JUVENILE PLANKTONIC CEPHALOPODS SAMPLED OFF THE COASTS OF CENTRAL GREECE (EASTERN MEDITERRANEAN) DURING WINTER

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ABSTRACT: Cephalopod early life stages were identified from plankton samples taken with bongo-nets (500 µm mesh size) off the coasts of central Greece (N: 39º 18´–37º 25´, E: 20º 15´–24º 33´) in December 2000–February 2001. The sampling was not directed at cephalopods but provided valuable information on the distribution of cephalopod planktonic stages in Greek waters. Oblique tows were carried out over a grid of 100 stations from a depth of 200 m to the surface on a 24 hour basis. At each station vertical profiles of temperature and salinity were also taken using a SBE-25 CTD profiler. A total of 9 taxa belonging to five families were caught at 21 stations. Among these, the Ommastrephidae was the most numerically abundant (75.7%) family followed by the Octopodidae (15.7%), Loliginidae (4.3%), Sepiolidae (2.9%) and Enoploteuthidae (1.4%). Frequency of occurrence (number of positive tows/total number of tows) of cephalopods was highest during evening tows and in waters with surface temperature >18°C. Most positive tows yielded less than 3 specimens.

INTRODUCTION

Knowledge of the early life and recruitment processes is very important for understanding of population dynamics and of managing of commercial species, especially those with a short life-span like cephalopods.

Although several cephalopod species are commercially important in Greece and the monitoring of their abundance and distribution in Greek waters has progressed during the last decade (Stergiou et al., 1997), information on their early life stages is still very limited (Degner, 1926; Lefkaditou et al., 1999); most of the published studies are related to the adults of demersal species caught by bottom trawl (D’Onghia et al., 1996; Lefkaditou et al., 2003; Lefkaditou and Kaspiris, 2004).

In the present paper, cephalopod paralarvae collected by bongo-nets off the coasts of central Greece during a sardine egg production survey during December 2000–February 2001 are reported and their occurrence in relation to hydrological regimes is discussed.
in the mouth of each net. At each station, vertical profiles of temperature and salinity were also taken using a SBE-25 CTD system. Immediately after collection, samples from the 250 μm net were preserved in 10% borax-buffered formalin solution, and those from the 500 μm net were preserved in 85% ethanol solution. Cephalopod paralarvae were sorted from the samples of the 500 μm net under a dissecting microscope and the species were identified following the keys in Sweeney et al. (1992), Mangold and Boletzky (1987) and (Bello, 1995). The mantle length (ML) of each specimen was measured to the nearest 0.01 mm using an image analysis system. All cephalopod specimens were subsequently stored in the National Centre for Marine Research, Athens, Greece, where additional studies on statolith microstructure are in progress.

RESULTS

Hydrography

The horizontal distribution of the surface (5 m) and the mean vertical profiles of temperature and salinity are shown in Figs. 2 and 3 respectively. Temperature and salinity varied between the eastern (Pagasitikos, N. Evoikos, S. Evoikos and Saronikos Gulfs) and the western part (Ionian Sea, Patraikos and Korinthiakos Gulfs) of the survey area (Figs. 2 and 3).

In the eastern part of the survey area, surface temperature ranged from 15.4 to 19.8 ºC, with the highest values recorded in Saronikos and the lowest in the N. Evoikos Gulf. In the western regions, considerably lower temperature values (13.9–16.5 ºC) were recorded, which was due to the time interval between the two parts of the survey coupled with the seasonal changes. Surface salinity (Fig. 2b) varied between 36.7 and 38.8 psu, and was lowest in the Pagasitikos Gulf, northern Evoikos Gulf and near river mouths due to fresh water discharge.

The water column (Fig. 3) appeared to be stratified in the earlier sampled (December 2000) eastern regions, showing a marked vertical stratification between 50 and 90 m with a thick thermally homogeneous surface layer. In the north Evoikos Gulf, the coldest temperatures (<12 ºC) were recorded below the thermocline, whereas low salinity values (<38 psu) were observed throughout the water column. In the western part (sampled...
Juvenile planktonic cephalopods sampled off the coasts of central Greece during January–February 2001, the vertical profiles of temperature and salinity were more homogeneous.

Composition and distribution of cephalopod paralarvae

A total of 70 cephalopod paralarvae were caught at 21 stations (Fig. 1). They were identified to 9 taxa, including one myopsid squid, two oegopsid squids, two sepiolids and four octopods. Remarks on each species are given below following the systematic order of Mangold and Boletzky (1988).

Order: Teuthoidea
Suborder: Myopsida
Family: Loliginidae
*Loligo forbesi* (Steenstrup, 1856)
Three paralarvae were collected at 3 stations in the Ionian Sea. Their mantle lengths ranged between 2.2 and 3.2 mm.

Order: Teuthoidea
Suborder: Oegopsida
Family: Ommastrephidae
Subfamily: Illicinae
*Illex coindetii* (Verany, 1839)
It was the dominant species represented by rhynchoteuthion larvae (ML: 1.2–9.0 mm), as well as by larger juveniles (ML: 9.0–17.0 mm) with separated tentacles, bearing suckers with the typical dentition for the species. Fifty-three individuals were caught at 9 stations in the eastern regions and 1 station from the Ionian Sea.

Family: Enoploteuthidae
Subfamily: Pyroteuthinae
*Pyroteuthis margaritifera* (Rüppell, 1848)
One specimen (4.8 mm ML) was collected from the Saronikos Gulf.

Order: Sepioidea
Family: Sepiolidae
Subfamily: Heteroteuthinae
*Heteroteuthis dispar* (Rüppell, 1844)
A juvenile (2.4 mm ML) bearing the species’ characteristic light organ (Bello, 1995) in its mantle cavity was found in the Ionian Sea.

Subfamily: Rossinae
*Neoressia caroli* (Joubin, 1902)
One paralarva (1.4 mm ML) was caught in the north Ionian Sea.

Order: Octopoda
Suborder: Incirrata
Family: Octopodidae
Subfamily: Octopodinae
*Octopus vulgaris* (Cuvier, 1797)
A total of 8 paralarvae was collected from 4 stations in the south Evoikos Gulf, 2 stations in the north Evoikos Gulf where 43 specimens were caught in a single tow between 56 m and the surface, whereas each of the other tows yielded fewer than 2 specimens.

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Figure 3. Mean vertical profiles of temperature (°C) and salinity (psu) in different regions of the surveyed area during the cruise of R/V Philia in December 2000/February 2001. The standard deviations are indicated as horizontal bars.
Juvenile planktonic cephalopods sampled off the coasts of central Greece

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DISCUSSION

The generally low occurrence of cephalopod species in the samples examined may be due to the inadequacy of conventional ichthyoplankton sampling for these species (Piatkowski, 1998), as well as to the high dispersion of cephalopod paralarvae. The exceptionally large number of
depths shallower than 50 m suggests that they are predominantly found below the mixed layer, as has been observed in other areas (Röpke et al., 1993).

The frequency of occurrence was low over depths greater than 200 m and at stations distant from the coast (Fig. 1). Similar distribution patterns have also been demonstrated for octopod, loliginid and ommastrephid paralarvae collected in Iberian Atlantic waters (Moreno and Pereira, 1998; Rocha et al., 1999).

Studies on the vertical distribution of cephalopod paralarvae have shown that they ascend at night (Röpke et al., 1993), which could explain why the frequency of occurrence was higher during evening hours than during the day. By comparing the different regions and sampling times of the surveyed area some differences in species occurrence were observed. No cephalopods were collected in the Pagasitikos and Patraikos-Korinthiakos regions, where the lowest salinity and temperature values, respectively, were recorded in the upper layers (Fig. 3). Octopods and ommastrephids were mostly found in the Evoikos Gulf and the Saronikos Gulf during December, where the highest surface temperatures were observed, whereas loliginids and sepiolids were collected only in the Ionian Sea (January–February) with relatively colder surface waters. Since analogous differences have not been observed in adult distributions (Lefkaditou et al., 2003a; 2003b), temperature seems to be an important factor associated with the occurrence of cephalopod early life stages. This is further supported by the results of plankton surveys in Portuguese waters, which show that paralarvae of ommastrephids and O. vulgaris are associated with warmer waters than those of loliginids and sepiolids (Moreno and Pereira, 1998).

The present collection of planktonic cephalopods is relatively restricted, comprising only 9 of the 48 cephalopod species occurring in the Greek seas (Lefkaditou et al., 2003a; 2003b). However, it provides valuable information on the distribution of cephalopod planktonic stages in Greek waters.

**Figure 5.** Frequency of occurrence (number of positive tows/total number of tows) of cephalopods in bongo-net collections with regard to sampling hour, bottom depth and surface temperature.
REFERENCES


