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DEEP-WATER CARIDEAN SHRIMPS ON THE STEEP SLOPE OF THE MORUROA ATOLL

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ABSTRACT

During 1986-1987 more than 700 baited traps were set on the outer slope of the Moruroa atoll in depths ranging from 200 to 800 m. Deep-water caridean shrimps represent the bulk of the catches. It has been possible to identify several species belonging to the family of Pandalidæ (*Heterocarpus* and *Plesionika spp.*). Depth distribution of these species has been studied and some biological aspects are given.

The maximum yield was at a depth of more than 500 m. However, the catches did not exceed more than a few hundred grams per trap and equipment losses were high.

INTRODUCTION

Surveys using baited traps have been undertaken by the Service Mixte de Contrôle Biologique on the outer slope of the Moruroa atoll since 1984 (Manac'h and Carsin, 1985). Several species of deep water caridean shrimps have been indentified (Crosnier, 1986). This present study continues with an examination of the biology and ecology of these shrimps. In the Pacific Ocean, many studies of this type have been carried out on the commercial fisheries potential of caridean stocks. Surveys have been carried out in Hawaii (Clarke, 1972 ; Struhsaker and Aasted, 1974), Mariannas (Moffitt, 1983), Guam (Wilder, 1977), Papua New-Guinea (King, 1982), Vanuatu (King, 1981 ; De Reviers et al, 1972), New-Caledonia (Intes, 1978), Fiji (King, 1984), Tonga (King, 1981) and western Samoa (King, 1980). There have been no surveys for deep water shrimps in French Polynesia, except for a brief prospecting survey in Tahiti (CNEXO, 1979).

This study presents the results achieved on Moruroa, an atoll of the Tuamotu archipelago, during two fishing seasons (in December 1986 and in June 1987) by the Biological Control Ship "MARARA" of the French "Direction des Centres d'Expérimentations Nucléaires", (DIRCEN).

MATERIALS AND METHODS

Baited cylindrical traps of the "NOIRMOUTIER" type were used (Figure 1). Fifteen baited traps were attached every twenty meters on a polypropylene buoy rope (Ø 12 mm). The line was ballasted with four lead pigs of 25 kg each, positioned between each group of five baited traps.

The lines were set down perpendicular to the reef, extending from a depth of 200 meters down a depth of 800 meters. A 800 to 1000 meter long buoy rope linked the bottom line to a 200 l surface float.

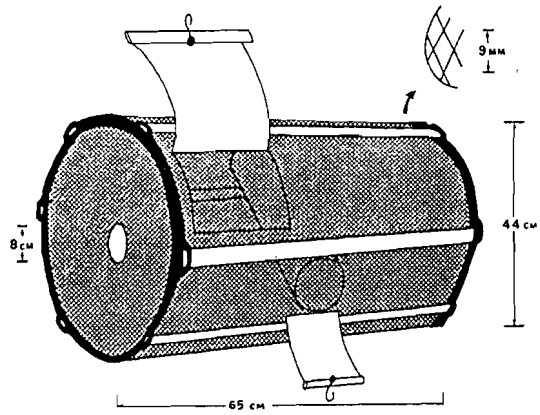

Figure 1. Diagram of the baited trap used (type "Noirmoutier").

The baited traps were set down at the end of the day, and were picked up in the course of the next day, resulting in a fishing period between 12 and 20 hours. The bait used was mostly dogtooth tuna (*Gymnosarda unicolor*) or parrot fish (*Scarus sp.*). In June 1986, 200 baited traps were set down between 200 and 800 meters, to test the fishing gear and methodology. In December 1986, 270 baited traps were set between 250 and 650 meters. In June 1987, the fishing effort was in deeper water with 254 traps set between 360 and 700 meters.

The setting depth of each baited trap was recorded for each fishing operation and catches analysed for every 20 meters depth range.

RESULTS - DISCUSSION

The major species caught

Shrimps caught during this survey all belong to the infraorder Caridea and particularly to the family Pandalidea. Detailed descriptions of the species caught are available in the studies of Crosnier and Forest (1973) and King (1986) for the already known species and in Crosnier (1986) for the new species.

Concerning the five species studied, the main external morphological characters used to distinguish them are :

- Carapace with strong longitudinal carinae :
G. *Heterocarpus*.

- Spines on abdominal somites 3 and 4. The length of the fourth segment's spine is equal to, or smaller than the one of the third segment. Dorsal carinae absent from first and second abdominal segments : *Heterocarpus ensifer* sl..

- Spines on abdominal somites 3 and 4. Both spines are of equal length. Dorsal carinae present on first and second abdominal segments : *Heterocarpus sibogae*.

- Carapace lacking strong longitudinal carinae : G. *Plesionika.*

- Rostrum long and slender at least twice as long as the carapace, dorsally and ventrally dentate ; abdomen with red striae : *Plesionika edwardsi.*

- Rostrum long and slender, not exceeding 2.0 times carapace length. The posterior side of the rostrum only carries 5 to 7 teeth on its basics part. Third abdominal segment armed with posterodorsal tooth : *Plesionika* aff. *ensis.*

- Rostrum short, not exceeding carapace length strongly up-curved distally, dorsally and ventrally dentate : *Plesionika fenneri.*

Species depth distributions

Figure 2 shows the depth distribution of the five species studied. Each dot represents the mean catch weight in about ten baited traps (due to a great number of empty traps the S.D. are very large and are omitted for clarity).

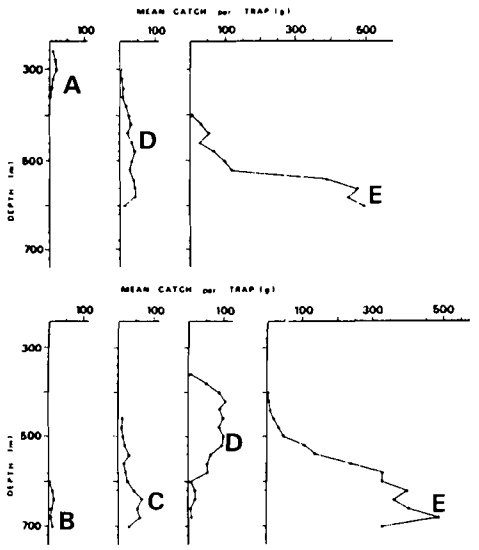

Figure 2. Depth distribution of the main species caught in December 1986 (above) and in June 1987 (below).

A : *P. edwardsi*
B : *H. sibogae*
C : *P.* aff. *ensis*
D : *H. ensifer*
E : *P. fenneri*

- *Plesionika fenneri* was the most common species caught (66,56% of the total weight). This shrimp, which appears in the catches from 400 meters down, is particularly abundant between 540 and 700 meters.

- *Heterocarpus ensifer*, a common species in the Pacific area, accounts for 25,94 % of the catches. Its vertical distribution stretches from 300 meters down to 600 meters with a maximum abundance between 380 and 580 meters. In New Caledonia (Intes, 1978) and in western Samoa (King, 1980), it is still abundant at 600 meters. In Hawaii (Clarke, 1972), it has been possible to catch this species abundantly from 275 meters.

Beside the two main species above, the three species listed below have been caught in small numbers.

- *Plesionika* aff. *ensis* (5,01 % of the total weight) has only been caught during the June 1987 season. This species closely resembles *Plesionika ensis*, but further study is necessary before this identification can be confirmed. It is found in depths ranging from 460 to 700 meters with a maximum abundance between 640 and 680 meters.

- *Plesionika edwardsi* is common in the Pacific area where it has been previously refered to as *Plesionika longirostris.* It represents 1,81 % of the catch on less deep bottoms, between 260 and 360 meters. However, King (1984) mentions its presence at the depth of 540 meters in the Fidji islands.

- *Heterocarpus sibogae* is the species among which the biggest individuals have been caught. However, it only represents 0,68% of the total catch weight. This species is to be found between 600 and 700 meters. In the south-west Pacific, King (1984) found the species in shallower water.

These observations clearly point out the importance of depth on the distribution of species. However for common species such as *Heterocarpus ensifer, Heterocarpus sibogae* and *Plesionika edwardsi* which have been investigated in other geographical areas of the Pacific, the vertical distribution is sometime quite different. We consider that, as reported by King (1986), the preferred depth for each species may vary between islands.

Comparison of the two fishing seasons

During the summer season, about 110 grams of shrimps were caught per trap. This result improved a little during the winter season: mean of 218 grams per trap. This increase of the catch in June is due mostly to increased fishing depth. Figure 3 shows that the mean captured weigth per trap is hardly increasing under 500 meters.

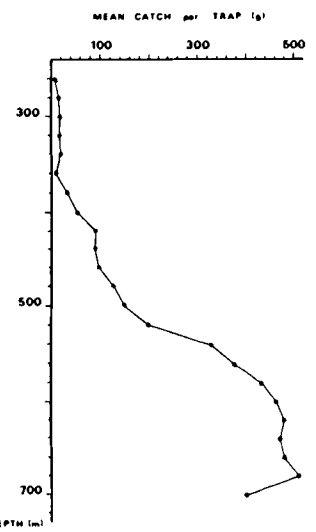

Figure 3. Evolution of catch (mean weight per trap) by depth. (10 observations at least were used to calculate each plot)

The increase in catch of *Heterocarpus ensifer* (mean weight per trap from 31 to 85 grams) in depths from 400 to 600 meters constitutes the only indication of a seasonal change in catch with a maximum in winter. Clarke (1972) points out the same trend in Hawaii.

In December as in June, *Plesionika fenneri* and *Heterocarpus ensifer* were the two main species caught with more than 90 % of the catch weight every time. *Plesionika edwardsi*, which is only abundant between 260 and 360 meters, is logically missing from the captures made in June over 360 meters. Same thing for *Heterocarpus sibogae* which is well represented from 600 meters but has not been caught in significant amounts in December when the fishing depth has not exceeded this limit. For the two last species, depth considerations therefore explain the results obtained during each season. In contrast, for *Plesionika* aff. *ensis*, which is to be found on bottom explored in December and in June (460 to 600 meters), another explanation must be given for its almost total absence from the December captures. This species is likely to congregate in groups located on the outer slope of the atoll.

During the last fishing campaign, where 17 geographic areas around Moruroa were prospected, the main catches of *Plesionika* aff. *ensis* have been taken in a single fishing area. This obsevation is akin to the data given by Struhsaker and Aasted(1974) and by De Reviers *et al* (1982). It would therefore turn out that, for some species at least, the distribution of the individuals on the bottom is not homogeneous but highly localized.

Reproduction-Sexuality

Contrary to the Pandalidæ in temperate waters which are protandrous hermaphrodites*, (Butler, 1964), the Pandalidæ observed in tropical areas have separate sexes. Concerning *Heterocarpus ensifer*, *Heterocarpus sibogae* and *Plesionika edwardsi*, King and Moffitt (1974) found a sex-ratio near to 1/1 for all size classes. These authors believe that this may be appliable to all Pandalidæ in tropical waters. It seems therefore interesting to investigate the sex distribution in *Plesionika fenneri* a new species, hardly represented. In a sampled of 251 individuals taken from different catches, males and females were separated. Determining the sex was easy, even for small individuals, by the examination of the first pleopod's endopod. The result is presented by 1 mm size-classes (cephalothorax-length) on figure 4.

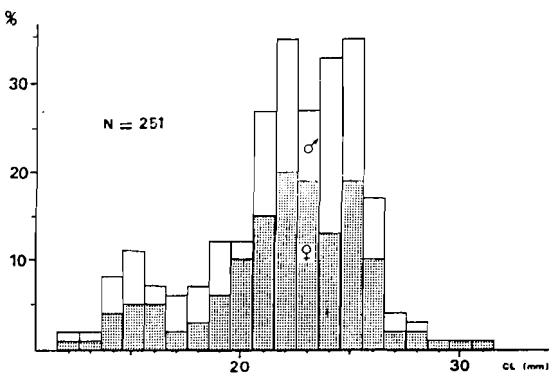

Figure 4. Size frequency distribution for a *Plesionika fenneri* sample.
(CL : Cephalothorax length)

* A same individual changes from male to female during its development.

For all size classes, the sex ratio (females/males = 1,17) gives a small adventage to the females. However this is not the case of a protandrous hermaphroditism where there would be a clear separation into a small sized male group and a larger size female group. The cases for separated sexes, proposed by King and Moffitt for the well known tropical species, seems therefore to be appliable to *Plesionika fenneri*.

After each capture, the percentage of ovigerous females was calculated for the two main species caught : *Plesionika fenneri* and *Heterocarpus ensifer*. The results are presented in terms of depth in figure 5.

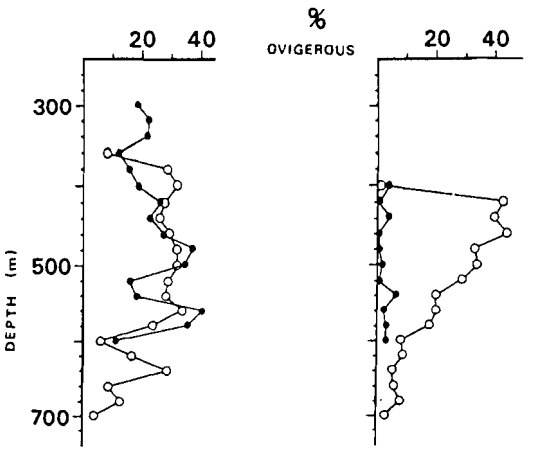

Figure 5 . Percentage of ovigerous females in the catches in terms of depth.
On the right : *Heterocapus ensifer*
On the left : *Plesionika fenneri*
●---● December
0---0 June

The percentage of ovigerous females in *Heterocarpus ensifer* is high, in December 1986 (24,3 %) as well as in June 1987 (28,8 %). It is not possible to point out any clear correlation within depth or season.

Althought the percentage of ovigerous females of *Plesionika fenneri* has been lower, it presents a pronounced seasonal character. In December, only 2,4 % of the shrimps caught carried some eggs. This percentage increased to 13,6 % in June. Moreover, though *Plesionika fenneri* was most abundant in depths greater than 520 meters, the highest percentage of ovigerous females, observed in June, were located above this limit, between 420 and 520 meters. These results suggest that there is for this species, a winter period of reproduction, with a vertical migration of ovigerous females to shallower depths.

The size at female sexual maturity has generally been estimated as the size at which 50 % of the observed females are ovigerous (King and Butler, 1985). From our samples, it has been possible to determine graphically this size for *Heterocarpus ensifer* and *Plesionika fenneri* (Fig. 6)

Females *Heterocarpus ensifer* from a carapace length of 18 mm and above have been observed carrying eggs. Above 23 mm, all the females were carrying eggs. Between these sizes, the size at sexual maturity for *Heterocarpus ensifer* is 19 mm. This coincides with the value obtained for this species in Fiji (CL=50 % ovigerous females = 20 mm; King and Butler, 1985). The small difference may be due to the small size of our samples (N=154). For *Plesionika fenneri*, the smallest ovigerous female observed measured 19 mm and the size at sexual maturity is 23 mm.

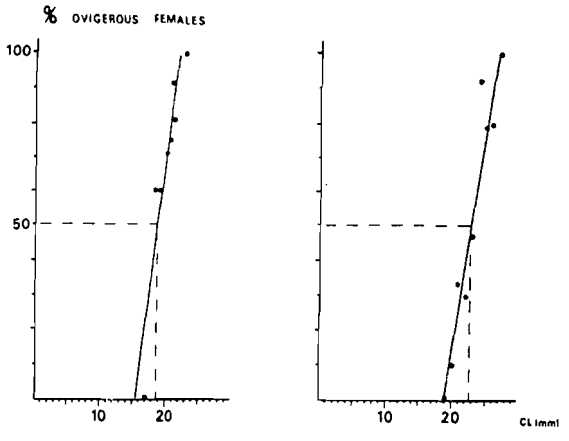

Figure 6. Determination of the size (Cephalothorax length: CL) at sexual maturity by females.
On the left : *H. ensifer* (N = 154) (r = 0,90)
On the right : *P. fenneri* (N = 140) (r = 0,95).

CONCLUSIONS

In relation to other tropical areas that have been surveyed in the Pacific, Moruroa constitutes an original area because the most abundant species, *Plesionika fenneri*, has only been discovered in recent times. The fishing depth play a major role in influencing the composition and quantity of the catch. The best observed catches were in depths greater than 500 meters. The total weight caught was about 64 kg, which represents a mean weight of 0,16 kg per baited trap. This result is one of the lowest observed in the Pacific. It is far lower for example, than the 2,9 Kg per trap mentioned in Hawaii (King, 1986). Moreover, trap losses were significant, mostly due to the uneven nature of the bottom. Among a total of 524 baited traps set in June and December, 120 were lost. It is therefore unrealistic, economically speaking to consider the development of fisheries on this shrimp stock. However, French Polynesia constitutes a wide territory of 5 million square km and other areas should be examined before coming to a decision on the fisheries potential.

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