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Discards from Deep-water Bottom Trawling in the Eastern-Central Mediterranean Sea and Effects of Mesh Size Changes

by

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Abstract

Data on discards were collected during deep-water bottom trawling targetting red shrimps (*Aristeus antennatus* and *Aristaeomorpha foliacea*) in the Ionian Sea (Eastern-Central Mediterranean). The performance of 3 codends, with stretched mesh size (sMS) of 40, 50 and 60 mm respectively, was tested. A cover with stretched mesh of 20 mm was employed on each codend.

The discarded catch from the deep-water shrimp fishery constituted an important fraction of the total catch (20÷50%). It was almost exclusively due to unwanted fish species while discards of the target species and other commercial species was negligible. Discard rates increased with total catch and depth.

No substantial differences were shown in the quantitative and qualitative overall performance of the used codends. Differences were only detected in the biomass of the escaped fraction of the catch (both marketable and discards) and in the size selectivity.

Larger mesh size codend allowed a higher number of small specimens to escape.

Introduction

According to Alverson *et al*. (1994) the "discarded catch" is the portion of the catch returned to the sea as a result of economic, legal or personal reasons. Generally, the qualitative and quantitative composition of the discarded catch are depending on a great number of variables, which include the season, the gear and the fishing method practiced, the depth and the fishing grounds exploited, the duration of the trip and hauls, the occurence of juveniles (Alverson *et al.*, 1994).

Despite of the great importance of discards phenomenon within the multispecies Mediterranean bottom trawling fisheries, there are only limited experiences concerning the amount, composition and factors affecting it (Stergiou *et al.*, 1997 and 1998; Carbonell *et al.*, 1998; Moranta *et al*., 2000; Ragonese *et al*., in press). From these experiences emerged that the "discards" from trawl fishery are generally due to unwanted species (without commercial value), bycatch species (of low commercial value) and undersized specimens of species with higher commercial value.

In the Ionian Sea (Eastern-Central Mediterranean), the deep-water decapod crustacean fishery targets primarily *Aristeus antennatus* and *Aristaeomorpha foliacea*. This fishery, along the Calabrian coasts, provide several bycatch species. Some of them, such as *Merluccius merluccius*, *Nephrops norvegicus*, *Parapenaeus longirostris*, *Helicolenus dactylopterus* and *Lophius budegassa*, are valuable species, many others, such as *Phycis blennoides*, *Micromesistius poutassou*, *Lepidorhombus boscii*, *Plesionika martia*, *Eledone cirrhosa*, are of low commercial value. Many species without commercial value are often associated to the catch and always discarded (Tursi *et al*., 1998). Although deep-water decapod crustacean have long been intensively exploited in the Ionian Sea, scientific information on discards determined during their fishing are only available as grey literature.

The aim of this paper is to provide the preliminary information on discards from the deep-water trawling in the Ionian Sea, pointing out the effects of the mesh size changes.

Materials and Methods

Data were collected during 8 seasonal trawl surveys carried out in the Ionian Sea (Fig. 1) from April 1996 to March 1998. A stratified sampling design was adopted in the depth range from 250 to 750 m, where trawl fishing on deep-water red shrimps occurs. A total of 12 hauls of 3 hours in duration were carried out, from dawn to dusk, during each survey, emulating commercial trawling in the area.

A professional 75 tons gross tonnage motor powered vessel (360 Hp), equipped with a nylon otter trawl net, was hired. The performance of 3 codends, with stretched mesh size (sMS) of 40, 50 and 60 mm respectively, was tested. A cover with stretched mesh of 20 mm was employed on each codend. The 40 mm sMS codend, which is the Italian legal mesh size, was used in all the surveys, while the 60 and 50 mm sMS codends were used in the first and in the last four cruises, respectively. The sampling scheme of the whole research is shown in Table 1.

The catches were standardized in kg/h. The discarded catch refers to the part of the total catch thrown back into the sea and constituted by unwanted species (species without commercial value), bycatch species of low commercial value and undersized specimens of bycatch species of high commercial value. The discard rate (DR), considered as the proportion of the total catch, which is discarded (Alverson *et al.*, 1994), was computed for the total catch, fish, crustaceans and cephalopods per each survey and codend. The G-test was used in order to evaluate significant changes of the discarded and marketable catch by surveys and mesh sizes. The relationship between discard rate and total catch and between discard rate and depth was performed for 40 mm sMS codend by means of linear regression. This kind of analysis was also made in order to evaluate the relationship between the catch passed in the cover, both marketable and discards, and mesh size codend. Length-frequency distributions for each used codend were performed for the following species: a) *Aristeus antennatus* (target commercial species); b) *Helicolenus dactylopterus*, *Phycis blennoides*, *Micromesistius poutassou* (bycatch species); c) *Caelorhynchus caelorhynchus* (unwanted species).

Results

40 mm mesh size codend

During this study, the discard rate with 40 mm sMS codend ranged from 0.21 (April '96) to 0.50 (July '97) within a total catch between 11.24 kg/h (July '96) and 23.32 kg/h (October '96) (Fig. 2). The highest discard rate values were shown during July of both years, however the changes of the discarded and marketable catch (both target and bycatch species) throughout the 8 surveys were not statistically significant (G-test = 4.36, $p>0.05$).

The relationships between discard rate and total catch and between discard rate and depth were both positive (Fig.3):

$$DR = 0.1856 + 0.0093 \text{ total catch};\ r = 0.35;\ n=48;\ p<0.01$$
$$DR = -0.3142 + 0.0013 \text{ depth};\ r = 0.67;\ n=48;\ p<0.01$$

Concerning catch composition, a total of 162 species was collected. Two of them (*Aristeus antennatus* and *Aristaeomorpha foliacea*) are target species, 34 are bycatch with various commercial value and 126 are unwanted species. Discarded catch was mostly due to the unwanted species (99.25% on average), mainly represented by *C.*

caelorhynchus, H. italicus, N. sclerorhynchus, H. mediterraneus, C. agassizi and *G. melastomus*. The contribution of bycatch species (both with high and low commercial value) to the discards was very low (0.75% on average). This latter contribution was mainly represented by small specimens of *H. dactylopterus, P. blennoides, M. poutassou*. The changes by surveys of these two discard fractions (unwanted and bycatch species) within the whole discarded catch were not statistically significant (G-test = 0.46, p>0.05) (Fig.4).

Fish, crustaceans and cephalopods represented 90.8%, 6.4% and 2.8% respectively of the discarded catch. With regard to the marketable catch, the highest fraction was constituted on average by crustaceans (66.9%), followed by fish (24.2%) and cephalopods (8.9%).

Mesh size codend comparison

Concerning the different mesh size codends, from the 50 mm sMS codend the discard rate ranged from 0.19 (July '97) to 0.35 (December '97) as part of a total catch between 10.51 kg/h and 9.68 kg/h, respectively. The 60 mm sMS codend showed discard rate values between 0.25 (April '96) and 0.44 (February '97) within a total catch of 9.25 kg/h and 12.33 kg/h, respectively (Fig.5).

The changes in discarded and marketable catch (both target and bycatch species) with the three codends, considered for the pooled data, were not statistically significant (G-test = 0.45, p>0.05). The relationship between the catch passed in the cover (total, marketable and discards) and mesh size codends was positive (Fig. 6). Although this positive relationship, the changes of the discard fraction in the cover with the different sMS codends were not significant (G-test = 0.12, p>0.05). In other words, the proportion between marketable and discards in the cover did not change with the mesh size increase in the codend.

No substantial differences were shown among the three codends with regards to the qualitative composition of discards and marketable.

Size distribution

With regard to the size distributions, it was shown that the 40 mm sMS codend resulted generally not selective for each study species. Only very small specimens escaped in the cover. Concerning *Aristeus antennatus*, very few specimens were discarded because crushed during hauling and sorting operations. The fraction escaped in the cover increased according to the mesh size (Fig. 7).

Specimens of *Helicolenus dactylopterus* smaller than 100 mm TL were always discarded. Their number retained in the codend decreased markedly with mesh size, thus reducing the discards fraction (Fig. 8).

Individuals of *Phycis blennoides* smaller than 150 mm TL were always rejected. From this size to 180 mm TL specimens resulted marketable or discards according to their preservation state. With regards to the mesh size, the greater forkbeard showed the same trend of the rockfish (Fig. 9).

Micromesistius poutassou is a demersal species whose recruitment occurs on the continental shelf, so that only greater specimens may be captured on the slope (Tursi *et al*., 1993). It was always discarded for size smaller than 190 mm TL. A remarkable fraction of individuals escaped in the cover was only shown with the 60 mm sMS codend (Fig. 10).

Also in *Caelorhynchus caelorhynchus* the fraction of specimens escaped in the cover increased markedly with mesh size in codend (Fig. 11).

Discussion

The discarded catch from the deep-water shrimp fishery in the Ionian Sea constitutes an important fraction of the total catch (20÷50%), as shown in other Mediterranean areas (Carbonell *et al*., 1998; Moranta *et al*., 2000; Ragonese *et al*., in press). It is almost exclusively due to unwanted fish species while discards of the target species *A.*

antennatus and *A. foliacea* and other commercial species was negligible. Although the discard rate varied monthly, no significant differences were shown in this study. On the contrary, discard rates increased with total catch and depth. According to Stergiou *et al*. (1998), the positive increase of discards with total catch could be due to the decreasing selectivity of codends as they fill and meshes become masked. Moreover, a greater fraction of crashed specimens may occur when codend is heavely filled. The positive increase of discards with depth may be attributed to the greater finding of unwanted species, such as macrourid fish, *Hoplostethus mediterraneus*, *Galeus melastomus*, which are very abundant in the study area (Matarrese *et al*., 1996; D'Onghia *et al*., 1998).

According to Ragonese *et al*. (in press), no substantial differences were shown in the quantitative and qualitative overall performance of the used codends. Differences were only detected in the biomass of the escaped fraction of the catch (both marketable and discards) and in the size selectivity. Particularly, such differences were more evident by using 60 mm sMS. This mesh size codend allows a larger number of small specimens to escape. Thus, its adoption would reduce the capture of low valued or undersized specimens, minimizing the sorting time and improving the catch quality. However, considering that nothing is known about the survival of escaped specimens during deep shrimp trawling, it is not yet possible to quantify the reduction of juveniles mortality and of the impact on the deep-sea ecosystem.

Furthermore, even though, according to Ragonese *et al*. (in press), the introduction of a larger mesh size (28 mm side) would determine minimal economic loss (due to the very small unit value of small-size specimens escaped), the escaped marketable biomass appears to be too high to the local fishermen and thus difficult to accept. Particularly, in the study area within deep-water trawling a wide depth range is generally sought with trawlers sharing fishing, throughout the year, both on deep-water shrimps (*A. foliacea* and *A. antennatus*) on the slope, and on the rose shrimp and hake on the shelf edge and upper slope. In accordance to the sea-weather conditions and the varying availability of the resources the same trawlers can fish in very shallow waters targetting red mullet and other coastal species. Thus, the adoption of a larger mesh than 40 mm stretched appears to be not actually feasible due to the lacking of a specific fishery targetting exclusively deep-water shrimps.

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Tab. 1 - List of the hauls carried out from April 1996 to March 1998, with indication of duration, depth range and stretched mesh size used.

Date	n. haul	Duration (minutes)	Depth range (m)	Mesh size (mm)
April 1996	6	1025	313-486	40
	6	1020	528-670	60
July 1996	6	1075	312-676	40
	6	1075	313-655	60
October 1996	6	1017	321-660	40
	6	1060	326-664	60
February 1997	6	1090	303-662	40
	6	1050	274-669	60
May 1997	6	1080	326-658	40
	6	1044	315-660	50
July 1997	6	1050	320-676	40
	6	955	305-666	50
December 1997	6	948	243-673	40
	6	975	304-659	50
March 1998	6	1045	306-673	40
	6	1065	314-672	50

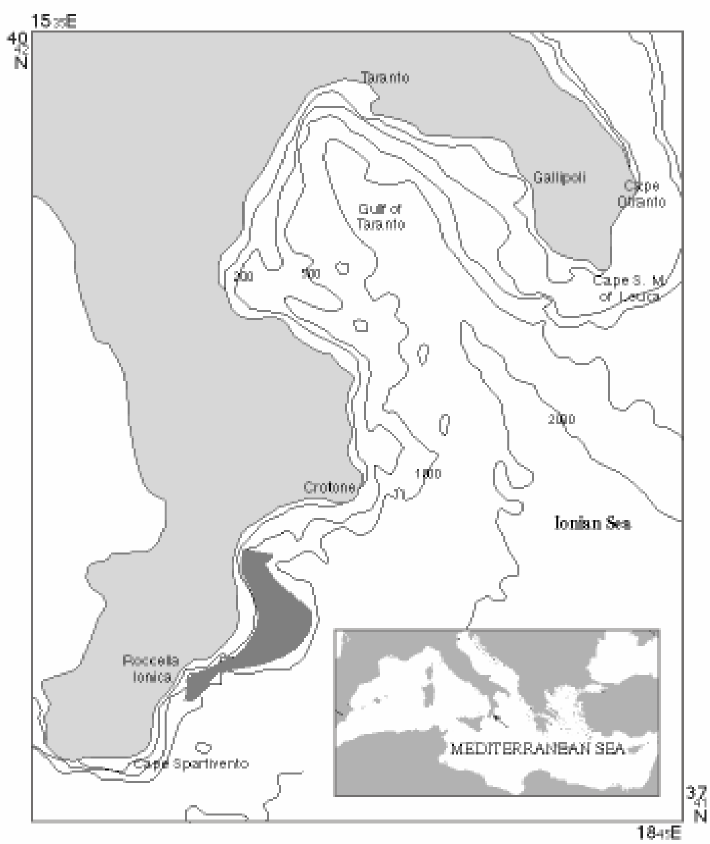

Fig. 1 – Map of the Ionian Sea (eastern-central Mediterranean) with indication of the area (■) investigated from April 1996 to March 1998.

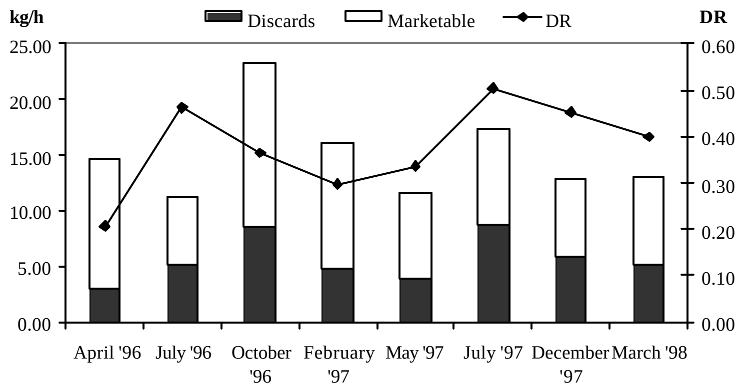

Fig. 2 - Discards and marketable catch (kg/h) with relative discard rate (DR) by survey computed for 40 mm mesh size codend.

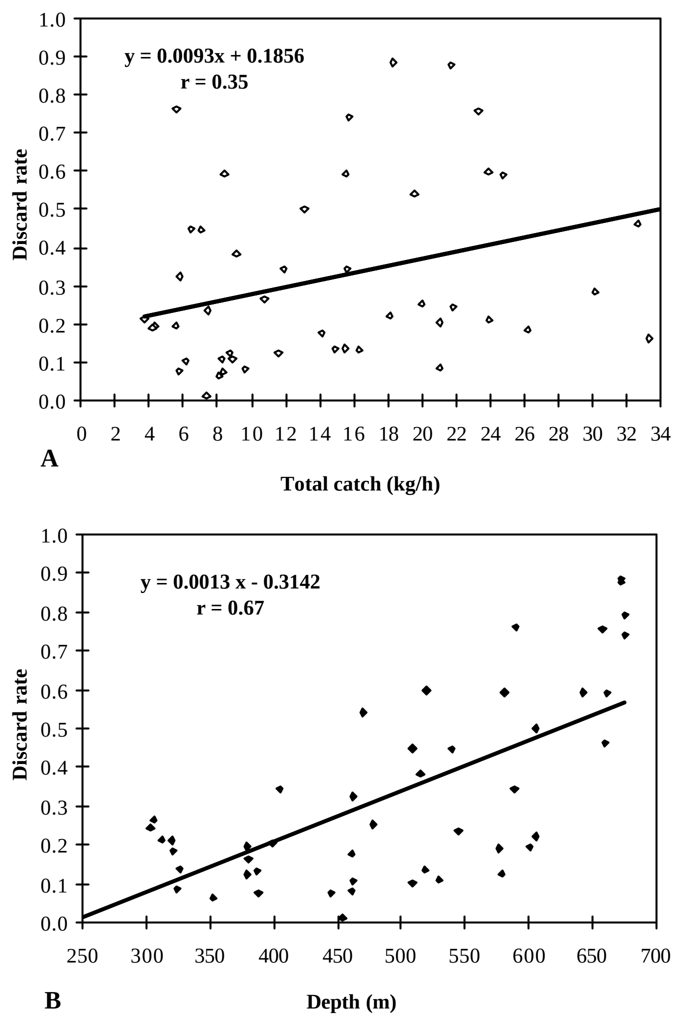

Fig. 3 - Relationship between discard rate and total catch (A) and discard rate and depth (B) computed for data of 40 mm mesh size codend.

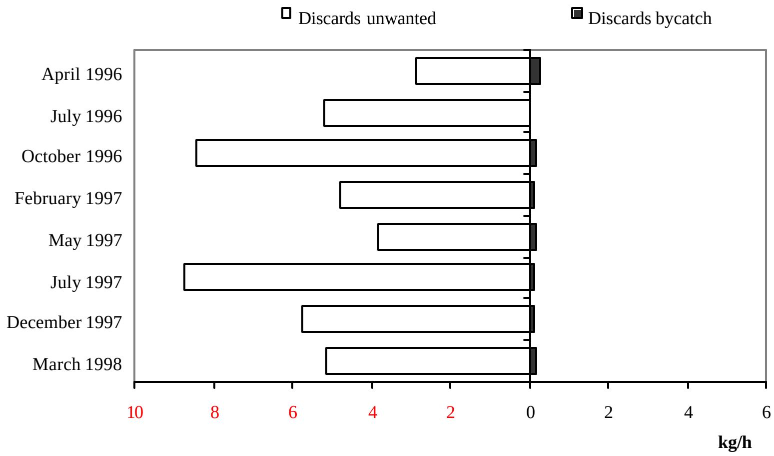

Fig. 4 - Fractions of unwanted and bycatch discards collected by survey with 40 mm mesh size codend

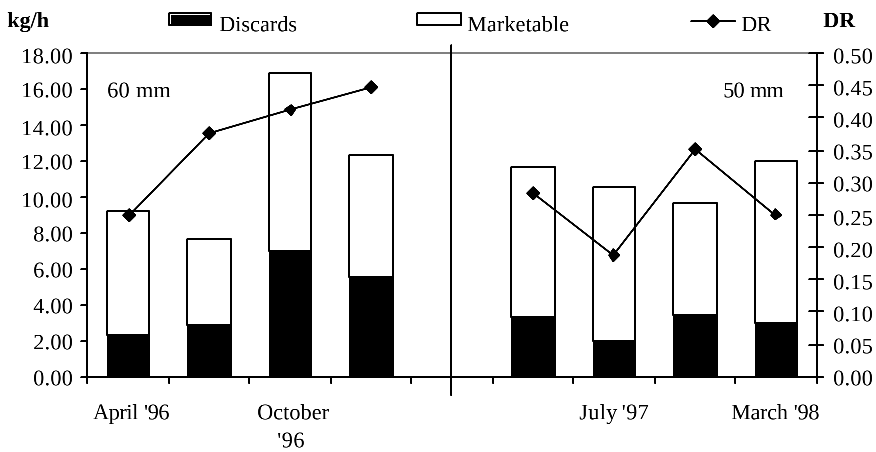

Fig. 5 - Discards and marketable catch (kg/h) with relative discard rate (DR) by survey computed for 60 and 50 mm mesh size codend.

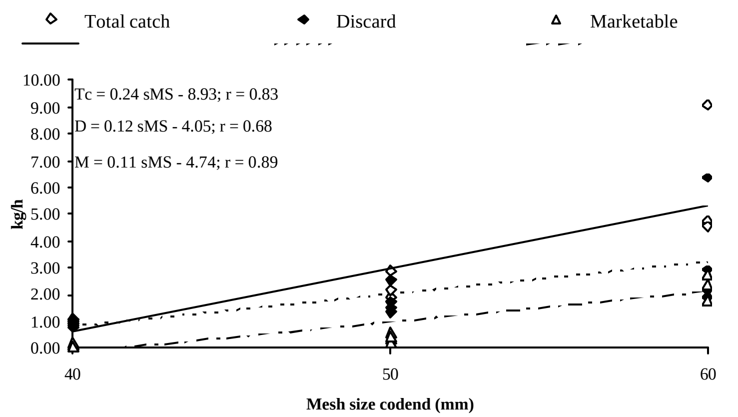

Fig. 6 - Different relationships computed for total catch (Tc), discards (D) and marketable (M) respect to mesh size codend (sMS).

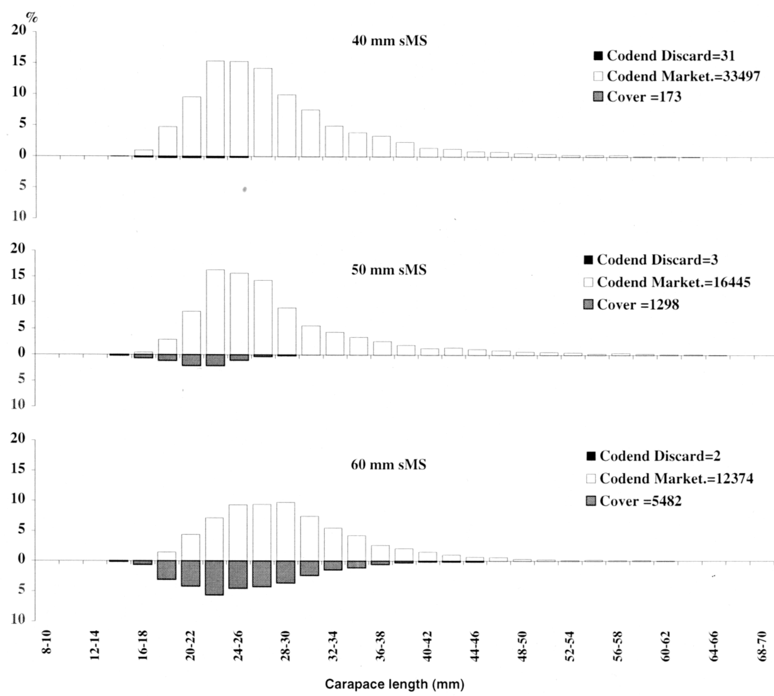

Fig. 7 - Lenght frequency distribution of *Aristeus antennatus* collected in the codend (40, 50 and 60 mm sMS) and cover with indication of discarded and marketable fraction.

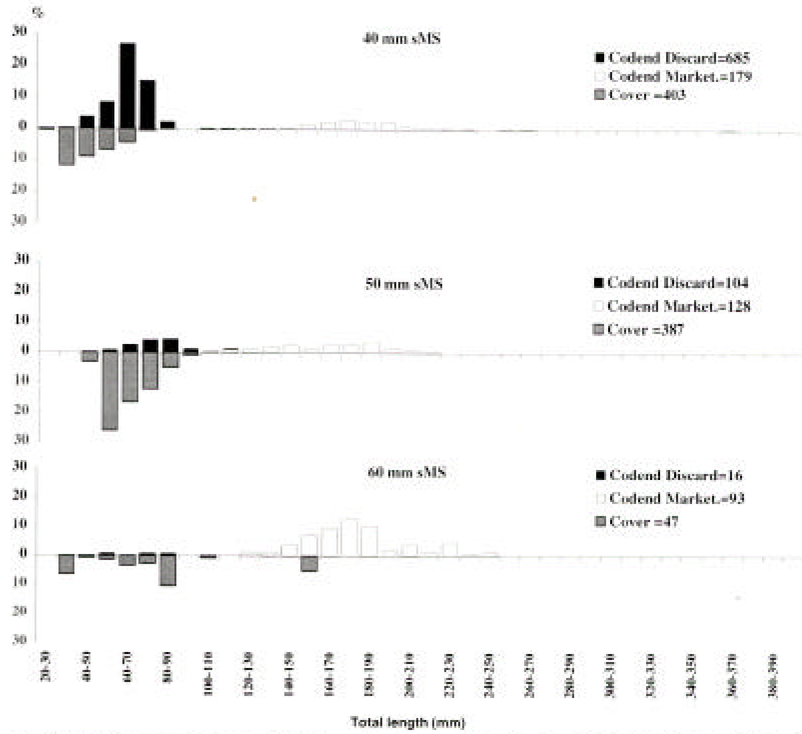

Fig. 8 - Lenght frequency distribution of *Helicolenus dactylopterus* collected in the codend (40, 50 and 60 mm sMS) and cover with indication of discarded and marketable fraction.

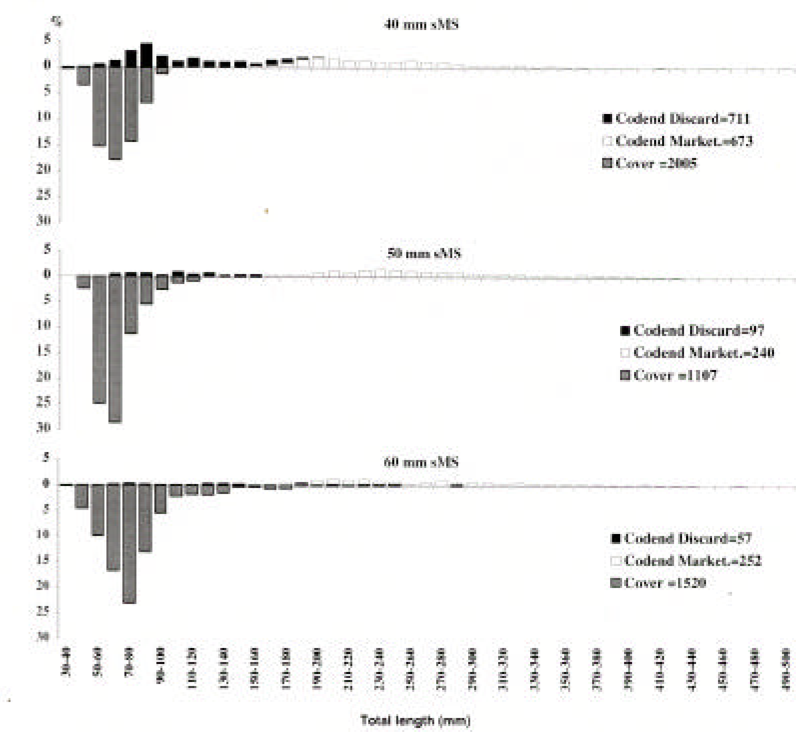

Fig. 9 - Lenght frequency distribution of *Phycis blennoides* collected in the codend (40, 50 and 60 mm sMS) and cover with indication of discarded and marketable fraction.

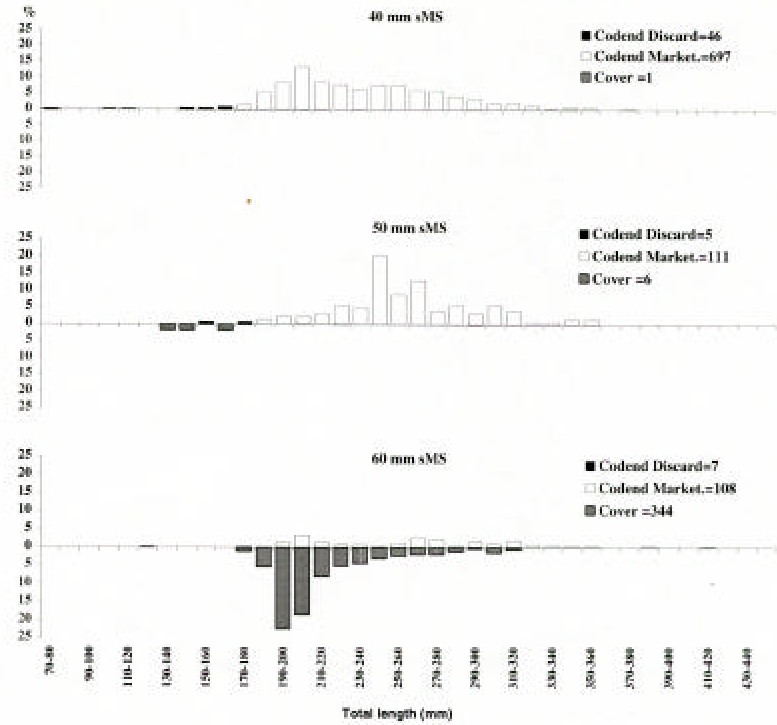

Fig. 10 - Lenght frequency distribution of *Micromesistius poutassou* collected in the codend (40, 50 and 60 mm sMS) and cover with indication of discarded and marketable fraction.

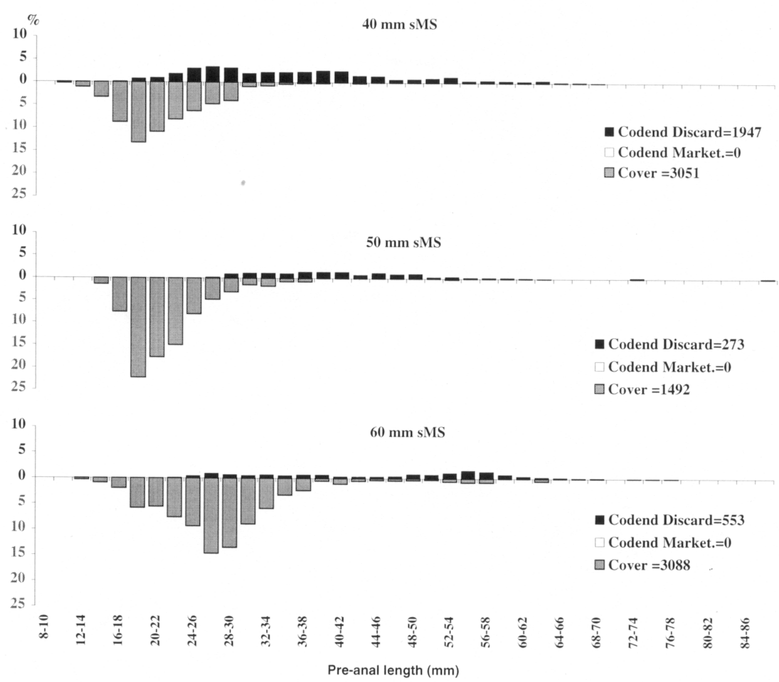

Fig. 11 - Lenght frequency distribution of *Caelorhynchus caelorhynchus* collected in the codend (40, 50 and 60 mm sMS) and cover with indication of discarded and marketable fraction.