An oasis for alien benthic Foraminifera in the Aegean Sea

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Abstract

The benthic foraminiferal fauna in Pamucak Cove (NW Kuşadası, Turkey) was investigated. A rich foraminiferal assemblage was observed around submarine springs, which were located 200 m off the coast. This foraminiferal assemblage is typical Mediterranean. However, the abundance of alien species is noteworthy. Fourteen alien foraminifera were found. Indo-pacific originated species; *Quinqueloculina* sp. C, *Triloculina* sp. A, *Pyramidulina catesbyi* (d’Orbigny), *Brizalina simpsonii* (Heron-Allen and Earland) and *Amphistegina lessonii* d’Orbigny were observed for the first time on the Turkish coastline. Specimens of *Haddonia* sp. and *Cymbaloporetta plana* (Cushman), abundantly observed in SW Antalya and *Nodopthalmidium antillarum* (Cushman), previously recorded from Iskenderun were also found in the study area, these are the first records for these species in the Aegean Sea. In addition, seven individuals of *Euthymonacha polita* (Chapman) were found around the springs, and this constitutes the first record of this species in the entire Mediterranean Sea.

Key words: *Euthymonacha polita*, foraminifera, alien species, Aegean Sea, Turkey

Many alien marine species have been recorded in the Eastern Mediterranean. The macroscopic aliens, such as algae, fishes, crustaceans and molluscs have been well studied. Recently, the scientific community started focusing on microscopic ones, such as foraminifera. Zenetos et al. (2008) reviewed the alien foraminifera in the Mediterranean and gave a list of 34 genera and 45 species. In a recent study, 32 alien foraminiferal species were reported from the Aegean and Mediterranean coasts of Turkey (Meriç et al. 2008a). The majority of these species are only observed on the Mediterranean coast, most probably because of their Indo-Pacific origin and high temperature preferences. Only a few species have been recorded in the central and northern Aegean Sea, most of which show both Indo-Pacific and Atlantic distribution (Meriç et al. 2008a), suggesting a broad range of environmental preferences.

Low sea water temperatures observed during winter times in the Northern Aegean Sea may be the key element limiting the distribution of Indo-Pacific originated foraminifera. It was reported that the occurrences of living amphisteginids are delimited by the 14°C winter isotherms (Langer and Hottinger 2000). Laboratory experiments showed that *Amphistegina lobifera* Larsen ceased all movements at temperatures below 12°C (Zmiri et al. 1974). However, *Amphistegina lobifera* has been recorded in the northern Aegean Sea and in the eastern Sea of Marmara (Meriç and Avşar 2001; Meriç et al. 2005), indicating that this species can adapt to much lower temperatures. Another possibility is that it might have been colonized near active fault lines that formed hot water submarine springs.

The foraminiferal fauna of the Eastern Aegean Sea is well studied (Meriç et al. 2004) and the general distributions of alien species are known (Meriç et al. 2008a). In the framework of this study, the foraminiferal fauna of a submarine spring located in Pamucak Cove (NW Kuşadası, Turkey) was investigated to figure out the local effects on the alien foraminifer ecology.

Hot water springs are commonly found around the coasts of Kuşadası (Aydın, Turkey). Submarine springs are also observed off the coast. High amount of fresh water input with mineral ingredients results in the formation of a special coastal habitats. The benthic foraminiferal fauna of such a submarine spring located in Pamucak...
Cove (NW Kuşadası) was investigated (Figure 1). The two springs, 5 m apart, are located 200 m off the coast, at a depth of 12.40 m and have a temperature of 19.6°C, almost stable throughout the year. Taking one of the springs as the center (36°55′18″N, 27°15′45″E), four vertical lines were set in south, north, east and west directions. The east line was 100 m, but because of rocky bottom structure, lines longer than 50 m could not be set in other directions. A total of 45 sediment samples were manually collected from the center and from different points on the lines. The center was labeled as “0 m” and samples were collected at each 5-10 m distance. The positions of the sampling points were as follows, 5, 10, 15, 20, 25, 30, 35, 45 and 50 m on the north line; 5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 m on the south line; 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90 and 100 m on the east line; 5, 10, 15, 20, 25, 30, 35, 40, 45 m on the west line.

A typical Mediterranean foraminiferal fauna was observed. However, the presence and abundance of alien species are noteworthy (Annex 1). *Haddonia* sp., *Pyramidulina catesbyi* (d’Orbigny), *Iridia diaphana* Heron-Allen and Earland, *Cymbaloporetta plana* (Cushman) and *Nodopthalmidium antillarum* (Cushman) are new records for the region. *Quinqueloculina* sp. C, *Triloculina* sp. A, *Brizalina simpsoni* (Heron-Allen and Earland), *Amphistegina lessonii* d’Orbigny and *Triloculina affinis* d’Orbigny are first records for the Turkish coastline and *Euthymonacha polita* (Chapman), which shows an Indo-Pacific distribution (Loeblich and Tappan 1994), constitute the first record from the Mediterranean basin.

**SYSTEMATICS**

Superfamily SORITACEA Ehrenberg, 1839  
Family Peneroplidae Schultze, 1854  
Genus *Euthymonacha* Loeblich and Tappan, 1994  
*Euthymonacha polita* (Chapman)

*Euthymonacha polita* was first described from the Timor Sea as *Peneroplis (Monalysidium) polita* by Chapman (1904) and its name was changed to *Euthymonacha polita* by Loeblich and Tappan (1994). Under different genus and species names it has been recorded from various parts of the Indo-Pacific (Chapman 1904; Heron-Allen and Earland 1915; Cushman 1930, 1933; Graham and Militante 1959; Saidova 1975; Cheng and Zeng 1978; Haig 1988; Hatta and Ujiie 1992). Seven individuals were found in seven sediment samples from Pamucak Cove (Figure 2 and Annex 1).

Although it is not yet reported from Red Sea, its wide distribution range in the Indo-Pacific suggests that *Euthymonacha polita* can be present in the Red Sea and might be introduced via Suez Canal. However, the foraminiferal fauna of the Mediterranean and Aegean coasts of Turkey have been extensively studied (Meriç et al. 2008a), and the spring in Pamucak Cove is

**Figure 1.** Map of the study area. The submarine springs are located on the north of Kuşadası, about 200 m off the shore.
Alien benthic Foraminifera in the Aegean Sea

Another important finding was the abundance of *Amphistegina lobifera* observed around the spring. In the Aegean Sea, *Amphistegina lobifera* has been previously recorded from Turkish and Greek coasts (Meriç et al. 2004; Triantaphyllou et al. 2009). The populations observed in Gökçeada, Gulf of Gökova, Gulf of Datça and Marmaris Bay always represented in the fauna by small numbers of individuals. However, with the exception of two samples, it was found in all samples analysed in the study area (Figure 3). At Station 22, 1954 individuals were found in five grams of sediment and 1072 individuals at Station 6. It was found in abundance on the southern line, less so on the northern line, yet was exceptionally abundant on the western line. The population density dramatically decreased on the eastern line with increasing distance from the spring (Figure 3).

In previous studies it was reported that the submarine springs found in the Aegean Sea create special ecological conditions and affect the native foraminiferal fauna (Meriç 1986; Meriç et al. 2002a, b; 2003a; 2005; 2008a). The abundance pattern of the alien foraminifer species observed around the springs in Pamucak Cove may be related to the distribution of the spring water according to the local currents. Water analysis revealed high abundance of diatoms around the springs, which may supply...
a rich food source for the foraminifera. Thus, the environmental conditions created by the spring may help the alien species to establish stable local colonies and hence spread the larval forms to new destinations. It is suggested that, in the near future, more alien species will be recorded around such submarine springs on the western coasts of Turkey.

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Annex 1. Number of alien foraminifer individuals observed in stations. All samples were collected by Cüneyt Bircan in autumn 2007. The water temperature was 17.5°C for all the sampling points, except the center, 19.6°C, which constituted spring water.

<table>
<thead>
<tr>
<th>Species</th>
<th>Stations</th>
<th>Line Direction</th>
<th>Distance (m)</th>
<th>Depth (m)</th>
<th>Number of specimens</th>
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<td>24</td>
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