

First record of a bathyal leptostracan, *Nebalia abyssicola* Fage, 1929 (Crustacea: Malacostraca: Phyllocarida), in the Aegean Sea, eastern Mediterranean

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Received: 13.12.2010

Abstract: Data on deep sea leptostracans (Crustacea: Phyllocarida: Leptostraca) are still scarce in many parts of the world. In the last few years, several species of *Nebalia* Leach, 1814, have been reported from the eastern Mediterranean; however, there have been no reports from waters deeper than 100 m. Samples collected recently from Gökçeada, Turkey—at depths of 680-820 m in the Aegean Sea, eastern Mediterranean—included *Nebalia abyssicola* Fage, 1929. This is the first record for the study area and one of the few known records of this species. Specimens are described and figured to complement previous descriptions. A key for all known leptostracans from the eastern Mediterranean is also provided.

Key words: Leptostraca, *Nebalia abyssicola*, Mediterranean Sea, new records, deep waters

Batiyal leptostrakan, *Nebalia abyssicola* (Crustacea, Phyllocarida)'nın Ege Denizi, doğu Akdeniz'den ilk kaydı

Özet: Dünyanın bir çok bölgesinde leptostrakanlar üzerine veriler hala yetersizdir. Son yıllarda doğu Akdeniz'de birkaç *Nebalia* Leach, 1814 türü rapor edilmiştir ancak 100 m den daha derin sulardan herhangi bir kayıt bulunmamaktadır. Doğu Akdenizde, Gökçeada'da 680 ve 820 m derinliklerden elde edilen çalışma örnekleri *Nebalia abyssicola* Fage, 1929'nun varlığını göstermiştir. Bu tür çalışma bölgesi için yeni kayıttır ve ender kayıtlarından biridir. Bireyler önceki tanımlamalara dayalı olarak tanımlanmış ve şekilleri çizilmiştir. Aynı zamanda doğu Akdeniz'de bilinen bütün leptostrakanlar için bir tayin anahtarı oluşturulmuştur.

Anahtar sözcükler: Leptostraca, *Nebalia abyssicola*, Akdeniz, yeni kayıtlar, derin sular

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Introduction

Although they were first discovered over 200 years ago, leptostracans (Crustacea: Phyllocarida: Leptostraca) are still poorly known in many parts of the world. In general, most of the known species are found in shallow ocean waters (<100 m) on sandy-muddy bottoms typically associated with seagrasses and algae (Rainer and Unsworth, 1991; Haney and Martin, 2004; Moreira et al., 2004). Records of deep sea leptostracans are scarce when compared to those from neritic areas (but see Fage, 1929; Hessler and Sanders, 1965; Mauchline and Gage, 1983; Hessler, 1984; Ledoyer, 1997; Haney et al., 2001). Nevertheless, it has been shown that leptostracans can be collected in large numbers from deep seas using baited traps because of the necrophagous habits of some species (Birnbaum and Wenner, 1993).

In the Mediterranean Sea most of the previous records of leptostracans were attributed to *Nebalia bipes* Fabricius, 1780 (e.g., Citarella, 1965; Macquart-Moulin, 1979). Dahl (1985) restricted the distribution of *N. bipes* to Arctic latitudes and listed *N. strausi* Risso, 1826 and *N. clausi* Dahl, 1985 in the western Mediterranean. Later, Ledoyer (1997) recorded the presence of *N. strausi*; *N. herbstii* Leach, 1814; and *Sarsinebalia typhlops* (Sars, 1870) in the western Mediterranean. In the same work, the author also described *N. biartiaculata* Ledoyer, 1997 and recognised the deep sea species (410-2368 m) *N. abyssicola* Fage, 1929 as a valid species.

Recently, 2 species of leptostracans have been reported from the eastern Mediterranean from samples collected at several localities in the Aegean Sea and Cyprus: *N. strausi* and *N. kocatasi* Moreira, Koçak and Katağan, 2007 (see Koçak and Katağan, 2006; Koçak et al., 2007, 2010; Moreira et al., 2007). Koçak et al. (2010) also reported several specimens from the Aegean Sea that might represent 2 new species of *Nebalia*. On the other hand, some specimens reported as *N. bipes* (Fabricius, 1780) from Cyprus by Kocataş et al. (2001) were later identified as *N. strausi* (Koçak et al., 2007). In general, all these reports of leptostracans come from specimens collected in shallow waters (<100 m). The present work is the first record of the bathyal species *N. abyssicola* for the eastern Mediterranean. It is based on 2 specimens collected at 820 m off Gökçeada that are described

and figured to complement the description of the species.

Materials and methods

Specimens of *N. abyssicola* were collected in the Mediterranean Sea at 820 m in the Aegean Sea off the coast of Gökçeada, Çanakkale Province, Turkey, using baited traps set on the seabed. All material was identified using the description of the species given by Ledoyer (1997); the original description by Fage (1929) was brief and did not provide much detail about many characters. Samples were washed through a 0.5 mm mesh sieve. Then specimens were sorted using a binocular microscope, identified, counted, and preserved in 70% ethanol.

Line drawings of specimens were made with the aid of a camera lucida connected to a compound microscope; measurements were made using an ocular micrometer. Total length (TL) was measured from the articulation between the rostrum and the carapace to the posterior end of the caudal furca (excluding setation); rostrum length (RL) was measured along the midline; dorsal carapace length (DCL) was measured as the distance between the articulation of the rostrum and the margin of the posterodorsal cleft; lateral carapace length (LCL) was measured as the distance along the lateral surface between the anteriormost and posteriormost margins; carapace height (CH) was measured between the dorsalmost and the ventralmost margins. Specimens were deposited in the Marine Biology and Ecology Laboratory, Sinop University, Turkey.

Results and discussion

Family Nebaliidae Samouelle, 1819

Genus *Nebalia* Leach, 1814

Nebalia abyssicola Fage, 1929

(Figures 1-5)

Fage, 1929: 41-42, figures 88-89. Ledoyer, 1997: 29-31, figure 1.

Material examined. Post-ovigerous ♀, TL 6.6 mm, RL 1.1 mm, DCL 2.5 mm, LCL 3.6 mm, CH 2.5 mm; off Gökçeada, 40°19'16"N, 25°52'79"E; April 2010; mud, clay, depth 680 m; ♂, TL 6.6 mm, RL 1.0

mm, DCL 2.5 mm, LCL 3.2 mm, CH 2.2 mm; off Gökçeada, Turkey, 40°21'35"N, 25°53'10"E; April 2010; mud, clay, depth 820 m.

Diagnosis. Compound eye sub-rectangular, lacking visual pigment. Ommatidia irregularly distributed between posterior part of proximal third and distal part of posterior third of eye. Antennular scale oval, 2.7 times as long as wide. On fourth antennular article, 1 short distal spine. Third antennal peduncle lateral margin with several proximal plumose setae and 3 distal thin, long spines. Second maxilla endopod proximal article longer than distal article. Second maxilla exopod slightly longer than first article of endopod. Denticles along posterior dorsal borders of pleonites 6-7 distally rounded. Pleopod 4 protopod posterior border with 4 acute serrations; posterolateral corner acutely pointed. Uropods longer than pleonite 7 and anal somite combined. Terminal seta of uropods longer than

entire ramus.

Description of post-ovigerous female. Fixed specimen whitish. Carapace more or less oval, covering partially lateral sides of pleonites 3-4 (Figure 1A). Rostrum long, extending beyond eyestalk, with parallel margins. Compound eye more or less rectangular, inferior distal border slightly turned downwards; ommatidia irregularly distributed between posterior part of proximal third and distal part of posterior third of eye (Figure 1C). Eyestalk not lobed. Supraorbital scale tapering distally to acute tip, slightly less than half the length of eyestalk.

Antennular peduncle 4-segmented (Figure 2A). First article shorter than eyestalk. Second article with plumose seta arising from anterior third, with cluster of 7-8 setae (some of them plumose) arising from posterolateral surface, and subterminal cluster of short and long simple setae. Third article shorter

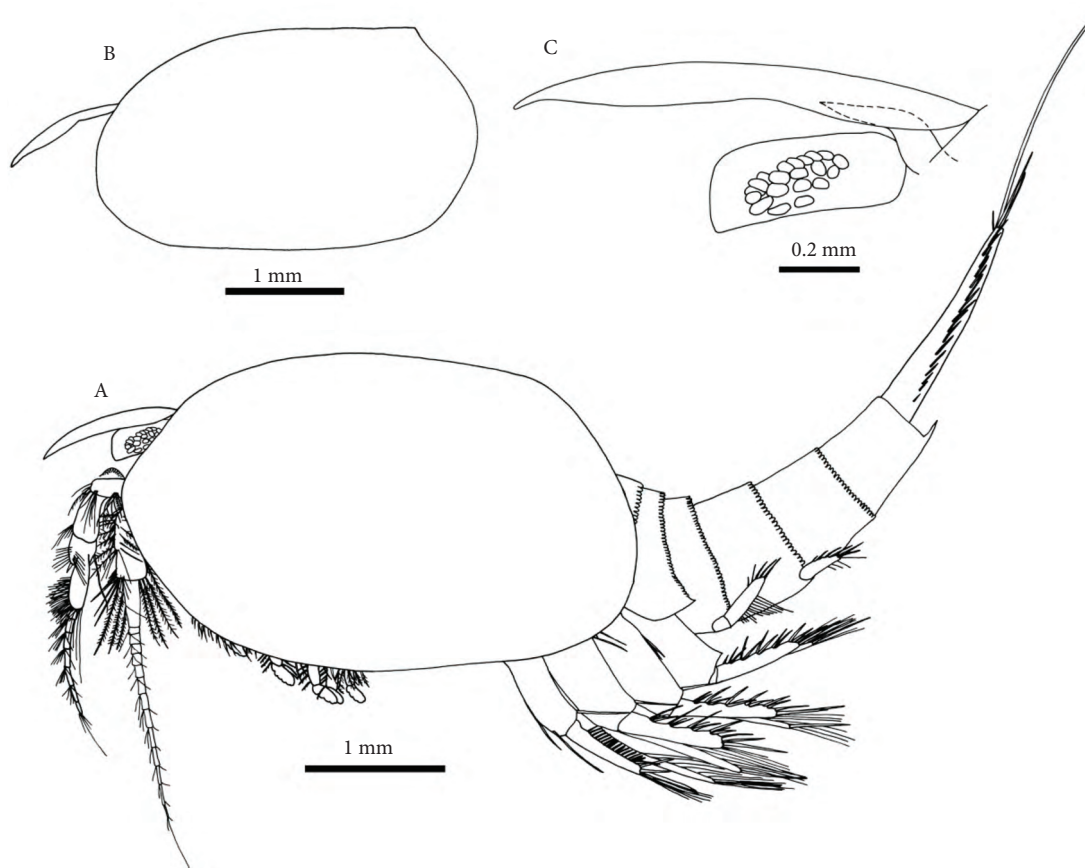


Figure 1. *Nebalia abyssicola* - (A) whole animal, lateral view (post-ovigerous ♀); (B) carapace and rostrum, lateral view (♂); (C) rostrum, supraorbital scale, and eye, lateral view (post-ovigerous ♀).

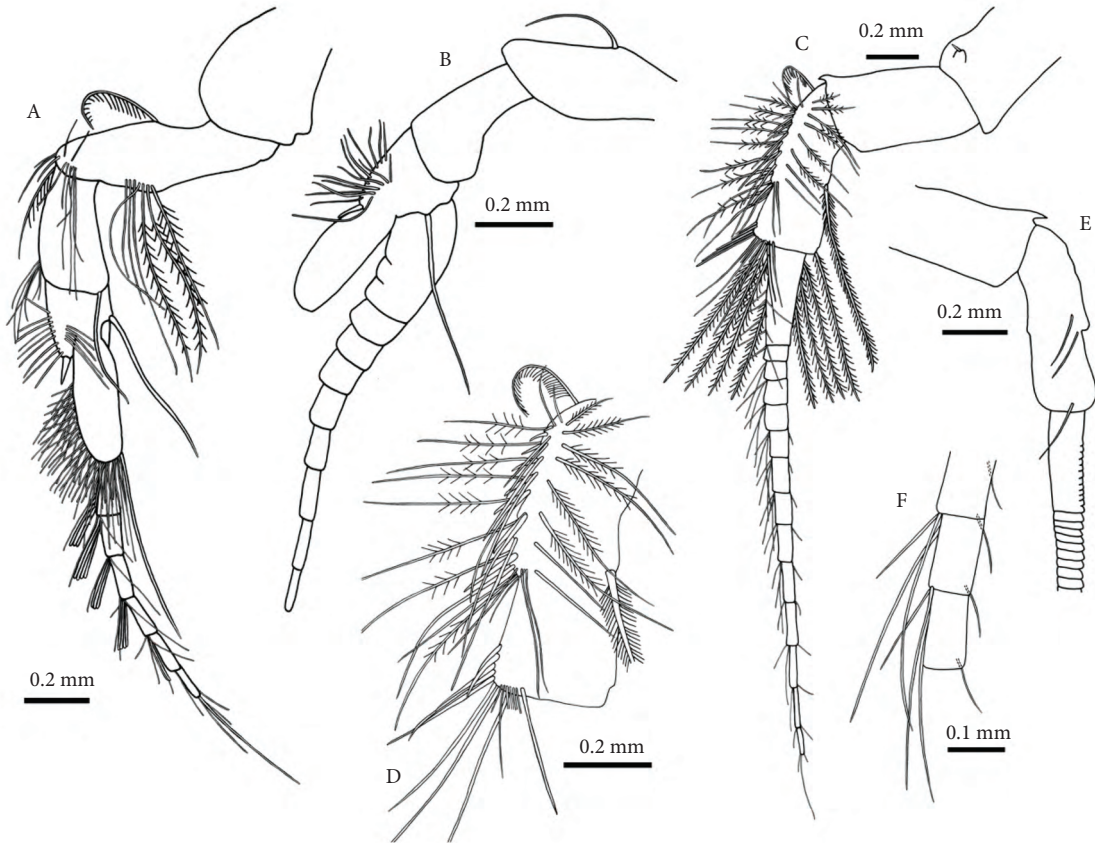


Figure 2. *Nebalia abyssicola* - (A) antennule, lateral view (post-ovigerous ♀); (B) antennule, lateral view (♂); (C) antenna, lateral view (post-ovigerous ♀); (D) antenna, third article, external side, lateral view (post-ovigerous ♀); (E) antenna, peduncle, and proximal half of flagellum, lateral view (♂); (F) antenna, detail of flagellum (post-ovigerous ♀). (B) and (E): only selected setae illustrated.

than second, widest distally, with cluster of simple setae on superior distal margin, 1 simple long seta on inferior distal margin. Fourth article shorter than third with (1) medial row of 9 simple setae, (2) 1 thick short spine distally, (3) lateral row of 5 simple setae, (4) simple long seta arising from inferior distal margin, longer than antennular scale. Antennular scale oval, about 2.7 times as long as wide; anterior margin convex with (1) row of setae provided with teeth along margin of distal half, (2) numerous simple setae of different lengths, (3) 1 long simple seta arising from inferior distal margin. Flagellum well developed, with 11 articles, shorter than peduncle; each article with several aesthetascs and simple setae on anterodistal margin.

Antennal peduncle 3-segmented (Figure 2C). First article with anterodistal process ending in small acute spine. Second article with distal acutely pointed process. Third article longer than second; 1 plumose seta on proximal margin and several rows of setae along medial anterior margin (Figure 2D): (1) 5 sparsely plumose setae of growing length and 3 thin spine-like setae, the distalmost slightly longest and associated with several longer and thinner setae, (2) 10 simple setae, the distalmost associated with 2 simple thinner setae, (3) 8 setae shorter and in general thicker than those of (2) along proximal half, being the longest distalmost, (4) 8 long, sparsely plumose setae along medial internal border, (5) terminal row of 8 spines, increasing distally in length, the 2

distalmost thinner than the others; long plumose seta on posterior margin; cluster of 8 plumose setae along distal interior margin. Flagellum composed of 13-14 articles; each article with 4 terminal setae, 1 shorter than the others (Figure 2F).

Mandibular palp 3-segmented (Figure 3A). Second article with 2 setae: 1 simple seta on lateral margin at mid-length and 1 distally plumose seta on distal third. Third article longer than second; proximal half of superior margin with row of short setae; inferior margin with 3 rows of setae (1) plumose setae from ending of proximal third extending to first half, (2) longer plumose setae than those of (1) extending along distal half, (3) about 9 curved, dentate setae along distal margin.

First maxilla proximal endite with rounded medial margin bearing simple plumose setae (Figure 3B). Distal endite larger than proximal; medial margin with 2 plumose setae and 3 rows of setae, (1) 10 setae of increasing size with 3 large teeth along distal inferior margin accompanied by several smaller teeth, (2) 6 spatulate setae, (3) row of 8 setae with several teeth along distal superior margin (Figure 3C). Palp well developed, 4.5 times length of protopod; long and spaced setae along entire length, setae with small setules along their length and apex recurved distally.

Second maxilla endopod 2-segmented, longer than exopod, proximal article about 1.4 times as long as distal one (Figure 3D); medial margin with spaced plumose setae; second article with 4 distal and subdistal setae, the distalmost longer than endopod. Exopod slightly longer than proximal article of endopod; medial margin with several plumose setae and 2 distalmost setae, the latter about as long as exopod.

Thoracopod endopod longer than exopod; numerous setae along anterior margin. Distal article of endopod slightly enlarged, more or less directed backwards, setae lost (Figure 3E). Endopod segmentation more or less defined at distal third. Exopod with about 10-13 plumose setae along posterior margin. Epipod with 3 plumose setae along posterior border of distal half. Thoracopod 8 epipod smaller than those of thoracopods 1-7, lacking setae (Figure 3F).

Pleopods 1-4 stenopodous, with protopod, endopod, and exopod (Figures 4A-C). First pleopod protopod with 3 basal simple setae: (1) shorter seta arising subdistally, (2) thicker seta between the 2 rami, (3) long seta near base of exopod, reaching first half of exopod spine-row. Endopod 2-segmented, longer than exopod; distal article with about 10 plumose setae along lateral and medial margins, distal margin with long terminal seta. Basal article shorter, *appendix interna* provided with 3 short recurved hooks. Exopod about 0.7 times as long as protopod; row of about 23 short serrate spines along lateral border (“spine-row”), each spine with tridentate tip, central tooth bifid; 4 stout spines on distolateral border, distalmost the longest; long plumose setae along medial margin. Pleopods 2-4 similar. Protopod with 2 setae on posterior distal borders, cluster of 3 setae subdistally; pleopods 2-3 protopod with posterior margin even. Endopod longer than exopod, 2-segmented; proximal article short and provided with *appendix interna*; distal article with about 10 plumose setae along lateral and medial borders, ending in long spine. Exopod with row of 4 spine pairs, each pair consisting of 1 superior long and 1 inferior shorter spine, with short plumose seta in between; medial margin with long plumose setae and 3 distal spines of increasing size. Pleopod 4 protopod with 4 acute serrations along posterior border (Figure 4D); posterior corner acutely produced.

Pleonite 4 with distally rounded denticles along posterior lateral border, posterior lateral corner acutely pointed. Dorsal posterior margin of pleonites 6-7 with denticles distally rounded (Figure 4E). Distal-lateral posterior margins with denticles slightly pointed (Figure 4F); lateral posterior margins with denticles distally rounded.

Pleopod 5 uniramous, 2-segmented (Figure 5A). Distal article about 4.5 times as long as wide with conical spines along distolateral and terminal border, the proximalmost the shortest. Several simple setae along medial and distal borders, setae appearing jointed at middle length. Pleopod 6 uniramous, 1-segmented (Figure 5B); 5 conical spines along distolateral and terminal border, the distalmost the longest. Medial and terminal borders with “jointed” setae similar to those of fifth pleopod. Pleopod 5-6 pairs with acute triangular process between bases of rami.

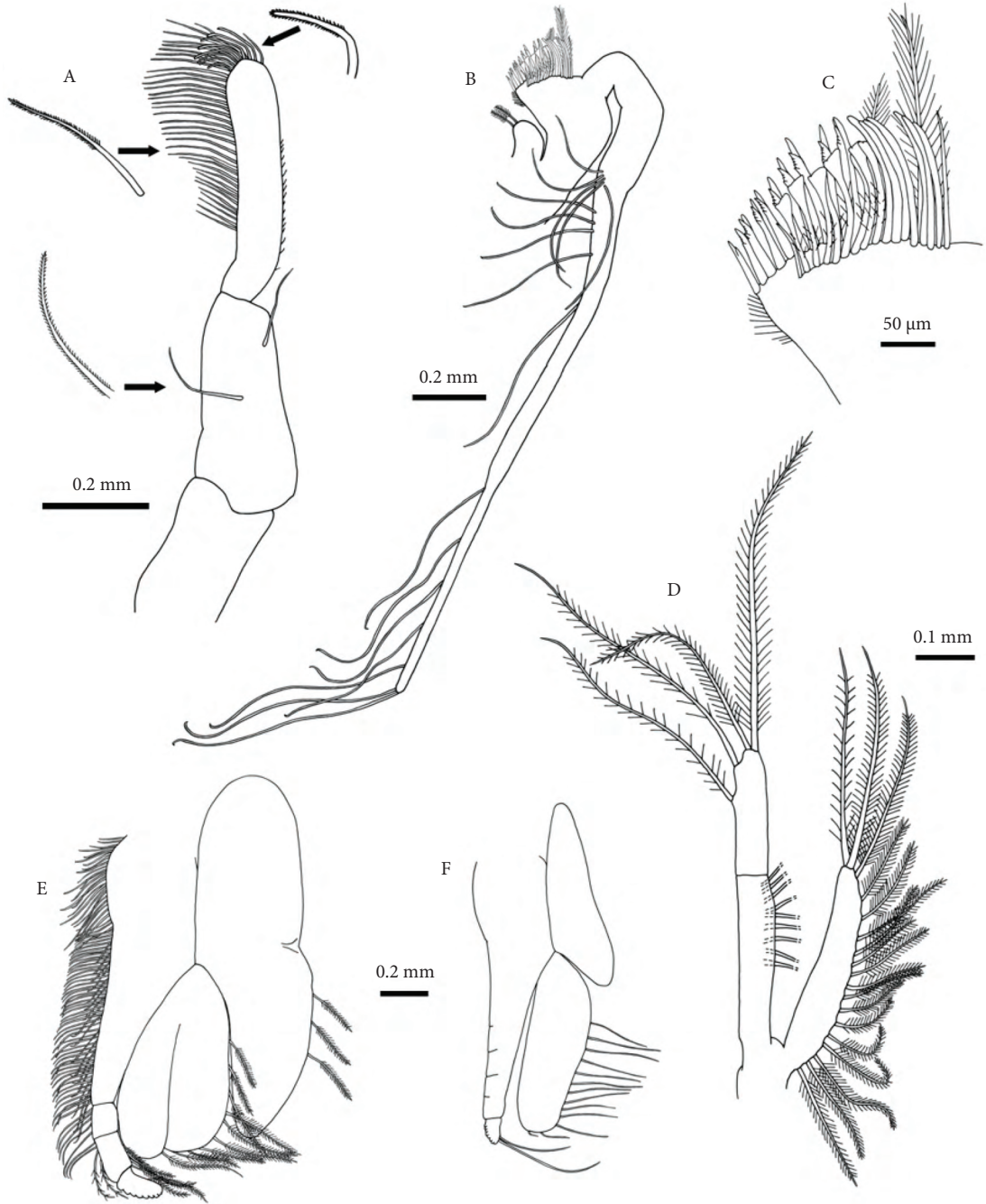


Figure 3. *Nebalia abyssicola* - post-ovigerous ♀: (A) mandibular palp and detail of setae; (B) first maxilla; (C) first maxilla, detail of distal endite and setae; (D) second maxilla; (E) thoracopod 3; (F) thoracopod 8. (E) and (F): same scale.

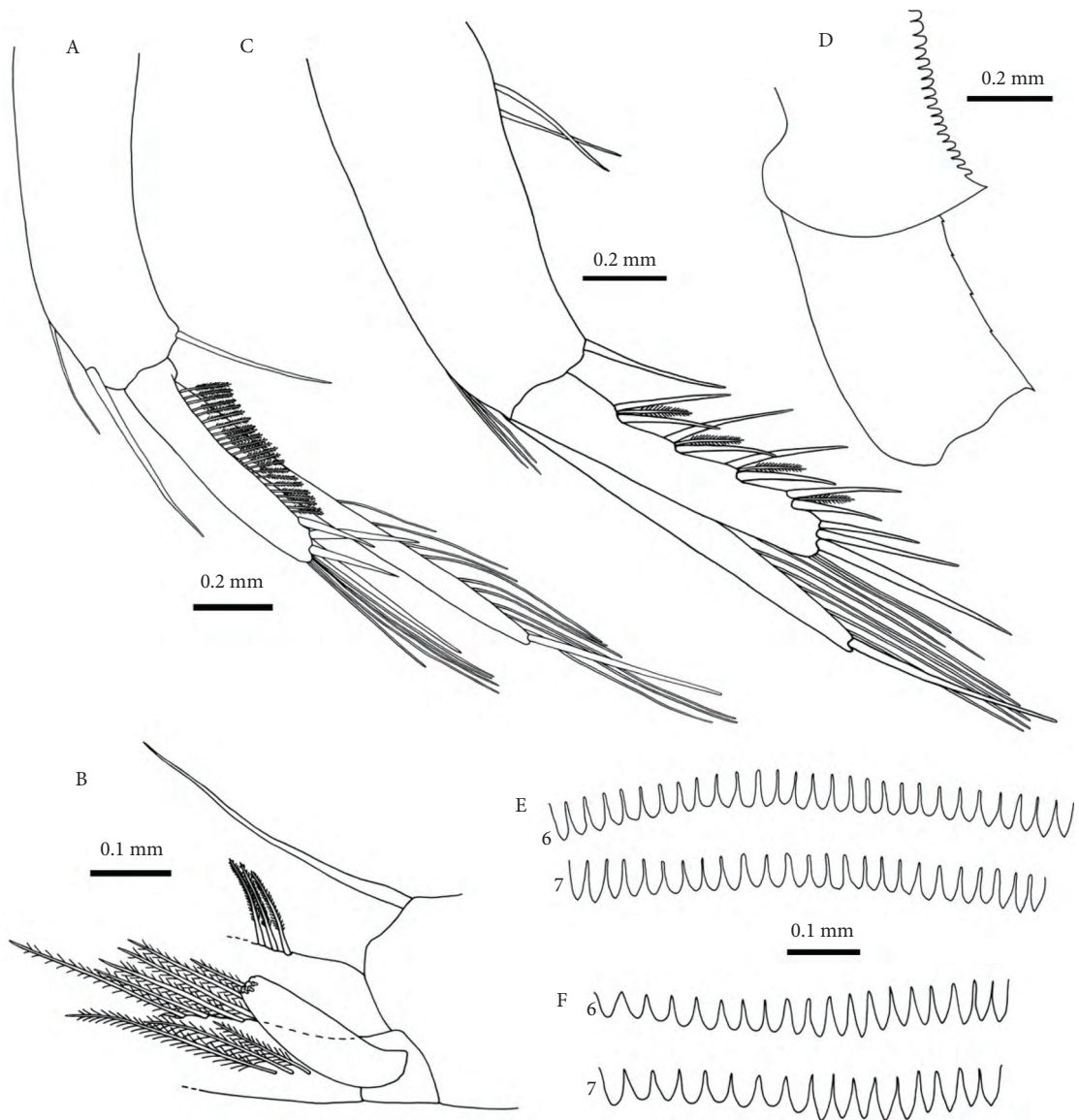


Figure 4. *Nebalia abyssicola* - post-ovigerous ♀: (A) pleopod 1, lateral view; (B) pleopod 1, endopod and exopod, proximal part; (C) pleopod 2, lateral view; (D) pleonite 4 lateral border and pleopod 4 protopod, lateral view; (E) pleonites 6-7, posterior dorsal border, denticles; (F) pleonites 6-7, posterior lateral border, denticles. (A) and (C): setules not illustrated for long plumose setae; (E) and (F): same scale.

Anal somite (pleonite 8) slightly longer than pleonite 7. Anal plates acutely tapering distally, lacking distinct “shoulder” (Figure 5C). Uropods elongate, more than twice the length of pleonite 8 (Figure 5D). Each uropod with 20-23 setae along

lateral margin, increasing in size distally, the terminal longer than entire ramus; several simple and plumose setae on lateral inner margins.

Male. The only male examined is very similar to the female. The male is distinguished from the female

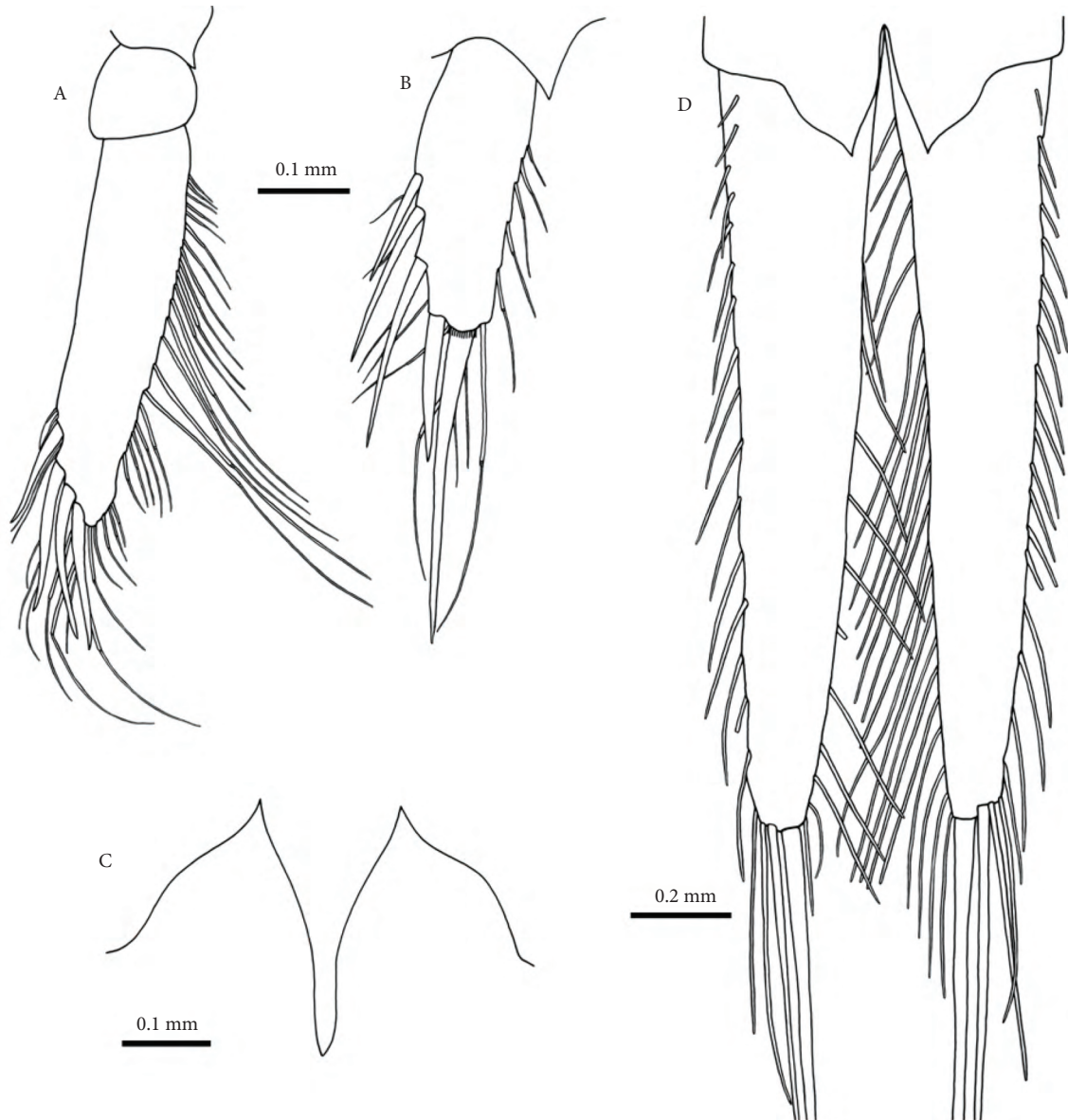


Figure 5. *Nebalia abyssicola* - post-ovigerous ♀: (A) pleopod 5, ventral view; (B) pleopod 6, ventral view; (C) anal scales, ventral view; (D) uropods, ventral view (setules not illustrated; medial border of left uropod: only plumose setae illustrated; medial border of right uropod: only simple setae illustrated). (A) and (B): same scale.

by its greater number of articles in the antennal flagellum (Figure 2E), its more swollen articles of the antennular flagellum (Figure 2B), and its carapace, which is slightly longer than wide in comparison to that of the female (Figure 1B).

Remarks. Ledoyer (1997) elevated *Nebalia bipes abyssicola* to species rank, distinguishing this species

from other *Nebalia* mostly on the basis of the lack of eye pigment and the appearance of ocular elements; the eyes of *N. b. abyssicola* are more rectangular than the typical dorsally-convex eye of most members of this genus (Dahl, 1985; Martin et al., 1996; Olesen, 1999; Haney and Martin, 2000). The eyes of bathyal and deep sea species of *Nebalia* tend to have aberrant eye shapes that lack pigment (Fage, 1929; Haney et al.,

2001). *Nebalia abyssicola* is also characterised by the presence of 1 thick distal spine in the fourth article of the antennular peduncle and by the antennular scale, which is more than twice as long as wide, and whose denticles on the posterior dorsal margin of pleonites 6-7 are distally rounded. Specimens from the eastern Mediterranean also have distinctive setae on the lateral margin of the third article of antennal peduncle. For example, there are 6 sparsely plumose setae along the proximal half followed by 2 thin spine-like setae and additional spine-like seta on the distal position that are slightly thicker than the others. These setae were not explicitly described by Ledoyer (1997) for specimens from the western Mediterranean. However, an accurate description of those setae may be useful to distinguish *Nebalia* species (Moreira et al., 2009). Thus, their disposition and shape in *N. abyssicola* is different from those of the other eastern Mediterranean leptostracans (*N. strausi*: Koçak et al., 2007, figure 2F; *N. kocatasi*: Moreira et al., 2007, figure 3C; *Nebalia* sp. 1: Koçak et al., 2010: figure 2E; *Nebalia* sp. 2: Koçak et al., 2010: figure 4E); the 3 distalmost setae are much thinner in comparison to their length in *N. abyssicola* than in the aforementioned 4 species of *Nebalia*.

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Key to the leptostracans of the eastern Mediterranean

1. Eye sub-rectangular; ommatidia irregularly distributed over central part of eye.... *N. abyssicola*
- 1'. Eye convex; ommatidia present in distal half of eye 2
2. Proximal and distal segments of second maxilla endopod subequal in length *N. kocatasi*
- 2'. Proximal article of second maxilla endopod clearly longer than distal segment 3
3. Pleonites 6-7 posterior dorsal border with distally acute denticles *N. strausi*
- 3'. Pleonites 6-7 posterior dorsal border with denticles of different shape 4
4. Second maxilla exopod about same length of proximal article of endopod; the latter about 1.8 length of distal article *Nebalia* sp. 1 (*sensu* Koçak et al., 2010)
- 4'. Second maxilla exopod longer than proximal article of endopod; the latter about 1.3 times as long as distal article *Nebalia* sp. 2 (*sensu* Koçak et al., 2010)

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