An oasis for alien benthic Foraminifera in the Aegean Sea

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Abstract

The benthic foraminiferan fauna in Pamucak Cove (NW Kuşadası, Turkey) was investigated. A rich foraminiferan assemblage was observed around submarine springs, which were located 200 m off the coast. This foraminiferan 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 simpsoni (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 İskenderun 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 foraminiferan species have been reported from the Aegean and Mediterranean coasts of Turkey (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 foraminiferan 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 foraminiferan 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 foraminiferan 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; Cushman et al. 1954; 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.
The only location this species is observed, which indicates that shipping is the most probable vector for introducing this species to the Mediterranean.

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 foraminfer 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

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**Figure 2.** *Euthymonacha polita* (Chapman) individuals found in Pamucak Cove. 1 Station 3; 2 Station 43; 3 Station 14; 4 Station 24; 5 Station 42. Scale bar: 50 μm

**Figure 3.** Number of *Ampistegina lobifera* Larsen individuals observed in five grams of sediment. The abundance decreases as the distance between the sampling point and the spring increases. E, W, N and S denote for the directions.
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.

Acknowledgements

The authors would like to thank Murat Dündar and Hüsnü Öztürk (ASSAN AŞ) for the support they provided for S.E.M. (Jeol JSM-5600) photography and to Dr Frances Lucy for editing the manuscript.

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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.

| Species                          | Stations       | Line Direction | Distance (m) | Depth (m) | Number of specimens |
|----------------------------------|----------------|----------------|--------------|-----------|---------------------|
| *Euthymonacha polita* (Chapman)  | 3, 4, 7        | South          | 10-30        | 9.7-11.3  | 1                   |
|                                  | 14             | North          | 15           | 8.7       | 1                   |
|                                  | 24             | West           | 15           | 11.3      | 1                   |
|                                  | 42, 43         | East           | 70, 100      | 19.1-20.2 | 1                   |
| *Haddonia sp.*                   | 4              | South          | 15           | 9.7       | 1                   |
| *Nodopthalmidium antillarum* (Cushman) | 4, 5, 7   | South          | 15-30        | 9.5-11.3  | 1                   |
|                                  | 12             | North          | 5            | 8.90      | 4                   |
|                                  | 15, 18, 20     | North          | 20-45        | 9.0-14.2  | 1                   |
|                                  | 21             | North          | 50           | 20.10     | 2                   |
|                                  | 22             | West           | 5            | 9.10      | 1                   |
|                                  | 23             | West           | 10           | 9.30      | 3                   |
|                                  | 24             | West           | 15           | 11.30     | 1                   |
|                                  | 25             | West           | 20           | 12.80     | 2                   |
|                                  | 26             | West           | 25           | 14.70     | 6                   |
|                                  | 30             | West           | 45           | 22.30     | 1                   |
|                                  | 42             | East           | 70           | 19.10     | 1                   |
| *Hauerina diversa* Cushman       | 15             | North          | 20           | 9.00      | 1                   |
| *Quinquelocalina sp. C*          | 23             | West           | 10           | 930       | 1                   |
| *Tricolaina affinis* d’Orbigny   | 28             | West           | 35           | 17.90     | 1                   |
| *Tricolaina sp. A*               | 39             | East           | 45           | 19.10     | 1                   |
|                                  | 8              | South          | 35           | 12.30     | 2                   |
| *Sorites orbiculus* Ehrenberg    | 22, 24, 29     | West           | 5-40         | 9.1-18.2  | 1                   |
|                                  | 38             | East           | 40           | 18.10     | 1                   |
| *Sorites variabilis* Lacroix     | 23             | West           | 10           | 9.30      | 1                   |
| *Pyramidalina catesby* (d’Orbigny) | 30             | West           | 45           | 22.30     | 1                   |
| *Brizalina simpsoni* (Heron-Allen and Earland) | 16           | North          | 25           | 10.10     | 1                   |
|                                  | 16, 19         | North          | 25-40        | 10.1-13.1 | 1                   |
|                                  | 23, 25         | West           | 10-20        | 9.3-12.8  | 1                   |
|                                  | 35, 41         | East           | 25-60        | 14.7-19.4 | 1                   |
| *Amphistegina lessonii* d’Orbigny | 1              | Spring         | 0            | 12.4      | 1                   |
|                                  | 27             | West           | 30           | 17.3      | 3                   |
|                                  | 35             | East           | 25           | 14.4      | 1                   |
|                                  | 45             | East           | 100          | 20.20     | 1                   |
| *Amphistegina lobifera* Larsen   | 1              | Spring         | 0            | 12.4      | 305                 |
|                                  | 2-11           | South          | 5-50         | 9.2-14.9  | 93-1072             |
|                                  | 12-21          | North          | 5-50         | 8.9-20.1  | 5-76                |
|                                  | 22-30          | West           | 5-45         | 9.1-22.3  | 12-1954             |
|                                  | 31-38          | East           | 5-40         | 11.5-18.1 | 44-161              |
|                                  | 39-42, 45      | East           | 45-100       | 19.1-20.2 | 1-8                 |