yellow in colour. It is found between 150 and 280 m and can reach 7 kg, although the average weight is only 2 kg.

E. septemfasciatus

This large grouper reaches 50 kg. Distinctive features are the membrane of the dorsal fin, which is deeply indented between the spines, and the eight vertical and sharply defined black bands along the body. In New Caledonia it is found between 260 and 320 m but in Australia, Japan, at Reunion and Mauritius, it occurs in much shallower depths.

CARANGIDAE (trevallies, jacks)

Deepwater amberjack *(Seriola rivoliana)*

It is taken near the bottom between 140 and 340 m. The largest specimens (up to 25 kg) are found in the deepest water.

FISHING METHODS

Longlines

The risk of snagging and loss by using ordinary bottom longlines is very great on rough bottoms from 120-250 m. It is less at greater depths but is not reduced to the acceptable level of 10 per cent until depths greater than 400 m.

For this reason the use of a longline set directly on the bottom is avoided. Instead, the line is suspended 15-20 m from the bottom (Fig. 1). The diameter of the main line (nylon, kuralon) is 8 mm. Every 25 m it carries a branch line (Fig. 2) of 50 kg test monofilament nylon. Each of these has a 1 l capacity float, a 1 kg sinker and five hooks. A 6-8 mm diameter buoy line is attached to 8 kg sinkers at each end of the longline. For the artisanal fishery using boats of around 12 m length a single longline of 800 m with three buoy lines or two 400 m longlines each with two buoy lines should be adequate. In both cases some thirty nylon branch lines carrying a total of 150 hooks are attached by clips to the longline. Only a low powered winch is needed to haul the line. Lines are set for 3/4 to one and a half hours depending on the abundance of fish and the frequency of sharks.

On the *Vauban* the starboard side can be cleared to allow trawling. It is also on this side and towards the stern that the longlines are handled. First, two inflatable marker buoys and the buoy line are shot. The buoy line, about 400 m long for *Etelis* fishing, is let go at a moderate speed. On getting close to the attachment point of the buoy, longline and sinker, the speed is reduced so that the small submersible floats and branch lines can be attached without difficulty. The first branch line is unrolled before reaching the first of the 25 m marks along the longline. The branch line and float are then attached by snap clips next to the mark. If a 400 m longline is being used, 15 branch lines and floats are attached before reaching the terminal sinker. The final buoy line is then shot away more rapidly. The operation requires five people, including the captain who must keep a watchful eye to ensure the boat is kept in the desired depth. On a small boat four people are enough.

If an 800 m longline with three sinkers and three buoy lines is used the middle line is coiled ready on the stern and attached as the central weight passes by. Instead of unrolling the buoy lines and longline from a drum onto which they were rolled during retrieval, it is also possible to shoot the buoy lines and pay out the longline from baskets where they have been coiled.

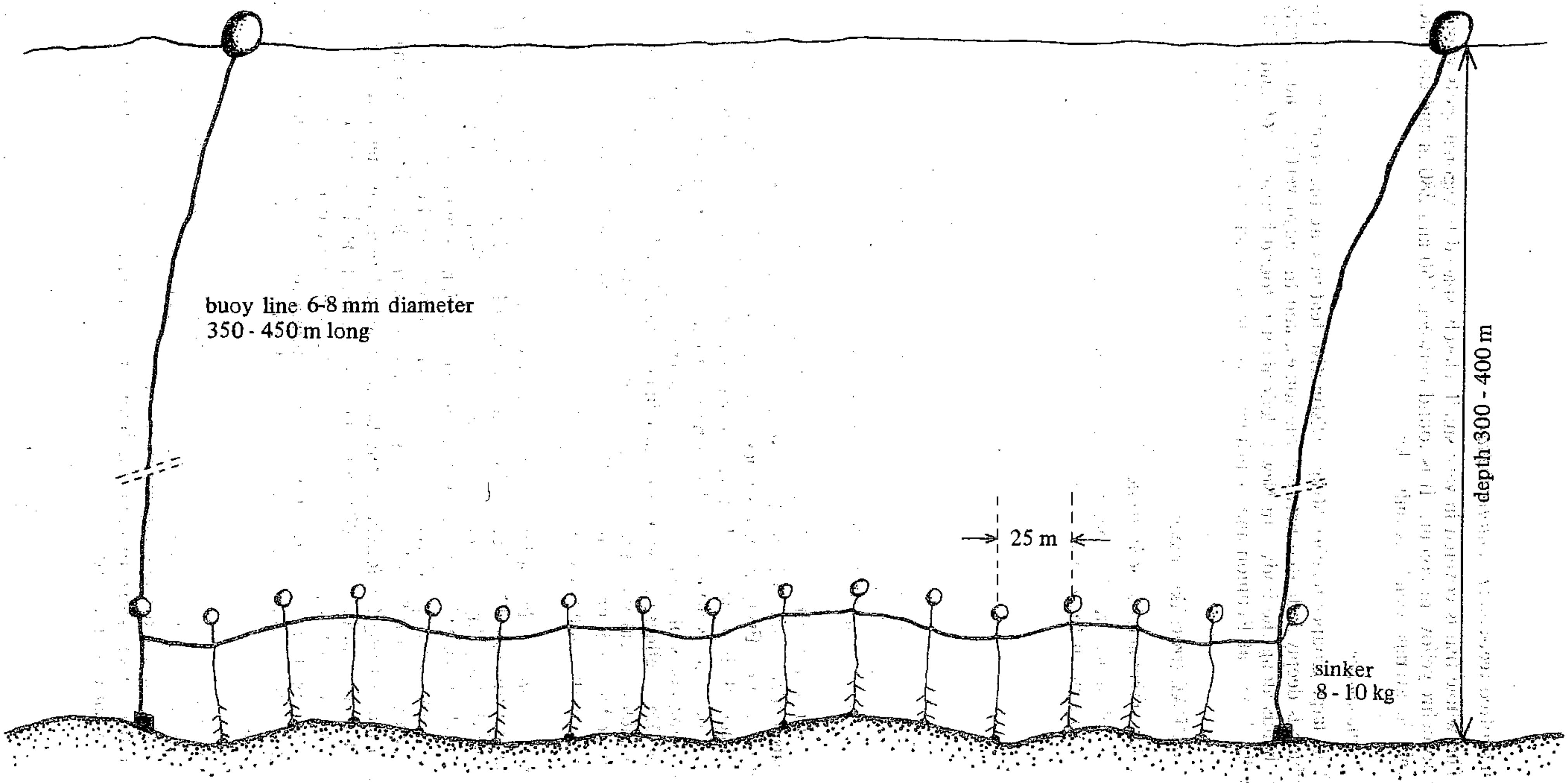

Fig. 1: Suspended longline for use in the deep water snapper fishery.

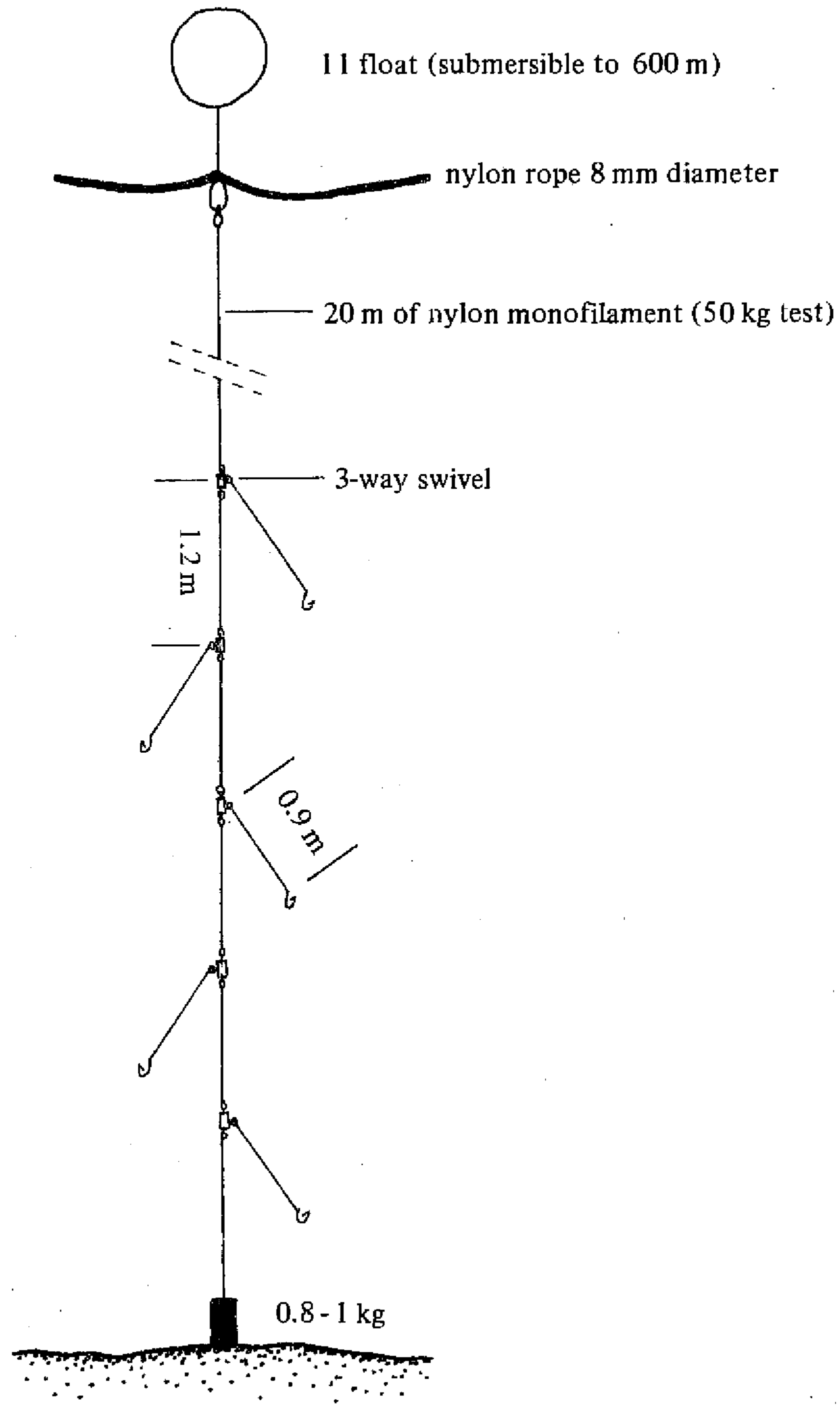

Fig. 2: Detail of branch line and its terminal rig.

Regarding the mounting of the branch lines, strong three-way swivels must be used at the attachment point for the trace carrying each of the five hooks (see Fig. 2). Suitable hooks are Mustad tuna circle or Mustad knife edge, sizes 7 or 8. At the moment of use the lower part of the branch line (about 6 m) is freed to allow baiting of the hooks. The rest of the nylon is kept rolled up by the tension of the snap clip. The part with the baited hooks and the 1 kg weight is put in the water first, drawing out the coils of nylon when the clip holding them has been released. The clip is then attached at the mark on the longline.

The longlines are used in two depth ranges.

150-250 m: The fish caught are predominantly pink and yellow snappers, seldom more than 3 kg in weight. When fish are very numerous (most commonly *Pristipomoides filamentosus*) they attract sharks of the genus *Carcharhinus (C. amblyrhynchos, C. albimarginatus, C. plumbeus)* which break the lines while attacking the hooked fish. It is necessary to make sure there are not too many sharks before leaving a line for one hour at these depths.

280-380 m: The *Carcharhinus* sharks, the main destroyers of the line, disappear successively in the order: *C. amblyrhynchos* (170 m), *C. albimarginatus* (300 m), *C. plumbeus* (320 m). In any case they become very rare after 260 m. The dogfish sharks *(Squalus,* 2 spp., *Centrophorus)* and the six-gilled cow shark *(Hexanchus vitulus)* which replace them, do relatively little damage.

By setting an 800 m line three times a day a catch of around 150 kg can be made, 90 per cent of which is *Etelis.* Squid, fresh or frozen, is the best bait.

This type of fishing is recommended because of the excellent quality of its target species, the deep water red snappers.

Fishing with reels

The sturdy 'red snapper' reel from the United States operated by hand or electrically, is recommended for the sea mounts found between Ouvea and Lifou, Lifou and Mare, and the shelf extending to the south of the Isle of Pines. It is most useful for depths between 130 and 220 m sometimes permitting fishing to be carried out rapidly. In the *Etelis* zone, around 300 m, it is not so useful[1].

CONCLUSIONS

Satisfactory results obtained in fishing trials with longlines on the outer reef slope and offshore banks make it possible to recommend the creation of a small fleet of 10-15 m boats designed for deep bottom fishing and provided with ice holds. The fishery should concentrate on the 280-350 m depth range with trip lengths of five days, when the weather permits.

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1. Editors' note: The SPC deep sea fisheries development project uses FAO design wooden handreels for deep bottom fishing with much success. They are simple, cheap, require few crew, and have proved effective down to 400 m.

PROMISING DEEP BOTTOM FISHING TRIALS BY SPC AT LIFOU AND ISLE OF PINES, NEW CALEDONIA

René Grandperrin

During 1979, Tevita Fusimalohi, one of the South Pacific Commission's master fishermen, spent several months in New Caledonia operating the SPC's deep sea fisheries development project[1]. He concentrated his efforts at Lifou and the Isle of Pines (Fig. 1) where he worked in close collaboration with fishermen from FADIL[2].

Lifou, which has an area of 1,500 km^2, is the largest of the Loyalty Islands. On the western side it is indented by a large bay, very well protected from the trade winds. There is no barrier reef and the bottom falls off sharply near the coast except to the north-west, where there are several sea mounts.

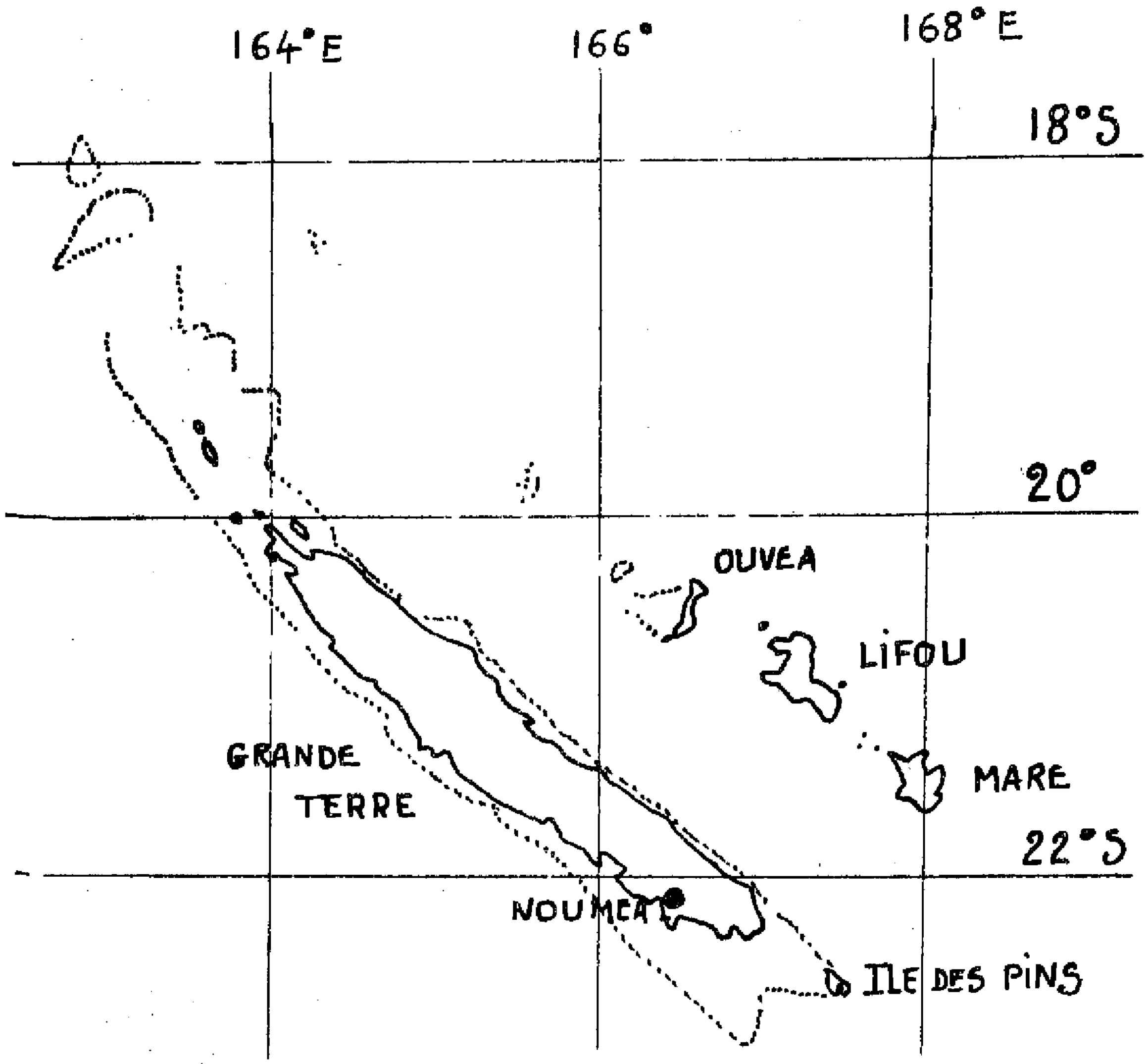

Fig. 1: New Caledonia

1. For full details see: Fusimalohi, T. and Grandperrin, R. (in press): Rapport sur le projet de développement de la pêche profonde en Nouvelle-Calédonie, 9 avril - 3 septembre 1979. SPC, Noumea, 28 pp.
2. Fonds d'aide au développement de l'intérieur et des îles (a government body for the promotion of rural development).

The inhabitants of Lifou are by tradition experienced fishermen. They fish with handlines in depths of 30-150 m. Outrigger canoes are still widely used but are being progresssively replaced by motor launches, 5-7 m long, some powered by small diesels but mostly outboard motors of 25-50 h.p. The aim of the operation was to show these fishermen how to benefit from the type of equipment used by the project, which is simple, cheap and easy to make or to obtain. The equipment consists of wooden handreels (FAO design), monofilament nylon 400 m long, self-hooking hooks (tuna circle hooks) and deep water anchoring equipment which is easy to recover. This gear, more efficient than handlines, enables deeper fishing areas to be explored and thus the capture of species unknown or almost unknown to local fishermen, notably the deep water red snappers, *Etelis carbunculus* and *E. oculatus*. The jobfishes, *Pristipomoides* spp., are well known to people of Lifou.

Using five different boats a total of 26 trips was made around Lifou, with altogether 96 hours of fishing. Some fishing was done at depths around 400 m but most was between 80 and 250 m. Catches totalled 621 fish weighing 1361 kg; the catch per reel per fishing hour was 7.5 kg.

The Isle of Pines has an area of 134 km². On its western side the depths are shallow with many small reef islets. The outer bottom slopes away gradually to form a large plateau.

Fishing there is a common activity but is not so important or remunerative as at Lifou. The traditional sailing canoes, made from the trunks of Cooks pines, are used for handline drift fishing in shallow water (50-60 m maximum), for net fishing, for catching lobsters, turtles, for collecting shellfish and for transport. As at Lifou they are being progressively replaced by powered craft.

Ten fishing trips were made around the Isle of Pines using two boats. Depths of 280-400 m on the east coast were the main ones surveyed. A total of 53 hours of fishing was carried out, catching 229 fish weighing 814 kg. The average catch per reel per fishing hour was 7.8 kg.

Four trips also took place from Noumea on the west coast of the main island of New Caledonia. Three of the trips were drift fishing, as the boat used could not be anchored, and were made in unfavourable weather. Although the results were not very significant, they showed the difficulty of developing a deep bottom fishery outside the reef. Conditions are better in the outer islands. The simple equipment and the anchoring technique were enthusiastically received there, to such an extent that FADIL has undertaken the manufacture of handreels. The deep water species are not known to cause ciguatera, so have good prospects for sale in Noumea.

Fishing activity suitably diversified depending on the seasons (trolling during the skipjack and yellowfin season, deep bottom fishing in good weather, net fishing, etc.) could be a source of substantial income to fishermen in the islands.

SAILBOATS FOR FISHING

Yvan Serve
B.P. 2387, Noumea
New Caledonia

INTRODUCTION

The economy of Pacific islands is closely dependent on the sea. Aware of this, all the governments of the region have announced their intention of declaring 200-mile exclusive economic zones. In these zones, fisheries is the most immediately available resource, and will continue to be so for many years yet. To leave fishing in these zones to foreigners in exchange merely for a licence fee will not develop the economies of the island states. The only way to profit fully from this resource is to develop local fisheries and thus provide employment and increase earnings through exports.

When considering development in any economic sector, the problem of investment must be considered. Looking only at the development of fisheries in industrialised countries gives the impression that fisheries is a heavy industry, requiring large investment. This is true for the United States, European and Asian fishing fleets which use increasingly large boats to go further and further afield in search of fish which are becoming scarce near their own shores. One should not be misled by this: most fish caught in the world are taken from small boats, sometimes very small craft or even simple rafts[1]. For modern boats entirely relying on motor power, however, it is true that the smaller the boat, the greater the consumption of fuel per weight of fish caught. The problem for fishing is therefore one of energy, and it is the one most difficult to solve in the Pacific region.

ENERGY REQUIREMENTS OF THE REGION

Oil, which provides almost all the energy needs of Pacific countries, is becoming very expensive and difficult to procure. Either simply for reasons of economy, to limit their imports, or from difficulty of supply, it is likely that most countries will have to impose restraints on the consumption of fuel one day or another. There are some things for which the use of liquid fuels is essential: cars, trucks, electric generators, aeroplanes. If the amount spent by energy consumers is limited too much the whole economy of a country will be stifled.

On the other hand, boats, and in particular fishing boats, can make the best use of the wind, which has the advantage of being free and in the Pacific Islands is almost constant. A return to the use of sail on fishing boats is thus a necessity to forestall restrictions in the supply of fuel. It is a necessity for the fisherman who wants to continue to go to sea as often as he would like despite possible restrictions and make as much as possible on the sale of his fish. It is also a necessity at the level of governments, which must do their best to encourage this change.

Foreign shipowners whose boats are presently fishing in the 200-mile zones of the Pacific countries are also affected by the constant increases in the cost of oil and will tend to shorten the voyages of their vessels. These zones then risk being fished less and having their resources neglected at a time when the world increasingly needs to obtain its food from the sea. But it should not be thought that Pacific countries will always find an inexhaustible source of revenue in the seas which surround them... If there is no more oil there is no more fishing, and if there is no more fishing there is no means to buy oil ... It is a vicious circle. The only way for governments to avoid this is to encourage the use of sailing boats for fishing as quickly as possible.

1. See page 21, Fishing Boats of the World: 3. Fishing News (Books) Ltd, London, 1967.

IS FISHING POSSIBLE FROM A SAILBOAT?

We are not concerned here to determine if fishing can be done from a sailboat - that has always been possible - but rather to know if it is economically feasible, and what are its limits. To be profitable, fishing can no longer rely just on traditional methods but must use techniques as close as possible to those used nowadays on modern vessels.

By chance, trawling, which requires the greatest power, is impossible on the coral bottoms of Pacific Island shores. Purse-seining is not possible with small boats and the cost of a seiner makes it impractical to consider this method for local fishermen. There remains fishing with floating longlines, pole-and-line fishing, trolling, bottom lining, and trapfishing.

A longline of several kilometres would be very difficult to haul by a boat manoeuvring under sail. Shorter lines with less resistance could undoubtedly be used on simplified sail-boats in the future when crews are more skilled. At present it seems sensible not to engage in this fishing method.

Pole-and-line fishing is quite feasible from a small sailing boat. The Polynesian technique of pearl lure fishing is limited by the speed of the boat while searching for schools. This can be compensated for by the use of floating objects under which skipjack congregate; the distance travelled is reduced and a fast speed is no longer necessary. The use of live bait in fish wells is equally possible as long as the boat is sufficiently large. Pole-and-line vessels are often slow, with good stability, which favours the use of sail. Seawater to the live wells can be supplied by the boat's movement through the water, as in former times.

Trolling is well suited to sailing, despite those who consider that a high speed is needed to catch tunas, especially skipjack. This method has already been used and is still being used with good success in the tropical waters of the Indian Ocean. It enables deeper fishing than the pole-and-line method and the capture of larger and more valuable species. Trolling costs nothing if the wind drives the boat.

Bottom fishing and trapping are carried out with the boat stopped. Propulsion is only needed to go from one fishing spot to another and the motor can always be used for manoeuvring. Sail will then mainly be used for travelling to and from the fishing grounds, which poses no problem.

Thus, most kinds of fishing can be carried out with a sailboat, with trolling and bottom lining suitable for small boats and live bait pole-and-line fishing for bigger boats.

MECHANICAL AIDS

Fishing has become more profitable since the introduction of chilling to preserve the catch and mechanical aids to haul lines or traps with a consequent reduction in crew and greater catch per fisherman.

The preservation of the catch poses no particular problem for sailboats, for it can be very well done using ice for trips as long as one week. Ice can be produced in port and its energy cost reduced compared to that from an installation on board.

To haul trolling or bottom lines small hand-winches with drum ends can be used. By changing the size of the drum, the speed of hauling can be modified for different methods of fishing. Some winches are connected to an hydraulic motor powered by a pump driven off the main engine. On a dory trolling four lines, the power necessary is only 2 HP, which can be supplied by a pump mounted directly at the end of the shaft of an outboard motor. Connecting the pump to a small diesel is better still. There are also electric winches requiring low voltage: 12 or 24V. Although not so robust, these motors have the advantage of being powered by batteries which are readily available. The charging of the batteries can be done off the main engine if it is used, or on shore after return from fishing. It is also possible to mount on the boat a wind-powered generator or a small wake propellor driven by the boat's movement through the water. An electric system is thus more versatile and easier to use, even though less reliable.

To haul traps or bottom longlines greater power is needed. Trap Fishing Ltd. use a flexible drive run off an outboard motor to power the trap hauler[1]. Another piece of equipment undoubtedly more reliable consists of a lawn mower motor with a vertical shaft which engages the poppet of the winch by a drive belt situated at the base. The whole thing is compact and can be installed anywhere.

These examples show that the use of sail does not prohibit the use of mechanical aids to haul lines, even if the only source of power on board is an outboard motor.

For trolling, an electric system seems preferable unless a more costly but more reliable oil hydraulic system is installed. For bottom lines and traps the choice is open. The methods of fishing possible on a sailboat having been determined, it now remains to define the means, that is the boat.

SAILS

It is most important to ensure that economy in crew members resulting from the use of line haulers is not counter-balanced by the necessity of employing a bigger crew to manoeuvre sails. In the same way it is necessary to ensure that the cost of maintenance work on the sailboat is not more than the cost of fuel on a motor boat. The ideal is that the use of sails does not require a bigger crew than is needed for fishing, that is to say, two men on a small 7-8 m boat and four or five on a boat of 10-12 m.

There is no question, however much one admires the nautical skills of the ancient Polynesians, of going back without modifications to the boats and sails used in the past. It is also an illusion to think that the sail plans of present-day pleasure-boats, which require multiple head-sails and continual sail changes, can be used. To be easily manoeuvred by a reduced crew the sails must:

- allow a very rapid reduction in sail without complicated manoeuvring;
- be able to be let fly without risk of tearing the sails while awaiting a reduction in sail or the passing of a squall;
- entail minimum encumbrance of the deck, which must remain a fishing deck.

These attributes must be obtained without reduction in the efficiency or aerodynamic qualities of the sails, speed also being an economic factor in a fishing boat. These qualities exist in various degrees in known sails. The oceanic lateen sails and lug sails are simple and efficient but heavy and difficult to manoeuvre. The Chinese sail is easy to manoeuvre and particularly to reduce, but it needs many lines to set it. Gaff-sails and sprit-sails are difficult to control when they begin to flap.

In my view, it is preferable to use a slatted sail like the Chinese sails but pivoting entirely abaft the mast to avoid the turbulence that the mast causes on the surface of the sail. This sail stays fixed to a triangular frame made up of a stay going from the masthead to the front of the boom, two lifts going from the top of the mast to the after end of the boom, and the boom itself between these two points. The boom also being attached to the deck at a point one third from the forward end, the whole triangle containing the sail pivots around this axis, almost following the bearing of the triangle. There is no reefing of the sail, which folds like an accordion between the lifts as a Chinese sail does. There can

1. See: Mini pot hauler driven by an outboard engine. *SPC Fish. Newsl.* 17: 29 (December 1978).

be no flapping of the sail as it is let fly because it is fixed to its frame. Its effectiveness is improved because its leading edge is always to windward of the mast. Its handling is also very simple because it has only one halyard and one sheet.

This patented sail, called an 'out-mast' sail, seems to me to best fulfil the requirements of a commercial sail, but there are probably other solutions more suited to the liking and to the uses of individuals.

SAIL FISHING BOATS

The size of fishing boats depends most of all on their type of operation. In the tropical Pacific there are several possible uses.

The first type of boat is 6-8 m long and represents the minimum investment. It is an open boat, usually powered by an outboard, and is suitable for family operation. It can only be used for fishing for about 100 days per year, when the owner is not occupied by other activities, such as agriculture. As a fishing boat its use is mainly for bottom lining and sometimes for pole-and line fishing or trolling. Trips usually last only one day and two men are enough to operate it. The catches are often used by the family, but in some islands their contribution to the economy of the country is quite important. The type of sailboat appropriate for this usage is the *Yandé* design, described later.

The second type of boat, 10-12 m, represents a much greater investment. To make it profitable an artisanal type operation with at least 200 fishing days per year (trip length 5-6 days) is necessary. The crew consists of 3-4 fishermen plus a skipper or boat owner. To be able to be used all the year, this boat must be multipurpose and suitable both for bottom fishing and tuna fishing, depending on the season. However, the economics must be carefully studied for profitability depends on the opportunities for sale of the catch and thus on a judicious choice of the most economical methods of fishing. To carry out this type of fishing with sail, the *Kunié* design (described further on) is suggested. Its operating cost would be at least two times less than that of an equivalent motor boat.

On a larger scale still, the most profitable fishery would be live bait pole-and-line fishing. The installation of fish wells of the required size means that these boats need to be at least 20 m long. The use of sail for such units is quite realistic, particularly on catamarans where the stability would be little affected by fish wells. However, the building of such boats should only be undertaken after a sufficient period of experimentation with the preceding designs.

THE 7 M *YANDE* DESIGN

The difficulty in the design of a small sail fishing boat is to reconcile speed with carrying capacity. A catamaran will be fast, but sensitive to overloading and much too fickle for professional use. A keel boat on the other hand will be reliable and can be heavily loaded, but it will be slow in all cases and its draught will be a constraint in places where there are no ports.

I have preferred to choose the original solution of the W-shaped hull (Fig. 1). This hull has the overall shape of a dory but the bottom is deeply indented longitudinally. Thus it preserves the stability which dories have at large heeling angles, but has in addition a large initial stability when the boat is upright and lightly loaded. Its shape also allows the hull to sink more deeply on each side which gives an adequate surface against leeway. When the boat heels this surface increases but at an angle of approximately 22° it reduces again, allowing the boat to side-slip if caught in a strong wind-gust. However, even sitting upright in the water this hull retains a strong righting couple. This great stability in shape makes ballast unecessary and the boat very light and fast. One thus obtains a combination of the advantages of a keeler - large carrying capacity and large reserve stability - and those of a catamaran - speed and good initial stability.

To maintain the simplicity of the design the boat is fitted with a single 'out-mast' sail of $22 m^2$ suspended from a mast stepped very far forward as on a cat boat. This sail can be handled in all situations with one halyard and one sheet.

The lightness the boat is equipped with an outboard mounted in a well abaft, the cockpit. For a sailboat which only uses a motor for short periods, an outboard is preferable. Its fuel consumption is no longer a problem and it is easily transportable if repairs are needed. We have already seen that such a motor can be equipped with an hydraulic pump, or an alternator to drive the fishing winches. The whole system is compact and requires a minimum investment.

The sides of the hull extend abaft the motor well and join in a point. In this point is incorporated a water-tight compartment so that the waves coming from astern are divided by the stern which they lift as they pass. Thus, the waves cannot enter the cockpit if they break over the support board for the motor.

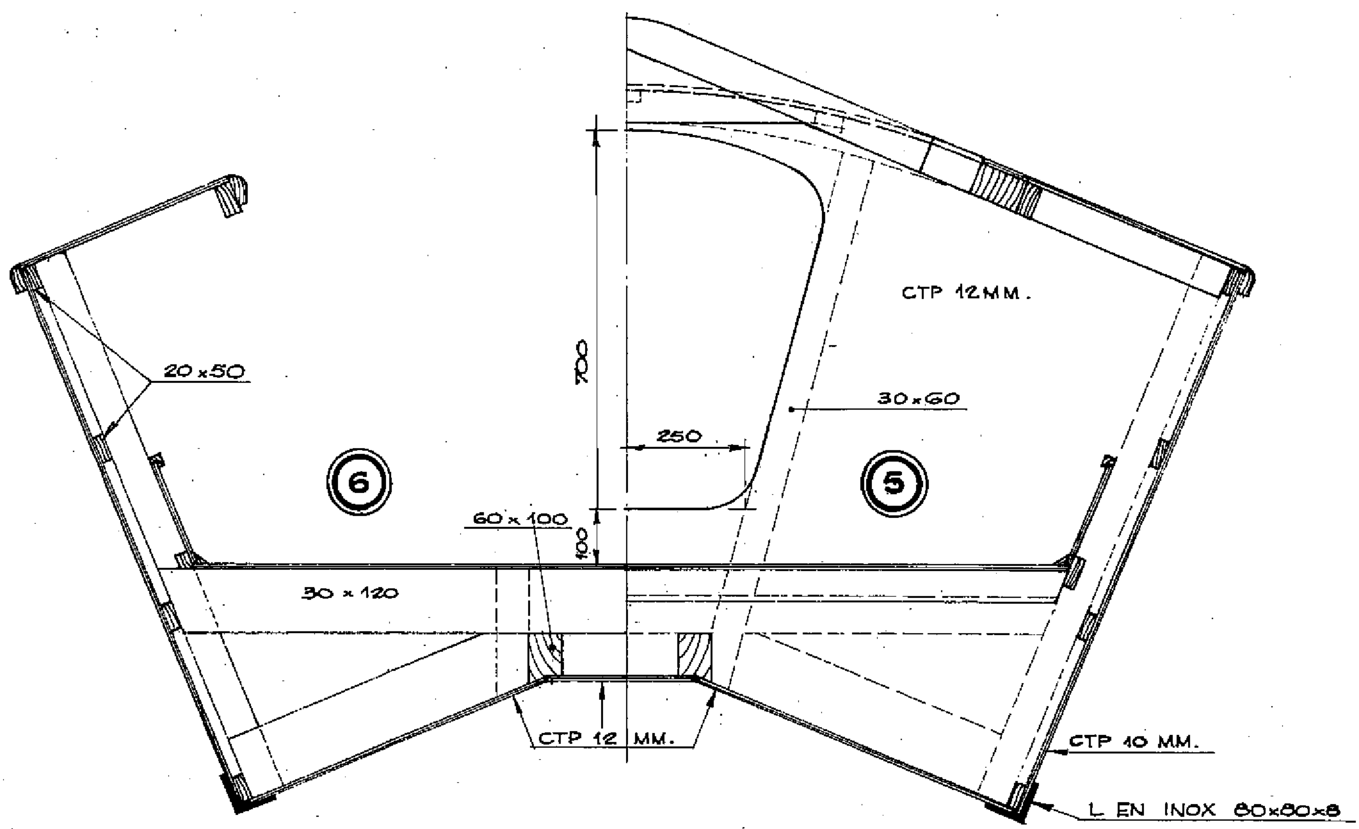

Fig. 1: Cross-section of the hull of the 7 m *Yandé* design sail fishing boat.

Figure 2 shows such a boat with a deck covering half its length, enabling a small cabin to be fitted beneath. However, for professional use the cabin size can be reduced to a simple shelter, keeping most of the boat's length available for fishing operations. In the illustrated design the cockpit is water-tight and self-draining through openings in the transom. This water-tightness could be retained if the cockpit were extended forward.

Two other features of the design are, the rudder, which is situated in the motor well and can easily be raised for beaching, and the rounded shape (like a banana) of the bilges which enables the boat to be beached without damage, like a sledge on its runners. This feature is particularly useful for the interior of lagoons.

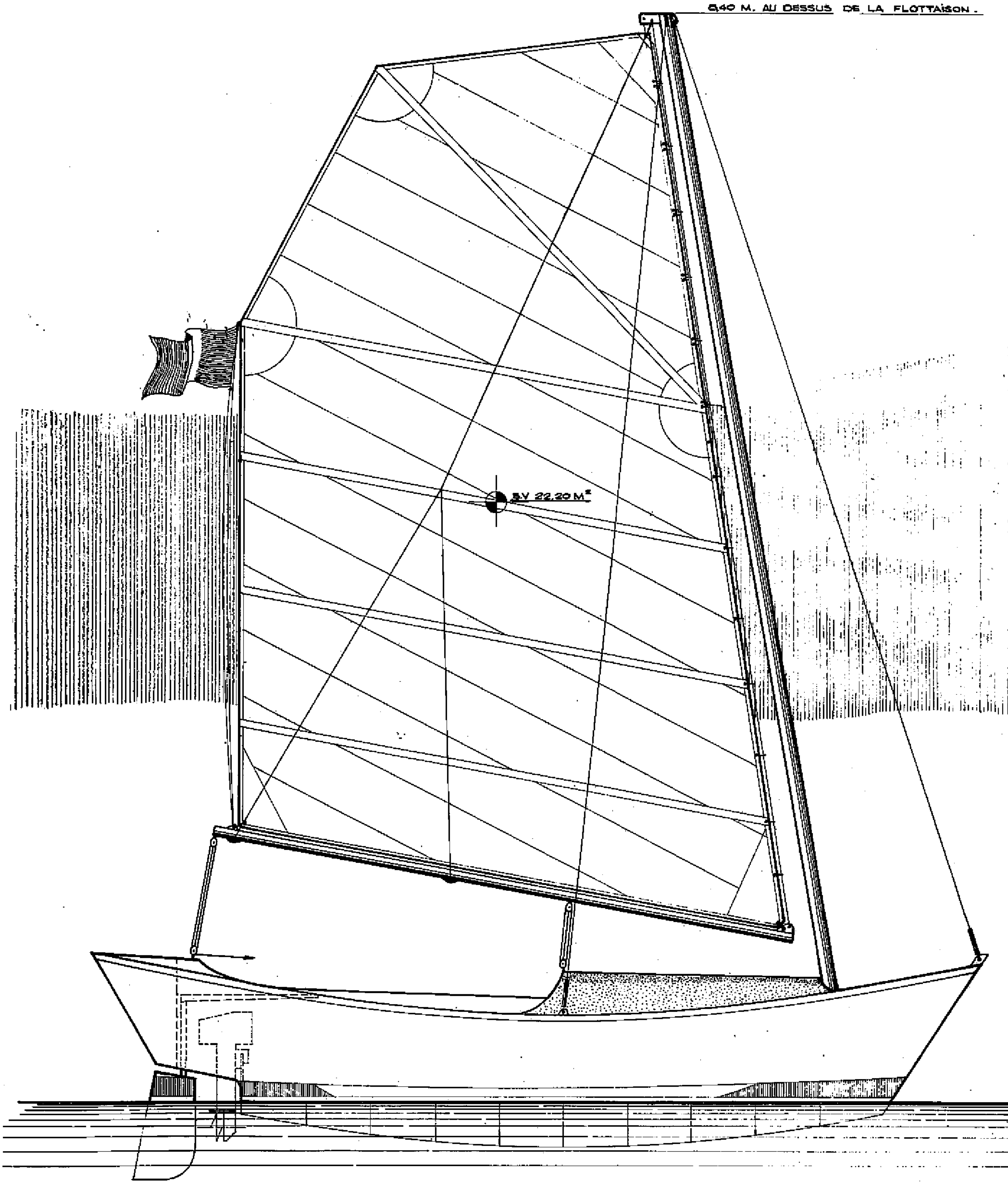

Fig. 2: The 7 m *Yandé* design sail fishing boat.

Construction of the boat is extremely simple. The materials which can be used are plywood on wood frames, plywood on steel frames, or aluminium for all parts. Plans are available for each type of construction. Equipped with four haulers for bottom lines or trolling lines this sail fishing boat represents the most profitable investment at the present time.

THE 12M *KUNIE* DESIGN

This sailboat is almost 12 m overall with a waterline length of 10 m and a maximum beam of 4 m. It would be constructed of steel as this is the cheapest material for a boat of this size. The hull is double chined with a long keel. Fully loaded the displacement is almost 20 t with a draught of 1.75 m. The holds situated amidships have a capacity of 5 t of fish preserved in ice. One mast is placed at the extreme front and the other in front of the steering gear. They carry 'out-mast' sails with jibs, with a total sail area of 90 m^2. These sails are each controlled by two winches, one for the halyard and one for the sheet. The four winches are operated by electric motors or by hydraulics, which allows true press button control. This system leaves a very clear deck.

The fishing winches, also electric or hydraulic, are situated on each side amidships and are run off batteries. Trolling booms are fitted on each side of the foremast. Four lines can be rigged on each boom and three handlines from the stern, making a total of eleven. Propulsion is provided by a 100 HP diesel which also supplies the batteries or hydraulics.

The boat has a cabin with four berths under the foc's'le deck. From the foc's'le to the steering gear the freeboard is very low to make fishing easy. However, the hatches to the holds are on a raised section in the middle of the boat and thus retain a good reserve of flotation.

The price of such a boat would not be more than A$100,000. This is certainly not very cheap but can be rapidly made profitable if the use of sails is taken into account; this allows a saving of $10,000 - $20,000 per year[1] in fuel compared to an equivalent motor boat (at the price of diesel in Noumea, approximately 20 cents per litre).

CONCLUSIONS

One could continue by giving the description of a 20 m catamaran for live bait fishing, but that would not be very realistic. Common sense dictates that trials should be carried out first of all with these two designs - or equivalent types - to discover in practice any constraints on the use of sails. These two types would be adequate to provide the basis of an efficient and profitable fishing fleet. Construction costs are low and the price of sails and accessories is not as great as the difference in price between their motors and the motor required for a normal boat. As to operating costs, it is easy to see the saving when it is realised that it takes an average of half a litre of diesel or petrol for each kilo of fish landed. The cost of repairs and spare parts for the motor, the loss of fishing time when they are unavailable and all the supplementary costs which cannot be detailed here, must also be added.

On thing is clear: fishing under sail power is certain to gain much more money per kilo of fish caught, and who can say without having tried, that the catches will be lower on a sailboat than on a motor boat? For the people of the Pacific it is becoming urgent to try. After tomorrow perhaps there will no longer be enough fuel for the whole world. When that happens, fishermen will not be the first supplied.

1. The actual saving will depend on the number and length of fishing trips.

DEEP TROLLING MAY BE WORTHWHILE

James Crossland

Trolling for pelagic fish is a common artisanal fishing method in many parts of the world. It seldom results in the large catches which can be taken by some other methods, but because it can be carried out from a very small boat and with a minimum of equipment it has always been popular. However, in recent years, the rapidly increasing price of fuel has tended to make this method less and less economic. It may be possible to reduce fuel costs by using sail power or a combination of sail and engine power.[1] There are several ways in which the economics of trolling can be improved. The search or non-productive time can be reduced by fishing only at times of maximum fish abundance or in areas where fish are known to concentrate. The use of buoys and other floating devices to aggregate tunas is becoming widespread. These devices increase catchability as boats can go directly to them, and begin successful fishing at once. Trolling can also be combined with other methods when on its own it is not worthwhile. It is the practice of the SPC master fishermen always to troll when travelling to and from bottom fishing grounds during the operations of the deep sea fisheries development project. It is surprising that this practice, which seems obvious and desirable, is frequently not done in some Pacific islands, yet a few large fish taken in this way can often turn a break even trip into a profitable one. The economics of trolling can also be improved through more effective gear or techniques so that the catch per unit effort is increased. A technique which offers promise, but which does not appear to have been widely tried in the tropics, is deep trolling. It is the purpose of this article to review what is known on deep trolling in the tropical Pacific and describe suitable equipment. Perhaps it will stimulate fishermen to experiment with these techniques.

Experimental depth trolling was carried out by SPC's first fisheries officer, Hubertus van Pel, in Tonga 25 years ago (van Pel 1955). The gear used (Fig. 1) consisted of a 6 mm steel mainline with a wooden kite attached. One trolling line was jointed to the kite and two others further up the mainline. Van Pel reported that the best trolling speed was 6 knots and that one depth line caught 15 times as much as one surface line. The catches included tunas, spanish mackerel, barracuda, dolphinfish, kingfish and the green jobfish *Aprion virescens*. Unfortunately the account did not give any details of the extent of the trials, so it is difficult to judge the significance of the results. Nevertheless, van Pel considered that two sets of depth lines (with three lines each) could be worked together and would have a catching power equivalent to 90 surface lines.

Van Pel found that it was not possible to tell when fish were hooked on deep trolling lines. He suggested that each branch line have a separate pull cord so that the whole rig need not be raised each time. Another solution, using a pulley and a double mainline, was proposed by Yesaki (1977). This system (Fig. 2) appears promising but was not tested. The branch lines should be widely spaced to avoid tangling. Smith (1979) recorded a technique used by sports fishermen in California which employs a downrigger for controlling the fishing depth. The downrigger consists of a short rod and small hand - or electrically operated winch. The winch drum is loaded with stainless steel wire with a heavy sinker at the end. The lower part of the trolling line is attached by a release clip to the sinker. The desired fishing depth is obtained by lowering the sinker and paying out the main part of the trolling line. When a fish strikes the troll line detaches from the sinker and the catch can be hauled in. This system does not appear suitable for trolling more than one line.

A simple method of deep trolling was used with good success by SPC's deep sea fisheries development project in Yap District (Trust Territory of the Pacific Islands). Five hundred metres of tuna longline wire[2] were fitted on an FAO design wooden handreel. The reel was fitted with a simple braking system and the line was run out through a pulley on the end of the reel arm. Thirty metres of 145 kg test monofilament nylon with swivels at each end

1. See the article in this issue: Sailboats for fishing, by Yvan Serve.
2. Turimoto No. 29.

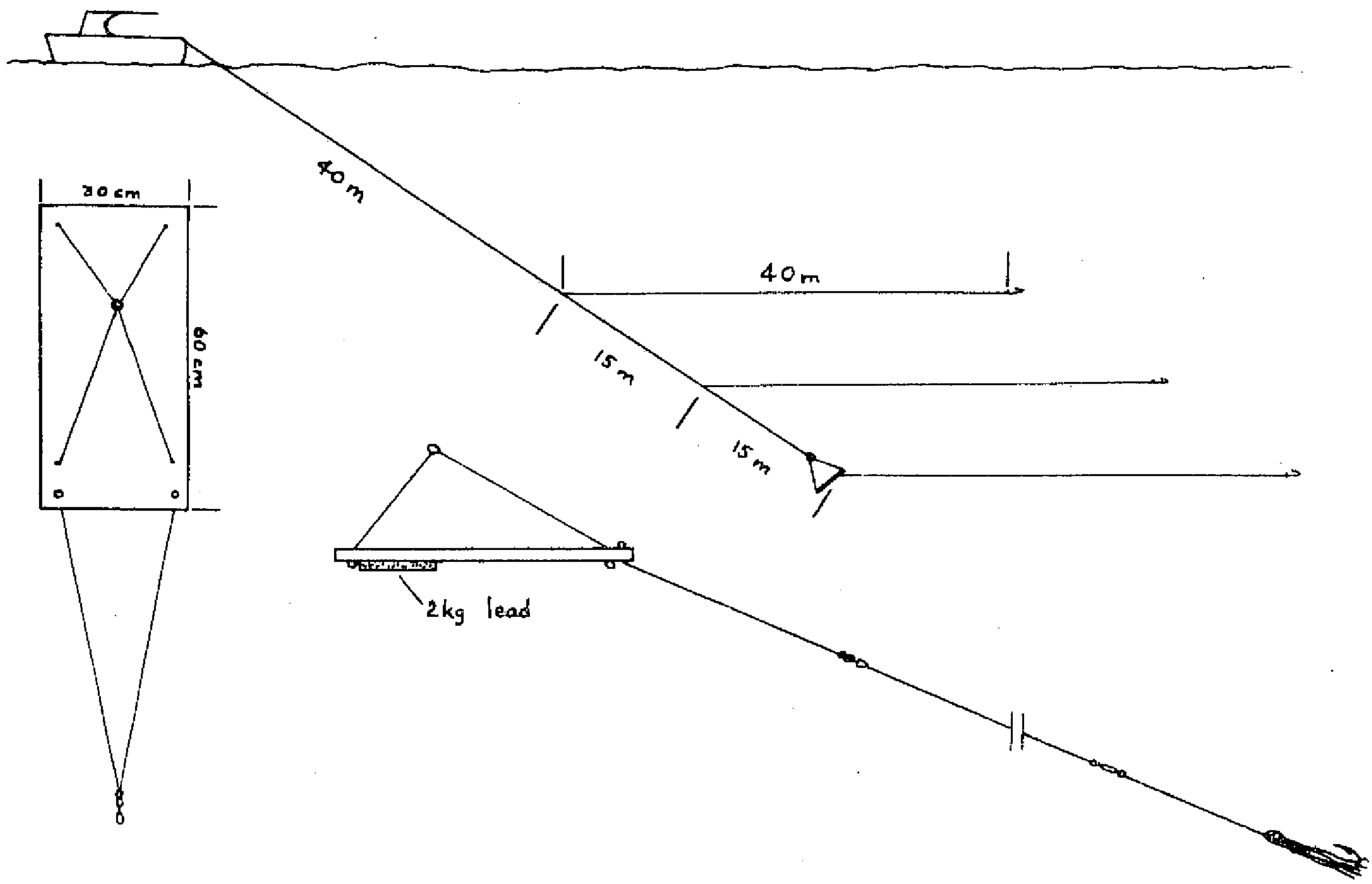

Fig. 1: Deep trolling rig using large wooden kite.

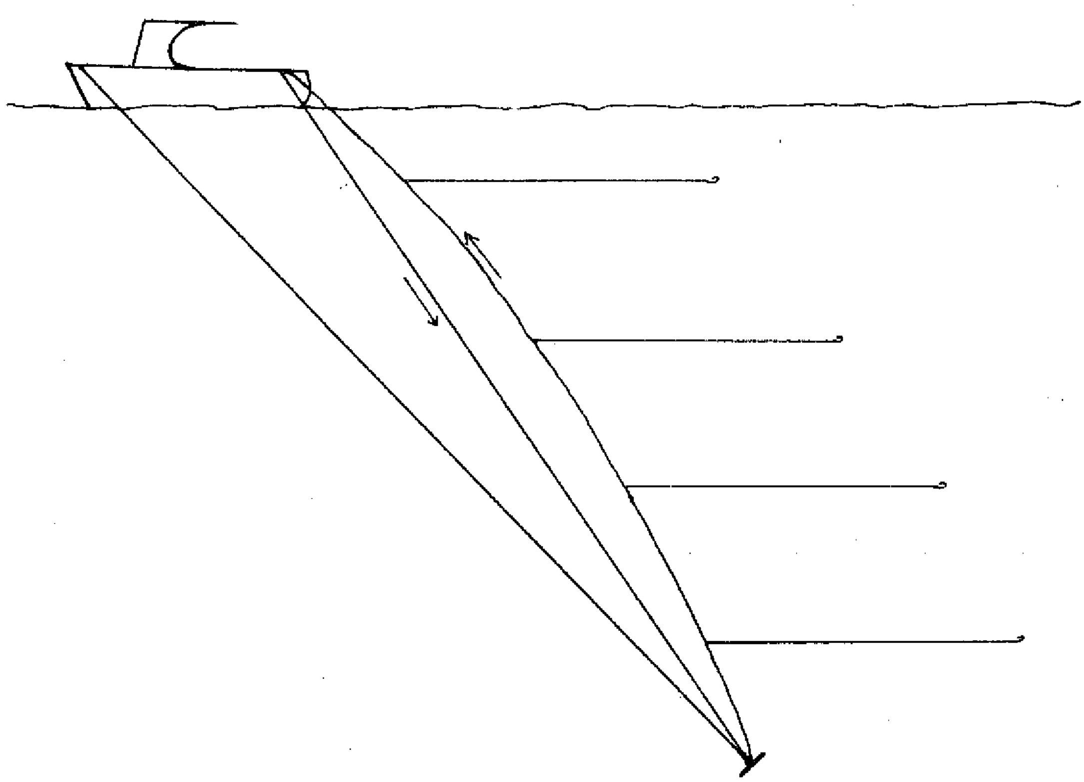

Fig. 2: Deep trolling rig using double mainline and pulley systenı.

was clipped to the wire as a shock absorber. The terminal rig was a flying fish mounted on a large double hook attached to a 1.5m wire trace. By trolling this some 150-200m behind the boat the weight of the long length of wire pulled the flying fish well down below the surface. Speeds of 3-7 knots were tried, with best results at 6-7 knots. This method gave good catches of dogtooth tuna *Gymnosarda unicolor* and barracudas *Sphyraena* spp. during daylight trips. Trolling by moonlight resulted in good catches of trevally *Caranx* sp. and barracudas. The catch rate varied from 3.5kg/reel/fishing hour at Yap Island to 4.0kg at Ulithi Atoll and a phenomenal 12.3kg at Ngulu Atoll. Futher details can be found in Mead and Crossland (1980).

Paravanes or trolling boards, similar to, but smaller than the kite designed by van Pel can be used to take individual lines below the surface. These devices are available from suppliers of fishing equipment but are not always easy to obtain and can be expensive. However, they are not difficult to make. A proven design for a wooden paravane, as used in New Caledonia, is shown in Fig. 3. Trolling at 4-6 knots with the lure at 12-30m below the surface, fishermen report improved catches of spanish mackerel *Scomberomorus commerson*. Two or three lines, each with its paravane, can be towed by one boat. When a fish takes the lure the rig comes to the surface.

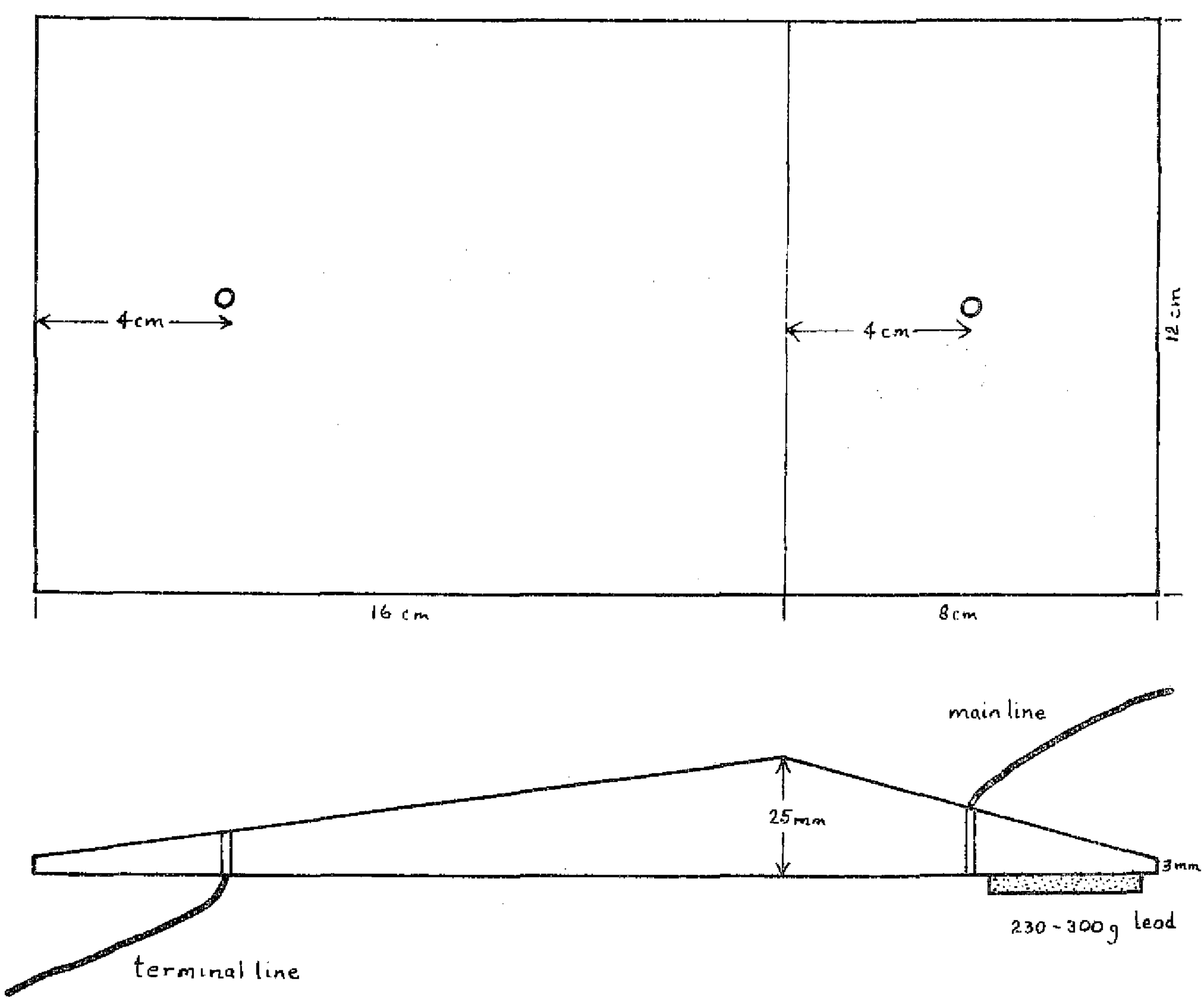

Fig. 3: Wooden paravane for subsurface trolling

A different but ingenious methods of subsurface trolling, primarily designed for the albacore fishery, was developed in New Zealand a few years ago. To sink the trolling line a diving can is used (Fig. 4). Any tin can is suitable; alternatively, a short piece of PVC pipe or even a section of bamboo, can be used. Clips, which can be made of coathanger wire, a plastic ring, a lead weight and some swivels are the other materials necessary. When a fish is hooked the clip attached to the ring is released, changing the orientation of the can and causing the line and fish to come to the surface. For a given boat speed the trolling depth can be varied by altering the weight on the can, the size of the can or the length of the line. Five or six lines can be operated at once, fishing at different depths, and kept apart by adjusting the sheering angle. The chances of tangles with this gear appear less than with diving boards because the cans are more stable in the water than diving boards, which can go off at erratic angles. Initial trials with the diving cans gave a catch rate about double that of surface lines (Hu,1974). The efficacy of the can as a diving device was shown by the capture on one occasion of a bottom dwelling grouper. This gear is also illustrated in Nedelec (1975) on page 187.

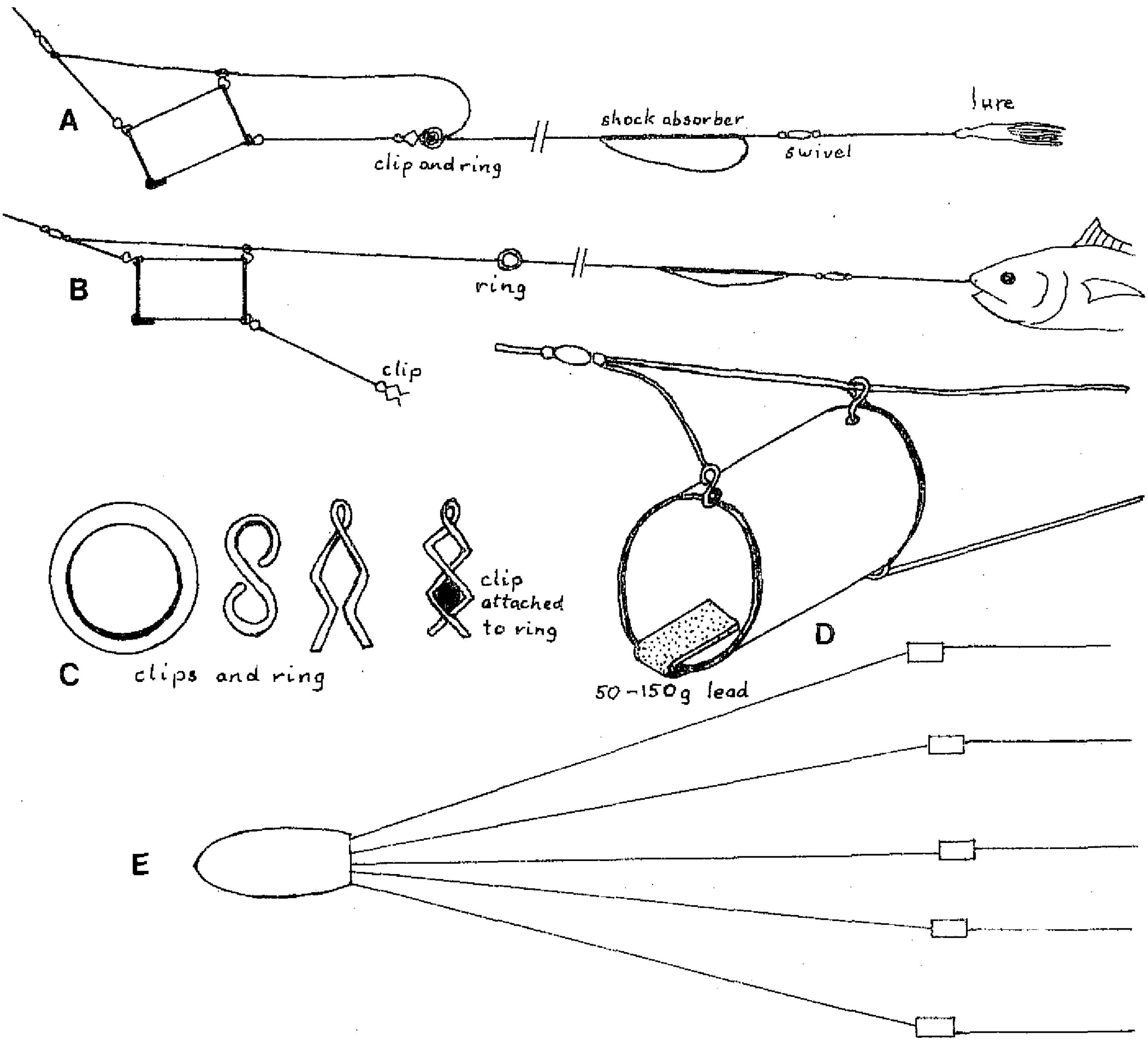

Fig. 4: Deep trolling rig using diving can. A: Rig in diving position. B: Rig after fish has struck. C: Clips and ring. D: Detail of can. E: Trolling lines kept apart by adjusting sheering angle.

In conclusion it can be said that the little information available strongly suggests that deep trolling gives an improved catch rate over surface trolling. It is also more likely to catch species such as spanish mackerel, wahoo *Acanthocybium solandri* and dogtooth tuna, which are not as highly migratory as skipjack or yellowfin, and therefore can be caught over a longer period of the year. If trolling is done around the outer reef slopes other species may be caught: barracudas, trevallies, the faster swimming groupers of the genera *Plectropomus* and *Cephalopholis* or *Variola louti*, or even the rosy jobfish *Pristipomoides filamentosus*.

The equipment needed for deep trolling can be easily and cheaply made by fishermen themselves. A few hours work may well be worthwhile.

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