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Marine Biodiversity

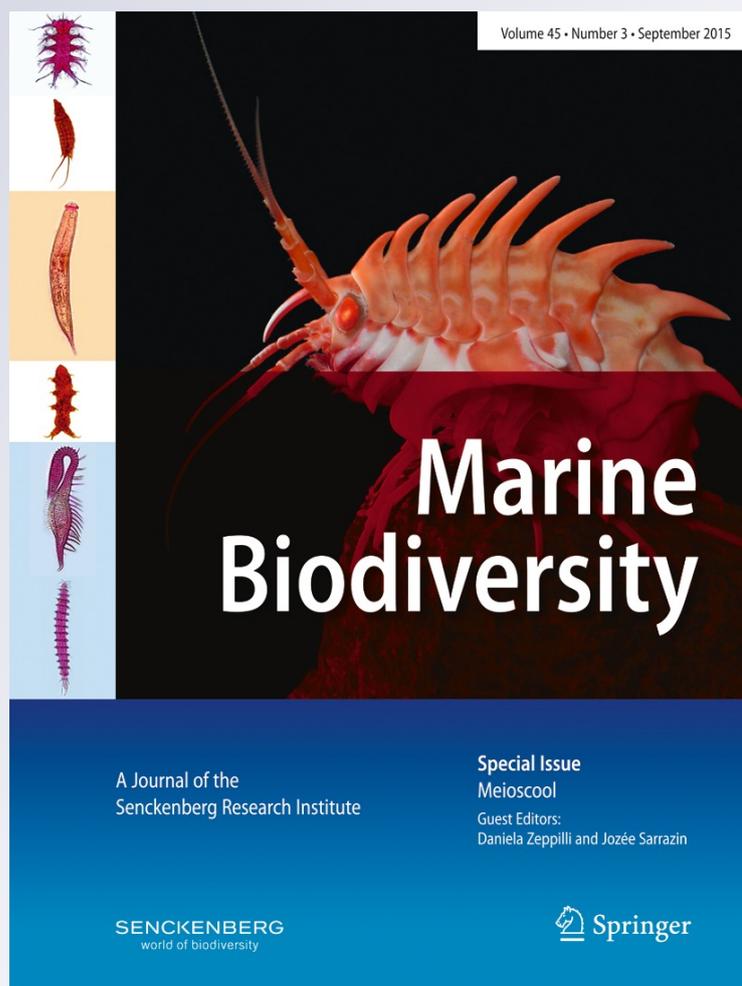
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Marine darcythompsoniids of the Turkish coasts with a description of *Leptocaris emekdasi* sp.nov. (Copepoda: Harpacticoida: Darcythompsoniidae) from the Aegean coast of Turkey

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Abstract The marine harpacticoid fauna of Turkey is inadequately known, despite the fact that the country has a vast shoreline. An intensive study of harpacticoid copepods from the intertidal zone of Turkish coasts resulted in the discovery of *Leptocaris emekdasi* sp. nov., *L. igneus* and *L. biscayensis* as Turkish fauna. The female specimen of *L. emekdasi* sp. nov. described in this study was collected from intertidal zone of the Aegean coast of Turkey. This new species is morphologically most closely related to *L. insularis*, and can be distinguished from its congeners by the presence of surface protuberances on the second to fourth thoracic somites, genital double somite and anal somite; by having more robust and shorter distal spines on the antennary exopod; by the unisegmented maxillulary palp; by the bare and shorter inner seta on P1 enp-2; and by the patch of sclerotized surface areas on the anterior surface of coxae of P1-P4.

Keywords Harpacticoida · New species · Meiofauna · Aegean Sea

Introduction

Copepods are aquatic crustaceans, minute relatives of the crabs and shrimps. They are the most important primary consumers in aquatic food webs. Some species are planktonic, some are benthic and some continental species may continue living in limno-terrestrial habitats and other wet terrestrial

places, such as swamps, underneath leaf fall in wet forests, bogs, springs, ephemeral ponds and puddles, damp moss, or water-filled recesses (phytotelmata) of plants such as bromeliads and pitcher plants. Many live underground in marine and freshwater caves, sinkholes, or stream beds (Huys et al. 1996; Boxshall and Halsey 2004) (See Table 1).

The family Darcythompsoniidae Lang, 1936 is a small interstitial group, including 33 species and four subspecies, including the nominate subspecies distributed over four genera *Leptocaris* T. Scott, 1899; *Darcythompsonia* T. Scott, 1906; *Kristensenia* Por, 1983; and *Pabellonia* Gomez, 2000. They have a considerably cylindrical and slender body shape. The genus *Leptocaris* currently comprises 26 species and five subspecies, including the nominate subspecies (Apostolov 2007; Wells 2007; Song et al. 2012). Kunz (1994) created four species groups according to the number of segments of the endopod of P1, and the number of setae on exopod 3 of P2 to P4.

Studies on Turkish marine harpacticoids are in their infancy. It was Noodt (1955a) who first studied the harpacticoids of the Sea of Marmara. Several additional marine harpacticoid records have been added since then (reviewed in Bakır et al. 2014; Sönmez et al. 2014). Here, we contribute to the knowledge of the marine copepod biodiversity in Turkey by reporting two new records, as well as describing a new species for science.

Materials and methods

During intensive sampling on the Turkish coasts, three species were found in different localities (Fig. 1). The samples were taken using the Karaman–Chappius method (Delamare-Deboutteville 1954), and all samples were initially fixed with 4 % formalin and later transferred into 70 % ethanol. Copepods were extracted from detritus under an Olympus SZX-16 stereo microscope. Whole individuals and dissected parts

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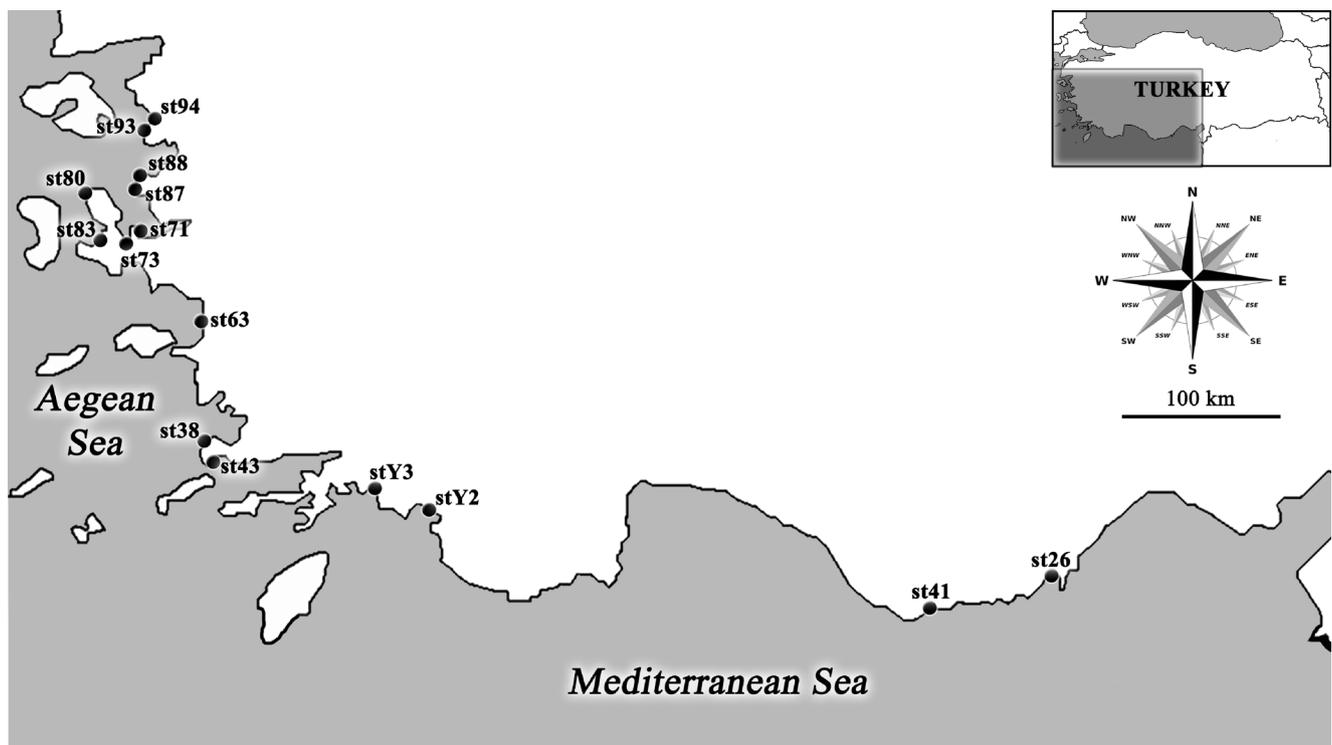
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Table 1 Coordinates and sampling dates of the sampling stations

Station	Locality	Coordinates		Date (d/mo/yr)
26	Akçakıl Beach	36° 17' 49.9"N	33° 50' 51.9"E	10/04/2007
38	Yalıkavak Beach	37° 06' 32.4"N	27° 17' 35.1"E	20/05/2012
41	Mamure Castle Beach	36° 05' 09.7"N	32° 54' 22.1"E	14/04/2007
43	Camel Beach	37° 00' 39.5"N	27° 19' 42.3"E	17/05/2012
63	Pygenia Beach	37° 54' 04.4"N	27° 16' 21.2"E	23/05/2012
71	Urla Beach	38° 23' 09.6"N	26° 45' 32.9"E	23/05/2012
73	İçmeler Beach	38° 18' 38.3"N	26° 41' 08.0"E	23/05/2012
80	Bademlibük Beach	38° 37' 16.8"N	26° 21' 28.0"E	24/05/2012
83	Ildırı Beach	38° 20' 50.0"N	26° 27' 01.8"E	24/05/2012
87	Ferah Beach	38° 41' 30.5"N	26° 43' 54.4"E	25/05/2012
88	Acar Camping Beach	38° 43' 53.5"N	26° 44' 32.8"E	25/05/2012
93	Bademli Beach	39° 02' 19.8"N	26° 49' 31.3"E	25/05/2012
94	Dikili Beach	39° 05' 14.8"N	26° 52' 58.5"E	25/05/2012
StY2	Yanıklar Beach	36° 41' 15.8"N	29° 02' 47.3"E	17/05/2012
StY3	Ekincik Beach	36° 49' 50.7"N	28° 33' 00.3"E	18/05/2012

were mounted on slides in lactophenol mounting medium. Broken pieces of coverslip were inserted between the coverslip and slide in order to prevent crushing of the appendages, and to allow viewing from different angles. Identification and drawings of specimens were made under an Olympus BX-51 microscope with attached DIC (Differential Interference

Contrast) and camera lucida. Scale bars on figures are in micrometers. Type species are deposited in the collection of Zoology Museum of Adıyaman University (ZMADYU). Abbreviations used in the text are: ae aesthetasc; P1-P6 swimming legs 1-6; exp (end)-1 (2-3) to denote the proximal (middle, distal) segment of ramus.

**Fig. 1** The sampling localities of *Leptocaris* spp.

Results

Systematics

Subclass COPEPODA Milne-Edwards, 1840

Order HARPACTICOIDA Sars, 1903

Family DARCYTHOMPSONIIDAE Lang, 1936

Genus *Leptocaris* T. Scott, 1899

Leptocaris biscayensis (Noodt, 1955)

Material examined: 1 ♀ (St.26); 5 ♀♀, 1 ♂ (St.38); 2 ♀♀, 3 ♂♂ (St.43); 2 ♀♀, 2 ♂♂ (St.63); 48 ♀♀, 18 ♂♂ (St.71); 1 ♀ (St.73); 2 ♀♀ (St.83); 4 ♀♀ (St.87); 1 ♀ (St.88); 25 ♀♀, 7 ♂♂ (St.94); 1 ♀ (St.Y2).

Distribution in Turkey: New record

Leptocaris igneus Cottarelli and Baldari 1982

Material examined: 1 ♀ (St.63); 3 ♀♀ (St.71); 1 ♀ (St.93); 1 ♀ (St.Y3).

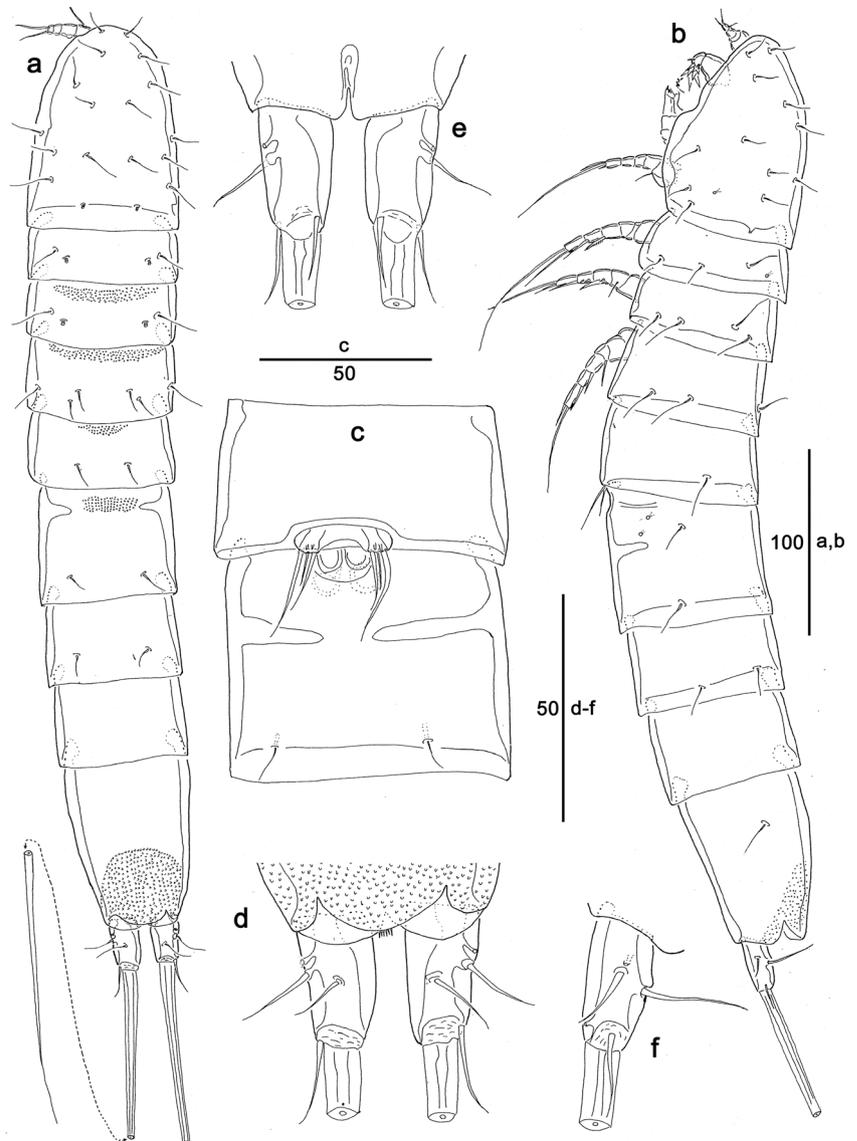
Distribution in Turkey: New record.

Leptocaris emekdasi sp. nov.

Type Material: Holotype: 1 ♀ (collected from St.80), dissected on 5 slides (reg. no. ZMADYU 2012/179). Paratype: 1 ♀ (collected from St.41), dissected on 3 slides (reg. no. ZMADYU 2007/265).

Description (female) Body elongate and cylindrical. Total body length 513 μ m. Second to fourth thoracic somites, genital double somite and anal somite ornamented with surface protuberances dorsally as in Fig. 2a. Posterior margin of body somites with plain hyaline frill. Rostrum (Fig. 3a) triangular, small and with two delicate sensilla.

Fig. 2 *Leptocaris emekdasi* sp. nov., female. **a** habitus, dorsal; **b** habitus, lateral; **c** anal somite and P5, ventral; **d** furca and distal part of anal somite, dorsal; **e** furca and distal part of anal somite, ventral; **f** furca, lateral



Urosome five-segmented, comprising P5-bearing somite, genital-double somite and three free abdominal somites. Genital-double somite (Fig. 2a–c) as long as wide, with two dorsal, two lateral and two ventral sensilla, completely fused dorsally and ventrally with weakly sclerotized traces laterally indicating original segmentation. Median copulatory pore (Fig. 2c) located in anterior half of genital double-somite; closed off by fused fifth leg. Seminal receptacles difficult to confirm. Anal somite (Fig. 2a, b and d) tapering posteriorly, about 1.5 times as long as wide. Anal operculum semi-circular, with cuticular ornamentation of protuberances on posterior half. Caudal rami (Fig. 2d–f) cylindrical, about two times as long as wide; each ramus tapering slightly distally with five bare setae.

Antennule (Fig. 3a) six-segmented; first segment longest and widest. Third segment with aesthetasc fused basally to a

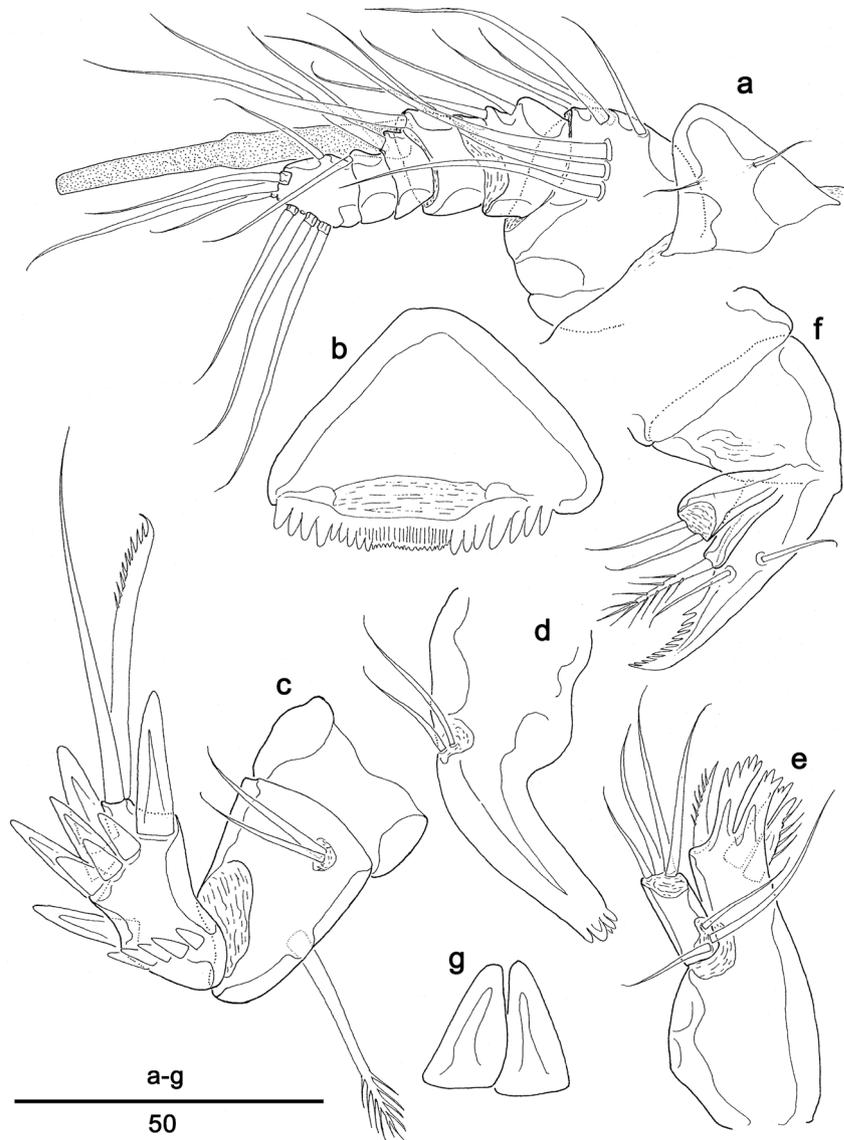
seta on a pedestal. Armature formula: 1-[7], 2-[7], 3-[2+ae], 4[2], 5-[1], 7.

Antenna (Fig. 3c). Coxa without ornamentation; allobasis about as long as endopodal segment and with strong spinulose seta located mid-length along the outer margin. Exopod represented by two bare setae on small protuberance. Endopod stout, ornamented with a transverse row of five spinules on surface and with three strong transverse spinules subapically. Lateral armature consisting of four blunt spines; distal armature consisting of one blunt spine, one long bare seta and one seta serrated at tip.

Labrum (Fig. 3b) large and triangular with strong spinules along the anterior margin.

Mandible (Fig. 3d). Strong gnathobase bearing several multicuspitate teeth ventrally and one short seta in proximal

Fig. 3 *Leptocaris emekdasi* sp. nov., female. **a** antennule and rostrum, dorsal; **b** labrum, anterior; **c** antenna, lateral; **d** mandible, ventral; **e** maxillule, ventral; **f** maxilla, ventral; **g** maxilliped, ventral



corner (difficult to observe); palp reduced and represented by two long bare setae.

Maxillule (Fig. 3e). Praecoxa without ornamentation. Arthrite strongly developed, with five distal spines. Palp elongated and unisegmented, with three outer setae and four distal setae.

Maxilla (Fig. 3f). Syncoxa without ornamentation. Proximal endite with two bare setae; distal endite with one plumose seta. Basis drawn out into a pectinate claw with two bare setae.

Maxilliped (Fig. 3g) reduced into small triangular lobe.

P1 (Fig. 4a and b). Basis with a bare seta both at outer and inner corner. Exopod 3-segmented; exp-1 with strong outer spinules around outer spine; exp-2 slightly longer than exp-1 and similar ornamentation; exp-3 longest with two unipinnate outer spines and two uniplumose long setae terminally. Endopod reaching end of exp-2; enp-1 with spinules on outer corner and one peculiarly barbed inner seta; enp-2 ornamented with three spinules on outer margin, apically with one unipinnate spine and one long uniplumose seta, and with one tiny bare inner seta.

Fig. 4 *Leptocaris emekdasi* sp. nov., female. **a** P1 without rami, anterior; **b** P1, posterior; **c** P2, anterior

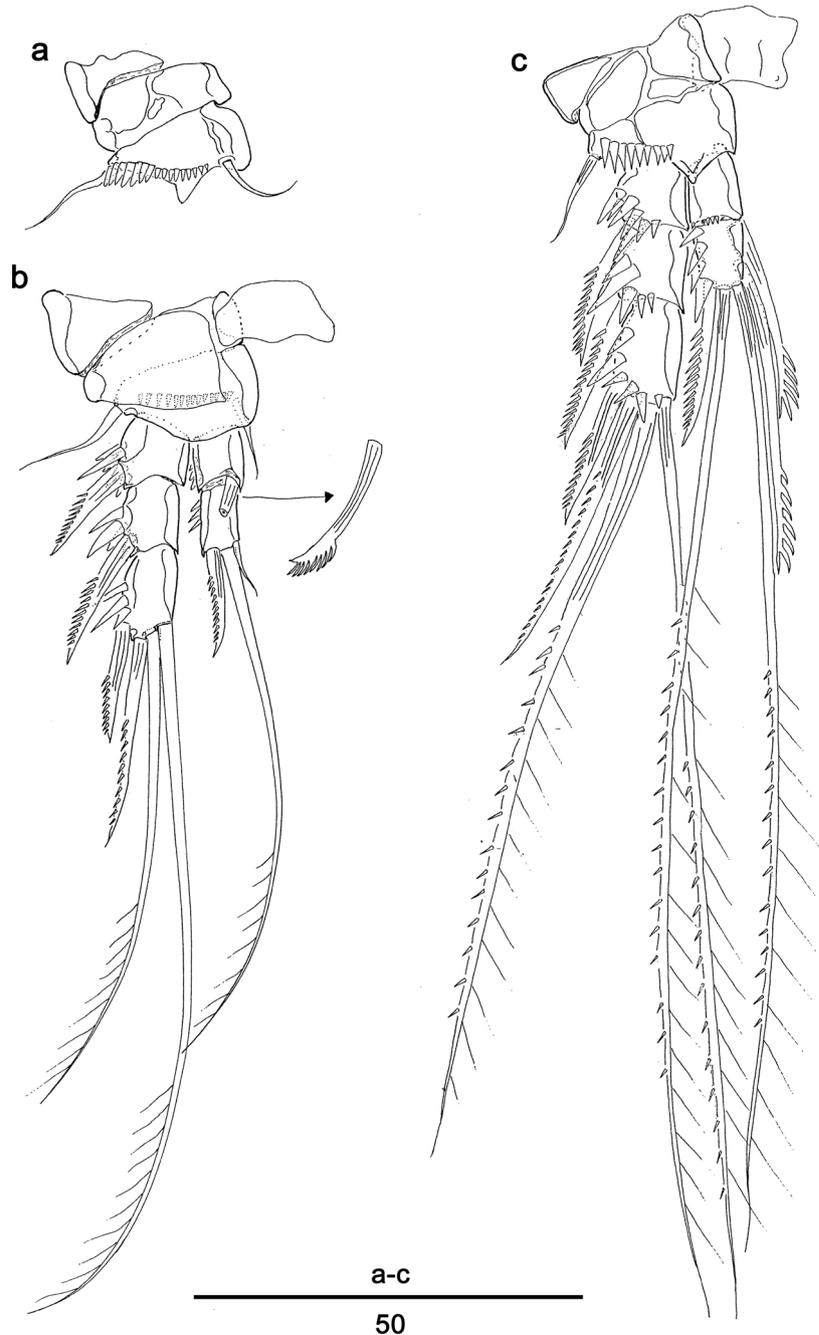
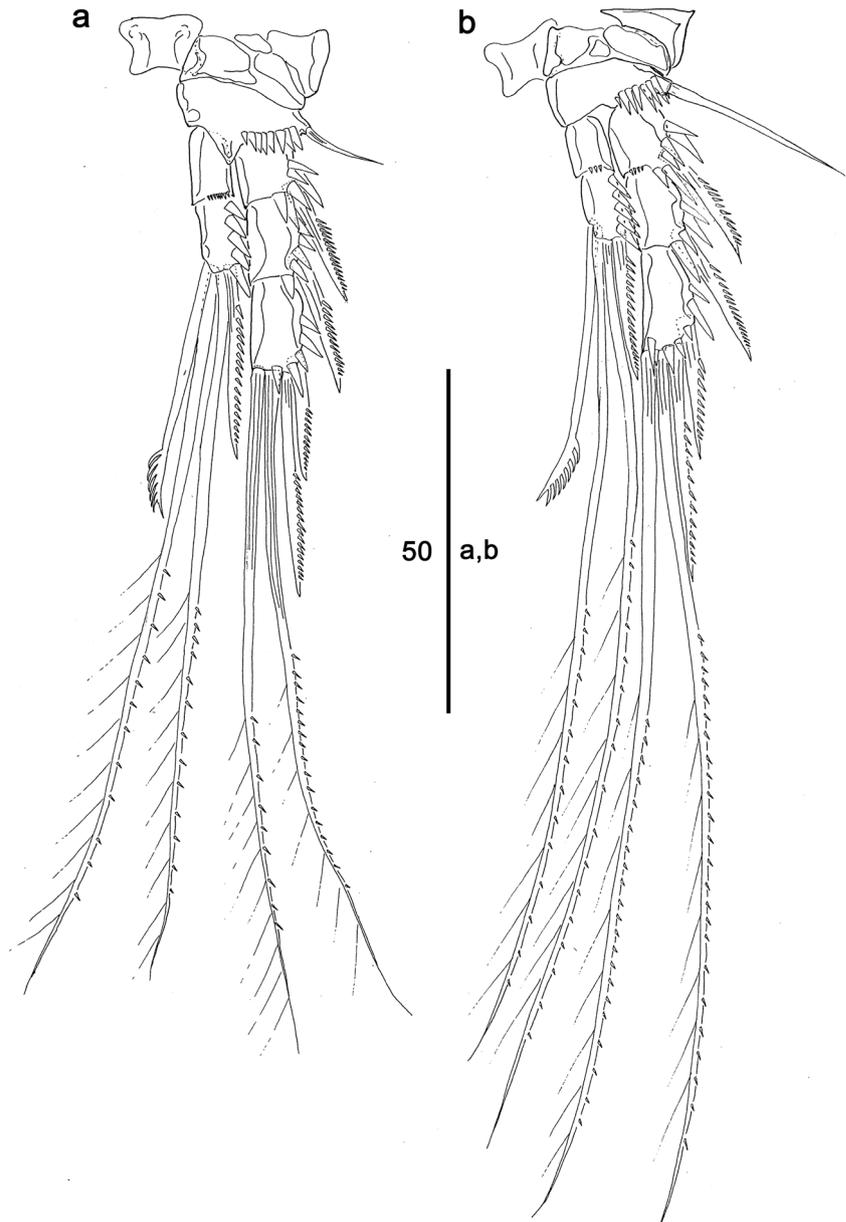


Fig. 5 *Leptocaris emekdasi* sp. nov., female. **a** P3, anterior; **b** P4, anterior



P2-P4 (Figs. 4c, 5a and b). Squarish intercoxal sclerite without ornamentation. Praecoxa triangular without ornamentation. Coxa rectangular without ornamentation and with a patch of sclerotized surface areas. Basis wider than long with spinular row on anterior surface, with bare seta at outer corner; P1 additionally with bare seta at inner margin. Rami three-segmented (exopod) and two-segmented (endopod). Inner seta of enp-1 (P1 and P3) and innermost seta of enp-2 (P2 and P4) apically serrate.

Setal formula of swimming legs:

P1		P2		P3		P4	
Exopod	Endopod	Exopod	Endopod	Exopod	Endopod	Exopod	Endopod
0.0.121	1.120	0.0.121	1.121	0.0.121	0.121	0.0.121	0.121

P5 (Fig. 2c) forming a small plate protruding medially, both rami of P5 confluent basally, with three bare setae.

Male: unknown.

Etymology: The specific name is given in honour of Prof. Dr. Gürol EMEKDAŞ in Mersin University.

Discussion

Turkish marine Harpacticoid studies were started in 1955, from the Sea of Marmara (Noodt 1955a). Several additional records have been added since then (Bakır et al. 2014; Sönmez et al. 2014), and thus far, 147 species have been reported from

the Turkish seas. On the basis of published data and with the addition of three new records (*L. igneus*, *L. biscayensis*, *L. emekdasi* sp. nov.) by this study, the number of marine harpacticoid species from Turkey that have been recorded so far has reached 150. Bakır et al. (2014) erroneously included *L. brevicornis* in the marine arthropod list of Turkey, because *L. brevicornis* has thus far only been reported from freshwaters in Turkey (Bozkurt 2007; Yalim et al. 2011). Noodt (1955b) initially described *L. biscayensis* from the Bay of Biscay (northeast Atlantic Ocean), along the western coast of France. Later, it was reported from Tenerife, the Canary Islands (Noodt 1955b, 1958; Kunz 1978), the Yugoslavian Adriatic Sea (Petkovski 1955), Waltair coast, India (Rao and Ganapati 1969), south of Italy (Cottarelli and Baldari 1982), the Mediterranean coast of Croatia, Azores and Spain (Kunz 1994). Populations assigned as *L. biscayensis* in the above literature as well as other freshwater reports (Dussart and Defaye 1990) indicate a cosmopolitan distribution of the species. The other species of *Leptocaris* found in this study is *L. igneus*, which was originally described from Vulcano Island, Italy (Cottarelli and Baldari 1982). Although the original description lacks the fine details, the present specimens match well with the original description. This is the first report of *L. igneus* since its original description from Vulcano Island (Italy).

The third species of *Leptocaris* found among the interstitial samples of the Turkish coast is new to science, and is named as *Leptocaris emekdasi* sp. nov. The new species clearly belongs to the genus *Leptocaris*, in having maxilliped completely absent or reduced to a small triangular lobe and P1 endopod proximal or only segment with anteriorly directed seta with terminal comb (Kunz 1994; Huys et al., 1996). According to Kunz (1994), four species groups of *Leptocaris* can be identified and the new species belongs to the *ignavus* group of species (it now contains 11 species), which is characterized by a two-segmented P1 endopod, maxilliped reduced to a small triangular lobe, and P2 to P4 exp-3 with four setae, respectively. The new species is morphologically most closely related to *L. insularis*, in sharing the same setal armature of the swimming legs and in having structurally very similar appendages. *L. insularis* was described from Tenerife, the Canary Islands (Noodt 1958), and has not been reported from anywhere else since then. *L. emekdasi* sp. nov. can be distinguished from *L. insularis* by several characters. The most notable is the presence of surface protuberances on the second to fourth thoracic somites, genital double somite and anal somite, as shown in Fig. 2a and d. *L. emekdasi* sp. nov. also differs from *L. insularis* by having more robust and shorter distal spines on antennary exopod, unisegmented maxillulary palp, the bare and shorter inner seta on P1 enp-2, and by the patch of sclerotized surface areas on the anterior

surface of coxae of P1–P4. *Leptocaris emekdasi* sp. nov. has some characters that may be considered as autoapomorphic, mainly the patch of sclerotized surface areas on the anterior surface of coxae of P1–P4.

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