Occasional Paper No.17

SOUTH PACIFIC COMMISSION

THE DEVELOPMENT OF DEEP BOTTOM FISHING IN THE TROPICAL PACIFIC

James Crossland
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René Grandperrin

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ABSTRACT

South Pacific Commission bottom fishing projects have operated at many locations in the tropical Pacific since 1974. This paper presents a brief review of the first project, the Outer Reef Artisanal Fisheries Project which terminated in 1977, and describes in more detail the Commission's current project, the Deep Sea Fisheries Development Project.

The aim of the Deep Sea Fisheries Development Project is to encourage development of a small-scale fishery for deep water bottom fishes occurring on the outer reef slopes and on sea mounts in depths of 100-400m. The project spends several months at one place under the control of a master fisherman. It demonstrates the techniques of deep water droplining using wooden handreels, monofilament line and wire terminal rigs. Fishing is done from local boats, either government or private. Local fishermen receive on-the-job training in all aspects of the operation.

Between March 1978 and March 1980 the project visited American Samoa, Tonga (twice), Niue (twice), Yap, Tanna (New Hebrides), Kosrae, Palau, New Caledonia and Papua New Guinea. Lutjanid fishes comprised about half the catch by weight, of which Etelis oculatus, E carbunculus and Pristipomoides sp. were the most important. Other important types were carangids, serranids, lethrinids and gempylids. The average catch in kg per reel per fishing hour varied from 2.8 at Niue to 9.6 at Kosrae. It is considered that in several places the catch rates achieved are sufficient to make this type of fishing economically viable.

CONTENTS

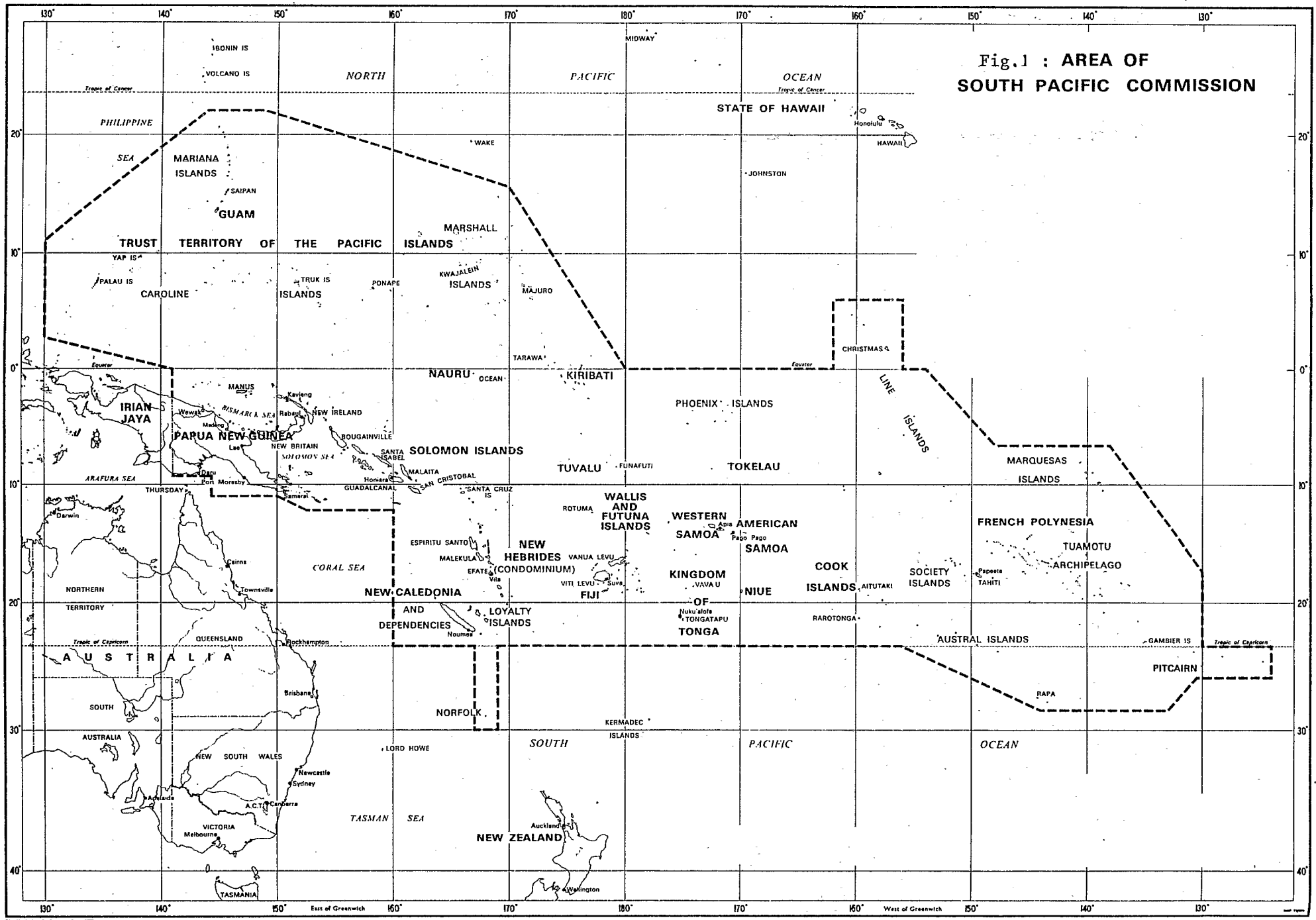
Fig.1 : AREA OF SOUTH PACIFIC COMMISSION
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
PHILIPPINE SEA
BONIN IS
VOLCANO IS
MIDWAY
STATE OF HAWAII
Honolulu
HAWAII
WAKE
JOHNSTON
MARIANA ISLANDS
SAIPAN
GUAM
MARSHALL ISLANDS
TRUST TERRITORY OF THE PACIFIC ISLANDS
YAP IS
PALAU IS
CAROLINE ISLANDS
TRUK IS
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KWAJALEIN
MAJURO
TARAWA
NAURU
KIRIBATI
CHRISTMAS
LINE ISLANDS
PHOENIX ISLANDS
MANUS
Kavieng
NEW IRELAND
Rabaul
IRIAN JAYA
Wewak
Madang
BISMARCK SEA
PAPUA NEW GUINEA
Lae
NEW BRITAIN
BOUGAINVILLE
SOLOMON SEA
SANTA ISABEL
SOLOMON ISLANDS
Honiara
GUADALCANAL
MALAITA
SAN CRISTOBAL
SANTA CRUZ IS
TUVALU
FUNAFUTI
TOKELAU
MARQUESAS ISLANDS
ARAFURA SEA
Port Moresby
THURSDAY
Samarai
Darwin
ROTUMA
WALLIS AND FUTUNA ISLANDS
WESTERN SAMOA
Apia
AMERICAN SAMOA
Pago Pago
FRENCH POLYNESIA
TUAMOTU ARCHIPELAGO
ESPIRITU SANTO
MALEKULA
NEW HEBRIDES (CONDOMINIUM)
VANUA LEVU
EFATE
Vila
VITI LEVU
Suva
FIJI
KINGDOM OF TONGA
VAVAU
Nuku'alofa
TONGATAPU
NIUE
COOK ISLANDS
AITUTAKI
RAROTONGA
SOCIETY ISLANDS
Papeete
TAHITI
CORAL SEA
Cairns
Townsville
NORTHERN TERRITORY
NEW CALEDONIA AND DEPENDENCIES
Noumea
LOYALTY ISLANDS
Tropic of Capricorn
QUEENSLAND
Rockhampton
AUSTRALIA
AUSTRAL ISLANDS
GAMBIER IS
PITCAIRN
RAPA
Brisbane
SOUTH AUSTRALIA
NORFOLK
KERMADEC ISLANDS
LORD HOWE
NEW SOUTH WALES
Newcastle
Sydney
Adelaide
A.C.T.
Canberra
VICTORIA
Melbourne
TASMAN SEA
NEW ZEALAND
Auckland
Wellington
TASMANIA
Equator
East of Greenwich
West of Greenwich

INTRODUCTION

In the tropical Pacific (Fig.1) island rise steeply from great depths and are of two main types - atolls, and high islands. High islands may have a barrier reef, or more usually, only a fringing reef. On atolls and islands with a barrier reef fishing has traditionally concentrated on the resources of the lagoon using a variety of fishing methods, including handlines, cast or gill nets and spearing. In many places lagoons are heavily exploited and some are overfished. Fishing is also carried on outside the reef of both atolls and high islands. This is mainly for pelagic species which are caught by trolling, with pearl lures, or on vertical longlines. On islands without a lagoon the pelagic resource is the main one exploited.

Because of the almost complete absence of a continental shelf demersal fish stocks in the tropical Pacific are limited. There is however, a small but significant resource of deep bottom fishes around most islands. Until a few years ago this was hardly exploited at all, and in many places is still not fished. It has been the aim of the South Pacific Commission bottom fishing projects to encourage exploitation of this resource by fishing the outer reef slopes in depths from 100-400m

It is not easy to fish this zone. Bottom longlining is difficult because of the rough bottom, the steep slope, and the prevalence of shark attacks on hooked fish. For similar reasons gillnetting is impractical. A line hauler is required because of the considerable depths fished. This leaves two possible methods - the use of portable fish traps and drop-lining (either handlines, handreels or electric reels). Trapfishing, which is the main method used in the Caribbean reef fishery, has been tried a few times in the Pacific but so far without much success. Drop-lining is to date the only proven method of deep bottom fishing. The aim of this paper is to briefly review the South Pacific Commission's first bottom fishing project, the Outer Reef Artisanal Fishery Project (ORAFP), and then to describe in more detail the project which has developed from it, the Deep Sea Fisheries Development Project (DSFDP), which is now operating successfully at various places in the Pacific.

THE OUTER REEF ARTISANAL FISHERIES PROJECT

The South Pacific Commission has been involved in bottom fishing projects since 1974 which year saw the start of the ORAFP. This project spent almost three years in the field, during which time it visited five South Pacific Island countries, spending 6-9 months in each. The project took with it its own personnel, boats, icemaking equipment, walk-in freezer, and fishing gear. Its objectives were to assess an area's fishing resources, demonstrate new fishing techniques and to train local fishermen. Although the project was designed to investigate many kinds of fishing, in practice it was mostly involved in deep bottom fishing (using electric reels), as this was found to be both the most productive and most economical method.

The ORAFP terminated fishing at the end of 1977. There were various reasons for this, the principal one being the difficulty and cost of transporting the boats and equipment to remote places. Nevertheless, in its three years of operation the project made a considerable contribution to artisanal fisheries development in several places, notably Western Samoa, where a flourishing deep bottom fishery now exists, and in Solomon Islands where the project's boats and equipment were sold to local fishermen and provide the nucleus of a small fleet at the island of Gizo. The full results of the ORAFP are given in a series of reports (Hume, 1975, 1976; Hume et al, 1976; Eginton and Mead, 1978; Eginton and James, 1979).

THE DEEP SEA FISHERIES DEVELOPMENT PROJECT

The objectives of this project are to investigate the deep bottom fish resources of the outer reef slopes and of seamounts (where present); to demonstrate and provide practical training in deep bottom dropline fishing techniques using wooden handreels; and to determine if this type of fishing is suitable and economically viable in the particular local conditions.

The project, which started in March 1978, operates simultaneously at separate locations, each part under the control of a single master fisherman. Three master fishermen are currently employed. Each master fisherman brings with him all necessary fishing equipment; the host country - either government fisheries department, fishing co-operative, or private fisherman - provides a suitable boat. The project is designed to spend one to three months at a single location; in practice it has sometimes stayed longer. From its commencement until March 1980 it has visited American Samoa (2 months), Tonga (two visits, 3½ months and 2½ months), Niue (two visits, 2 months and 2½ months), Yap District (6 months), Kosrae (1½ months) and Palau (3 months) in the Trust Territory of the Pacific Islands, Tanna in the New Hebrides (4 months), New Caledonia (5 months) and Papua New Guinea (3½ months).

Boats

The project has used many different types and sizes of boat ranging from the Government of Tonga's 16.5m Takuo, a Japanese style pole-and-line boat, down to a 4m aluminium dinghy. Although deep bottom fishing can be carried out from a variety of craft some are too large for economic operation and very small ones are difficult to work from, and restricted in the sea conditions in which they can operate. A particularly suitable boat has proved to be the 8.6m Alia catamaran which since 1976 has been produced in large numbers by the FAO/DANIDA boat building project in Western Samoa. This craft is based on a traditional Pacific design and is constructed either in marine plywood or aluminium. It can comfortably fish four hand-reels, has a good carrying capacity, is seakindly, and is economically propelled to a maximum speed of 13 knots by a 25 h.p. outboard motor.

Fishing gear

The linchpin of the DSFDP fishing equipment is the large wooden hand-reel used for retrieving the line (Fig.2). This reel which was designed by A. Overa and O. Gulbrandsen of the FAO/DANIDA project combines simplicity, robustness and cheapness. The principal advantage of a reel over a handline line is that there is no loose line on deck, making it much easier for several people to fish simultaneously. Another advantage is that it is easier and faster to haul (a hauling rate of 90m/minute can be achieved), greatly reducing the loss of fish to shark attack and making it possible to fish in considerable depths. The reel can also be used for trolling. A plan of the reel is given in Gulbrandsen (1977).

The mainline is monofilament nylon, 114 or 136 kg test. Five hundred metres of this, the usual length, are easily fitted on the handreel.

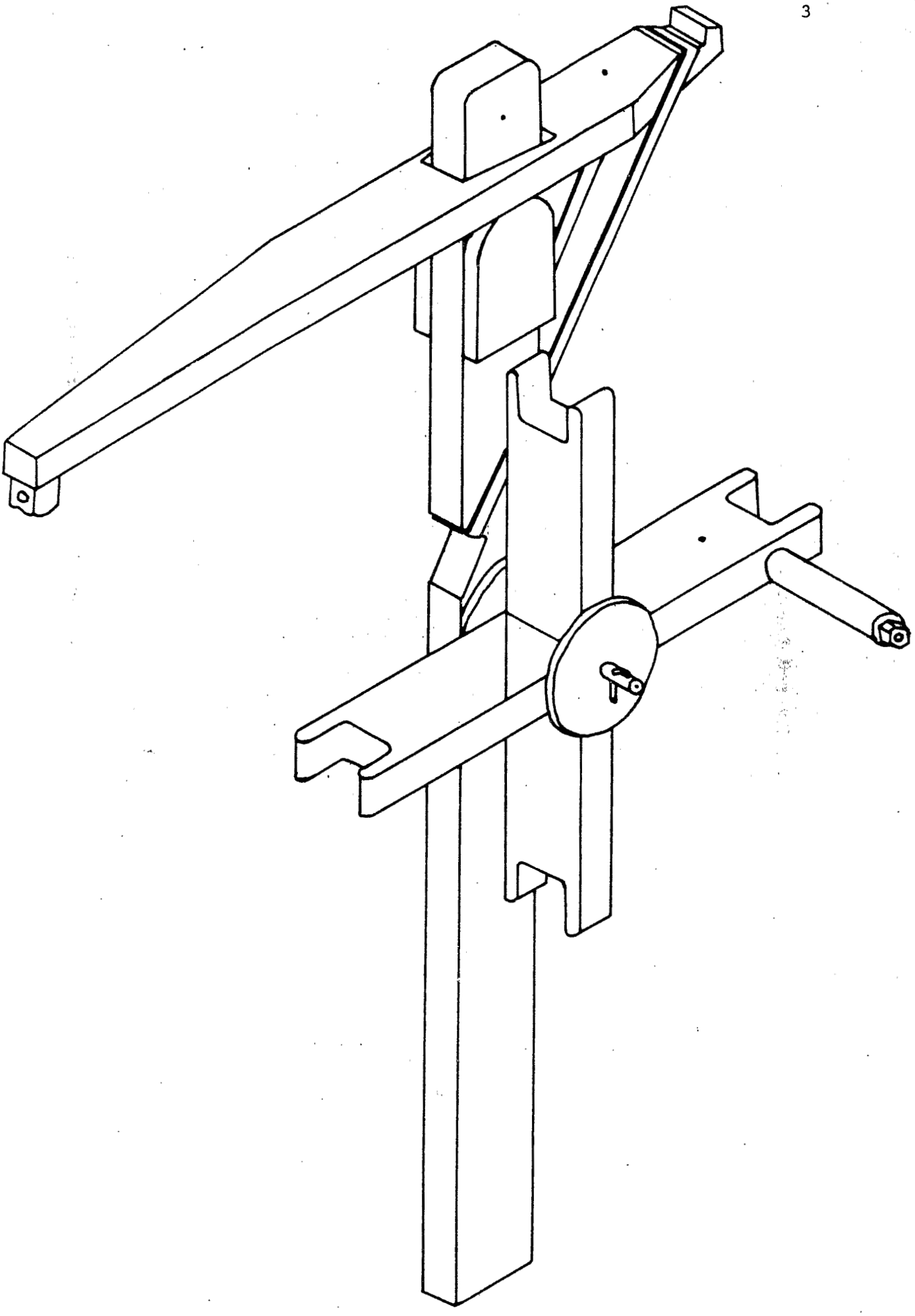

Fig 2: Wooden handreel used in deep bottom dropline fishing

Attached to the mainline is a wire terminal rig as shown in Fig.3. Sometimes a short length of 50 kg test nylon is used as a breaker below the mainline. Mustad tuna circle hooks are used, the most usual sizes being 3-6, although smaller ones may be used for small fish. Where different sized hooks are fished on the same terminal rig the largest hook is attached furthest from the bottom. The advantage of the tuna circle hook, apart from its efficiency, is that fish are nearly always hooked through the jaw;and only rarely is the hook embedded in the throat.

For surveying new fishing areas and in locating seamounts and particular fishing spots the project uses the small, comparatively inexpensive Japan Marina Company echo-sounder, model 707 A/B. This can be run off either D size batteries or a regular 12V system. The transducer is mounted on a 1.2m piece of 36mm galvanised pipe, held over the side.

Electric reels can be used for deep bottom fishing and are undoubtedly appropriate in some situations. They were not chosen for this project for a number of reasons. Both the reels and the stainless steel mainline they require are much more expensive than the handreel and monofilament. (The spool of electric reels is too small to hold sufficient monofilament for fishing deep water). Electric reels require batteries and a power source to charge them. Travelling time to and from fishing grounds is usually too short to charge them from the motor, so either the motor must be kept running during fishing or they must be charged ashore. Also repair of electric reels can be difficult in remote places.

Fishing methods

To give good results deep bottom fishing should be done from an anchored position. This requires an offshore wind or current. Currents are often more important than winds and frequently dictate the area to be fished. Once a suitable fishing spot has been surveyed and chosen the anchor is let go, usually in a depth of about 100m. The anchor rope is then paid out until the vessel drifts out to the desired depth. In cases where the drop off is steep and close to shore the boat must be brought almost to the edge of the reef before the anchor is let go. When fishing on seamounts the direction of winds and currents does not affect fishing operations so much.

A suitable anchor is a four pronged grapnel made from 12mm steel rod and a piece of 36mm galvanised pipe to which is attached a short length of 6mm chain (Fig.4). The anchor rope should be a floating type, 600-800m long, with the rope diameter appropriate to the size of the boat. It is often necessary to shift position while fishing. To reduce the labour of hauling the anchor the method described and figured by Gulbrandsen (1977) is used. The boat tows the anchor free and a buoy is clipped on the the rope, sliding along it to be trapped near the anchor. This keeps it afloat while the motor is stopped and the slack line is quickly hauled in.

Fishing hours depend on local circumstances. Usually fishing is done during daylight, but in some places and for certain species, night fishing is more productive. Only experience will determine this. Trips are normally of a few hours duration, but can be 1-2 days if a supply of ice is available. At least two reels should be fished together. When one line is being hauled the other is kept down. The theory is that fish stay around and bite better if one baited line is always on the bottom.

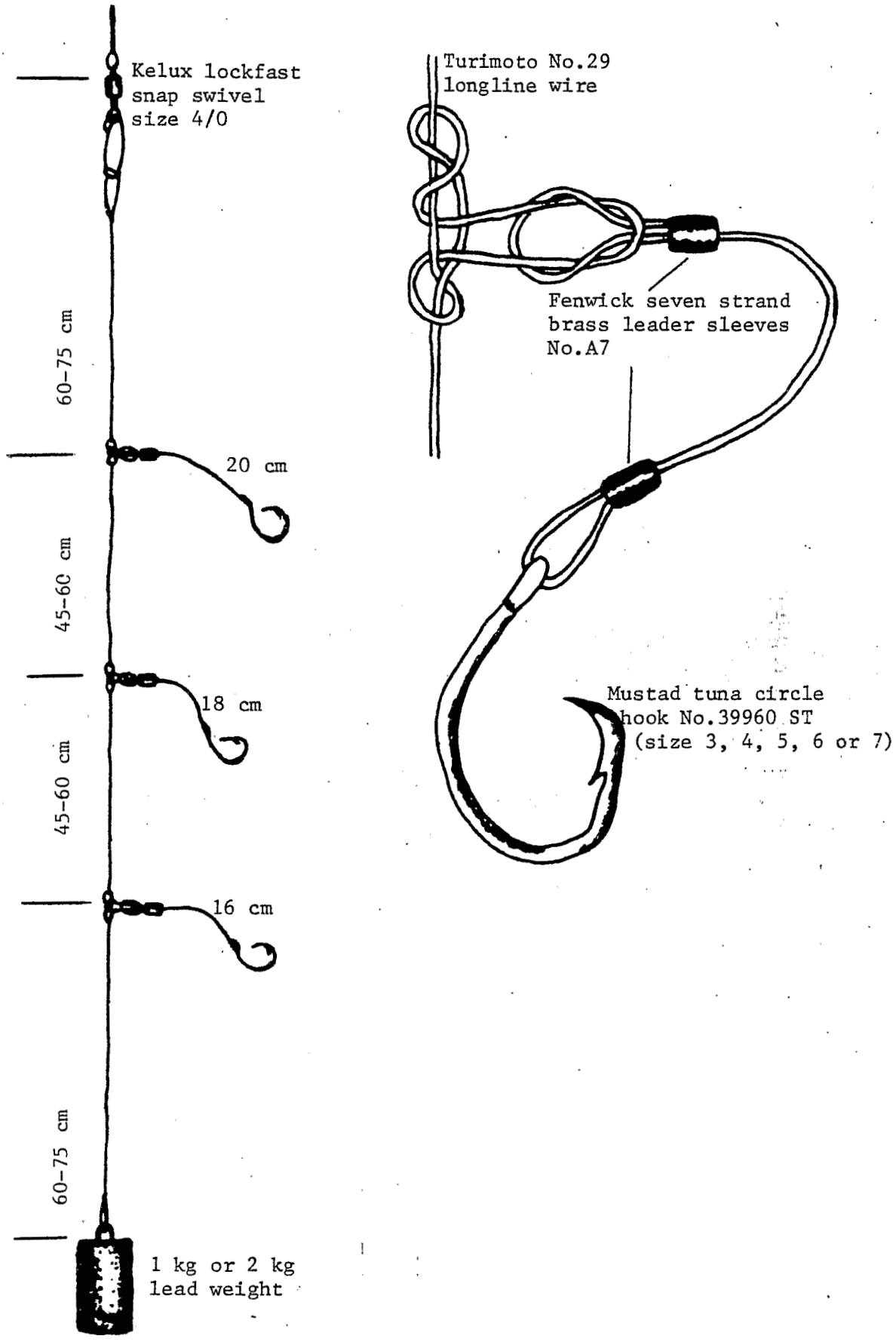

Fig. 3: Terminal rig used for deep bottom fishing in the tropical Pacific

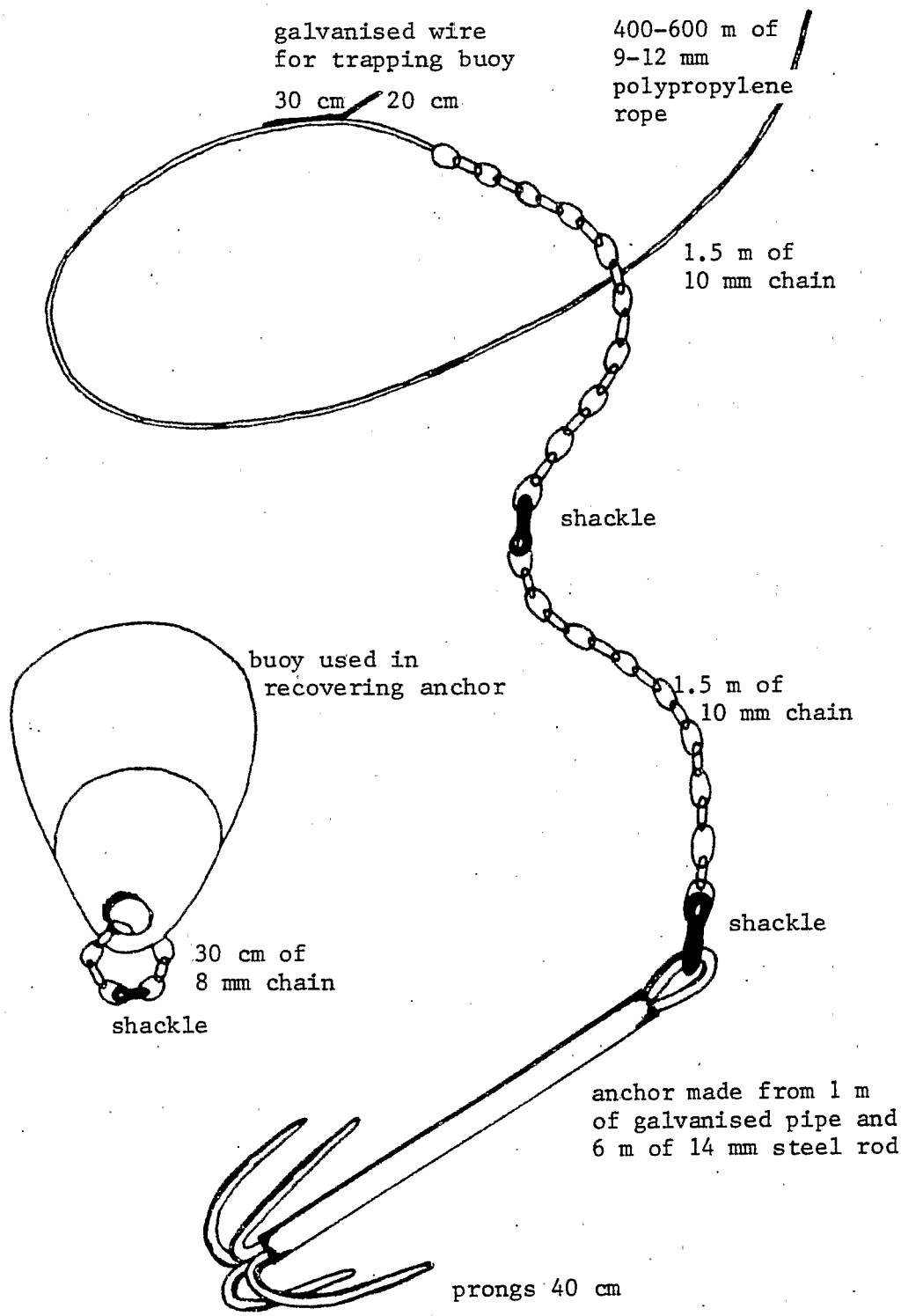

Fig. 4: Anchoring gear suitable for deep bottom fishing

The best baits are skipjack, octopus or squid, but many other kinds are used when the preferred types are not available.

Although deep bottom fishing is the stated aim of this project it does not exclude other methods. At least one trolling line is always towed when travelling to and from bottom fishing grounds. This often supplies the bait needed, or if one or two good fish are caught may make the difference between a break-even trip and a profitable one. At other times trolling can be carried out when the weather is too rough for bottom fishing.

Training

Local fishermen to receive training are selected by the host country's fisheries department. Training is entirely on the job, by instruction in and demonstration of the fishing methods described above. After an initial period the trainees are encouraged to take charge of all operations themselves. Another aspect stressed is that fishing needs to be done on a regular basis to be economic.

Catch results

The master fisherman keeps a detailed record of the fishing hours, depths fished, species caught, numbers and weights, bait used, weather, etc. A copy of these data is given to the host country on completion of the project.

Fishes of the family Lutjanidae have made up almost half of the catches from the countries so far visited (Table I), the most important species being the large red snappers Etelis oculatus and E. carbunculus, and the rosy jobfish, Pristipomoides sp. Other important components of the catch consist of carangids, serranids (mainly of the subfamily Epinephelinae, of which there are numerous species), lethrinids, and gempylids (principally the castor oil fish Ruvettus pretiosus). Some of these fishes can attain a large size, Ruvettus up to 80 kg and E. carbunculus up to 35 kg. Catches of sharks have not always been recorded because in many places they are thrown away. At times they may comprise a not insignificant part of the catch.

To compare catches from different places the unit used has been catch (in kg) per reel per fishing hours. Table II shows the results from eight of the countries so far visited and additional data from the ORAFP. The full results of the DSFDP are contained in the reports by Mead (1978, 1979a), Mead and Crossland (1980, in press), Fusimalohi (1978, 1979), Fusimalohi and Crossland (in press) and Fusimalohi and Grandperrin (1980). Information on the depth distribution of the common fish species encountered is given in Mead (1979b).

Economics

An important part of this project (and the ORAFP previously) has been to collect information on the cost of boats, motors, fuel, ice, wages, etc. Earnings are calculated from the observed catch rates and the local selling price of fish. In several places projected earnings have shown a profitable balance over expenses but because so many different factors are involved in the economics of a fishing enterprise and because they vary greatly from place to place it is not possible to usefully summarise them here; details can be found in the individual reports. One factor that is becoming increasingly important is that compared to other fishing methods (such as trolling), deep bottom fishing uses very little fuel.

DISCUSSION

The catch rates achieved in this type of fishing may be low compared to those in industrial fisheries, but in the context of small Pacific communities are quite significant. Some caution is necessary in projecting from the data because they are in most cases from virgin fisheries. For example in Kosrae, where no bottom fishing had been done at all and where the best catch rate was obtained, the project caught 11 species of fish previously unknown to the islanders. On the other hand, the reported catch rates incorporate quite a lot of unproductive exploratory work. Only several years of exploitation can determine whether these catch rates can be sustained. There is a possibility that in some very small islands overfishing could occur, especially for some of the larger species, high in the food chain. At present almost nothing is known of the biology of the deep water snappers, and information on their age and growth is totally lacking. There is a need for research in this area, but the difficulties are formidable because of the multiplicity of species, sampling problems, and the difficulty in aging tropical species.

In many parts of the tropics the full utilisation of reef fisheries is not achieved because of the problem of ciguatera poisoning. Ciguatera is caused by a species of dinoflagellate Gambierdiscus toxicus common in coral reefs. It enters the food chain through ingestion by small fishes and is in turn biologically concentrated by higher level predators. There is no practical test to tell if a particular fish is poisonous (except by eating it), which results in much non-poisonous fish being discarded on suspicion. One of the advantages of deep bottom fishing is that fishes taken from depths greater than 100 m are not known to cause ciguatera. There is need for publicity concerning this. In places where ciguatera is common, people avoid eating large fishes because they are more likely to be toxic than smaller ones. Many of the deep water fishes are large and have at times met consumer resistance although they are perfectly safe to eat.

What are the prospects for the future? Deep bottom fishing uses simple equipment, does not require large investment, can be quickly learned and can be operated at a village level. The best strategy is probably to develop a multi-purpose fishery. Deep water droplining can provide the mainstay, but at times when migratory pelagic species are abundant, trolling or pearl lure fishing may be more profitable. There is also a need to utilise all the catch, including sharks; there may be a market for shark fins, liver oil, jaws or teeth, even when the flesh is unsaleable. The DSFDP has shown that in several places in the Pacific deep bottom fishing can provide not only a useful protein source and reduce the need for imported fish, but also a profitable living to an enterprising fisherman.

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Table I: Composition of the catches by the Deep Sea Fisheries Development Project (as percentages by weight) from various places in the tropical Pacific

	Lutjanidae	Carangidae	Serranidae	Lethrinidae	Gempylidae	Others
American Samoa	68.4	4.7	1.3	23.0	0.3	2.3
Tonga	22.3	30.0	3.7	4.1	30.3	9.6
Niue	45.6	1.6	25.1	25.3	0.0	2.4
Yap (TTPI)	38.6	26.3	26.6	2.7	4.9	0.9
Tanna (New Hebrides)	69.2	2.1	19.8	0.0	0.0	8.9
Kosrae (TTPI)	45.0	17.4	5.9	1.7	9.9	20.1
West New Britain (Papua New Guinea)	80.3	7.9	0.2	0.0	0.0	11.6
New Caledonia	47.8	2.6	14.8	22.0	0.0	12.8
Means	52.2	11.6	12.2	9.9	5.7	8.6

Table II: Average catch in kg per reel per fishing hour in places where South Pacific Commission bottom fishing projects have operated

Outer Reef Artisanal Fisheries Project (electric reels)		Deep Sea Fisheries Development Project (handreels)	
Malekula (New Hebrides)	3.5	American Samoa	4.4
Western Samoa	4.1	Tonga	3.6
Aitutaki (Cook Islands)	3.5	Niue	2.8
Tuvalu	2.5	Yap (TTPI)	6.9
Gizo (Solomon Islands)	5.7	Tanna (New Hebrides)	3.1
		Kosrae (TTPI)	9.6
		New Caledonia	7.6
		West New Britain (PNG)	4.9

APPENDIX : Basic equipment for deep bottom fishing.

1. Western Samoan type wooden handreels
2. 113 or 136 kg test monofilament line, 500m per reel
3. Turimoto No.29 longline wire or equivalent (three stranded, three wires per strand, 120 kg test)
4. Mustad tuna circle hooks quality No.39960 ST, sizes 3, 4, 5, 6, 7
5. Fenwick sevenstrand brass leader sleeves No.A7, or equivalent
6. Berkley - McMahon swivels size 4/0 or equivalent
7. Kelux stainless lockfast snap swivels size 4/0 or equivalent
8. 1 kg and 2 kg weights
9. 600-800m of polypropylene rope (rope diameter appropriate for size of boat)
10. Grapnel anchor and chain
11. Buoy for retrieving anchor
12. Pair of standard pliers
13. Pair of sidecutting pliers
14. Pair of crimping pliers
15. 15cm bait knife