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REPRODUCTIVE BIOLOGY AND FECUNDITY OF *MERLUCCIUS MERLUCCIUS* (LINNAEUS, 1758) IN THE NORTHERN TYRRHENIAN SEA

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The Mediterranean hake, *Merluccius merluccius*, is an important species in terms of biomass and frequency of occurrence in the commercial catches of bottom trawlers and gill-nets in the Southern Tuscan Archipelago (Northern Tyrrhenian Sea). This area is one of the few zones of the western Mediterranean Sea where a massive presence of big size spawners has been reported (Sbrana & Belcari, 1993). In the framework of a research program aimed at gaining greater biological knowledge of the hake, a study was begun on the reproductive strategy of this species by sampling fishes of large size from commercial landings.

Materials and Methods

Specimens were sampled from commercial landings in Porto Santo Stefano during 1992 on a monthly basis: fecundity studies were carried out on samples collected during the winter from February to March.
The characterization of the main stages of the sexual cycle was achieved both by visual inspection of ovary morphology and ponderal analysis as well as by histological examination. Sarano's (1986) maturity scale was followed for females, whereas Holden and Raitt's (1974) partial spawner maturity scale was followed for males. For histology analysis, the ovaries, fixed in Bouin liquid and then transferred in 70% alcohol, were subjected to dehydration and inclusion in paraffin. The section thickness ranged from 10 µm to 15 µm and the staining was carried out by two different treatments with Elrich Ematóssilin and Mallory solutions. The oocyte population study and the fecundity estimation were achieved using volumetric method on ovaries kept in Gilson's fluid for over three months and then sieved with six nets of decreasing mesh size (840-100 µm).

Results and Discussion

Both the polymodal distribution in the oocyte population and the recovery of postovulatory follicles in ovaries in an advanced stage of development, induced us to classify this species as partial spawners, in agreement with other authors (Sarano, 1986; Tsmenidis & Papaconstantinou, 1985).
The analysis of the percentage of fishes with different maturity stages and the variation of the gonadosomatic (G.I.) and hepatosomatic (H.I.) indices during the year (Fig. 1) led us to identify three peaks, around the months of February-March, May and September, when the reproductive activity was most intense. However, fishes in advanced maturity stages are found throughout the year. The histological observations we made, showing affinity with two different colours, and the different morphology of the vitellogenic granules, demonstrated the presence of two distinct vitellogenic phases. The first phase of vitellogenesis begins when the first vitellogenic vacuoles appear; the oocyte diameter is about 100 µm and the nucleoplasmatic ratio (NPR) is near 0.5. The second phase of vitellogenesis begins when the second type of vitellogenic vacuoles appear, larger than the first type and with a different chromatic affinity; the oocyte diameter is about 300 µm and NPR=0.3. The hydrate oocyte (hyaline) sizes were found to be within the range 600-650 µm (about 930 µm fresh), smaller than in the literature (Sarano, 1986). The absolute fecundity (Kartas & Quignard, 1984) associated with these small oocyte diameters, obtained by counting the number of oocytes with a diameter larger than 170 µm, the lower threshold of vitellogenic eggs, turned out to be much higher than for Sarano (1986), with a maximum of 2,916,450 for a female of 75.5 cm total length (T.L.). The relationships between fecundity and length (Fig. 2) and between fecundity and eviscerated weight, calculated on 40 specimens, supplied a multiplicative relationship in the first case of the type $F = a \cdot L^b$, with b=3.07 and a=2.54 (R^2=0.74), and a linear relationship in the second case of the type $F = a + b \cdot W$, with a=-77188 and b=614.17 (R^2=0.85). The relationship between the number of members in the group with the largest oocytes and the number of vitellogenic oocytes found in the ovaries of 17 females in the prespawning phase (when the 520 µm group is clearly evident) allowed us to estimate that the number of successive depositions is between 3 and 5.
Other important aspects for understanding the biology and the dynamics of a species are represented by the smallest size of maturity and the size of first maturity, the latter being estimated by logistic functions. For the males (n=1062) with a maturity stage higher than or equal to III (maturing), the two sizes turned out to be 17 cm and 27 cm respectively, whereas for the females (n=584), considering stages that are equal to or higher than II (maturing), they were 23.5 cm and 46.5 cm. Nevertheless the smallest female in prespawning stage was 35.5 T.L.. Such values agree with those of other authors as far as male maturity is concerned but they do not agree with female size at the onset of sexual maturity, as this is much higher.

The results obtained with this type of research allow us to clarify some points on the reproductive biology of *Merluccius merluccius* and add new original data to the few works on the fecundity of the Mediterranean hake, giving insight into the selected reproductive strategy. The long spawning season and the high fecundity suggest that the hake's investment in reproductive energy is very high. The large size of first maturity together with a high number of small eggs showed that reproductive strategy would be able to keep the hake role in the ecosystem and attenuate fluctuations in year class strength.

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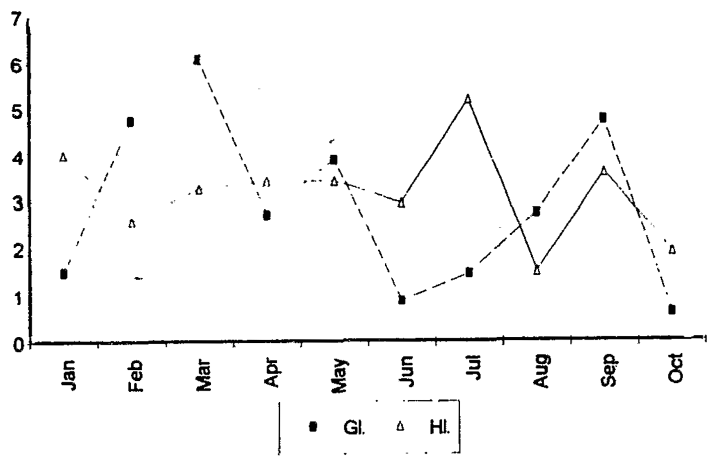

Fig 1: Monthly variations of gonadosomatic and hepatosomatic indices

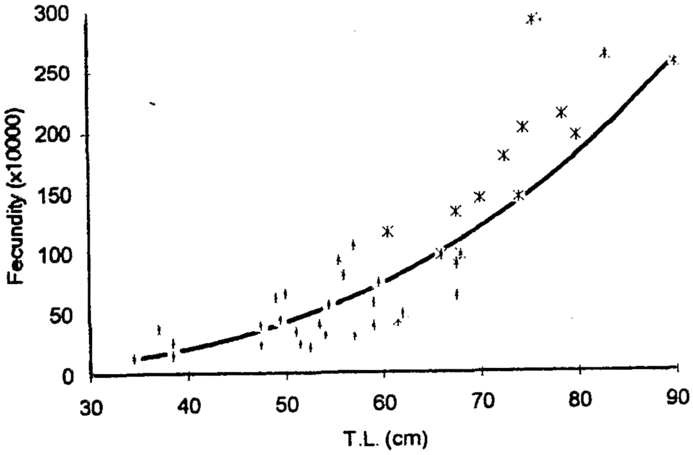

Fig 2: Fecundity-length relationship