# DEEP WATER SHRIMP TRAPPING

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## INTRODUCTION

The crustacean order Decapoda[1], which contains many commercially valuable species, can be divided into the crawling forms Reptantia (crayfish, lobsters, crabs) and the swimming forms Natantia (shrimps and prawns). The natants can be further divided into two major lines, the Penaeidea and the Caridea. The penaeids include several species which form the basis for important fisheries or aquaculture ventures in the warmer parts of the world. The carids are more varied in form and habitat than the penaeids and can be found in fresh water, shallow coastal waters and deep offshore waters in midwater and on the bottom, down to depths of hundreds of meters. This article will be concerned with the benthic deep water carids of the family Pandalidae.

The world-wide stocks of deep water carid shrimps represent a considerable under exploited resource, according to Struhsaker and Aasted (1974), who speculated that possible global yields were in the order of 250,000 - 2,500,000 t annually. There are important fisheries for these shrimps in Europe, Japan, Chile and at various places along the west coast of North America, including Alaska. In their own area of study, Hawaii, Struhsaker and Aasted estimated yields of 1-2 t/km$^2$. More recently, in the Hawaii Fisheries Development Plan 1979 (Anon. 1979), the resource was considered to be worth at least US$ 10 million [per year][2]. Other places in the tropical Pacific where carid shrimp stocks have been investigated are Fiji (Brown and King 1979), Tahiti (CNEXO 1979), New Caledonia (Intès 1978) Guam (Wilder 1977) and the New Hebrides (Anon. 1980). Results from these studies have not been as encouraging as in Hawaii, but this may be because of sampling differences rather than a lesser abundance of shrimps.

## FISHING GEAR AND METHODS

The greatest part of the world catch of shrimps, both shallow and deep water, is taken by trawling. Many different types of trawl gear are used. This method is of little use in the SPC region because, apart from the Gulf of Papua[3], there are no areas of continental shelf. Most of the potential fishing grounds consist of uneven or sloping bottoms unsuitable for trawling and fishing which can best be fished with traps.

### Trap design

Types of traps commonly used for catching shrimps may be square in section (Fig. 1A), oblong (Fig. 1B), triangular (Fig. 1C) or in the shape of a truncated cone (Fig. 1D). Recent trials on the U.S. National Marine Fisheries Service research vessel *Townsend Cromwell* have used semi-cylindrical traps (Fig. 1E). In Tahiti both truncated conical and truncated pyramidal traps were used. Frames are of steel rod 6 - 10 mm in diameter, covered with square mesh metal netting, chicken wire or fibre netting, with mesh sizes of 12 - 20 mm. Plastic netting would probably also be suitable. Funnel entrances are fitted at both ends of the traps (or sides in the conical trap). These taper to an inner aperture 7.5 - 10 mm in diameter.

Traps are baited with waste fish held in containers made of mesh or in perforated plastic jars. Oily fish, such as skipjack, make good bait. According to Butler (1970), trials carried out at various places along the Pacific coast of North America showed that traps covered in solid materials, such as sheet metal or plastic, gave a higher catch rate. Covering the traps (except the ends) has the

1. Decapoda = ten legged
2. The period was not stated but it is assumed to be one year.
3. There is a trawl fishery for prawns in the Gulf of Papua. This is in shallow water for various penaeid species.

effect of concentrating the bait odour through the entrance funnels and directing the shrimps into the trap. Struhsaker and Aasted (1974) experimented with uncovered traps and traps covered with burlap and found that the catch rate of the covered traps was 2.5 -10 times greater. In the New Hebrides (Anon. 1980) statistical analysis of the results showed that the catch did not differ significantly between covered and uncovered traps.

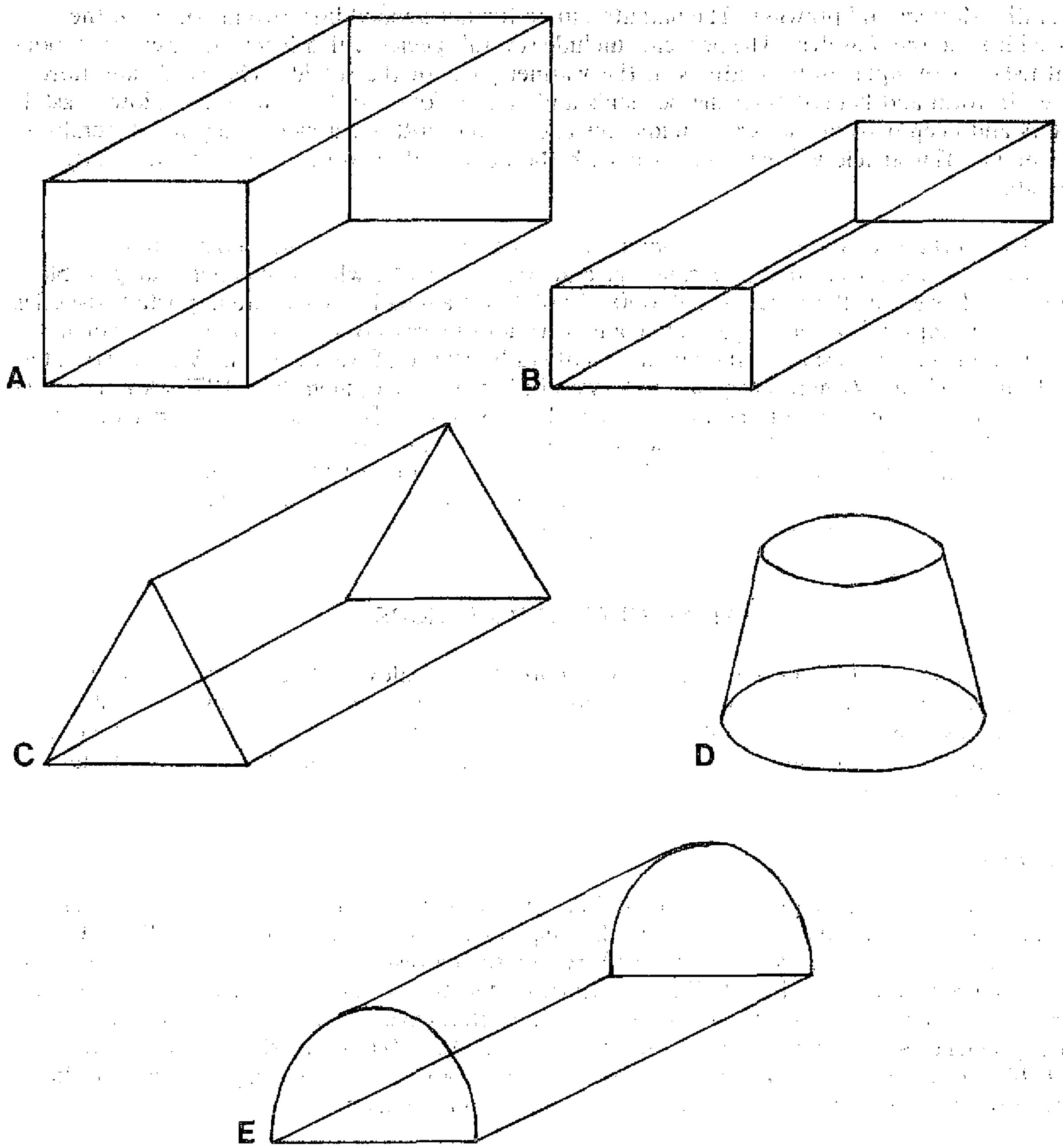


Fig. 1: Different shapes of shrimp traps: A: square; B: oblong; C: triangular; D: conical; E: semi-cylindrical. Funnel entrances, which are fitted at the ends (sides in the conical trap) are not shown.

Brown and King (1979) tested the effectiveness of the oblong[1], triangular and conical designs and found that the oblong and conical traps had similar catch rates which were both better than that of the triangular traps. They recommended the use of the conical traps because they were only about half the weight of the oblong traps and could be stowed more easily. Struhsaker and Aasted tried four designs - square, oblong, triangular and conical. Although not giving their full results they reported that catches of *Heterocarpus ensifer* were consistently lower from oblong and conical[2] traps than from square traps. In general escapes from traps decrease as the volume of the trap increases and it is likely that one of the reasons for the better catches of the square design was because its volume was twice as large as those of the other two. Three types of traps, triangular, conical and square, were used by Intès (1978). Intès, who was also interested in catching other benthic animals such as crabs, fitted large entrances to his square and conical traps. In the square traps the entrance funnels tapered to a rectangular opening 60 cm wide and 15 cm deep. The conical trap had a single cylindrical entrance on the top which was 30 cm in diameter. Intès did not directly compare the performance of the different trap designs. However, he recorded that the large aperture square traps gave very good catches.

### Setting of traps

Traps are set in strings. In the commercial fishery for *Pandalus platyceros* in Alaska up to 40 traps are set on a string and boats fish a total of 50 - 200 traps (Butler, 1970). For exploratory fishing a greater number of strings with fewer pots per string is better. Also, long strings are not suitable for areas of uneven bottom because of the risk of losing gear. Struhsaker and Aasted fished 4-6 traps per string, Intès 4-5 and Brown and King 3 (one each of their three designs). Traps are usually spaced 25 m apart and joined by a short bridle to the groundline of 12 mm polypropylene rope. An anchor or weight is attached at each end of the string. The length of the buoy line should be at least 25 per cent greater than the depth of water to allow for the effect of tides or currents.

Traps are hauled using a line hauler once or twice a day, an overnight soak frequently being favoured.

### Depths fished

The depths to be fished will depend on local conditions and the target species. The most productive depths appear to be in the 400 - 600 m range. Depth distribution for the different species will be discussed in more detail below.

## SPECIES OF POTENTIAL ECONOMIC VALUE

### Genus *Heterocarpus*

Species of this genus appear to offer the best prospects for commercial exploitation in the Pacific Islands. *Heterocarpus ensifer*[3] has been the species taken in the greatest abundance in the exploratory fishing carried out so far. In different places it is recorded over a depth range of 275 - 600 m (Fig. 2), being most abundant between 365 - 440 m in Hawaii, 400 - 500 m in New Caledonia, 440 - 500 m in Fiji and below 400 m in the New Hebrides[4]. In Tahiti, *Heterocarpus* sp. was recorded as being most abundant between 340 - 430 m. It is possible that temperature affects its depth distribution[5]. In Hawaii, Struhsaker and Aasted obtained catches varying from 0.9 - 15.9 kg per trap, with an average of 6.6 kg. Catches were much lower in Fiji, Tahiti, New Caledonia and the New Hebrides.

Individuals of this species average 9 - 10 g and reach a maximum weight of 16g. The tail muscle makes up 25 - 35 per cent of the total weight.

1. They called their oblong traps 'square' though in section they measured 40 x 69 cm (see Table 1).
2. They called oblong traps 'flat' and conical traps 'round'.
3. Brown and King (1979) called this *H. sibogae (ensifer?)*.
4. As the deepest traps (650 m) were still catching considerable numbers of *H. ensifer*, it was not possible to determine the bottom of the vertical distribution.
5. Temperatures would be around 17°C at 300 m depth, 13.5° at 400 m, 11° at 500 m and 8° at 600 m.

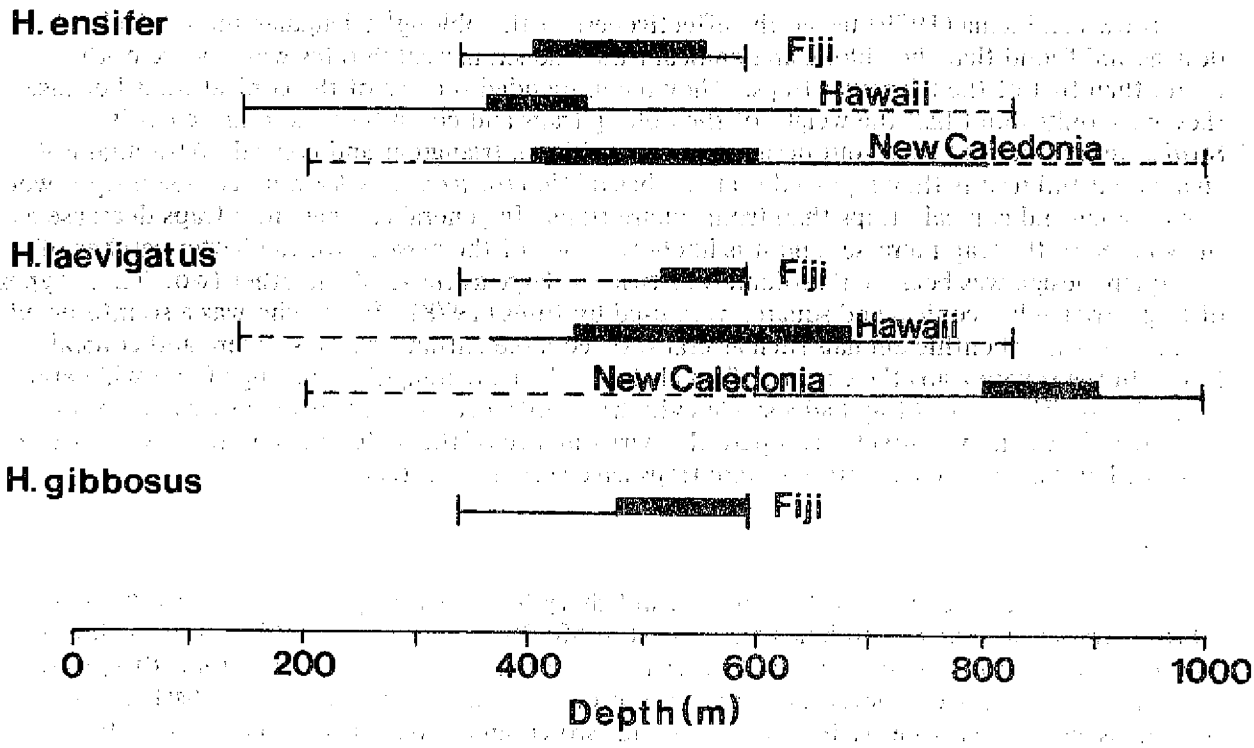


Fig. 2: Depth distribution of *Heterocarpus ensifer, H. laevigatus* and *H. gibbosus*. Thin lines indicate range of occurrence, thick lines ranges of maximum abundance and dashed lines depths investigated but species absent; vertical bars delimit sampling depths. Data are from Brown and King (1979) Fiji, Struhsaker and Aasted (1974) Hawaii, and Intès (1978) New Caledonia.

*Heterocarpus laevigatus* occurs in deeper water (Fig. 2) than *H. ensifer*, down to at least 1000 m (Intès 1978). In New Caledonia best catches have been obtained in the 800 m zone but in Hawaii, Struhsaker and Aasted recorded it to be most abundant between 440 and 680 m. In Fiji and the New Hebrides it occurred in depths greater than 470 m and became increasingly abundant down to 570 m, which was the maximum depth fished. Recorded catches of this species have not been as great as *H. ensifer* although this may reflect the depths which have been sampled and also the effectiveness of the traps. Intès found that catches of this large species (maximum size 22 cm[1]) were improved by fitting larger trap entrances. Average weight of the Fiji specimens was 17.9 g. No data is available on the meat recovery percentage but it could be expected to be similar to that of *H. ensifer*. Intès considered that *H. laevigatus* offered the best potential for exploitation in New Caledonia.

*Heterocarpus gibbosus* has so far only been recorded from Fiji in the shrimp trapping literature in the Pacific. Its depth range (Fig. 2) appears to be from 400 to at least 570 m (Brown and King 1979). Although not as abundant as *H. ensifer* or *H. laevigatus* it nevertheless made up 24 per cent of the catches of *Heterocarpus* species, and with its large size (average weight 13.5 g) could be a species of potential importance.

*Plesionika longirostris* is found in shallower water than any of the *Heterocarpus* species. In Fiji and the New Hebrides it was taken in the lower part of the depth range fished (330 - 400 m) and (240 - 460 m) respectively which suggests that its distribution extends into shallower water. In Hawaii it was not recorded by Struhsaker and Aasted (1974) but more recent surveys by the *Townsend Cromwell* have taken it in sets at 331 and 335 m. In the Hawaii Fisheries Development Plan (Anon 1979) *Plesionika* sp. is recorded as occurring from 110 - 460 m with quantities of 11kg per trap being taken at 460 m. This depth distribution plus the size of the Hawaiian specimens (7.1 - 14.2 g for larger individuals) compared to an average weight of 5.5 g in Fiji suggest that two different species may be involved. In Tahiti, *Plesionika* sp. is recorded from 80 to 500 m.

1. Maximum weight not known but would be about 70 g at this length.

Although *P. longirostris* is of small size, Brown and King considered it may be of commercial importance because its meat recovery rate is higher than that of the *Heterocarpus* species, and it is found in shallower water.

## POSSIBLE FUTURE DEVELOPMENTS

### Exploratory fishing surveys

The exploratory shrimp trapping so far carried out in the tropical Pacific has shown encouraging results in Hawaii and interesting, but less good results, in the other places. However, except in Hawaii, the effort has been very small and probably not with the most effective traps. The potential size of the deep water shrimp resource and its high value would suggest it is worthwhile to carry out further exploratory fishing in selected places. The results reported from Fiji were only the first phase of the Fisheries Division's deep water shrimp trapping project. Further investigations are planned to determine the geographical and depth distribution of the stocks. There are plans to carry exploratory fishing further in the New Hebrides. In New Caledonia it would certainly seem desirable to follow up the work of Intès. Another possible place not yet explored is Tonga, which has a large area of sea with depths under 1,000 m.

To carry out a useful exploratory fishing survey its objectives need to be carefully defined beforehand and it needs to be on a large enough scale to achieve them. Thus something more comprehensive than the trials already reported, though less exhaustive than a full scale resource assessment, must be considered. It would be desirable that any survey has the status of a full project rather than being done on an opportune basis in conjunction with other programmes.

The objectives should be set to obtain information under three main headings. The first concerns the distribution of the resource, and will include spatial and depth distribution, comparative abundance and seasonal changes in these. Other useful information to collect would be the type of bottom and the water characteristics (such as temperature) where shrimps are most abundant. The second kind of data concerns the catch rate and the factors affecting it. The calculation of an average catch rate per trap is essential if any projection is to be made concerning the commercial feasibility of shrimp trapping. Factors affecting the catch rate will include trap design, bait type, soak time and the number of possible fishing days. Thirdly, it may be desirable to collect some biological information. This should be done only for specific purposes and not just because 'it may be useful later'. However, it is essential that different species are recognised and correctly identified.

A first plan for a survey would be to map out potential fishing areas and to conduct initial trials over a fairly wide area. Subsequently, sampling could be carried out more intensively over a smaller area, where shrimps were found to be concentrated. If resources allowed it, one week's fishing per month could be done in the sub-area over a 12-month period. It would be wise in addition to sample the wider area three or four times a year, as the original survey might have been affected by seasonal variation or sampling error.

Based on the results previously reviewed the best choice of trap is the covered square design of Struhsaker and Aasted. This trap has twice the volume of their oblong design but requires only an additional 14 per cent of framing material and 30 per cent covering material for its construction. To carry out large scale trials it may be necessary to design a collapsible trap so that sufficient traps can be carried on the survey vessel. This should not be difficult with this simple design if the entrance funnels are made of fibre netting, in a similar manner to those illustrated in Figs 6 and 7 of Struhsaker and Aasted (1974).

The importance of keeping and publishing a proper record of the results of any exploratory survey cannot be overstressed.

**A commercial fishery?**

Deep water shrimp trapping will probably require a boat at least 8 - 9 m long so as to carry sufficient traps and to be able to operate in moderate sea conditions. A suitable boat could be similar to those used in New Zealand and Australia for rock lobster fishing. These have a small cabin or shelter right forward and a large, clear working deck. Initial investment in equipment - traps, ropes, buoys, line hauler - may be quite high, depending on the number of traps and the depth of water to be fished. For a given number of traps the amount and size of rope required will depend on the number of traps per string and the type of bottom. A few strings with many traps each will be more economical than a lot of short strings. However, the possible loss of a lot of gear at once, if a long string becomes fouled, must be considered. On the other hand, in areas with a smooth bottom a lighter rope could be used and this would reduce costs.

As well as a proven resource of shrimps, a viable commercial fishery will depend on other factors. Most importantly there must be an assured market for the catch. Because of the relatively small quantities involved for the effort expended, compared to other fishery products, shrimps must realise a high price to make fishing worthwhile. This requires access to a moderately large, urbanised home market or an export outlet. Also vital is the requirement for adequate preservation of the catch. The flesh of the *Heterocarpus* species does not keep well unless chilled or frozen as soon as caught. Probably the most practical preservation method for the Pacific Islands is the use of crushed ice.

The above factors would seem to limit the development of deep water shrimp fisheries to those grounds near main centres of population, at least for some years to come. Supposing shrimps are worth $5 per kg and a fisherman can work 100 traps per day catching 1.5 kg per trap, earnings per day will be $750.

**Table 1: Sizes of different traps used in deep water shrimp trapping trials. Dimensions are in centimetres (for the conical traps, base diameter, top diameter and height are given); volumes in cubic metres (including entrances) are shown in brackets.**

| Reference | Place | Trap type | | | |
|---|---|---|---|---|---|
| | | square | oblong | triangular | conical |
| Struhsaker and Aasted (1974) | Hawaii | 60 x 60 x 120 (0.432) | 30 x 60 x 120 (0.216) | 60 x 120 (0.187) | 86 x 60 x 36 (0.152) |
| Intès (1978) | New Caledonia | 100 x 100 x 150 (1.5) | - | 60 x 120 (0.187) | 90 x 30 x 52 (0.162) |
| Brown and King (1979) | Fiji | - | 40 x 69 x 90 (0.248) | 60 x 120 (0.187) | 75 x 52 x 40 (0.126) |
| CNEXO[1] (1979) | Tahiti | - | - | - | 100 x 30 x 70 (0.255) |
| CNEXO (1979) | Tahiti | - | - | - | 90 x 30 x 80 (0.245) |

1. In Tahiti two different types of conical traps were used.

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