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SEASONAL DISTRIBUTION OF LOLIGINID EARLY YOUNG STAGES IN THE PORTUGUESE CONTINENTAL SHELF

by

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ABSTRACT

The seasonal distribution of loliginid early young stages is analysed based on monthly samples collected from October 1986 to January 1989, with Bongo nets (mesh size = 335μm), in 4 transects along the Portuguese continental shelf.

Despite the scarcity of loliginids in the samples (0-4 specimens/haul), a seasonal pattern of higher abundance during winter and spring was observed, as well as in the north coast, in particular throughout 1988.

Length composition shows that the majority of specimens caught can be considered hatchlings (mode = 2.1 mm) of *Loligo vulgaris*.

In general, loliginid early young stages were mainly concentrated around the 80-90 m isobath in winter and spring, and 60 m during summer and autumn.

Their distribution was limited within surface water temperatures above 13°C and below 20°C, with higher catches between 13 and 16°C.

INTRODUCTION

Alloteuthis subulata (occasionally *A. media*), *Loligo forbesi* and especially *Loligo vulgaris* are the loliginid squids that occur in the Portuguese waters. *Loligo* species are the most important squid fishery resources, and their life history, distribution and abundance, from juveniles to adults, has been, recently, subject of several studies. Despite some references (Sousa Reis, 1989a,b), the knowledge of their early young stages distribution in the Portuguese coast is still insufficient.

In the Portuguese west coast predominate winds from the north which favour the coastal upwelling between March and November, especially between July and September (Fiúza *et al.*, 1982). In the south coast upwelling is occasional, however, upwelling waters of the west coast frequently affect the south continental shelf and slope (Fiúza, 1983). In general, the primary production levels of upwelling areas is high, resulting in high zooplankton production and consequent high food availability for the upper trophic levels, almost all around the year.

Loliginid squids, nektobenthic species, have paralarvae with planktonic lifestyle, which means that the newly hatched specimens are released in the water column where they are influenced by hydrodynamic processes, like advection and eddy diffusion (Richards *et al.*, 1995). This results in the dispersal of hatchlings away from the spawning site. Although, a certain correlation between paralarvae distribution and seasonality, and spawning area and timing of adults, is expected.

MATERIAL AND METHODS

The seasonality of the early young loliginids was studied based on historical plankton samples collected monthly between October 1986 and January 1989 (with some exceptions), in the course of a survey sampling programme for sardine spawning time, carried out with the research vessels "Noruega" and "Mestre Costeiro" from the Instituto Português de Investigação Marítima (IPIMAR), in 4 transects along the Portuguese continental shelf.

Plankton samples were collected with a Bongo net (⌀ 60cm, 335μm mesh size) by oblique tows, from a maximum water depth of 200 m. Surface water temperature was recorded. Zooplankton biovolumes data (Cunha, 1993) were analysed (500μm mesh size) for the same sampling stations.

Cephalopods were sorted from the samples already preserved in 4% formalin. In loliginid specimens, mantle length (ML), head length and width was measured. Preserved hatchlings of known species (*Alloteuthis* spp., *Loligo vulgaris* and *Loligo forbesi*) were also measured.

Monthly abundance of loliginids was estimated as the mean number per haul for north (A + B) and south (C + D) transects. Stations with zero records, in every sampling, were excluded.

RESULTS

The loliginid specimens found in the preserved samples were in poor condition with no visible chromatophores. Due to the similarity of the young forms between species and genera (Hanlon *et al.*, 1992), identification was only possible to the family level.

Size structure of the specimens caught (Fig.1) was compared with size at hatching (also preserved specimens) of the loliginid species that can be found in Portuguese waters (*Alloteuthis* spp. = 1.4-1.7 mm, *L. vulgaris* = 2.0-2.4 mm, *L. forbesi* = 2.7-3.1 mm). Together with the relative abundance of those species, makes specimens caught, likely to be mainly hatchlings of *Loligo vulgaris* with some mixing of *Loligo forbesi* hatchlings, some *Alloteuthis* spp. (mostly *A. subulata*) and some specimens of all those species in more advanced stages.

Body proportions between mantle length, head length and width didn't help genera or species identification.

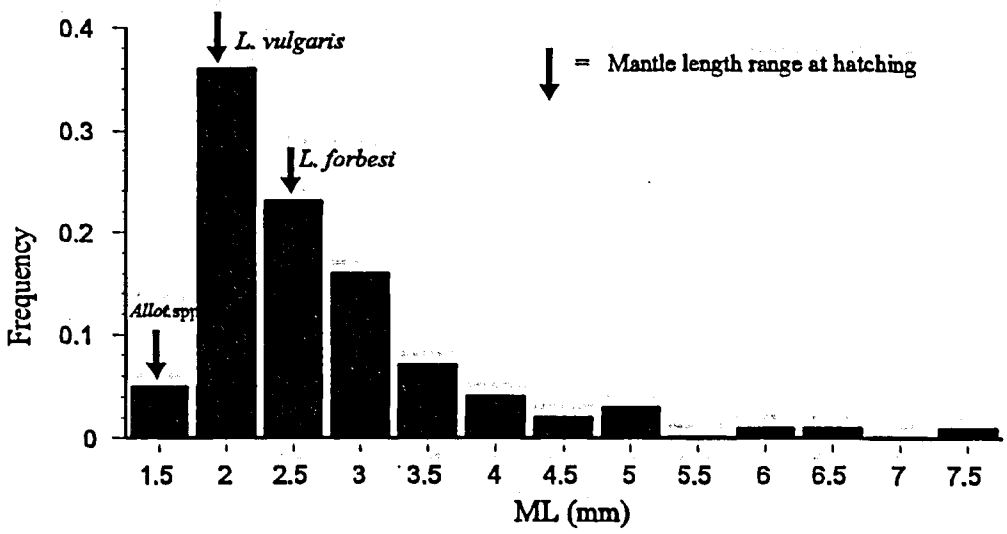

Figure 1 - Size structure of the loliginid early young stages caught between October 1986 and January 1989 in the Portuguese continental shelf.

Loliginid early young stages were more abundant in the west coast, close to the 80-90 m isobaths, mainly in the north (Fig.2). In this area, almost 40% of specimens had mantle lengths between 2 and 2.4 mm, a second mode of larger animals being observed (4.5 mm). In the south, most specimens had mantle lengths between 2 and 3.4 mm.

In general, abundance was higher during winter and early spring and lower in autumn.

In the north, during 1987, a higher abundance was verified in winter (February) with some fluctuations until the end of summer. In 1988, a great peak was observed in early spring (April).

In the south, abundance during 1987 was higher in winter and early spring (February - April), with a second peak in late summer (September). Abundance decreased significantly throughout 1988 and was also higher in winter.

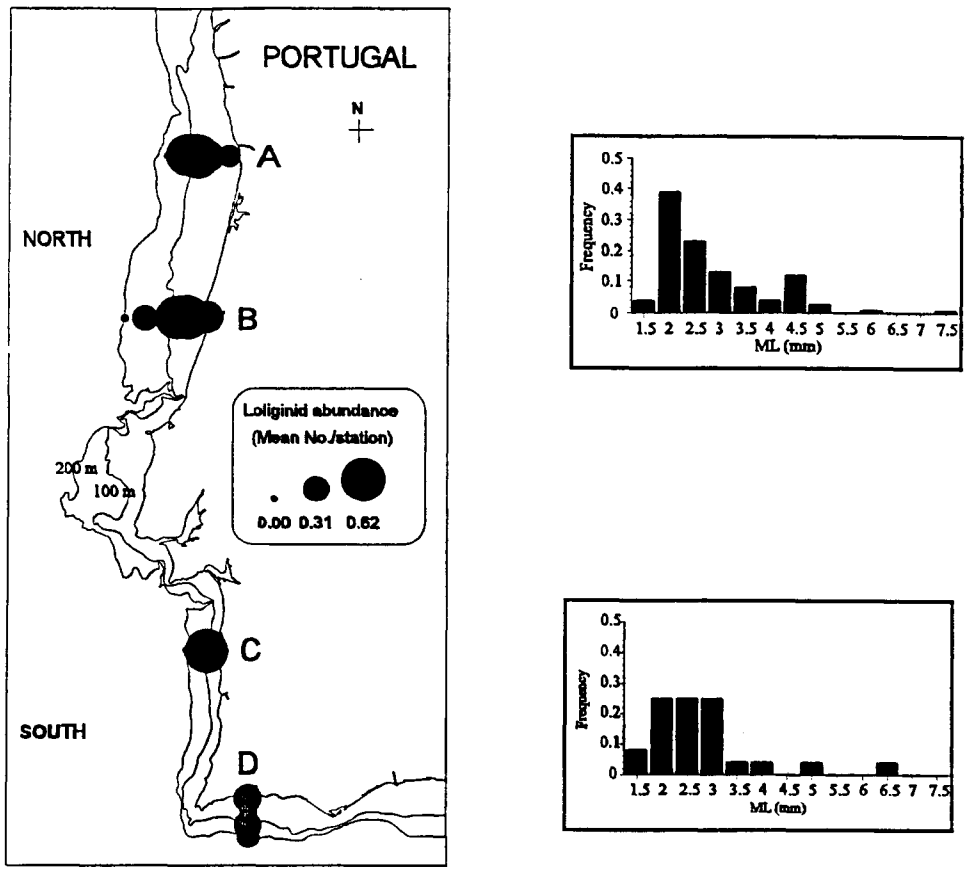

Figure 2 - Distribution, abundance and size structure of loliginid early young stages in the north (transects A and B) and south (transects C and D) Portuguese continental shelf.

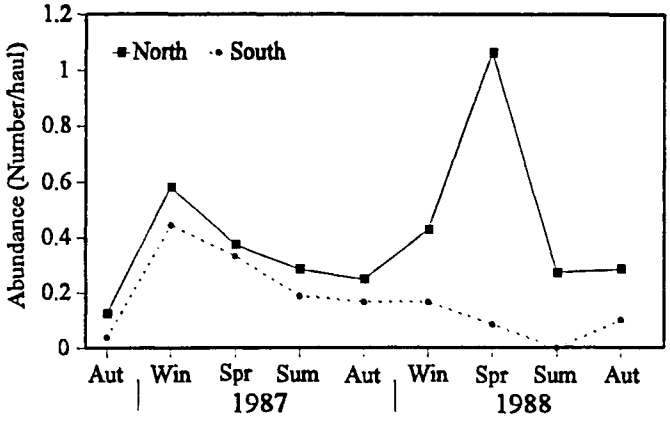

Figure 3 - Seasonal abundance of loliginid early young stages in the north (transects A and B) and south (transects C and D) Portuguese continental shelf.

The occurrence of the smallest squids (< 1.9 mm) was verified close to the coast only in December, and more offshore in January (90-140 m).

The squids with mantle length ranging of 2.0-2.4 mm were present during all the year from the coast to the 100 m isobath in the west continental shelf and close inshore (35 m) in the south (transect D). Offshore catches (> 140 m) were verified only in winter.

Larger animals (4.5-8 mm) appeared between the 80 and 140 m isobath, from February until June.

In general, loliginid early young stages were mainly concentrated around the 80-90 m isobath in winter and spring, and 60 m during summer and autumn (Fig.4).

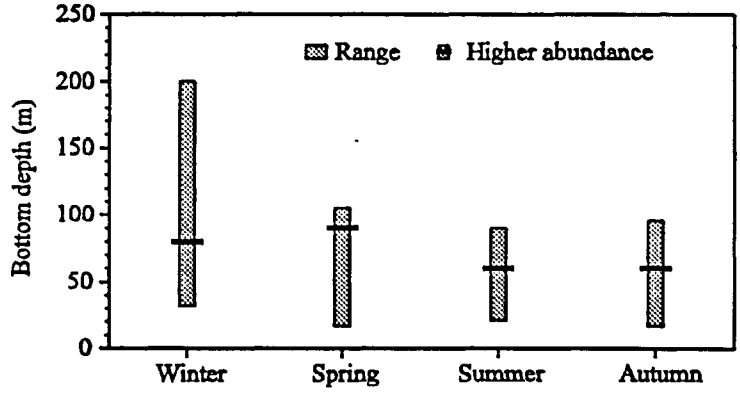

Figure 4 - Seasonal bathimetric distribution of loliginid early young stages.

In figure 5 is depicted the average monthly abundance of loliginid early young stages and the average biovolumes of zooplankton in the same areas, during the same sampling period.

Zooplankton volume presented high values during most part of the year, with lower values from November until February. A first peak was observed in March and a second and most important in August. Loliginid paralarvae were caught more often in February and April with a second minor peak in September.

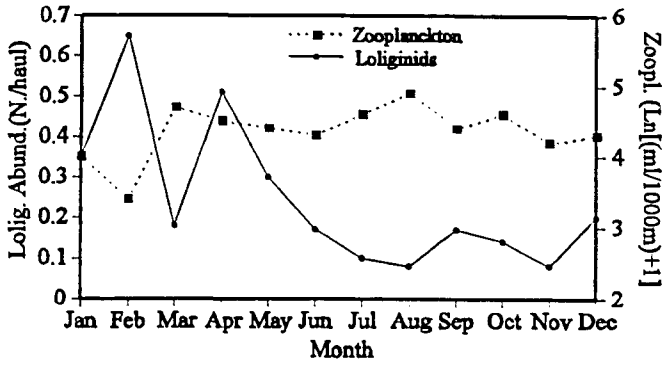

Figure 5 - Seasonality of loliginid early young stages in relation to zooplankton availability.

The distribution is limited to surface water temperatures above 13°C and below 20°C (Fig.6). The surface water temperature, where specimens were mostly found, was slightly lower (1-2 degrees) than the mean surface water temperature of sampled stations.

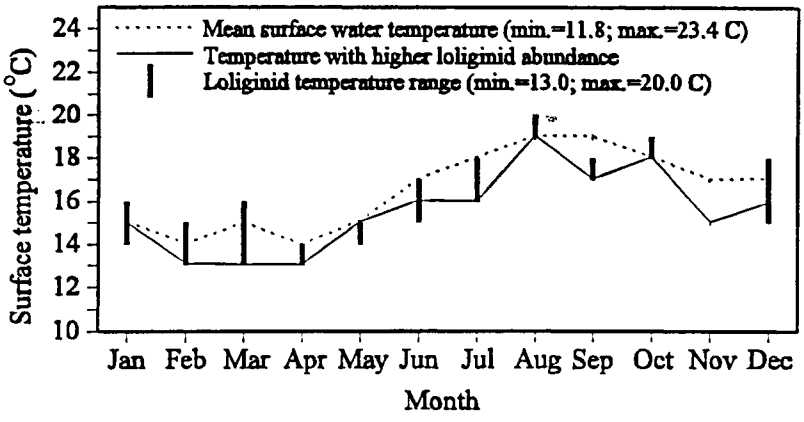

Figure 6 - Monthly variation of loliginid early young stages distribution in relation to surface water temperature.

The highest concentrations were found in the north coast in February 1987 and April 1988, when the surface water temperature was around 13-14°C. During

January-April, when specimens were caught more often, surface water temperature ranged between 12 and 20°C in the north and between 14 and 23.5°C in the south and paralarval distribution ranges were 13-15.5°C and 14-16°C, in the north and in the south, respectively.

DISCUSSION

In species raised in captivity, like some of the family Loliginidae, different aspects of the early young stages biology, such as growth, age and mortality, have been well investigated (Boletzky, 1987; Segawa *et al.*, 1988). Their distribution and seasonality have been mostly inferred from the spawning behaviour of the adult female population, however "larval surveys" are fundamental to studies on distribution and identification of spawning areas (Anon., 1994).

The capture of loliginid paralarvae, probably mainly *Loligo vulgaris* hatchlings, in the 4 studied areas, suggests that spawning occurs all along the Portuguese coast. Also the records of egg masses of *Loligo* spp. along the coast (Cunha *et al.*, 1995) reveal the wide distribution of the loliginid spawning sites.

The occurrence of recently hatched paralarvae throughout the year with a general higher abundance during winter-early spring is a reflex of the protracted spawning period, most prevalent in autumn-winter, of the Loligo species (Moreno *et al.*, 1994), followed by an embryonic development until hatching of 45 to 70 days for *L. vulgaris* (Mangold-Wirz, 1963; Boletzky, 1974) and/or 68 to 75 days for *L. forbesi* (Segawa *et al.*, 1988).

The presence of *Loligo* spp. early young stages throughout the year, and their higher abundance in winter-early spring had already been observed by Sousa Reis (1989a) in different inshore locations of the Portuguese west coast.

Loliginid hatchlings (2.0-2.4 mm) were caught mainly close to the 80-90m isobaths and larger animals (4.5-8 mm) between 80 and 140 m, what seems to indicate that hatchlings are released in the water column close to the spawning sites (30-80m, Cunha *et al.* (1995)) and, due to their low mobility, they are passively

transported in the offshore direction.

In the Portuguese coast dominant winds from the north favour the coastal upwelling during the most part of the year, with consequent extended phytoplankton blooms and related zooplankton high levels (Cunha, 1993). For this reason, the food availability for the active predators like the loliginid paralarvae (Hanlon *et al.*, 1985), should not be a seasonal limiting factor for survival.

On the other hand, temperature must play an important role in the distribution of the early young stages, since it has a great influence in particular on the exponential growth (Forsythe, 1993). In fact, loliginid early young stages were found in a narrow range of surface water temperature during the season of higher abundance (13-15°C in the north and 14-16°C in the south). The great differences in the surface water temperature, in that season, in 1987 and 1988, can explain the inter-annual differences in abundance peaks.

Loliginid paralarvae appeared in low numbers in standard oblique ichtio and zooplankton hauls in the Portuguese continental shelf, suggesting that a directed sampling is needed to study more accurately their distribution and seasonality.

Improvement of sampling gears and methodologies can overcome problems like net avoidance and paralarval dispersion. Another problem is the possibility of cephalopod paralarvae aggregation within a layer strata (Sousa Reis, 1989; Piatkowski *et al.*, 1993). This eventual patchiness needs more investigation.

Despite the low numbers of caught loliginid paralarvae, the presented results provide new information to the understanding of the early life cycle of loliginid squids in the Portuguese waters.

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