

Abnormal formations in peneroplid foraminifers: *Peneroplis-Coscinospira* togetherness

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Resumen

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Formaciones anormales en foraminíferos peneróplidos: Unión de Peneroplis- Coscinospira

Se ha observado una rica y variada fauna de foraminíferos en muestras obtenidas con dragas y core en Ayvalık (costa norte del Egeo en Turquía) y Antalia (suroeste de Turquía). Frecuentemente se obtuvieron individuos morfológicamente anormales de *Peneroplis pertusus* (Forskål) y *P. planatus* (Fichtel & Moll), los cuales mostraban características de *Coscinospira*. Datos anteriores, obtenidos en Çeşme (este del Mar Egeo), indican que este tipo de anomalías no son raros en peneróplidos. El objetivo de este estudio es determinar las posibles causas del desarrollo anómalo. Los gametos y juveniles de diferentes especies de peneróplidos pueden fundirse en morfologías aberrantes. Por otro lado, las racimos de *Amphicoryna* spp. con dos o tres individuos, observados en el Pacífico y el Mediterráneo, apoyan, en parte, la idea de formación de colonia.

Palabras clave: Formas anormales, *Peneroplis pertusus*, *Peneroplis planatus*, *Coscinospira hemprichii*, Turquía.

Abstract

A diverse and rich foraminifer fauna has been observed in core and grab samples obtained from Ayvalık (North Aegean coast of Turkey) and Antalya (Southwestern Turkey). Morphologically abnormal individuals of *Peneroplis pertusus* (Forskål) and *P. planatus* (Fichtel & Moll) showing *Coscinospira* characteristics were commonly observed in these sediment samples. Previous findings from Çeşme (East Aegean Sea) indicate that such anomalies in peneroplids are unrare events. The aim of this study is to determine the possible causes of this abnormal test development. Gametes and juveniles of different species of peneroplids may fuse to form such aberrant morphologies. On the other hand, the clusters of *Amphicoryna* spp. with two or three individuals observed in the Pacific and in the Mediterranean partially support the idea of colony formation.

Key words: Abnormal forms, *Peneroplis pertusus*, *Peneroplis planatus*, *Coscinospira hemprichii*, Turkey

Introduction

In some foraminiferal assemblage studies conducted along the Aegean and Mediterranean coasts of Turkey, abnormal peneroplid specimens have been observed to be locally common (Sözeri 1966, Sellier de Civrieux 1970; Meriç et al. 2005). Such abnormal morphologies have been shown in other studies, but without mentioning the possible causes (e.g., Cimerman & Langer 1991, Loeblich & Tappan 1994, Meriç et al. in press).

Abnormal peneroplid individuals from Turkey have been first reported by Sözeri (1966) in the sediment samples from Ilıca Bay (Çeşme-İzmir) (Fig. 1).

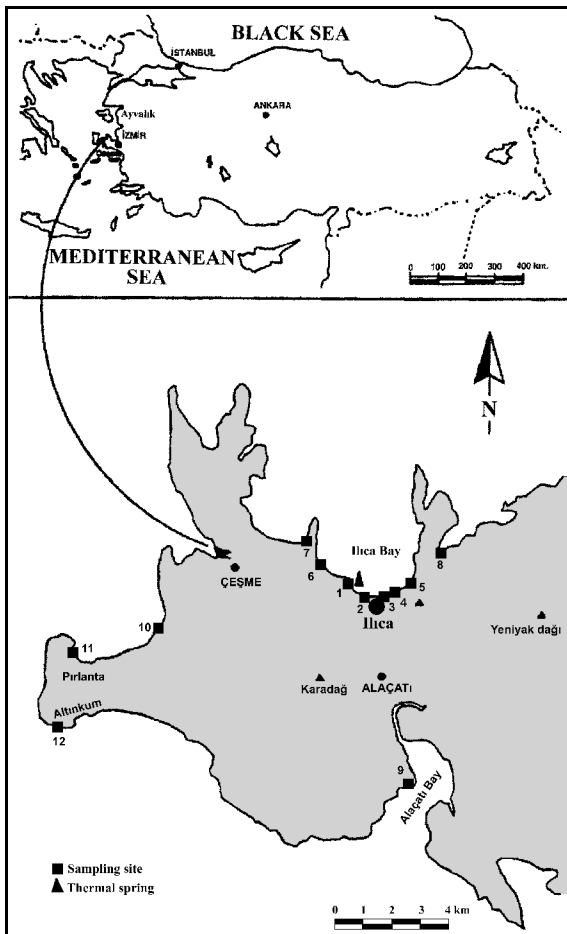


Figura 1. Estaciones muestreadas por Sözeri (1966) alrededor de Çeşme (İzmir, Turquía). Redibujado de Sözeri (1966).

Figure 1. Stations sampled by Sözeri (1966) around Çeşme (İzmir, Turkey). Redrawn from Sözeri (1966)

Later, Sellier de Civrieux (1970) reported the same specimens in his study, giving the drawings

but not the original photos (Fig. 2). Meriç et al. (2005) described an abnormal *Astacolus crepidulus* (Fichtel & Moll) specimen from Harmantaşı locality (Saros Bay, Northeastern Aegean Sea), with an elongated, hourglass-shaped test, on which a secondary part showing an abnormal test organization with chamber and aperture characteristics of a nodosarid (Meriç et al. 2005, Fig. 5c).

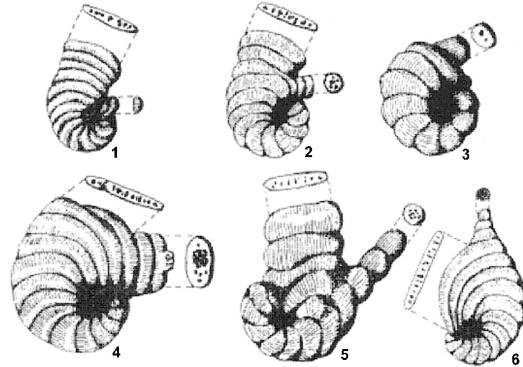


Figura 2. Anomalías morfológicas observadas en *Peneroplis* provenientes de la bahía de Çeşme Ilıca. Reproducido de Sellier de Civrieux (1970) con permiso de la Revista Española de Micropaleontología.

Figure 2. Morphological anomalies observed in *Peneroplis* from Çeşme Ilıca Bay. Reprinted from Sellier de Civrieux (1970) with permission from Revista Española de Micropaleontología.

The specimens reported from Ilıca Bay (Çeşme, East Aegean Sea) are the examples of *Peneroplis-Coscinospira* combination (Sellier de Civrieux 1970) (Fig. 2). No explanation was given by Sellier de Civrieux (1970) concerning the abnormal test development shown in plate 2, figs. 1, 2, 3, 5, 6, and 7. The aim of this study is to figure out the possible causes of these abnormal test developments seen in peneroplids, which is locally commonly observed in certain localities on the Aegean and Mediterranean coasts of Turkey.

Material and Methods

Three stations were investigated on the north of Ali-bey Island and one station on the east of Maden Island (Ayvalık, North Aegean coast of Turkey). A total of 11 core samples were manually collected (three samples from stations 1c, 2c and 4b, two samples from station 3a) (Figs. 3, 4/1-3).

The water depths of the sampling stations varied between 0.8 and 8.0 m. The lengths of the core

samples were between 42 and 52 cm. Two core samples from each station were cut longitudinally. One of them was used to analyze the sedimentary characteristics. The other core sample was divided into 2 cm thick slices to investigate the faunal content. Five grams of sediment were sampled from each slice. The samples were treated with 10% H₂O₂ for 24 hours and were with pressurized water sieved through pores of size 0.063 mm, dried at 50°C and separated with different sieves of pore sizes of 2.00, 1.00, 0.500, 0.250 and 0.125mm.

The samples were analyzed and sorted for abnormal tests under stereomicroscope.

A total of 227 sediment samples were manually collected by SCUBA diving from various depths ranging between 3.5 and 30 m along the coasts of Kalkan, Kaş, Kekova, Beşadalar and Üçadalar (Southwestern Antalya) (Figs. 4a, 4b, 5/4-10). Five grams of each sample were treated with 5% H₂O₂ for 24 hours. The samples were washed under pressurized water through a 0.063 mm sieve, transferred to petri dishes and dried at 50°C. Dry samples were then put through 2.00, 1.00, 0.500, 0.250 and 0.125 mm sieves. The foraminifer and ostracod fauna were analyzed using a stereomicroscope. The identification of *Peneroplis* and *Coscinospira* follows the morphological descriptions by Loeblich & Tappan (1964, 1988).

Results

Only molluscan specimens were observed in the sediment samples sieved through 2.00 and 1.00mm. The comparison of the 0.500 mm sieves showed that samples from Antalya included more foraminifers than core samples from Ayvalık. Ostracod species were rarely observed in these samples. However, both the foraminifers and ostracods were found to be very abundant in the 0.250 mm sieve.

In the 91 sediment samples from Ayvalık, two conjoined *Peneroplis-Coscinospira* individuals were observed. Four individuals with similar morphological characteristics were found in the sediment samples from Kaş (33/13m; 58/24m) and Kekova (84/14m; 99/24m) (Fig. 5/4-7).

The majority of the test of a *P. planatus* (Fichtel & Moll) individual from the 0-2 cm section of the core sample 3a (Ayvalık) was found to show

typical characteristics of the species; however, the

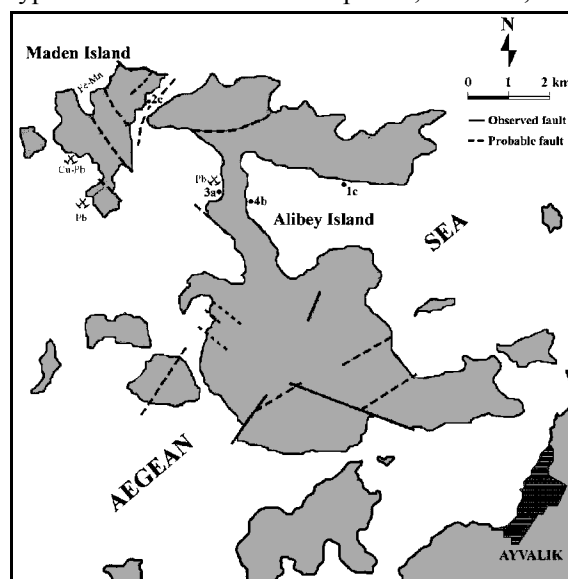


Figura 3. Estaciones de muestreo y localización de minas en Ayvalık (Balıkesir, Turquía).

Figure 3. Sampling station and locations of the mines at Ayvalık (Balıkesir, Turkey).

left side of the test showed *C. hemprichii* Ehrenberg characteristics (Fig. 5/1). Another conjoined individual showing *P. pertusus* (Forskål) and *C. hemprichii* Ehrenberg morphologies was found in the 2-4 cm section of the same core sample (Fig. 5/2). A *P. planatus* (Fichtel & Moll) individual with two separate linear apertures was also found in 2-4 section of the sample 2c from Ayvalık (Fig. 5/3). Similar abnormal morphologies were observed in various sections of all the core samples.

The same type of conjoined test morphology was observed in two peneroplid individuals from Kaş (Fig. 5/4-5) and also in other two individuals from Kekova (Fig. 5/6-7). The morphological characteristics of the each aperture of the conjoined individuals were not different from the normal individuals of *C. hemprichii* Ehrenberg (Fig. 5/8), *P. pertusus* (Forskål) (Fig. 5/9) and *P. planatus* (Fichtel & Moll) (Fig. 5/10). Many *P. planatus* (Fichtel & Moll) individuals with two separate but linear apertures have been found on the Kalkan-Üçadalar coastline (SW Antalya) and also in Ayvalık (Meriç et al. in press).

Discussion and conclusions

The abnormal test morphology of the peneroplid individuals collected from Aegean and SW Medi-

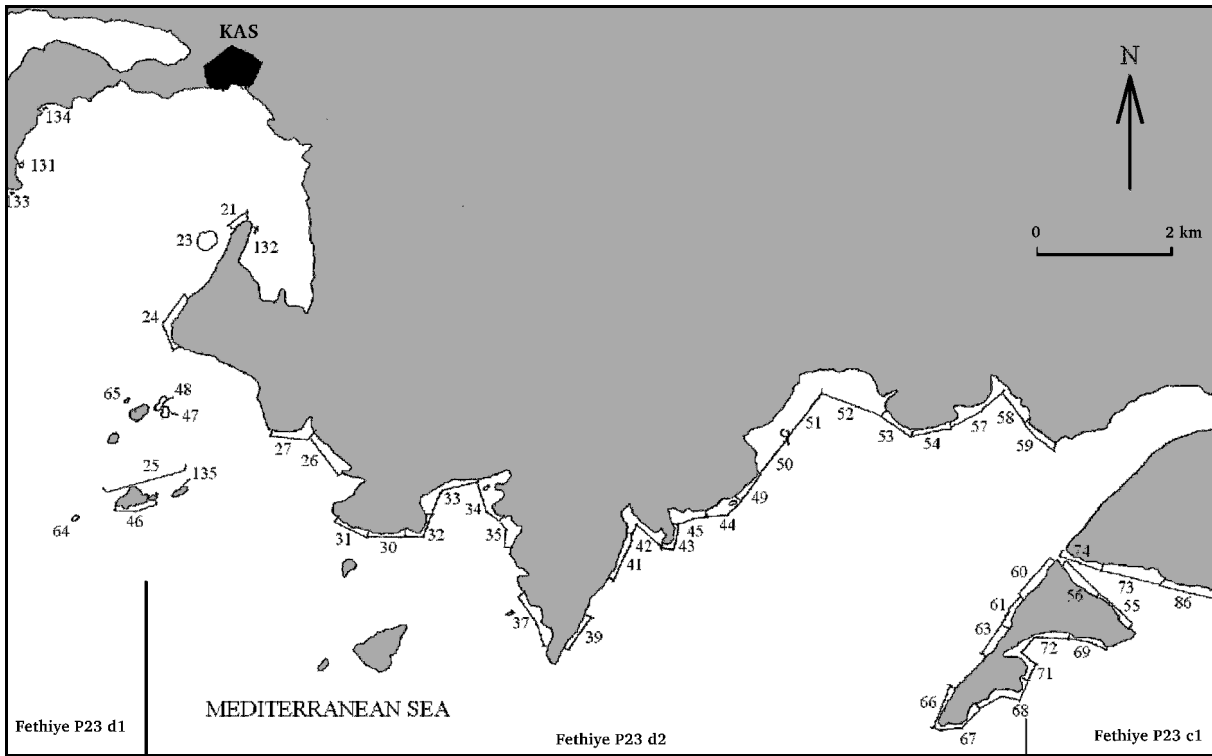


Figura 4a. Estaciones de muestreo en Kaş (Antalya).
Figure 4a. Sampling stations at Kaş (Antalya).

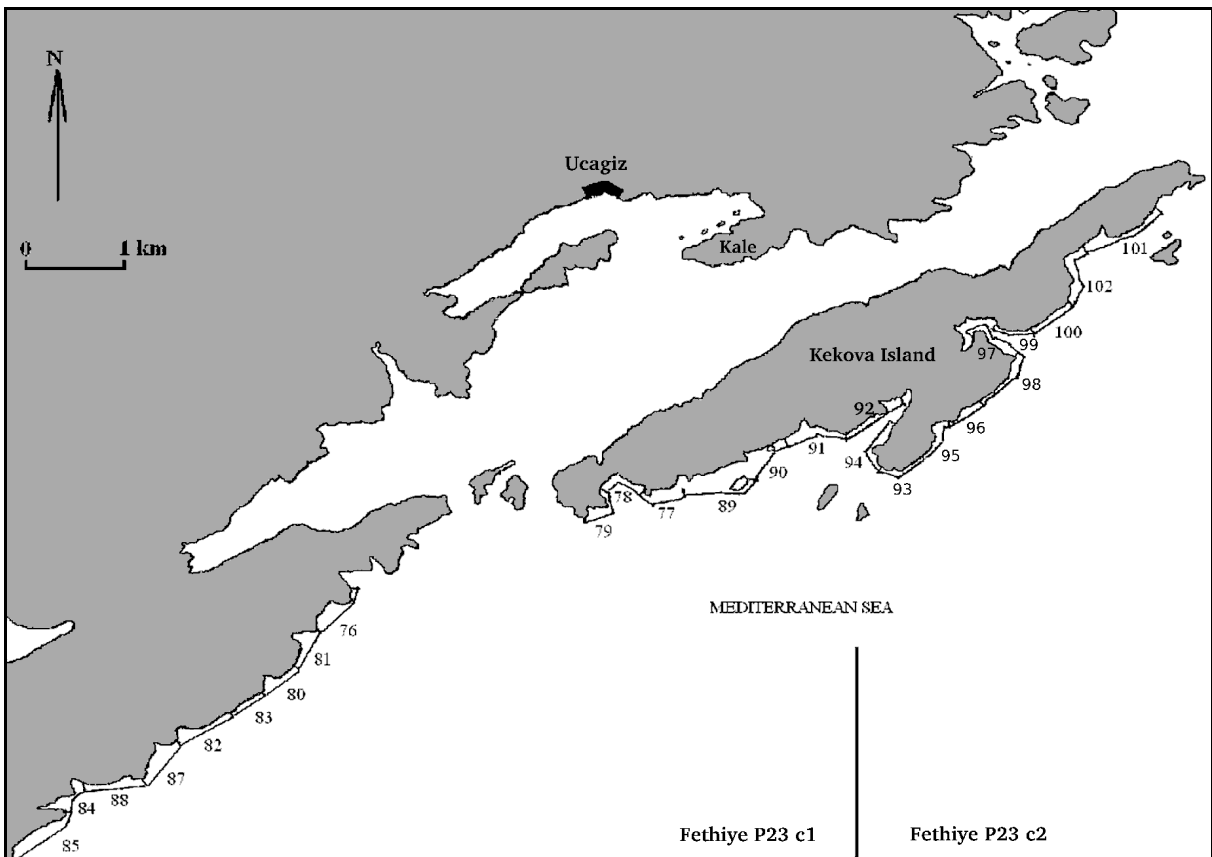


Figura 4b. Estaciones de muestreo en Kekova (Antalya).
Figure 4b. Sampling stations at Kekova (Antalya).

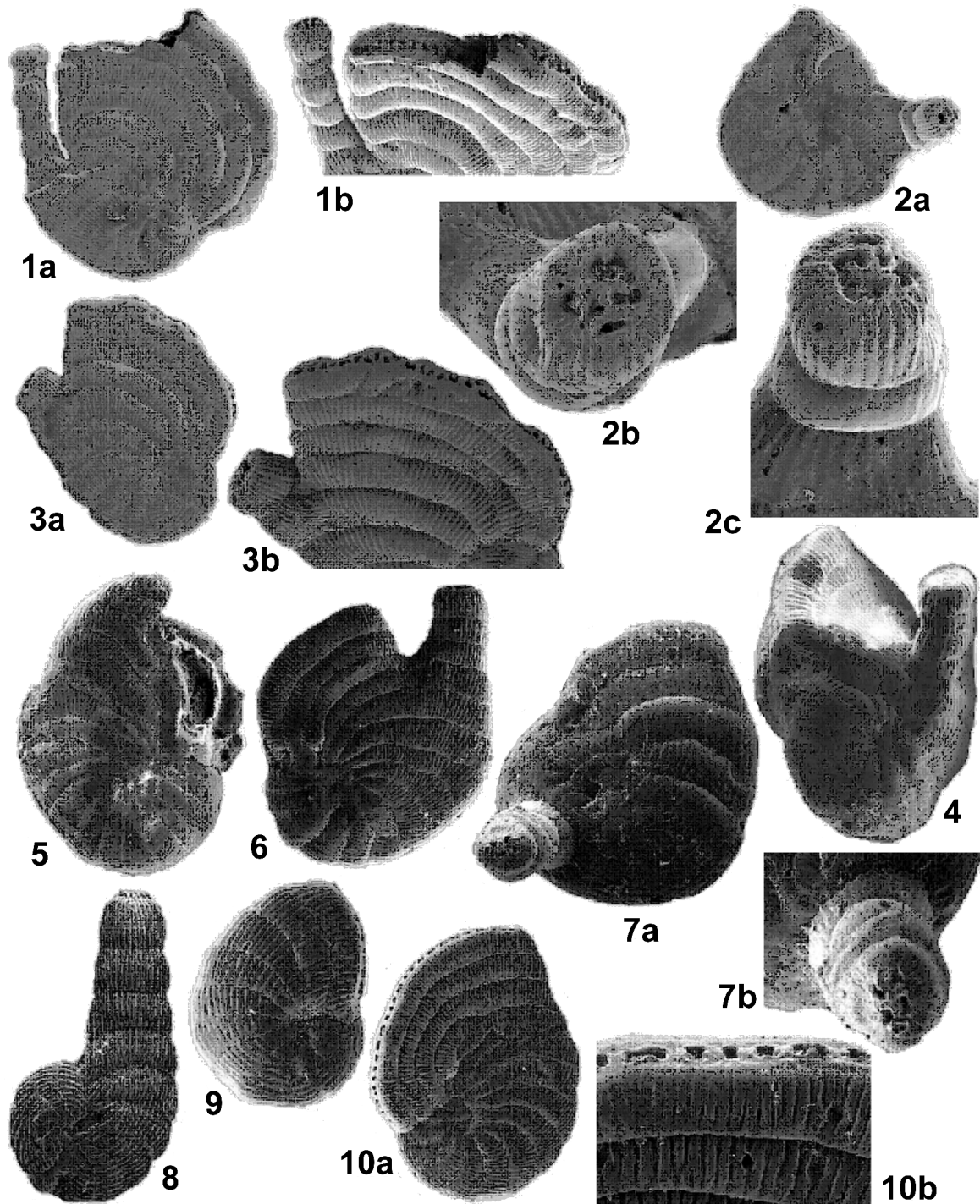


Figura 5. **1** *Peneroplis planatus-Coscinospira hemprichii*. **1a**: vista lateral x33; **1b**: ampliación de las últimas cámaras y aberturas x45, core 3a, 0-2cm, Ayvalık; **2** *Peneroplis pertusus-Coscinospira hemprichii*. **2a**: vista lateral x36; **2b**: vista detallada de la apertura x134; **2c**: otra vista detallada de la apertura x130, core 3a, 2-4cm, Ayvalık; **3** *Peneroplis planatus* con dos aperturas lineares definidas. **3a**: vista lateral x38; **3b**: ampliación de las aperturas x55, core 2c, 2-4cm, Ayvalık; **4** *Peneroplis planatus-Coscinospira hemprichii* vista lateral x37, Kaş, estación 33/13 m; **5** *Peneroplis planatus-Coscinospira hemprichii* vista lateral x29, Kaş, estación 58/24m; **6** *Peneroplis planatus-Coscinospira hemprichii* vista lateral x28, Kekova, estación 84/14m; **7** *Peneroplis planatus-Coscinospira hemprichii*. **7a**: vista lateral x50; **7b**: ampliación de la apertura x90, Kekova, estación 99/24m; **8** *Coscinospira hemprichii* vista lateral x28, Kaş, estación 131/12m; **9** *Peneroplis pertusus* vista lateral x46, Üçadalar, estación 123/12m; **10** *Peneroplis planatus*. **10a**: vista lateral x24; **10b**: vista detallada de las aperturas, x102, Kaş, estación 131/12m.

Figure 5. **1** *Peneroplis planatus-Coscinospira hemprichii*. **1a**: side view x33; **1b**: enlargement of last chambers and apertures x45, core 3a, 0-2cm, Ayvalık; **2** *Peneroplis pertusus-Coscinospira hemprichii*. **2a**: side view x36; **2b**: detailed view of aperture x134; **2c**: another detailed view of aperture x130, c3a, 2-4cm, Ayvalık; **3** *Peneroplis planatus* with two distinct linear apertures. **3a**: side view x38; **3b**: enlargement of apertural views x55, c2c, 2-4cm, Ayvalık; **4** *Peneroplis planatus-Coscinospira hemprichii* side view x37, Kaş, station 33/13m; **5** *Peneroplis planatus-Coscinospira hemprichii* side view x29, Kaş, station 58/24m; **6** *Peneroplis planatus-Coscinospira hemprichii* side view x28, Kekova, station 84/14m; **7** *Peneroplis planatus-Coscinospira hemprichii*. **7a**: side view x50; **7b**: enlargement of apertural view x90, Kekova, station 99/24m; **8** *Coscinospira hemprichii* side view x28, Kaş, station 131/12m; **9** *Peneroplis pertusus* side view x46, Üçadalar, station 123/12m; **10** *Peneroplis planatus*. **10a**: side view x24; **10b**: detailed view of the apertures x102, Kaş, station 131/12m.

terrestrial coasts of Turkey shows that these individuals present the characteristics of two different genera. These are *Coscinospira* and *Peneroplis*. The finding of abnormal individuals with morphological characteristics of two separate taxa brings some questions in mind concerning reproduction. The reproduction methods of the recent foraminifers, schizogony and gamogony, have been studied by many researchers (Winter 1907; Myers 1935a, 1935b, 1936, 1938; Le Calvez 1950, 1953; Grassé 1953; Loeblich & Tappan 1964; Berthold 1971; Röttger & Spindler 1976). Schizogony is asexual production of macrospheric individuals from microspheric ones, which takes place in cold seasons. Alternatively, gamogony is the production of microspheric individuals from the fusion of the gametes of two parental individuals, which is observed in summer. The abnormal peneroplids described herein may have formed by fusion of gametes from intergeneric individuals. The gametes of *P. pertusus* and *P. planatus* could have been combined with those of *C. hemprichii*. The offspring resulting from interbreeding between intergeneric (or interspecific) foraminifers are hybrids and represents re-arranging of the genetic material between them. Normally animal hybrids are infertile and cannot produce viable gametes, because the chromosome set cannot fully make homologous pairs at meiosis. Viable gametes are not formed. This may also be the case for foraminiferal hybrids.

The presence of interspecific and intergeneric hybrids can have consequences for the understanding of morphologically defined taxa. For example, the genus *Amphicoryna* includes a species defined on abnormal type material. *A. meringella* Loeblich & Tappan has been recorded from the Mediterranean coast of Turkey and is also known from the West Pacific Sea. An individual from Timor Sea, which was presented as a holotype (Loeblich & Tappan 1994, pl. 128, figs. 1, 2), shows differences in test morphology when compared to the paratypes (Loeblich & Tappan 1994, pl. 128, figs. 3, 4, 5, 6, 7). Numerous thin spines are found on the tests of the paratypes, however, together with the spines, longitudinal stripes are also observed on the holotype. On the other hand, *A. sublineata* (Brady) individuals presented in Loeblich & Tappan (1994, pl. 128, figs. 8, 9, 10, 11, 12) have only the stripes. The holotype of *A.*

meringella Loeblich & Tappan exhibits both the thin spines of the paratypes and the longitudinal stripes of *A. sublineata* (Brady), suggesting that the holotype *A. meringella* Loeblich & Tappan is an abnormal individual showing characteristics of both *A. meringella* Loeblich & Tappan and *A. sublineata* (Brady).

Colony formation is known to occur in many microorganisms, such as phytoplankton species, especially in diatoms (Sournia 1986; Graham & Wilcox 2000). It appears likely that benthic foraminifers are able of forming colonies (i.e., clusters) of individuals from different species. Juveniles of *P. planatus* and *P. pertusus* could have fused with *C. hemprichii* juveniles. The togetherness of such individuals may happen by coincidence, which also can be recognized among other species and genera. The clusters of *A. sepeans* (Brady) with two or three individuals observed in Pacific and the clusters of *A. scalaris* (Batsch) with two individuals observed in the Mediterranean partially supports the idea of colony formation (Meriç et al. 2005, figs. 3d, e, f, g, 4a, f, g, h). Future laboratory studies should address the formation and ecology of conjoined individuals.

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