

**Some aspects on the reproduction of six deep water fish species in West Coast of Greece (Ionian Sea).**

George Petrakis, Anna Terrats, Apostolis Plastiras and Costas Papaconstantinou

**Abstract**

In the framework of the "Deep Water Fisheries" project, twelve monthly sampling cruises took place in the Ionian Sea from December 1996 to November 1997. The maturity stage and the sex were recorded macroscopically for *Helicolenus dactylopterus*, *Hoplostethus mediterraneus*, *Merluccius merluccius*, *Lophius budegassa*, *Phycis blennoides* and *Micromesistius poutassou*. Even though mature specimens of both sexes of *H. dactylopterus* were found during all cruises, the pick of the reproduction activity occurred during January-March. The length of the sexed specimens ranged from 6-38 cm. *H. mediterraneus* showed reproductive activity during all year, but the pick occurred from January to May. The length of the sexed fish ranged from 6-24 cm for the females and from 6-21 cm for the males. Almost all the specimens of *L. budegassa*, *M. merluccius* and *P. blennoides* were immature even though large specimens were caught. The lengths of *L. budegassa* ranged from 16 to 76 cm, of *M. merluccius* from 16 to 69 cm and finally of *P. blennoides* from 17 to 60 cm. Some mature *M. poutassou* were caught during January to March. The females were larger than males. The length of the females *M. poutassou* ranged from 21 to 44 cm where as the length of the males ranged from 19 to 41 cm.

**Keywords:** Deep water fish, Reproduction, Greece, Ionian Sea, Mediterranean Sea.

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**Introduction**

Reproduction plays a leading role in the life history of fish, therefore, knowledge of the reproductive biology of a fish species is a key factor for comprehending its life history and estimating fluctuations in its abundance. The size of an incoming year class and the maintenance of the stock depend on the success of the breeding season. The environment in deep water is characterized by high homogeneity, stability and lack of clearly determined seasonal cycles. So convergent phenomena in the reproductive strategy of the species would be expected in order to cope with the peculiarities of the environment.

Knowledge on the deep-water ecosystem is very limited; a broad range of unpublished raw data exists, concerning mostly deep water fish species of the north east Atlantic and the Mediterranean (Connolly *et al.*, 1995). New records of deep water species are constantly being reported (Kotlyar & Pakhorukov, 1992; Trunov, 1991). Pressure on inshore fish stocks has led to the exploitation of demersal fish in the European deep

Waters (400-1500m). Some of the deep-water species currently exploited are relatively long lived, slow to mature and have low fecundities. These characteristics make them especially vulnerable to overfishing and given rise to serious concerns within the scientific community (Connolly & Kelly 1996). Therefore, new information on fish biological parameters such as age, growth and reproduction is required, in order to formulate an effective management policy about deep water resources and subsequently regulate their exploitation in a sustainable way.

The reproduction cycle of *Merluccius merluccius* (hake), *Micromesistius poutassou* (blue whiting), *Lophius budegassa* (monk fish) and *P. blennoides* have been studied in Greek waters (Papaconstantinou, et al. 1988; 1993; 1995; 1998) but there are no information about blue mouth and *H. mediterraneus*.

In this paper some results on the reproduction cycle of the following species are presented: hake, *Hoplostethus mediterraneus*, *Helicolenus dactylopterus* (blue mouth), monk fish, *Phycis blennoides* and blue whiting. These species were caught in abundance in the deep waters of the Ionian Sea and they have commercial value except *H. mediterraneus*. Furthermore, they are considered to be key species of the deep water ecosystem of the area, as they consist an inseparable part of the food web.

## Materials and Methods

Sampling took place in the South Ionian Sea in monthly basis from December to November 1997 (Fig. 1). The sampling took place only during daylight. In total 90 valid hauls were carried out. The duration of the tows ranged from 30 to 115 minutes according to depth and to substrate. In 72% of the tows the duration was 60 minutes, in 14% was less than 60 minutes and in 14% was more than 60 minutes. The depth ranged from 300 to 750 m. All the surveys were performed by means of a hired commercial bottom trawl fishery vessel named "Panagia Faneromeni II". The overall length of the vessel was 26 m, it had an engine with 450 HP and was equipment with 2 radar, geographical plotter with GPS, sonar and a hydraulic winch. The gear used in this project was a common bottom trawl used by the fishermen in Greek waters. The mesh size in the cod end was 14 mm (bar length).

In each station the catch was sorted to species level and the number and weight of specimens per species were recorded. The lengths of all the species were measured. Biological data (sex and maturity stages) and otoliths were taken for the target species. The sex and maturity stages of hake, monk fish, blue whiting and *P. blennoides* were determined macroscopically on board and of blue mouth and *H. mediterraneus* were determined in the laboratory from frozen samples. The maturity stages were defined according to Nicolsky's scale (1976). Overall, the sex and the maturity stages were determined in 4498 specimens: 1325 blue mouth, 2233 *H. mediterraneus*, 198 monkfish, 251 hake, 214 *P. blennoides* and 277 blue whiting.

As immature were considered specimens in stages I, II and III, and as mature were considered specimens in stages IV, V and VI. In stage VI (spent stage) the ovaries had remaining eggs from the last spawning thus they were gathered with the mature. A Kolmogorov-Smirnov test was used in order to examine if there were differences in the length distribution between the sexes.

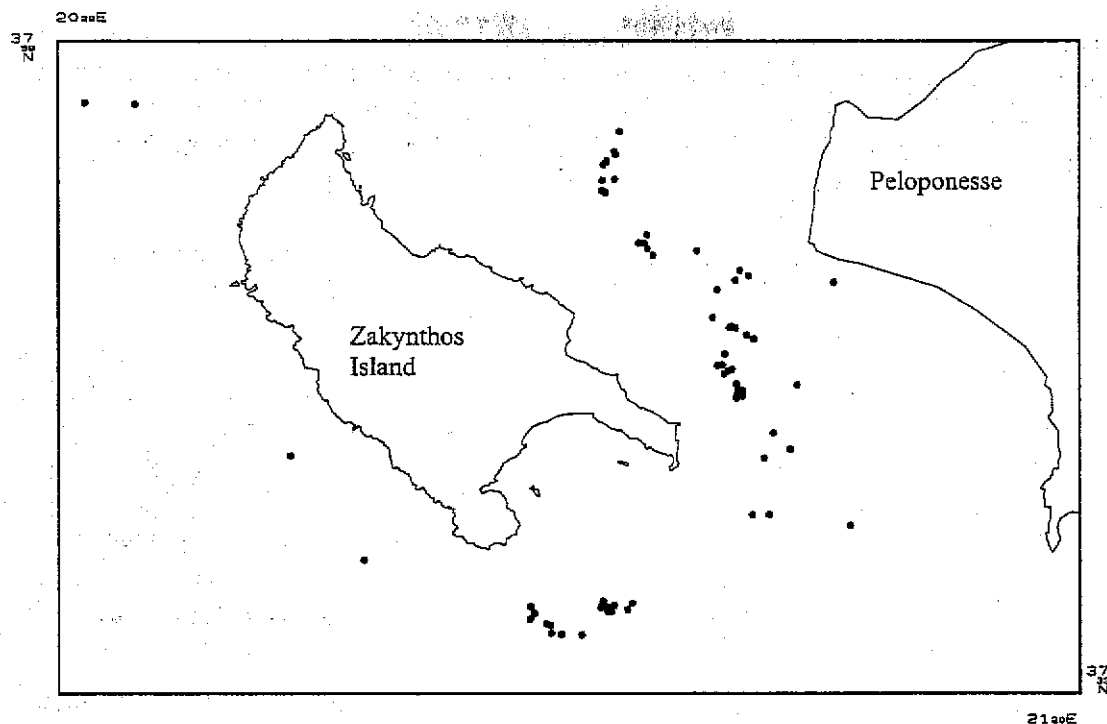


Fig.1. Map of the sampling area with the fishing stations.

## Results

The lengths of the examined blue mouth specimens ranged from 7 to 37 cm Total Length (TL) (Fig. 2). The difference in the length distribution between males and females was significant at the 95% confidence level (Kolmogorov-Smirnov test  $p=0.034$ ). The number of blue mouth examined was higher during the first half of the sampling season (December until May). There were mature specimens during all months, but higher number during December-March for males and during January-March for females.

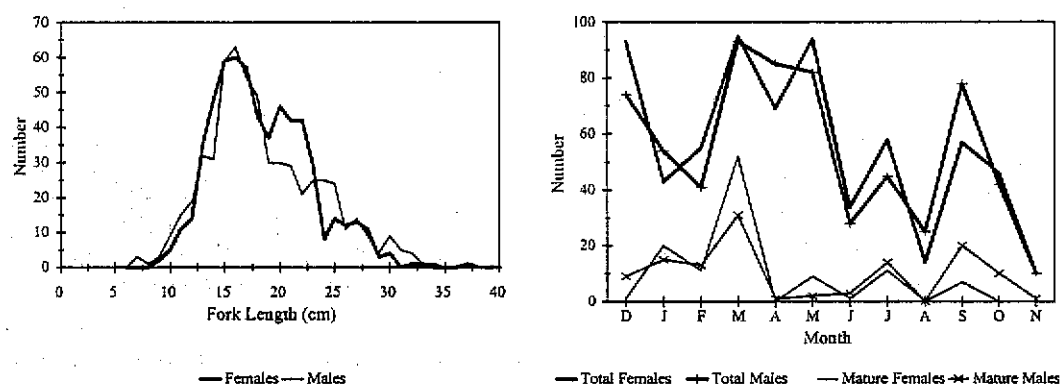


Fig. 2. Length frequency distribution and number of examined, mature and immature, individuals of blue mouth.

The total length of *H. mediterraneus* ranged from 7 to 21 cm for males and from 7 to 23 cm for females (Fig. 3). The difference on the males and females length

distribution was significant at the 95% confidence level (Kolmogorov-Smirnov test,  $p=0.000$ ). The number of *H. mediterraneus* examined was high throughout all the sampling period, the lowest number was caught in August were 33 females and 21 males were examined. Even though some mature individuals were found through all the year, the majority was mostly found during February-April.

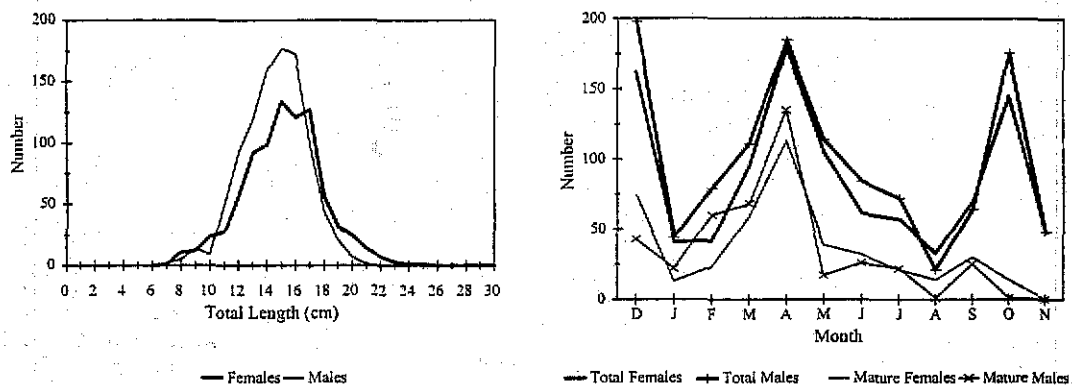


Fig. 3. Male and female length frequency distribution and number of examined, mature and immature, individuals of *H. mediterraneus*.

A relatively low number of monk fish ( $N=198$ ) was examined due to the low abundance of the catch during the study period. The total length of the males ranged from 15 to 57 cm whereas the females were generally composed of larger specimens (20-70 cm) (Fig. 4). There was a statistically significant difference between the two length distributions (male and female) at the 95 % confidence level (Kolmogorov-Smirnov test,  $p=0.000$ ). The number of males examined was higher than the females (151 and 47 respectively). Overall there were just 2 mature females and they were found in December. The mature males were not abundant and the majority were found in February (8 individuals) and in April (5 individuals).

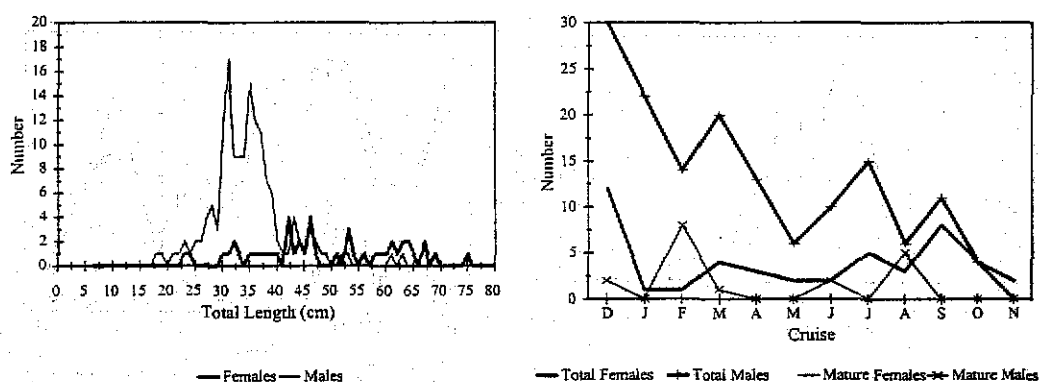


Fig. 4. Male and female length frequency distribution and number of examined, mature and immature, individuals of monkfish.

During the sampling period the sizes of the majority of the hake caught were small (less than 20 cm TL) therefore they were discarded for further examination. The lengths of the hake examined ranged from 15 to 60 cm and 15 to 70 cm TL for the

males and females respectively (Fig. 5). Generally, the abundance of females was higher. There was a statistically significant difference between the two length distributions (male and female) at the 95 % confidence level (Kolmogorov-Smirnov test,  $p=0.019$ ). The number of hake females examined was higher than the males (174 and 77 respectively). The majority of the specimens examined were caught during September (39 females and 25 males). Almost no mature individuals of both sexes were found.

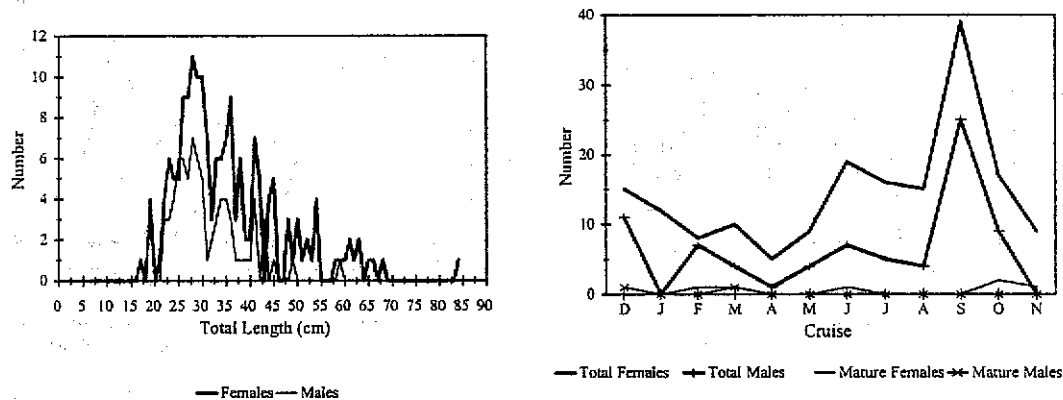


Fig. 5. Male and female length frequency distribution and number of examined, mature and immature, individuals of hake.

Blue whiting female length ranged between 22 to 43 cm TL, but almost all specimens had lengths ranging from 30-40 cm (Fig. 6). On the other hand, males were smaller than females, having lengths from 20 to 41 cm TL and the bulk of the stock being at 25-35 cm. The difference on the males and females length distribution was significant at the 95% confidence level (Kolmogorov-Smirnov test,  $p=0.000$ ). More females were examined during all the sampling months except in December and May. Low number of blue whiting was examined in February (2 females) due to the low catch. The majority of the mature specimens were found during December (2 females and 18 males), and during August (4 males and 3 females)

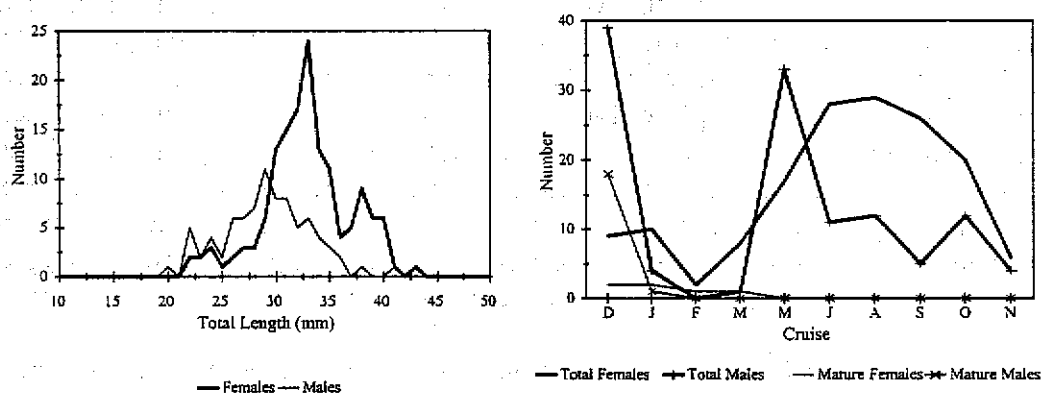


Fig. 6. Male and female length frequency distribution and number of examined, mature and immature, individuals of blue whiting.

The length of the *P. blennoides* females ranged from 14 to 56 cm TL with a peak at 25 cm (Fig. 7). On the other hand the number of males examined was lower and the individuals were smaller ranging from 15 to 49 cm TL. There was a statistically

significant difference between the two length distributions (male and female) at the 95 % confidence level (Kolmogorov-Smirnov test,  $p=0.007$ ). Overall, the number of females examined was higher than the number of males (171 and 43 specimens respectively). The number of mature males and females was almost null (1 mature female was found in April and 1 mature male was found in September).

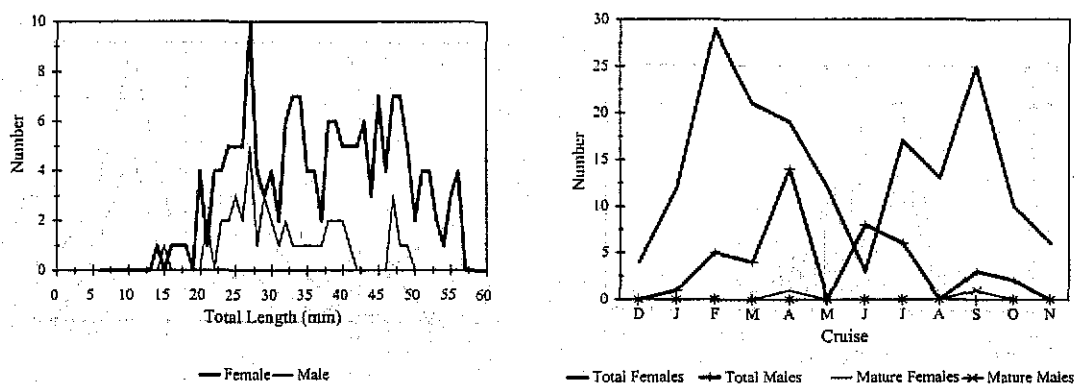


Fig. 7. Male and female length frequency distribution and number of examined, mature and immature, individuals of *P. blennoides*.

## Discussion

The reproduction cycle of the commercial demersal fish species has been studied extensively in shallower waters (e.g. Papaconstantinou et al. 1988; 1993; 1995). Generally, in Greek waters the spawning period of many species starts early in the spring and finish late in the summer. In most cases the duration of the reproductive activity does not extend a period of 6 months. Reproductive activity around all the year has been referred for hake (Papaconstantinou and Stergiou, 1995). The reproductive period of *Trisopterus minutus capelanus* (poor cod) lasts nine months.

In deep waters of the Ionian Sea, the two most abundant fish species (blue mouth and *H. mediterraneus*) showed reproductive activities during all the sampling period. The peak which was considered to occur when the proportion of the mature/immature individuals was higher, took place during December to March for blue mouth and during January to April for *H. mediterraneus*. Another deep water species which has been caught in abundance in the same area is *Peristedion cataphractum*. This species showed the same reproductive behavior (Terrats, unpublished data), mature individuals of *P. cataphractum* were caught during all the sampling period but higher proportion of mature individuals was found during August to October.

Generally, the number of mature female monk fish, which have been caught during bottom trawl surveys in Greece is very low and therefore the spawning areas of the species can not be defined. The same was observed during the sampling in the Ionian sea where only 2 mature females and 18 mature males have been caught.

Hake is showing reproductive activity around all year in Greek waters. The number of mature hake, which have been caught in deep waters in the Ionian Sea is very low. The length at first maturity ( $L_{50}$ ) of hake occurs at 18-35 cm for male and 18-41 cm

for females (Papaconstantinou and Stergiou, 1995). In the Ionian Sea, the majority of the examined fish were larger than 25 cm but they were immature. A possible explanation for the lack of mature specimens could be that the species is using the deep waters ecosystem mainly as a feeding ground and not as a spawning ground.

The spawning period of blue whiting in Euboikos gulf (Greece) is extended from late winter to spring (Papaconstantinou et al., 1989). Mature females and males have been caught during the same months in the Ionian Sea (Terrats, unpublished data). The number of the examined fish was low and therefore it is difficult to give safe conclusions about the intensity of the spawning activity of the species in this ecosystem.

No mature individuals of *P. blennoides* were caught during the surveys in the Ionian Sea and generally during the surveys in other Greek areas where the species is quite abundant. Since large specimens have been caught during all the cruises and all the individuals were immature, the species could spawn in deeper waters or in bottoms which are inappropriate for bottom trawl fishery.

From the specimens which have been examined so far it is difficult to extract reliable conclusions about the reproduction of the deep water species in the Ionian Sea. There are some indications which have to be verified in the future by examining more specimens by means of histological sections of the gonads. Species that are distributed mainly in depths more than 400 m (blue mouth, *H. mediterraneus*, and *P. cataphractum*) showed a peak in their reproductive activity for some months but during all the year mature specimens were caught. *P. blennoides* occurs mainly in this depth but since no mature individuals have been caught, we speculate that the species is using this area as feeding ground. On the other hand, hake and blue whiting have broader depth distribution, blue whiting spawns in these depths during winter and hake spawns in shallower waters.

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