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Size Structure Comparison in Some Demersal Species Between Two Areas of Different Fishing Impact in the Deep Waters of Eastern-central Mediterranean (Ionian Sea)

by

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Abstract

The average size and the size structure of some fish and decapod species (*Helicolenus dactylopterus, Hoplostethus mediterraneus, Galeus melastomus, Aristaeomorpha foliacea, Aristeus antennatus, Plesionika martia* and *Polycheles typhlops*), dwelling the deep waters of the Ionian Sea (eastern-central Mediterranean), were analysed in two areas of different fishing activity. One of the areas is offshore the south-eastern Italian coast, where trawl fishing is carried out intensively between 300 and 700 m. The other is offshore the north-western Greek coast, where fishing is carried out down to 400 m depth. Data were collected during August-September 2000 by means of an experimental trawl survey. The mean size and the size frequency distribution were compared between the two areas using non-parametric statistical tests. *H. dactylopterus, A. foliacea* and *P. typhlops* showed highly significant larger mean size and higher percentages of larger specimens in the unexploited area (Greece) than in the exploited one (Italy), indicating the influence of fisheries on these species. *A. antennatus, H. mediterraneus, G. melastomus* and *P. martia* presented close average size values between the two studied areas. However, statistically the comparison of their mean, median and size structure revealed significant differences. A different pattern was indicated by each species that could not be related directly to the fishing activity in each area. The results are discussed considering the different fishing impact in the two areas as well as the depth distribution of the species, their vulnerability to the trawl gear and the environmental conditions of the two surveyed zones in the same basin.

Introduction

The last years, there is a growing scientific, political and public awareness of the environmental impact of fishing activities (e.g. Rijnsdorp *et al.*, 1996; Jenning & Kaiser, 1998). The long-established technique of bottom trawling is attracting increasing criticism over the environmental damage it may cause (Jones, 1992). This makes of particular importance the effects of trawling activity on deep waters, a sensitive ecosystem for which our knowledge is scarce.

The commercial fishery in the Greek Ionian Sea, as generally in the Greek waters, is carried out mainly down to 400 m depth; the narrow continental shelf of the Greek Seas, the lack of scientific knowledge on the deep marine biological resources, the lack of experience of the Greek fishers in deep-water fishing and the low commercial value of the deep-water resources are the main reasons (Anon., 2001). As a result, large marine grounds remain unexploited, while the stocks of the shallower grounds suffer from overexploitation (Stergiou *et al*., 1997). That lead to an increasing interest for the development of a Greek deep water fishery. In contrary, since many years in the neighboring Italian Ionian Sea, the deep bottoms are intensively fished targeting mainly to the red shrimp resources. As a consequence, some of the deep resources of the area are overexploited (Tursi *et al.*, 1999; D' Onghia *et al*., 1998; Anon., 2001). The knowledge on the effect of fishing impact on the resources of the Mediterranean Sea is very scant (e.g. Smith *et al*., 1997; Simboura *et al*., 1998; Moranta *et al*., 2000; Pranovi *et al*., 2000). The unexploited status of the Greek waters give the opportunity to study stocks in pristine conditions and to compare with those of exploited areas.

The present study, in the framework of the project INTERREG Greece-Italy (Anon., 2001), was carried out in two areas of different fishing conditions in the Ionian Sea in order to detect the fishing impact on some deep demersal resources. One of the areas, in the Italian Ionian, is intensively exploited between 300 and 700 m. The other, in the Greek Ionian, consists mainly a pristine area, where fishing is carried out down to 400 m depth.

Materials and Methods

Data were collected during August-September 2000 in two study areas, one in the Greek Ionian Sea (39°54?-37?57? and 19?18?-20?45?) and the other in the Italian Ionian Sea (39°55’-39°25’ and 17°40’-18°50’) (Fig. 1). A hired commercial trawler was used, equipped with an italian type trawl net of 20 mm stretched mesh size in the cod-end. Sampling took place between 300 and 900 m and was based on random stratified design. The depth was used for the stratification of the study area and therefore three depth zones were defined, 300-500 m, 500-700 m and 700-900 m. A total of 30 and 21 hauls were carried out in the Greek and Italian study areas, respectively. Catches were identified to the species level and species abundance in number and weight was recorded on board. Seven species (three fish: *Helicolenus dactylopterus, Hoplostethus mediterraneus, Galeus melastomus* and four decapods: *Aristaeomorpha foliacea, Aristeus antennatus, Plesionika martia* and *Polycheles typhlops*) were selected for the present work, distributed mainly in the depth zone 500-700 m. The total length (TL) in fish species and the carapace length (CL) in decapod ones were recorded on board from a random sample per species and sampling station. For each sampling station, the measurements were extrapolated to the total number of specimens per fishing hour in order to pool the data of all stations. The mean size, the median size and the size frequency distribution of each studied species were estimated for each studied area. Since the distributions of the data were not normal, comparison between areas was based on non-parametric tests (Mann-Whitney test & Kolmogorov-Smirnov test) using the Statgraphics program (1998).

Results

The length data analysis for the seven studied species in the two study areas revealed the following:

In *Helicolenus dactylopterus,* the comparison of the mean (median) size and the size distribution showed statistically significant differences ($P<0.05$) between the Greek and the Italian study area. Mean, median and maximum size were quite larger in the Greek unexpoited area (Table 1). In addition, more large specimens were found in this area than in the Italian exploited one, where a high percentage of small sizes was observed (Fig. 2a).

In *Aristaeomorpha foliacea,* the mean (median) size and the size distribution in the Greek and the Italian study areas showed highly significant differences ($P<0.05$). Mean, median and maximum sizes were larger in the Greek area (Table 1). The size range was also larger and more large specimens were found in the latter area, resulting to a different size distribution between the Greek and Italian samples (Fig. 2b).

Polycheles typhlops showed the same pattern as the above two species. Statistically significant differences ($P<0.05$) were detected from the comparison of the mean (median) size and size distribution between the exploited (Italian) and the unexploited (Greek) area (Table 1). The size distribution included a very high percentage of specimens in the large sizes (Fig. 2c).

In *Aristeus antennatus,* the statistical analysis revealed significant differences ($P<0.05$) between the Greek and the Italian samples. However, the mean size value was a little larger in the Greek area, the median and the maximum size values were quite similar in the two studied areas (Table 1) and the size range was wider in the Italian one (Fig. 2d). It is worth to mention that the median size was not found to differ in the 0.001 significance level (Table 1).

Hoplostethus mediterraneus data analysis revealed no statistically significant difference ($P=0.3$) between the median size of the species in the two areas. However, mean size was larger in the Greek Ionian (Table 1). In addition, maximum size and size range was larger in this area, resulting to statistically significant difference in the size distribution of the species between the two areas (Fig. 2e).

In *Galeus melastomus,* the comparison of the mean (median) size showed no statistically significant differences between the Greek and the Italian study area in the 0.0001 level of significance (Table 1). Mean size value was a little larger in the Italian area (Table 1). In the same area, more smaller and larger specimens were found, producing a different size distribution of the species from that of the Greek area (Fig. 2f).

Finally in *Plesionika martia,* statistically significant differences ($P<0.05$) were found between the mean (median) size and the size distribution of the species in the Greek and Italian study areas (Fig. 2g), although mean, median and maximum size values were quite close.

Discussion

The results of the present work showed that *H. dactylopterus, A. foliacea* and *P. typhlops* present highly significant larger mean size, larger specimens and higher percentages of large specimens in the unexploited area (Greece) than in the exploited one (Italy). On the other hand, *A. antennatus*, *H. mediterraneus*, *G. melastomus* and *P. martia* showed a different pattern by species. *A. antennatus* and *H. mediterraneus* showed little larger mean sizes in the Greek unexploited area, but the former presented a wider size range in the Italian area, whereas the latter in the Greek one. *G. melastomus* and *P. martia* showed little larger mean size value and wider size range in the exploited Italian area, but the former species displayed quite larger specimens in the Italian than in the Greek area.

Lack of the larger sizes in the population structure of a species indicates overexploitation. Thus, the results of the present study for *H. dactylopterus, A. foliacea* and *P. typhlops* indicate a fishing effect on them, whereas that for *A. antennatus*, *H. mediterraneus, G. melastomus* and *P. martia* could not be related directly to the fishing activity in each area. The three first species seem to be more vulnerable to the fishing pressure than the other:

H. dactylopterus is a slow growing species, distributed mainly in depths ranging between 300-500 m for the young and 500-700 m for the adults (D' Onghia *et al*., 1992, 1994; Anon., 2001). This depth range is intensively exploited in the Italian Ionian waters, and that could explain the larger size and the higher percentage of large specimens of *H. dactylopterus* in the unexploited study area (Greek Ionian).

A. foliacea is a species with higher abundance in the Greek than in the Italian Ionian Sea, where *A. antennatus* predominates (Anon. 2001). This may be explained by the link of *A. foliacea* to warmer and more saline waters comparing to *A. antennatus,* as Ghidalia & Bourgois (1961) have suggested. Since the Greek Ionian provides these characteristics comparing to the Italian part (Theocharis *et al*., 1993), the Greek waters seem to present more favourable environmental conditions for *A. foliacea,* whereas the Italian waters for *A. antennatus*. On the other hand, the latter species exhibits a higher reproductive potential, a deeper bathymetrical distribution (in less exploited depths) and a geographical distribution in more protected grounds (less available to trawl fishery) than the former one. These make *A. antennatus* less vulnerable to the fishing pressure (Sardà, 1993; Matarrese *et al*., 1997) than *A. foliacea*. The above could explain the highly significant differences in the size structure of the latter species between the exploited (Greek) and the unexploited (Italian) study areas. In contrast, *A. antennatus* did not showed so pronounced differences.

P. typhlops could be considered as a more benthic species than the other studied species of the present work. The close relation of this species to bottom makes it more sensitive to the trawl fishing activities. This could be the reason that *P. typhlops* presented a size structure including mainly small sizes in the intensively fished Italian Ionian Sea. If no other reasons affect the population structure of the species in the Italian waters, then *P. typhlops* could be a good example of the effect of the fishing impact on the ecosystem and particularly on a non-commercial species.

H. mediterraneus did not showed a great effect by fishing. The big size of their eggs, the low natural mortality and the distribution of the species in deep waters may explain this situation (D' Onghia *et al*., 1998). In addition, young specimens exhibit a wider bathymetrical distribution comparing to young *H. dactylopterus* (Anon., 2001). This would make the former species less vulnerable to the fishing pressure, and this may be the reason that *H. mediterraneus* did not indicated so pronounced differences between the exploited and unexploited studied areas as *H. dactylopterus* did.

G. melastomus also seems to be less vulnerable to the fishing activities. Its bathymetrical distribution in deep less exploited waters (>900 m) (Tursi *et al*., 1993; Anon., 2001) may confirm this suggestion. The colder Italian Ionian waters could also be a more favourable environment comparing to the Greek ones, since the species prefer lower temperatures (Capapé & Zaouali, 1977). Concerning *P. martia*, the patchiness in the distribution of the species (Carbonell & Abelló, 1998) may help its protection from fishing pressure. On the other hand, *P. martia* consists an important prey in the *A. foliacea*'s diet (Cartes, 1995; Kapiris, personnal communication). Therefore, the fishing impact in the Italian Ionian waters and the predation in the Greek ones may be factors affecting the size structure of the species in each area, associated with no pronounced differences in the mean, median and maximum size.

The results of the present study indicate the fishing impact on some demersal deep species, that make us suggest the necessity of a reasonable management in the sensitive deepwater environment. Particularly this should be the case for the Greek Ionian waters where a deepwater fishery is planned to be developed.

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Table 1. Mean, median, minimum and maximum lengths of the studied species in the Greek and Ionian Sea. The obtained P values from the Mann-Whitney and Kolmogorov-Smirnov tests are also shown.

Species	Mean Length (mm)		Minimum length (mm)		Maximum Length (mm)		Median length (mm)		Mann-Whitney test	Kolmogorov-Smirnov test
	Greek Ionian Sea	Italian Ionian Sea	Greek Ionian Sea	Italian Ionian Sea	Greek Ionian Sea	Italian Ionian Sea	Greek Ionian Sea	Italian Ionian Sea		
H. dactylopterus	202	103	48	43	368	320	208	64	P=0.0	P=0.0
A. foliacea	32.2	28.8	13.0	17.6	64.0	59.5	29.0	28.0	P=0.0	P=0.0
P. typhlops	27.2	20.6	18.0	13.0	38.0	35.0	27.0	20.0	P=0.0	P=0.0
A. antennatus	39.2	37.4	18.5	14.0	60.7	60.0	39.0	39.0	P=0.002	P=0.0
H. mediterraneus	154	150	44	60	296	240	152	152	P=0.3	P=0.0
G. melastomus	352	360	118	112	561	620	353	378	P=0.0002	P=0.0
P. martia	18.4	18.6	9.4	7.5	24.0	25.0	18.0	18.8	P=0.0	P=0.0

$P < 0.05$ indicates statistically significant difference.

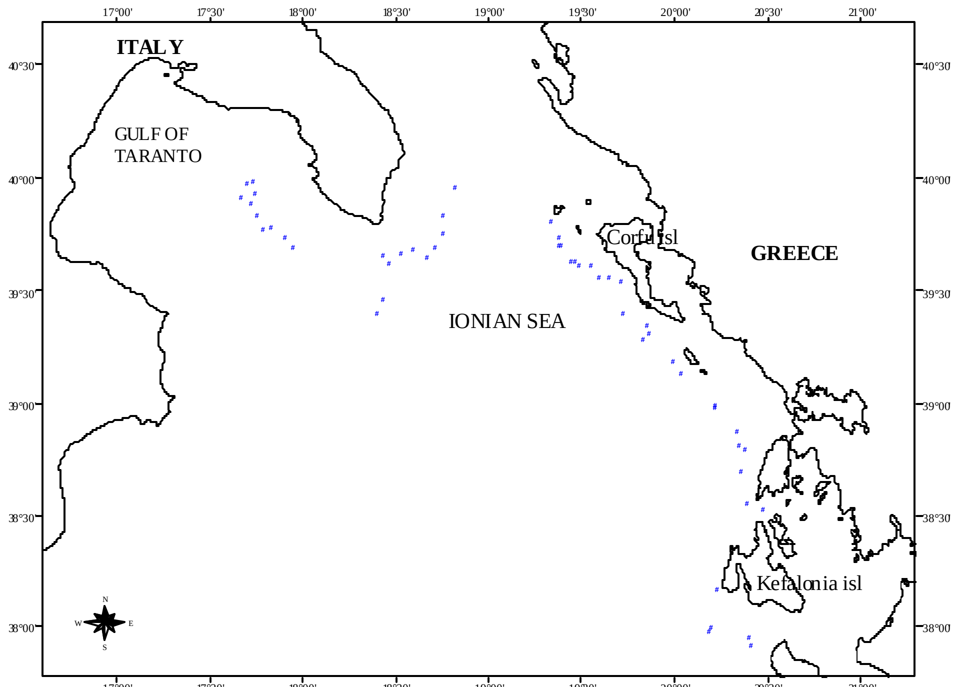

Fig. 1. Sampling area in the Greek and Italian Ionian Sea, showing the sampling stations in the two studied areas.

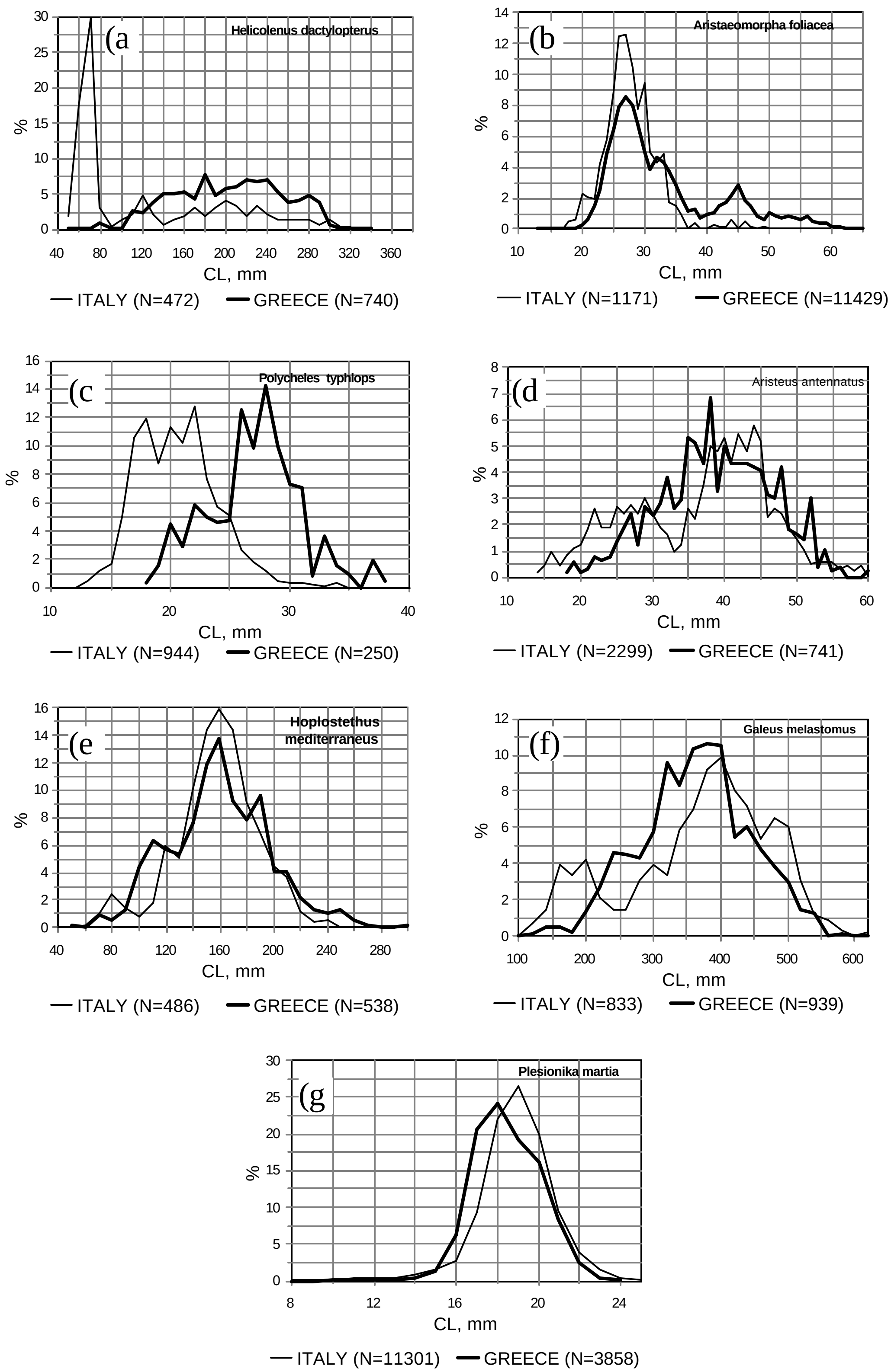

Fig. 2. Size distributions of *Helicolenus dactylopterus* (a), *Aristaeomorpha folia*cea (b), *Polycheles typhlops* (c), *Aristeus antennatus* (d), *Hoplostethus mediterraneus* (e), *Galeus melastomus* (f) and *Plesionika martia* (g) in the Greek and Italian Ionian Sea during August-September 2000.