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Checklist of copepods (*Calanoida* and *Podoplea*) from the northern Levantine basin shelf waters

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Abstract

This paper is based on the qualitative and quantitative description of planktonic materials collected from the northern Levantine basin shelf waters during the period 1998–1999. Analysis of a total of 75 zooplankton samples collected along the Turkish Mediterranean coast has shown the presence of approximately 200 copepod species. Among these, 76 species are recognised for the first time in this region including four new species. At present, the total list of copepod species from the Levantine basin numbers 233, with several Indo–Pacific species included. The copepod species inhabiting the region are interesting not only because of faunistic properties, but also due to their distribution, which is related to the existing current regime.

Introduction

In the Mediterranean, long-term time series data on zooplankters, especially on copepods, are few and mainly limited to its northwest regions (Kouwenberg & Razouls, 1990; Mazzocchi & Ribera d'Alcala, 1995), the Adriatic Sea (Regner, 1985; Baranovic et al., 1993) and the Aegean Sea (Epaminondas, 1998). Although not long-term, there are also several zooplankton studies concerning dynamics and composition from certain regions of the eastern Mediterranean (e.g. Zorgani, 1984 in Libya; El Maghraby, 1965; El Maghraby & Halim, 1965; Halim et al., 1967; Salah, 1971; and Halim, 1976 in Egypt; Berdugo, 1968; Pasteur et al., 1976; Kimor & Wood, 1975 in Israel; Lakkis, 1973, 1976a,b, 1990, 1994, 1995a,b and Lakkis & Zeidane, 1990 in Lebanon). Among the other studies related to the copepod fauna of the region are those of Gurney, 1927, Casanova, 1973; Shmeleva, 1973; Kovalev & Shmeleva, 1982; Moraitou-Apostolopoulou, 1985; Kovalev et al., 1999; and Belmonte & Potenza, 2001. The northern Levantine basin of the eastern Mediterranean is probably the least studied region with respect to zooplankton. A few species have been mentioned as auxiliary data in the studies of Akyuz (1957), Gokalp (1972), Salihoglu et al. (1997) and Yilmaz et al. (1997). Only the work of Gucu (1987) has aimed to study the time series (biweekly) species composition and dynamics of zooplankton over a 1-year period in the region.

In a wider scope, the northern Levantine is a subdomain of the eastern Mediterranean, where little is known about the structure and function of the marine ecosystem. In general, the marine ecosystems of interior seas are especially vulnerable to significant changes in nutrient supplies taking place in their confined waters. The coastal ecosystems of the eastern Mediterranean have been greatly altered with major changes in the drainage systems, such as the construction of the Aswan Dam in the upper Nile. Following construction, terrestrial nutrient input to the receiving Mediterranean waters was greatly blocked and resulted in a non-fertile, oligotrophic water system. Shortage of nutrients first diminished phytoplankton

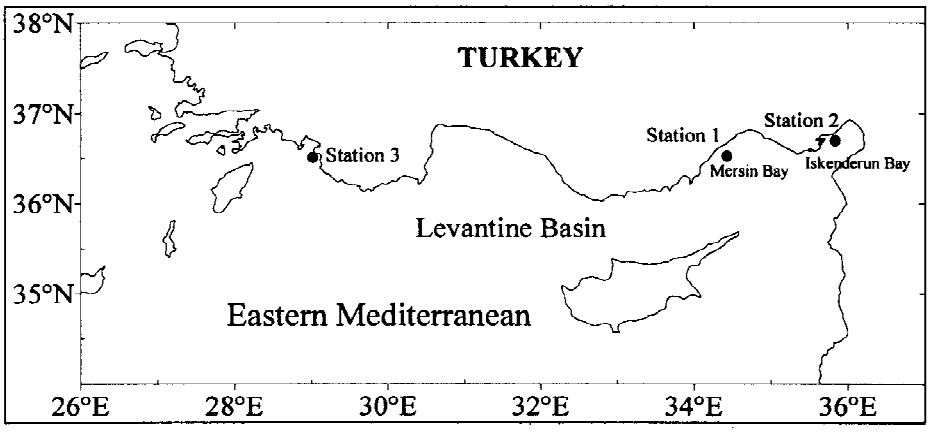

Figure 1. Map showing the location of zooplankton sampling stations along Turkish coastal waters of the northern Levantine Basin.

productivity, and hence the zooplankton as the second step in the marine food chain. Recent studies indicate that changes are occurring intensely in the northern Levantine basin at different trophic levels (Gucu et al., 1992, 1994; Uysal & Mutlu, 1993; Gucu & Bingel, 1995; Kideys & Gucu, 1995). The most predominant anthropogenic impact is the severe eutrophication experienced in Iskenderun and Mersin Bays. The introduction of alien species through Lessepsian migration from the Red Sea also represents a notable example of anthropogenic effects in this region.

Materials and methods

The majority of samples for this study were collected from a single station, about 10 km offshore from the Institute of Marine Sciences, Middle East Technical University, located in the northeastern coast of the Mediterranean (Station 1 – Fig. 1, coordinates are 34°22′E, 36°30′N). This station, with a total depth of 150 m, was visited at weekly intervals with R/V Erdemli (19 m in length and used for coastal surveys) from January 1998. The zooplankton samples were hauled from 100 m to the surface. In addition, two samples from the highly eutrophic Iskenderun Bay (Station 2 – Fig. 1, coordinates are 36°49′E, 35°53′N) during July 1999 were also analysed for their copepod contents. For this, samples were hauled from the bottom to the surface, as the station was rather shallow (about 20 m deep). Finally, a third site in the west, the Fethiye Bay (Station 3 – Fig. 1) was also studied for their copepod faunal assemblages during September 1999. Vertical tows from the bottom to the surface using the same equipment were performed on board R/V Bilim.

All samples were collected by a Nansen net with a mouth opening of 0.385 m^2 and 112 micron mesh size. On board, the samples were preserved in a 4% borax buffered formaldehyde solution in seawater. In the laboratory, large and rare species were identified and counted for the whole sample. Mass species were sorted by taking duplicate sub-samples of one or two millilitres using the stempel pipette.

Physical properties of the region

The temperature (°C) and salinity (ppt) values for the station offshore Erdemli range between 16.01 °C in March and 29.91 °C in August and between 38.52 ppt (May, 1998) and 39.43 ppt (September, 1998), respectively. The temperature range observed is much narrower in the Red Sea with a minimum of about 20.3 °C in March and a maximum of 29 °C in August (data obtained from NOAA Sea surface temperature data averaged over the years 1992–1996 for Eilat, Red Sea).

There is a significant water exchange through the Suez Channel between the Red Sea and the Mediterranean. Previous investigations show (Bogdanova, 1973) that through the Suez Channel, the flow of the Red Sea water mass towards the Mediterranean is twofold greater than in the opposite direction. The surface temperature ranges from 17.1 °C in February to 26.2 °C in August at the Red Sea exit of the Suez Channel. In September, in the central region of the channel the temperature may reach 29 °C at the surface. Maximum salinity ranging from 45 to 54 ppt was observed in

Table 1. List of copepod species encountered for the first time in the northern Levantine basin shelf waters

Copepod species	Rare	Common	Mass
Calanoida			
Acartia discaudata Giesbr., 1881	+		
Acartia italica Steuer, 1910	+		
Acartia tonsa Dana, 1849	+		
Acrocalanus monachus Giesbr., 1888		+	
Bradyponticus sp.	+		
Calanopia americana Dahl., 1894	+		
Calanopia biloba Bowman	+		
Calanopia levantina n. sp.	+		
Calanopia metu n. sp.		+	
Calanopia minor A. Scott, 1902	+		
Calanopia sp.**	+		
Calocalanus atlanticus Shmel., 1975	+		
Calocalanus gresei Shmel., 1973			+
Calocalanus kristalli Shmel., 1968		+	
Calocalanus latus Shmel., 1968		+	
Calocalanus lomonosovi Shmel., 1975	+		
Calocalanus longisetosus Shmel., 1965		+	
Calocalanus minor Shmel., 1975	+		
Calocalanus plumatus Shmel., 1965		+	
Calocalanus pyriformis Shmel., 1975	+		
Calocalanus vivesi Shmel., 1979	+		
Candacia catula Giesbr., 1889	+		
Candacia sp.	+		
Canuella furcigera Lang, 1948	+		
Centropages caribbeanensis Park, 1970	+		
Clausocalanus jobei Frost, Fleminger, 1968	+		
Clausocalanus pergens Farr., 1926		+	
Ctenocalanus citer Bowman, Heron, 1971		+	
Delius nudus Sewell, 1929		+	
Disco populosus Gordejeva, 1976	+		
Eucalanus sp.	+		
Lucicutia gaussae Grice, 1963		+	
Lucicutia paraclausi Taisoo Park, 1970	+		
Microcalanus pusillus Sars, 1903		+	
Mormonilla phasma Giesbr., 1891	+		
Neocalanus robustior Giesbr., 1888	+		
Pareucalanus sewelli Fleminger, 1973	+		
Paracalanus denudatus Sewell, 1929		+	
Paracandacia simplex Giesbr., 1889		+	
Paracartia latisetosa Kriczaguin, 1873	+		
Paradisco mediterraneus Gordejeva, 1974	+		
Parvocalanus elegans Andronov., 1972		+	
Parvocalanus latus Andronov., 1972		+	
Pteriacartia josephinae Crisafi, 1974	+		
Pontellina sobrina Fleminger & Hulsemann, 1974	+		
Prodisco sp.	+		

Continued on p. 18

Table 1. Continued

Copepod species	Rare	Common	Mass
Scaphocalanus emine n. sp.	+		
Scolecithricella marginata Giesb., 1888	+		
Scolecithricella sp	+		
Scolecithricella tenuiserrata Giesb., 1892	+		
Scolecitrichopsis ctenopus Giesb., 1888	+		
Spinocalanus sp.	+		
Stephos scotti Sars, 1902	+		
Subeucalanus subcrassus Giesbr., 1888	+		
Tortanus sp.	+		
Podoplea			
Corycaeus elongatus Claus, 1899	+		
Corycaeus sp.	+		
Cyclopina gracilis Claus, 1862	+		
Epicalymma exigua Farran, 1908	+		
Lubbockia brevis Farran, 1908	+		
Microsetella norvegica Boeck, 1864			
Oculosetella gracilis Dana, 1852	+		
Oithona attenuata Farran, 1913		+	
Oithona fallax Farran,1913	+		
Oithona hamata Rosendorn, 1917		+	
Oncaea atlantica Shmel., 1967	+		
Oncaea brodskii Shmel., 1968	+		
Oncaea clevei Fruchtl, 1923	+		
Oncaea curta Sars, 1916		+	
Oncaea longiseta Shmel., 1968		+	
Oncaea neobscura Razouls, 1969	+		
Oncaea notopus Giesbr., 1891		+	
Oncaea obscura Farran, 1908		+	
Oncaea oceanica Gordejeva, 1972	+		
Oncaea parobscura Shmel., 1979	+		
Oncaea tenuimana Giesbr., 1891	+		

**Species name will give given later (study in preparation).

the central part of the channel, located in the lakes. Then, salinity sharply decreases to 28–30 ppt. The flow, which gathers a large proportion of high salinity waters, drains into the eastern Mediterranean. The denser water mass moves along the bottom layer of the shelf while sinking in the slope until it reaches the middle high salinity layer (Bogdanova, 1973).

Results and discussion

The list of copepod species found for the first time in this region, as well as their relative occurrences in the samples, at three different stations along the northern Levantine basin shelf waters, are given in Table 1. Most of the species from this list is common for the Mediterranean while some other species have been introduced from the Red Sea, but over a period of time have become common in the plankton.

Among the total 19 Acartiidae species present in the Ponto-Mediterranean Province (Belmonte & Potenza, 2001) only six of them were identified during this study. The presence of only two species namely *Acartia clausi* and *Acartia danae* was reported earlier from this region (Gucu, 1987). *Acartia clausi* has been reported from the Indian, Atlantic and Pacific oceans (Carli & Crisafi, 1983) as well as from the eastern Mediterranean (El Maghraby & Halim, 1965; Pas-

teur et al., 1976; Lakkis, 1976b). *Acartia discaudata* mainly present in the western Mediterranean has been found only along the Lebanese coast (Lakkis et al., 1990) and is regarded as a coastal species. *Acartia italica* was previously found in various regions of the Ponto-Mediterranean Province (Brian, 1927; Potemkina, 1940; Alcaraz et al., 1988) including the Lebanese coast (Lakkis & Zeidane, 1990). *Acartia tonsa* has been reported earlier from the northern area of the Ponto-Mediterranean Province (Belmonte et al., 1994) from the south at Cagliari (Zagami & Guglielmo, 1990) and also from the Sea of Marmara (Hajderi, 1995). This species was only recently reported in the Ponto-Mediterranean Province (Gaudy & Vinas, 1985). *Paracartia latisetosa* is common in the entire Ponto-Mediterranean Province (Belmonte & Potenza, 2001) and regarded as strictly coastal. Finally, the sixth Acartiidae species *Pteriacartia josephinae* observed during this study has been recorded in the western Mediterranean around the Italian coasts and along the Lebanese coasts (Lakkis & Zeidane, 1990).

Both the genus *Calanopia* of the northern Levantine and the genus *Parvocalanus* are predominantly Indo–Pacific species (Bowman, 1957; Andronov, 1972). In addition, two species, namely *Centropages furcatus* and *Euchaeta concinna* are also of Indo–Pacific origin as well as *Eucalanus crassus* and *E. subcrassus* (Sewell, 1948). Some of these species were previously recorded from different regions of the Mediterranean, for example, *E. concinna* (Casanova, 1973), and some others in the Levantine basin waters (e.g. *Calanopia elliptica*, *C. media*, Lakkis, 1976b; *Centropages furcatus*, Lakkis, 1990 and *Parvocalanus crassirostris*, Delalo, 1966). Other species of Indo–Pacific origin, *Parvocalanus latus*, *P. elegans*, *Calanopia biloba* and *C. minor* have not previously been sampled throughout the Mediterranean basin. Some species including *Calanopia metu* n.sp.*, *Calanopia levantina* n.sp.*, *Calanopia sp.* n.sp.** and *Scaphocalanus emine* n.sp.* are new both to science and to the world oceans (*=manuscript submitted, **=unpublished data of Uysal & Shmeleva). *Calanopia metu* was abundantly found in the samples. *Calanopia metu* was also observed in the Marmara and Aegean Seas but remains absent from the Indian Ocean as confirmed by Shmeleva recently (unpublished data). The presence of all developmental stages of the genus *Calanopia* indicates their suitability for the Levantine basin shelf waters. Indo–Pacific individuals such as *Parvocalanus latus* and *P. elegans* and *Centropages furcatus* were also recorded in the Marmara Sea recently (Unal et al., 2000).

Calanopia elliptica and *C. media* which are of Indo–Pacific origin are present in the Levantine Sea (Lakkis, 1973, 1976b), but neither was observed in the western part of the Mediterranean nor in the Atlantic ocean. *Calanopia biloba* and *Calanopia minor* present in our samples are also new to the Mediterranean. The species distribution of *Calanopia* from all stations shows them to be coastal species. Berdugo (1968) and Lakkis (1976b) also mentioned the presence of *C. media* and *C. elliptica* along the coastal waters near Port Said and Haifa. Both species were found to be abundant in autumn (about 100 individuals m^{-3}). Some individuals belonging to the genus *Scolecithricella* were not identified on a species level, but in our view they should also belong to the Indo–Pacific group.

Parvocalanus crassirostris was numerous both in the Levantine basin and in the Red Sea (Delalo, 1966), while other *Parvocalanus* species, *P. latus* and *P. elegans* were recorded in small numbers from the Levantine waters. *Centropages furcatus* was recorded in Levantine coastal waters on a yearly basis, with peak numbers occurring in the autumn (70 individuals m^{-2}) and a reduced abundance in winter (50 individuals m^{-2}). Near the Lebanon coast *C. furcatus* was found from April until December where it was numerous only in the warmer months (Lakkis, 1990, 1995b). High abundances of *C. furcatus* and *Calanopia* species which are common in the plankton of the Indian Ocean (Fleminger & Hulsemann, 1973) is interesting from a faunistic view, because these species of the Indo–Pacific group are recorded for the first time in the Levantine basin along the Turkish coast. Sharing the same species of Indo–Pacific origin gives the copepod fauna of the Levantine basin a subtropical affinity. Some of the Indo–Pacific species like *C. furcatus* and species of the genus *Calanopia* are numerous and reproduce in the Levantine waters.

Other species, like, *Ctenocalanus citer* is common in the Antarctic epiplankton and it reaches a density of about 2400 individuals m^{-2} in the spring (Kaczmaruk, 1983; Zmijeiwcka, 1983; Hopkins, 1987; Tucker & Burton, 1990; Schnack-Schiel & Mizdalski, 1994). *C. citer* originally described by Heron & Bowman (1974) from the Antarctic waters was not previously reported for the Mediterranean (Lakkis, 1976b; Kovalev & Shmeleva, 1982) but is common here as well. For example, *C. citer* has been found lately in samples collected on board R/V 'Prof Vodyanitskiy'

during November–December, 1987 from the Iberian and Ionian Seas, and recently in the eastern part of the Marmara Sea (Unal et al., 2000). Perhaps, this species was confused with very similar species, such as *Ctenocalanus vanus*, which was not found by Shmeleva in the western and central regions of the Mediterranean. The present records from the Mediterranean and Antarctic waters demonstrate that the geographical range of *C. citer* extends from the colder Antarctic region to the much warmer Mediterranean.

Conclusion

Qualitative and quantitative analysis of zooplankton from the northern Levantine basin shelf waters during the period 1998–1999 revealed the presence of about 200 copepod species of which 76 are reported for the first time in the region. With the addition of new species and new records the total number of copepod species reached 233 species in the Levantine basin. The copepod species inhabiting the region are interesting in their faunal composition, and in their distribution, which is related to the existing current regime. Observation of Indo–Pacific species in the Levantine Sea confirms the fact that the Red Sea waters penetrate into eastern regions of the Mediterranean. The distribution of these species may indicate possible boundaries of this penetration. The presence of new species being introduced into the Levantine Sea points out that their invasion and acclimatisation in this region is intensive at present which therefore necessitates further studies.

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