

On the dynamics and management of the σ group Hake (*Merluccius merluccius*) off the W. Coast of Greece

C. PAPACONSTANTINOU

National Centre for Marine Research, 16604 Hellinikon, Athens (Greece)

INTRODUCTION

The hake (*Merluccius merluccius* L.) ranks among the most important commercially species in Greek Seas, amounting to some 1200 tonnes annually. The biology and the feeding habits of the species have been studied intensively for the last years (Caragitsou & Tsimenidis, 1977; Tsimenidis et al., 1978; Tsimenidis et al., 1985; Papaconstantinou et al., 1986; Papaconstantinou & Caragitsou, 1987). This paper presents results on the seasonal migration and fluctuation in abundance of σ group hake in the Patraikos Gulf (nursery ground), and their implications to fishing management.

MATERIAL AND METHODS

A general fishing survey of the study area started in June 1983. From June 1983 to June 1985, year round trawl samples were taken at collecting stations, at approximately three month intervals. Trawl samples were taken in three areas, the Patraikos Gulf, the Korinthiakos Gulf and the Ionian Sea, by means of a 425 HP commercial trawling vessel. A 60 m trawl, with 25mm stretch mesh bag, was used to make 30-45 min hauls at each station. Age was determined from otolith readings. Total mortality estimates were obtained from the catch-curve methods (Ricker, 1975; Pauly, 1980), while natural mortality from Pauly's (1980) method.

RESULTS AND DISCUSSION

The abrupt reduction of the abundance of 0 age group between September and December in Patraikos Gulf, can not be attributed to the trawl fisheries, because the samples were taken in September, as also just before (end of November) or after the start of the fishing season which, in this area, extends from 1st December to 31st March. Therefore, the reduction of hake must be attributed to reasons, except fishery, as movement in neighbouring region or natural mortality.

From the seasonal distribution of the 0 group a very substantial movement of the group from the Patraikos to Korinthiakos Gulf or Ionian Sea between September and December can be concluded. Limited movement towards Ionian Sea seems to take place with the start of the next spring and particularly towards the sea area close to Patraikos, with depth up to 130 m. This area, as the seasonal length distribution analysis proved, is the mixing area between two different hake population coming one from the Patraikos gulf and the other from the Ionian. These two populations differ almost by six months at the time of recruitment.

Movement of the 0 group from Patraikos to Korinthiakos Gulf seems to be rather improbable due to the geomorphology of the area (strait Rio - Antirio); also hake with length between 160-190 mm was found during winter simultaneously in the whole area of the Korinthiakos Gulf, which is rather large, something which indicates that the hake was born in the Korinthiakos area.

The recruitment of the 0 group in Patraikos starts in June, becomes maximum in September and reduces substantially in December, despite the fact that the area is not fished (Table 1); therefore this reduction can only be attributed to the natural mortality. This conclusion is very important because it allows the evaluation of the

TABLE 1. Total mortality of 0 and 1 group hake in the Patraikos Gulf.

Round	No specimens	Total mortality	Round	No specimens	Total mortal
June 1983	399	0.845	June 1984:	1228	0.887
September	6363	1.302	September:	4276	1.502
December	760	1.089	November:	1812	1.011
March	576	1.020	March:	976	1.133
June 1985	1448	0.788			

seasonal variation of abundance. Natural mortality, which is by definition constant, depends on two factors (a) number of hake recruits and (b) environmental factors. The first factor seems to be variable in time as low natural mortality is observed in summer and high mortality in autumn which is mainly attributed to the high densities of young hake. In November - December a sharp decline in the abundance of young hake occurs as shown by the slope of the catch-curve. This decline is associated with the decreasing abundance of young hake with size, as the number of mature hake is small and does not undergo seasonal oscillations. The second factor is considered rather constant. There are indication that the natural mortality of the 0 group in Patraikos Gulf is due to the feeding habits and to food shortage. Young-of-the-year hake preyed mainly on euphausiids and mysids. The abundance of the last two invertebrates is the reason making this area the nursery ground for the hake. As a result of the continuous increase of the abundance of the 0 group and the growth of each individual, euphausiids and mysids are not enough for their feeding and therefore increase fish mortality. Besides, in the area the presence of decapods and fishes which form the main prey of the larger hake is rather limited to support such a large population.

These findings have significant value for the fisheries management of the Patraikos Gulf, because this substantial quantities of the 0 group hake should fished and not left to natural mortality.

REFERENCES

- CARAGITSOU, E. & M. TSIMENIDIS, 1977. The feeding of hake (*M. merluccius*) in the Saronikos Gulf. *Thalassographica*, 1 (3): 232-244.
- PAPACONSTANTINOU C. & E. CARAGITSOU, 1987. The food of hake (*M. merluccius*) in Greek Seas. *Vie & Milieu*, 37 (2): 77-83.
- PAPACONSTANTINOU, C., G. PETRACIS & V. VASSILOPOULOU, 1986. The fecundity of hake (*M. merluccius*) and red pandora (*P. erythrinae*) in Greek seas. *Acta Adriat.*, 27 (1-2): 85-95.
- PAULY, D., 1980. A selection of simple methods for the assessment of tropical fish stocks. *FAO Fish. Circ.*, 729, 54 p.
- RICKER, W.E., 1975. Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Res. Bd. Can.*, 191, 382p.
- TSIMENIDIS, M., C. PAPACONSTANTINOU and Ch. DAULAS, 1978. Age and growth studies of the hake (*M. merluccius*) in the Saronikos and Thermaikos Gulfs. *Thalassographica*, 2 (1): 27-56.
- TSIMENIDIS, M. and C. PAPACONSTANTINOU, 1985. A preliminary study of the fecundity of hake (*M. merluccius*) in the Greek seas. *Inv. Pesq.*, 49 (1): 55-59.

The relations of the Hake (*Merluccius merluccius* L.), the Blue Whiting (*Micromesistius poutassou* Risso) and the Poor Cod (*Trisopterus minutus capelanus* Lac.) to the depth and bottom in the Adriatic

Radosna MUZINIC

Institute of Oceanography and Fisheries, Split (Yugoslavia)

The catches of the studied fishes were obtained within the otter-trawling of the "Hvar" fishery biological expedition, 1948 and 1949, mainly in the central and southern offshore Adriatic, at depths from 20 m to 382 m and at a mean depth of 125 m (KARLOVAC, O., 1956; MUZINIC and O. KARLOVAC, 1975). The means between the initial and final bottom depths of the hauls were used. Most of the hauls lasted 50-70 min. As small catches (<500 g) were omitted (KARLOVAC, O., 1959), the data on catches of blue whiting and poor cod are incomplete. Extreme total lengths for the hake catches were available (KARLOVAC, O., unpublished data). Lower limits in the 1 cm classes were applied. The standard deviations are used with the means.

The hake was present in 98% of the "Hvar" catches (MUZINIC and O. KARLOVAC, 1975). In the 150-199 m interval 23% of the catches with 50% of the individuals were taken and in the 100-149 m interval 34% of the catches containing only 25% of the individuals; 25% and 8% of the catches from the 50-99 m and 200-249 m intervals included only 8% and 9% of the individuals (from unpublished data of O. KARLOVAC). Thus, the greatest number of the catches was recorded in the 100-149 m interval and that of the individuals in the 150-199 m interval.

The unique or dominant mode in most of the larger hake catches did not exceed 20 cm (KARLOVAC, J. and O. KARLOVAC, unpublished data). Some relation of the length range to the depth in the "Hvar" area was recorded (MUZINIC and O. KARLOVAC, 1975). The hake from the waters exceeding 150 m showed the mean lower and upper lengths of 6.6 ± 4.87 cm and 56.2 ± 16.54 cm, and those from the waters of less than 100 m 13.7 ± 6.73 cm and 38.5 ± 10.00 cm (from unpublished data of O. KARLOVAC).

The 47 catches containing blue whiting were recorded at depths from 141 m to 382 m, mostly from the 150-249 m interval and at a mean depth of 201 m (MUZINIC, 1984).

In 24 catches with blue whiting from the 150-199 m interval 50% of the individuals were found and in 14 catches from the 200-249 m interval 22% of the individuals; however, only 3 catches from the 300-349 m interval included 25% of the individuals. In spite of the small number of catches and extremely variable numbers of individuals in them, a preference of the species for greater depths is obvious. The catches were made in the wider Jabuka Pit area (31) and southwards (16). However, the blue whiting was recorded in the shallow north-eastern channels (ZEI, 1949; CRNKOVIC, 1959, 1970).

In the wider Palagruža I. waters the length of the blue whiting was 7-26 cm (rare exceptions >22 cm) (MUZINIC, 1984) and it might have been rather small in the whole "Hvar" area too.

The 121 catches with poor cod were made at depths from 46 m to 258 m, mostly from the 100-199 m interval and at a mean depth of 140 m (MUZINIC, 1984).

The 36% of the poor cod catches from each of the 100-149 m and 150-199 m intervals contained 28% and 48% of the individuals; in the 17% and 8% of the catches from the 50-99 m and 200-249 m intervals 9% and 14% of the individuals were found. However, the fish is also caught in the shallow inshore waters of the eastern Adriatic.

In the wider Palagruža I. waters the poor cod showed a length of 3-19 cm (MUZINIC, 1984) and it might also have been rather small in the whole "Hvar" area. From an early sexual maturity in the poor cod from the north-eastern channels (KOTHAUS and ZEI, 1938; ZEI, 1940) a separate dwarf population was presumed (MUZINIC, 1984).

The catches of the hake, the blue whiting and the poor cod were taken above sandy and muddy bottoms. 53%, 87% and 67% of their catches realized above a muddy bottom included 69%, 73% and 75% of the individuals respectively. In the "Hvar" area the muddy bottom was recorded, with a few exceptions, at mean depths from 150 m to 199 m (data of MOROVIC, 1951). Therefore, a preference for such a bottom could not be presumed.

REFERENCES

- CRNKOVIC, D. 1959. Contribution to the study of economically valuable benthonic species of the channels of the north-eastern Adriatic. *Proc. gen. Fish. Coun. Medit.*, 5:355-363.
- CRNKOVIC, D. 1970. A contribution to the study of biological and economic problems of trawling in the channels of the north-eastern Adriatic. *Thalass. Jugosl.*, 6:90 (en croate, résumé en anglais).
- KARLOVAC, O. 1956. Station list of the M.V. "Hvar" fishery-biological cruises 1948-1949. *Rep.*, The M.V. "Hvar" Cruises, Researches into fisheries biology, 1948-1949, 1 (3): 179.
- KARLOVAC, O. 1959. Exploration of fish stocks and edible invertebrates carried out by trawling in the open Adriatic. *Rep.*, The M.V. "Hvar" Cruises, Researches into fisheries biology, 1948-1949, 5 (1): 203.
- KOTHAUS, A. i M. ZEI. 1938. Izvještaj o pokusnom ribarenju "kočom" u Hrvatskom primorju. *Ann. Inst. Océanogr. Yougoslavie*, 1:125-140.
- MOROVIC, D. 1951. Composition mécanique des sédiments au large de l'Adriatique. *Rep.*, The M.V. "Hvar" Cruises, Researches into fisheries biology, 1948-1949, 3 (1):18.
- MUZINIC, R. 1984. The hake (*Merluccius merluccius* L.), the blue whiting (*Micromesistius poutassou* Risso) and the poor cod (*Trisopterus minutus capelanus* Lac.) in the wider Palagruža area. *Rad JAZU*, 41:105-119 (en croate, résumé en anglais).
- MUZINIC, R. and O. KARLOVAC. 1975. On food preferences of the Adriatic hake, *Merluccius merluccius* (L.). *Acta Adriat.*, 17 (7): 47.
- ZEI, M. 1940. A short account of results of the fishery investigations of the Oceanographic Institute in the Channels of the Croatian Coast. *Ann. Inst. Océanogr. Yougoslavie*, 2:137-147 (en croate, résumé en anglais).
- ZEI, M. 1949. Investigations with trawl in the north eastern part of the Adriatic. *Razprave SAZU*, 4:89-119 (en slovène, résumé en anglais).