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DIAMYSIS BACESCUI N.SP., A NEW BENTHOPELAGIC MYSID (CRUSTACEA: PERACARIDA) FROM MEDITERRANEAN SEAGRASS MEADOWS: DESCRIPTION AND COMMENTS ON STATOLITH COMPOSITION

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On décrit *Diamysis bacescui* n.sp., mysidacé benthopélagique vivant sur la *Posidonia* et largement répandu, bien qu'assez rare, en Méditerranée. Au point de vue morphologique la nouvelle espèce est bien différentiée par rapport à *D. bahirensis* (G. O. Sars), avec laquelle elle a été parfois confondue. La composition minérale des statolithes (CaCO3 en phase de vatérite, non pas CaF2 comme en général chez les Mysidés marins) semble témoigner une origine d'eau saumâtre, probablement dans l'aire de la Parathéthys dont les sédiments miocènes gardent des statolithes calcaires de Mysidés.

Keywords: Mysidacea, Mysidae, marine coastal species, statoliths mineral composition

All Mediterranean *Diamysis* populations recorded thus far have been assigned to the species *D. bahirensis* (G.O. Sars), and only in part described as modifications or subspecies (Băcescu, 1940; Ariani, 1966; Almeida Prado-Por, 1981). This species was assumed to cover a vast ecological range from freshwater (Spandl, 1926; Holmquist, 1955; Minelli and Trevisanello, 1985) to metahaline environments (Almeida Prado-Por, 1981). Most reports are from brackish waters such as lagoons (Gourret, 1897; Sudry, 1910; Tattersall, 1927; Băcescu, 1941; Genovese, 1956; Ariani, 1981a), estuaries (Stammer, 1932; reported as *Mysis relicta*), or karstic springs (Ariani, 1966; Almeida Prado-Por, 1981); less frequently from coastal marine environments (Sars, 1877; Graeffe, 1902; Băcescu, 1941; Hoenigman, 1963; Ariani, 1967; Wittmann, 1978; Hatzakis, 1982); rarely also from freshwater lakes (Spandl, 1926; Holmquist, 1955) or rivers (Minelli and Trevisanello, 1985). Ariani (1966, 1981a) and Almeida Prado-Por (1981) argued that the species *bahirensis* (*sensu lato*) may represent a complex of different biological entities in which the genetic, bio-

geographical and ecological interrelations are largely obscure. In order to conduct a revision of that complex, a vast material was collected during the last three decades along the E- and W-Mediterranean coasts by the present authors. The examination of this material along with hybridization experiments among diverse populations are in progress. The present description of a new species contributes to this larger revision.

The evidence of euhalobious species among an- to metahalobious congenerics poses the question of the primary environment for that group of animals. In the case of mysids, statolithological (Voicu, 1981) studies provide powerful tools to answer such questions. Especially correlations between the mineral composition (fluorite, vaterite, or non-mineral) of statoliths and the distribution in marine versus brackish and freshwaters may provide indication of the primary habitat (Franco, Wittmann, Ariani and Voicu, 1989; Ariani, Wittmann and Franco, 1993; Wittmann, Schlacher and Ariani, 1993). In addition, there are clear biogeographical relations (Ariani, 1981b; Ariani, Wittmann and Franco, 1993), with carbonatic (as vaterite, a metastable crystalline polymorph of CaCO3) statoliths showing a Recent center of world-wide distribution in the Pontocaspian region, where a rich fossil material (Voicu, 1974, 1981) of carbonatic (as stable calcite) statoliths is recorded from Miocene deposits of the brackish Paratethys.

METHODS

Dissected materials were mounted on slides in glycerine or in Swan medium for diascopic examination with phase contrast microscopy. In addition, statoliths and carapace were studied with scanning electron microscopy (SEM) on objects coated with gold.

Body size was measured from tip of rostrum to end of telson, without spines. Egg diameters were measured as the geometric mean of apparent length and width; statolith diameters are given according to Wittmann, Schlacher and Ariani (1993). Thoracic legs are termed according to Tattersall and Tattersall (1951), larvae in the marsupium according to Wittmann (1981).

The mineral composition of statoliths was determined according to Wittmann, Schlacher and Ariani (1993) using X-ray diffraction and/or a combination of chemical and optical examinations, termed WSA-method. Statolith morphology is termed according to Wittmann, Schlacher and Ariani (1993).

RESULTS

Diamysis bacescui n. sp.
(Figs 1-4)

Diamysis bahirensis, Graeffe, 1902: 63 (*partim*, Gulf of Triest, surface plankton); Hoenigman, 1963: 614 (S. Adriatic, surface plankton); Ariani, 1967: 1 (S. Adriatic, night surface plankton); Hatzakis, 1982: 149 (*partim*, Aegean Sea, plankton and benthos, 10-45 m, in part from *Posidonia* meadows); Ariani, Marmo, Balsamo, Franco and Wittmann, 1983: 334 (*partim*, Gulf of Naples, *Posidonia* meadows); Ariani, Wittmann and Franco, 1993: 33 (as before).

Material

Type material. *Holotype* male 5.9 mm; *paratypes*, 49 fem., 20 males, 11 subad., Aegean Sea, Island of Lesbos, off shore at Petra, 39°20'N/26°10'E, 20 m, *Posidonia* meadow, boat-operated bottom net, day, 18 Sept. 1990, leg. Wittmann; deposited at Naturhistorisches Museum Wien (reg. nos 17921, 17922), Museo delle Science Naturali, Università di Napoli "Federico II", and "Grigore Antipa" National Museum of Natural History (MYS 003).

Reference material. 2 fem. 4.8-5.4 mm, 1 male 4.0 mm, 1 subad., S. Adriatic Sea, Apulia, off mouth of Fiume Morello (karstic spring), 2 km offshore, 40°50'N/17°28'E, night surface plankton, 15-20 m above ground with *Posidonia* stands, 12 Sept. 1967, leg. Ariani.- 3 samples with 2 fem. 4.7, 5.4 mm, 12 subad., E. Tyrrhenian Sea, Gulf of Naples, Island of Ischia, Punta Vico, 40°45'N/14°53'E, 12-30 m, *Posidonia* meadow, sand, diver-operated hand net, day, Nov., Dec. 1979, Sept. 1988, leg. Wittmann.

Diagnosis

Carapace with short rostrum, forming a distinct edge. Numerous small fringes (Fig. 4 C; termed according to Klepal and Kastner, 1980) in median to mediolateral position (Fig. 2 D) on posterior half of male carapace, in part near but not on its posterior margin; carapace of females without fringes. Palpus of maxilla with terminal segment subcircular, armed with 10-27 distinct denticles. Basal segment of all thoracic exopods with outer corner spiniform, or occasionally rounded in eighth exopod of males. Carpopropodus of third to eighth thoracic endopods with 3, 2, 2, 2, 2, or 2-3 segments, respectively. Carpopropodus of third endopod with basal segment of about equal length compared with combined remaining segments. Seventh thoracic endopod (Fig. 3 B, D) with stout carpus and

strong claw, well contrasting with remaining pereiopods (Fig. 3 A, C, E, F). Exopod of fourth male pleopod 2-segmented, with large modified seta at tip, and smooth or sparsely barbed seta at basal segment. Telson flanked by subtriangular projections (Fig. 2 F) of the sixth pleonite; projections with convex upper and straight to convex lower margin, tip acutely or bluntly pointed. Telson subtriangular to subquadrangular, well incised apical cleft with 7-15 laminar processes.

Description

Adult animals from Lesbos (females 4.8-6.5 mm, males 4.0-5.9 mm) show all characters as in diagnosis. Body proportions, antennae, mouth parts, marsupium, penis, pleopods, and uropods essentially as in *D. bahirensis* (G.O. Sars, 1877).

Carapace (Fig. 2 D) with a pair of post-suborbital spines; cardial region crossed by transverse row of 12-18 pores, arranged in two symmetrical groups of 6-9 pores each; cervical region medially with 2-4 pores, often also arranged in two groups. SEM-inspection revealed that cardial and cervical pores have lip-like margins giving the pores some superficial resemblance to plant stomata (Fig. 4 E). In addition to these pores, there are numerous smaller pores (Fig. 4 F) with simple openings. Without special staining (Mauchline, 1977) the smaller pores could not be well visualized with phase contrast microscopy. According to Mauchline (1977), pores of this size (1-2 μm) are scattered more or less evenly in the integument in diverse orders of pelagic crustaceans and are thought to be the openings of the glands that secrete the integument itself. Fringes (Fig. 4 C) on male carapace are 20-30 μm long and are distributed (Fig. 2 D) in a large field at some distance in front of cardial pore row; and in a transverse narrow belt, a relatively small distance in front of posterior margin. No fringes were found in the area around cardial pore row (Figs 2 D, 4 D). The fringes observed on the carapace of *D. bacescui* are visually identical to that found by Klepal and Kastner (1980) on telson and uropods of the cumacean *Cumella limicola* G. O. Sars. As a further coincidence the fringes show a two by two pattern of distribution (Fig. 4 C) in either species of peracarids.

Cephalic appendages. Eyes normal; cornea spherical in lateral view, 70-80 % the length of stalk. Eyestalks with smooth cuticle all around. Both sexes with median segment of antennular peduncle bearing a large plumose seta near inner distal corner; only females with two large plumose setae and a smaller, more sparsely plumose one on inner distal corner of the terminal segment (Fig. 1). Male antennula with appendix masculina large and well setose, oriented obliquely downwards. Antennal scale setose all around,

length is 1.5-1.8 times antennular peduncle; small apical segment with five setae.

Thoracic appendages. First and eighth thoracic exopods 9-segmented, remaining exopods 10-segmented (not counting the large intersegmental joint between basal and second segment). Third to fifth and eighth thoracic endopods with slender carpopropodus; claw long and slender, subterminally feebly to strongly serrated (Fig. 3 A, C, E, F). Seventh, and less distinctly sixth, thoracic endopods with stout carpus (Fig. 3 B); claw strong, more strongly serrated and more recurved (Fig. 3 D) than in remaining pereiopods (Fig. 3 E). Pereiopods with paradactylary setae (termed by Băcescu, 1954) distally smooth (Fig. 3 A, B), with the exception of such setae being subterminally pectinate (Fig. 3 C) in eighth endopod of females.

Abdomen. Pleopods reduced to simple setose plates, except for third and fourth pleopods of males. Third male pleopod entire, with endopodal portion 1.0-1.4 times the length of basis; posterior face of basis concave (Fig. 3 H). Endopod of fourth male pleopod small, with distinct subbasal articulation. Endopod of uropods with one spine below statocyst. Telson length is 1.3-1.5 times its maximum width or 0.7-0.9 times the length of sixth abdominal somite, respectively; maximum width near basis is 2.1-2.4 times that at apex; lateral margins straight, each with 7-11 spines (excluding the large apical ones). Apical cleft of telson with straight to slightly convex margins; cleft is 10-18 % telson length.

Colour. General appearance of fixed animals is transparent to light brown, depending on the state of chromatophore expansion. Dorsally: one small chromatophore on eighth thoracomere and on fourth and fifth pleonites. Ventrally: two medium-sized chromatophores on last oostegite; a pair of small chromatophores on third and sixth thoracic sternites and only one in central position on all pleonites. Eyestalks with well ramified chromatophores; cornea reddish brown.

Nauplioid stage. The nauplioids are virtually identical to those described by Wittmann (1992) for species of *Mesopodopsis* Czerniavsky. Freshly hatched nauplioid with only two pairs of free appendages, the antennae. Free mandibles appear in advanced stage 2 nauplioids. Antennae, abdomen, and sparsely also ventral cephalic region covered with spine-like scales. Large scales with sparse punctation.

Etymology. This paper was presented at the 90th birthday celebrations for the great zoologist and mysidologist Acad. Mihai Băcescu in Bucharest in 1998.

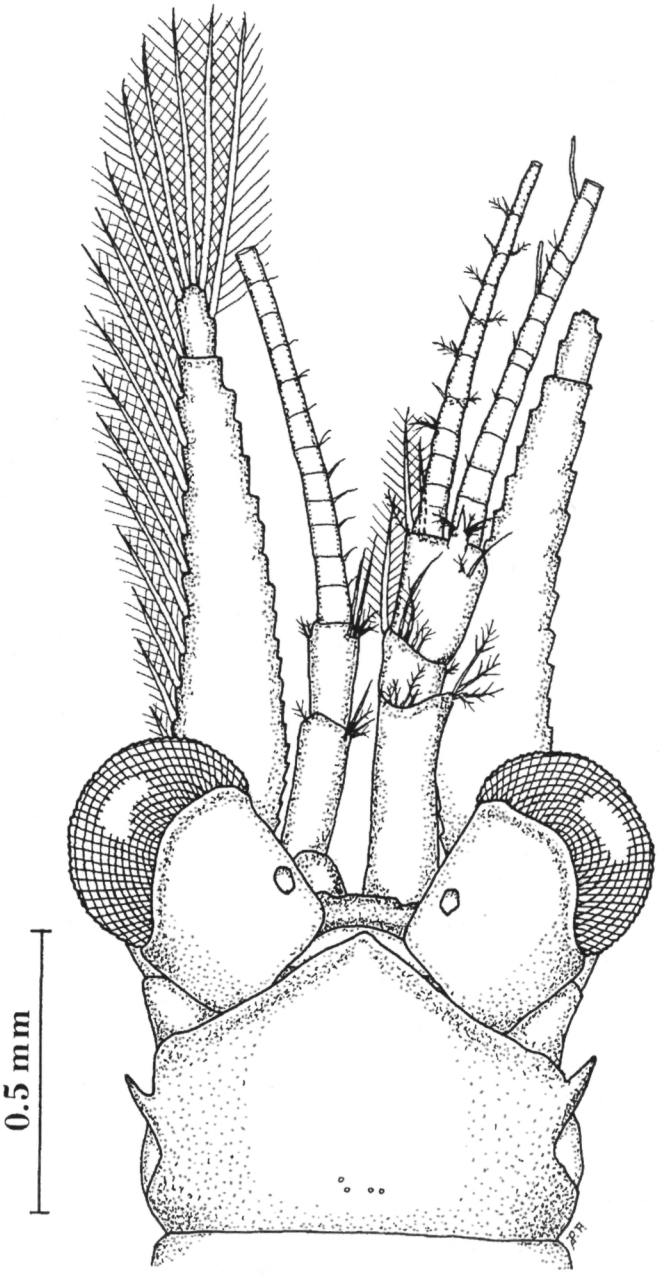

Fig. 1 – *Diamysis bacescui* n.sp. Cephalic region of female paratype with body length of 5.9 mm in dorsal view (cervical pores are not on scale).

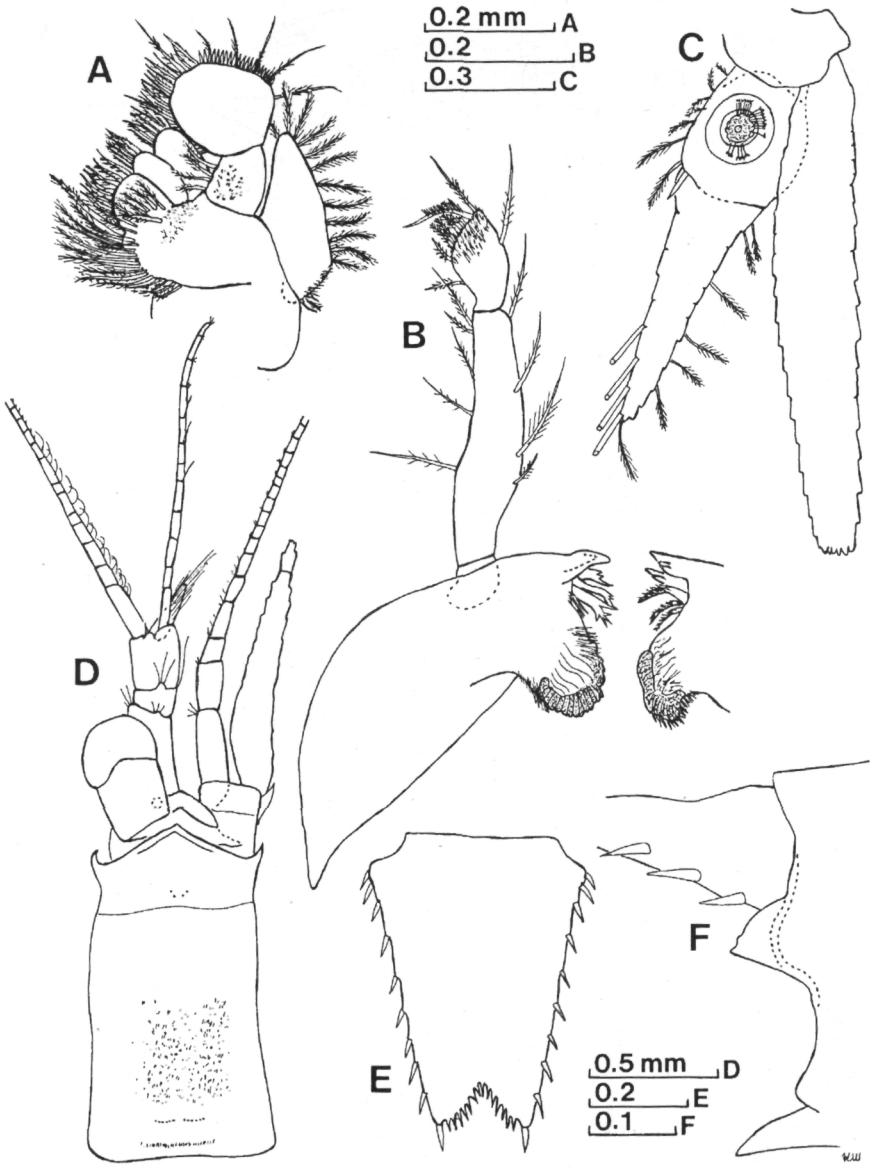

Fig. 2 – *Diamysis bacescui* n.sp. Paratypes, female 6.5 mm (A, B, F) and male 5.9 mm (C-E); A, maxilla, frontal face; B, mandibles, caudal aspect; C, left uropod, ventral aspect; D, anterior body region of male, slightly inclined dorsal view; fringes, cardial pores and cervical pores are visible on the carapace; E, telson, dorsal aspect; F, posterior margin of sixth pleonite in lateral view.

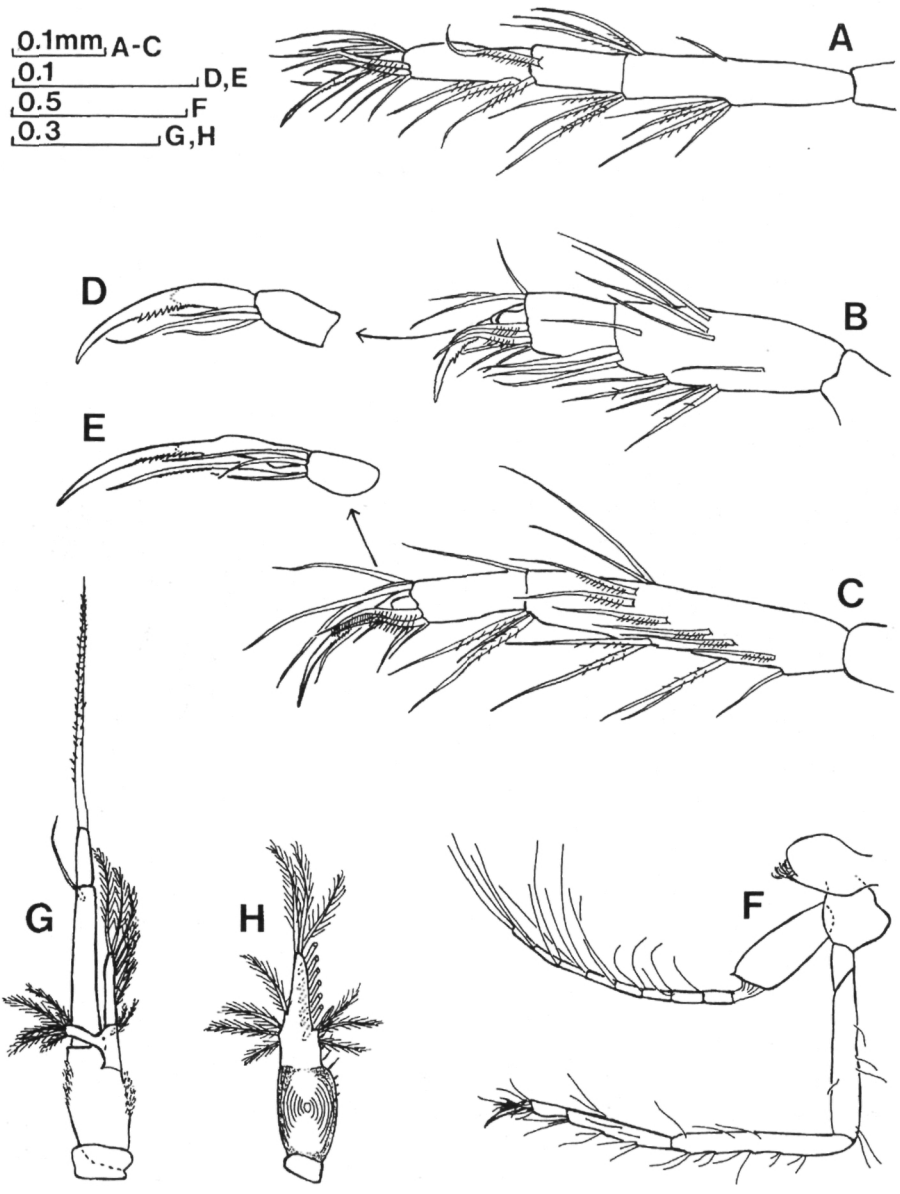

Fig. 3 – *Diamysis bacescui* n.sp. Paratypes, female 6.5 mm (A-E) and male 5.9 mm (F-H); A-E, tarsus of third (A), seventh (B) and eighth (C) thoracic endopods; details show dactylus with claw in seventh (D) and eighth (E) endopods; F, eighth thoracopod with penis; G, H, fourth and third male pleopods, caudal aspects.

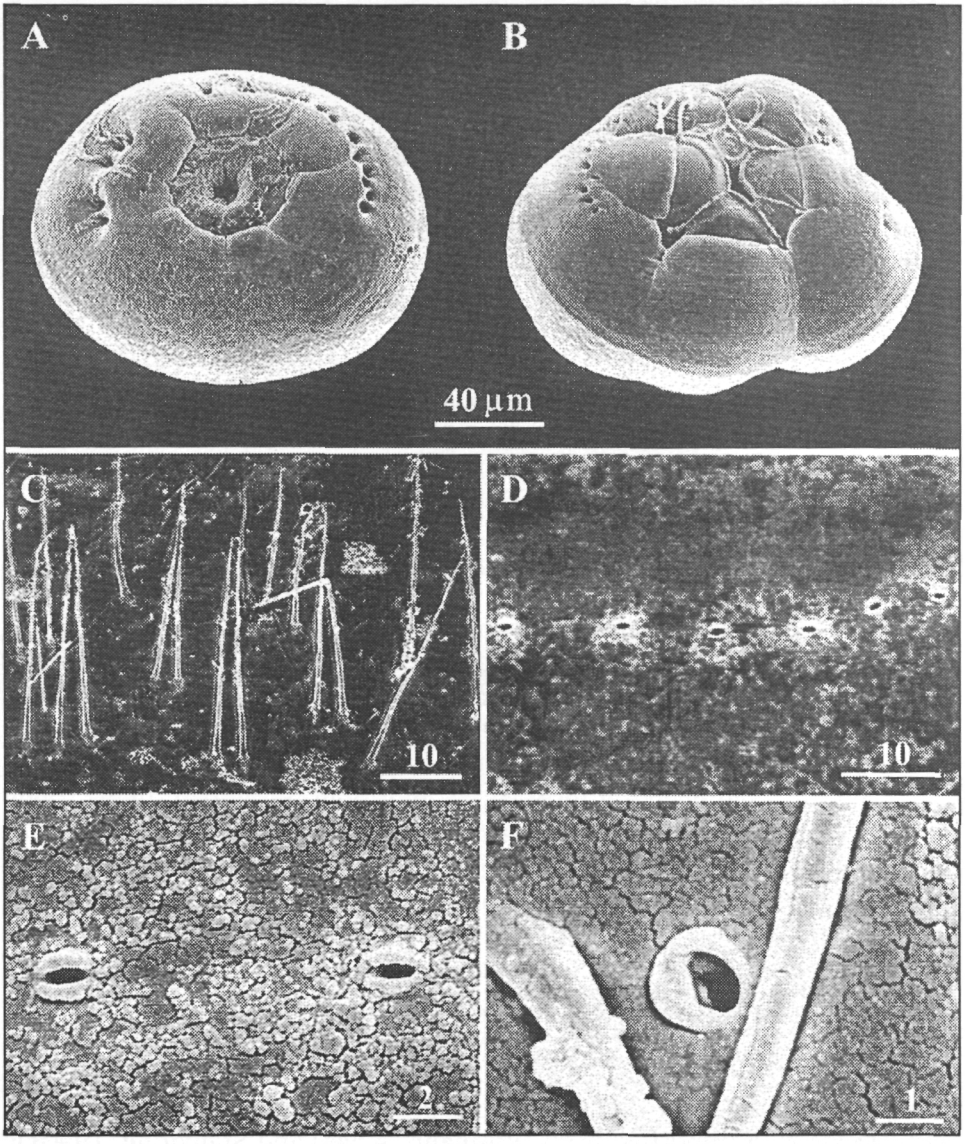

Fig. 4 – *Diamysis bacescui* n.sp. SEM-micrographs of statoliths (A, B) and male carapace (C-F); A, right statolith in lateroventral view; posterior face (to the left) is marked by five large pores arranged in a 2 + 3 pattern; B, left statolith (not from same individual) in lateroventral view, posterior face is to the right; C, fringes near posterior margin of carapace, mostly arranged in pairs; D, right group of cardial pores; E, detail of D with two cardial pores showing lip-like differentiation of opening; F, small pore with simple opening, located among fringes.

Distribution and bionomy

Rarely found, nevertheless widely distributed in the Mediterranean (Tyrrhenian, Adriatic, and Aegean Seas). In 12-45 m depth in meadows of the seagrass *Posidonia*. The animals are essentially benthopelagic, but may be pelagic during the night and thus sampled in nocturnal plankton catches, also several km offshore. Exclusively marine coastal species; measured salinity range is 36-38 ‰ (derived from conductivity measurements). Integration of literature records (Graeffe, 1902; Hoenigman, 1963; Hatzakis, 1982) suggests a salinity range of about 30-39 ‰. Type locality is Island of Lesbos (Greece), 39°N/26°E.

In the type material, males showed a body length of 5.0 ± 0.6 mm (mean ± S.D.; n = 13); breeding females measured 5.7 ± 0.5 mm (n = 23) and carried on the average 5.3 ± 1.8 embryos or larvae in the brood pouch. Egg diameters were 0.36 ± 0.02 mm (n = 23).

Statolith structure and composition

The external morphology of the statoliths (Fig. 4 A, B) essentially resembles that of other *Diamysis* populations so far studied (Almeida Prado-Por, 1981; Ariani, Marmo, Balsamo and Franco, 1981; Schlacher, Wittmann and Ariani, 1992; Ariani, Wittmann and Franco, 1993; Wittmann, Schlacher and Ariani, 1993). Statolith diameters in 17 adults measured 107-164 µm (133 ± 17 µm). Habitus subhemispherical, dorsoventrally flattened, ellipsoidal to moruloid in dorsal view; body convex-plane, centre convex-concave. Ambitus, dorsal and ventral face vary from almost evenly rounded (Fig. 4 A) to strongly moruloid (Fig. 4 B). Dorsal face without tegmen development. Ventral face with pore row arranged in five groups proceeding mostly near inner ventral margin of ambitus; fundus feebly (Fig. 4 A) to strongly (Fig. 4 B) sculptured, central portion with shallow to deeply incised hilum.

Statolith formula of Voicu (1974, 1981), expressed as in Wittmann (1992), is 2 + 3 + 1 + (8-11) + (5-7) = 19-23. This is similar, although on the average different for the fourth pore group, compared with 2 + 3 + 1 + (5-9) + (3-14) = 17-26 (modified from Wittmann, Ariani and Stanzione, 1990) in *Diamysis* populations from karstic springs on Adriatic coast of Apulia (Italy).

Internal structure of statoliths. Sagittal fractures showed that both core and mantle are bilayered as figured by Wittmann, Schlacher and Ariani (1993) for *Schistomysis assimilis* (G.O. Sars). Mantle with spheritic aligment of crystal aggregates as in that species.

Mineral composition of statoliths was determined by X-ray diffraction on material from the Island of Lesbos, and with the WSA-method on Lesbos, Gulf of Naples, and S. Adriatic materials. All determinations yielded vaterite, a metastable crystalline polymorph of CaCO3. This coincides with determinations of Ariani, Marmo, Balsamo, Franco and Wittmann (1983) and of Ariani, Wittmann and Franco (1993) on material of *D. bacescui* from the Gulf of Naples, reported under the species name *D. bahirensis*.

DISCUSSION

D. bacescui n.sp. is outstanding among Mediterranean *Diamysis* populations in showing apparently a strictly marine habit, living in meadows of the seagrass *Posidonia*. This habit, bathymetric distribution and its appearance in night plankton samples at the surface make it highly probable that the *D. bahirensis* materials reported by Hoenigman (1963) and in part also by Graeffe (1902) and Hatzakis (1982) actually belong to *D. bacescui* (Note: the mysid collection of J. Hoenigman may be missing. It is not at the Inst. Oceanogr. Ribarstvo in Split and not at the Univ. of Ljubljana). Morphologically, *D. bacescui* is outstanding in having a stout carpus and strong claw on the seventh thoracic endopods. Similarly strong claws are known from Pontocaspian species (Sars, 1907; Băcescu, 1954). From all species of *Diamysis* described to date, *D. bacescui* differs also by numerous small fringes in median to mediolateral position on the posterior half of the male carapace.

Within the genus *Diamysis*, a similarly marine habit is only known from *D. frontieri* Nouvel living in coastal waters of Madagascar and the Red Sea. With that species, *D. bacescui* shares also the occurrence in nocturnal surface plankton (Nouvel, 1965). Nevertheless, both species appear to be morphologically remote from each other. *D. frontieri* shows bristles on the distal segment of the maxillary palpus and no seta on the basal segment of the exopod of the fourth male pleopod. In contrast, all known Mediterranean *Diamysis* populations, including *D. bacescui*, share a number of distinct denticles on the distal segment of the maxillary palpus and 1-2 small setae on the basal segment of the exopod of the fourth male pleopod (in addition to the large modified seta on the tip of the terminal segment).

The finding that the statoliths of *D. bacescui* are composed of vaterite, a metastable polymorph of CaCO3, coincides with previous determinations on a number of Mediterranean *Diamysis* populations

(Ariani, Marmo, Balsamo and Franco, 1981; Ariani, Wittmann and Franco, 1993; Wittmann, Schlacher and Ariani, 1993). In contrast to fluorite (86%), vaterite is rare (9%) in mysid statoliths on a world-wide scale and points to a possible origin in brackish waters of the Pontocaspian region (Ariani, Wittmann and Franco, 1993; Wittmann, Schlacher and Ariani, 1993), where a rich fossil material of carbonatic statoliths is known from Upper Miocene deposits of the brackish Paratethys (Voicu, 1981). For *D. bacescui*, this view is also supported by the lack of Atlantic populations and by the generally strong euryhalinity of *Diamysis* populations living in the Black Sea and Mediterranean (Băcescu, 1940; Ariani, 1979). Consequently, the euhalobious habit of the new species may be of secondary or, more precisely, tertiary nature: the species or its close precursors may have immigrated from low salinity environments back to the sea.

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DIAMYSIS BACESCUI N.SP., UN NOU MIZID BENTOPELAGIC (CRUSTACEA: PERACARIDA) DIN PAJIŞTILE DE IARBĂ DE MARE MEDITERANEENE: DESCRIERE ŞI COMENTARII ASUPRA COMPOZIŢIEI STATOLITULUI

REZUMAT

Unele populaţii de mizide din bentosul Mării Mediterane, care au fost confundate cu *Diamysis bahirensis* G. O. Sars, se deosebesc de această specie având o gheară puternică şi un carpus viguros la endopodele toracice 7 şi prin solzi setiformi în poziţie median-mediolaterală în jumătatea posterioară a carapacei masculului. De aceea, *D. bacescui* n. sp. a fost descrisă ca specie diferită. Similară cu *D. frontieri* Nouvel din Madagascar şi Marea Roşie, specia nouă a fost găsită numai în apele marine costiere, unde este prezentă ziua în pajiştile de *Posidonia* şi poate migra noaptea

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aproape de suprafață. Morfologia larvelor nauplioide arată o puternică înrudire cu speciile de *Mesopodopsis*.

Morfologia statolitului în esență este asemănătoare cu a altor populații de *Diamysis*. Oricum, formula statolitului speciei noi prezintă unele caractere particulare. Compoziția minerală a statolitelor este vaterita, o formă metastabilă de CaCO3 (nu CaF2 ca la majoritatea speciilor de mizide existente). Această descoperire, absența populațiilor atlantice și comportamentul puternic eurihalin al speciilor înrudite, sugerează că *D. bacescui* poate proveni din precursori din medii cu salinitate scăzută ale regiunii Paratethyene unde au fost găsiți statoliții calcaroși în sedimente Miocene.

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