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A new species of *Parastenhelia* Thompson & A. Scott, 1903 (Copepoda, Harpacticoida, Parastenheliidae) from Turkey

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Abstract. Both sexes of *P. aydini* sp. nov. are described in detail. The new species can be differentiated from its congeners by the combination of following features; i) 2-segmented P5 exopod with total of five setae in the male, ii) 9-segmented antennule, iii) spinular rows near outer margin of the basis of P1-P4 significantly reduced, iv) P4 enp-3 with four setae, v) inner terminal seta of caudal rami (seta V) not swollen at the base. It is concluded that the insufficient descriptions of many species are the main obstacle in testing the monophyletic status of several genera in the family Parastenheliidae.

Key words: species complex, taxonomy, monophyly.

Introduction

The family Parastenheliidae is a small group, at present including 5 genera and 20 species (Gee 2006, Wells 2007, Back & Lee 2013). They are essentially marine, free-living and benthic, and mainly inhabit the intertidal zone or shallow subtidal habitats and frequently found among algal assemblages (Boxshall & Halsey, 2004). Taxonomic history of the family and its taxa have been complicated and problematic (Gurney 1927, Sewell 1940, Lang 1944, 1948, Willen 2000, Gee 2006). There is still confusion about the taxonomy of the family Parastenheliidae, mainly due to the deficient descriptions of certain species such as the type species *P. spinosa* Fischer, 1860 (see Gee 2006 for historical review). The revision of so called *P. spinosa* complex is urgently needed and such revisionary study has already been initiated by the present authors.

Taxonomic studies on Turkish marine harpacticoids were started very late although the country has a very long shore line. It was Noodt (1955) who first published taxonomic paper on Turkish harpacticoids from the Sea of Marmara. Several additional records have been added since then (for the review, see Sönmez et al. 2014, 2015, Kaymak & Karaytuğ 2014, Bakır et al. 2014).

The aim of the present study is to describe both sexes of the new species in detail to contribute the taxonomy of the genus *Parastenhelia* and to the biodiversity of Turkish fauna.

Material and methods

The new species was found among the sand samples collected by hand (at the depth of 0.3 meter) adjacent to rocky shore. Sample was immediately preserved with 4% formalin solution. Copepods were extracted from detritus under OLYMPUS SZX-12 stereo microscope and later stored in 70% ethanol. Selected specimens were dissected in lactic acid and mounted on slides in lactophenol mounting medium. Broken glass fibres were added to prevent the animal and appendages from being compressed by the coverslip and to facilitate rotation and manipulation, allowing observation from all angles. All drawings were made by using a camera lucida attached on Olympus BX-51 differential interference contrast microscope. Preparations were subsequently sealed with Entellan. Measurements were made with an ocular micrometer. Scale bars in illustrations are in µm. The descriptive terminology is adopted from Huys et al. (1996). Abbreviations used in the text are: ae, aesthetasc; P1–P6, for swimming legs 1–6; exp (enp)-1 (-2, -3) to denote the proximal (middle, distal) segments of a ramus.

Results

Order Harpacticoida Sars 1903
Family: Parastenheliidae Lang 1944
Genus: *Parastenhelia* Thompson & A. Scott 1903
***Parastenhelia aydini* sp. nov.** (Figs 1-8)

Type Locality: Kızkalesi, Mersin, 36° 27.473' N, 34° 08.647' E, collected on 15/07/2011. Leg. Prof. Dr. S. Karaytuğ.

Material Examined: Holotype, female, dissected on eight slides, allotype dissected on eight slides. Paratypes; one female dissected on seven slides, one female dissected on six slides. Five females and one male deposited in alcohol. The types are deposited in the collection of the Biology Department of Mersin University.

Other Material: Two females; one female dissected on six slides, other female deposited in alcohol from Denizyıldızı beach, Urla, İzmir Province (38° 12' 33.7" N; 26° 41' 36.7" E). Collected on 23.5.2012. Leg. S. Kuru.

Description (female)

Body (length 340 µm) semicylindrical, widest at posterior margin of cephalothorax, tapering posteriorly without clear distinction between prosome and urosome (Fig. 1A). Rostrum (Fig. 3A) small and triangular with a pair of sensilla, extending slightly halfway of the second antennulary segment. Cephalothorax tapering anteriorly and with pores and sensilla as figured (Fig. 1A). Cephalothorax, free prosomites and first urosomite with plain hyaline frills. Others urosomites with serrate hyaline frills (Fig. 2A, C). Genital double somite (Fig. 2A, C) completely fused, ventral surface with trace of sub-cuticular rib indicating original segmentation, ornamented with row of spinules, pores and sensilla as figured. Genital apparatus (Fig. 2A) with median ventral copulatory pore. Urosomites 3 and 4 with dorsolateral row of spinules extending ventrally to the base of ventral sensilla near posterior margin as figured. Anal somite with ventral and dorsal row of spinules; anal operculum (Fig. 2C) semicircular with fine spinules. Caudal rami (Fig. 2A-C) broader than long, with complex rows of spinules as figured; minute seta I and larger seta II implanted anteriorly on lateral mar-

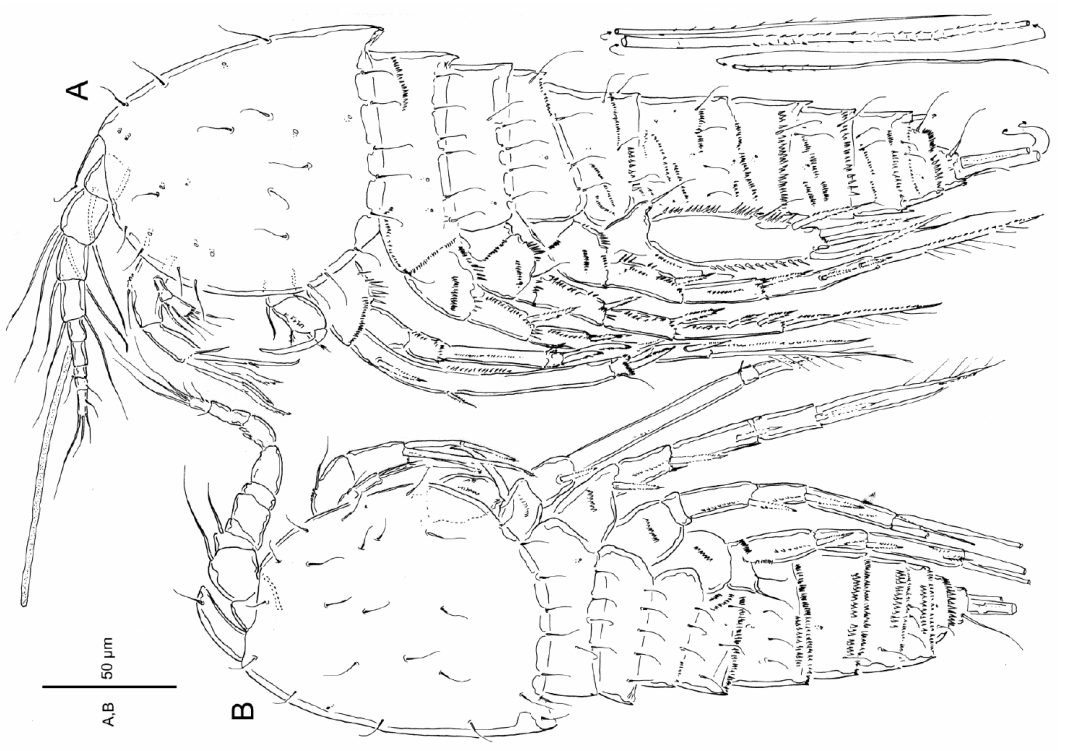

Figure 1. *P. aydini* sp. nov. A, ♀, habitus lateral; B, ♂, habitus lateral.

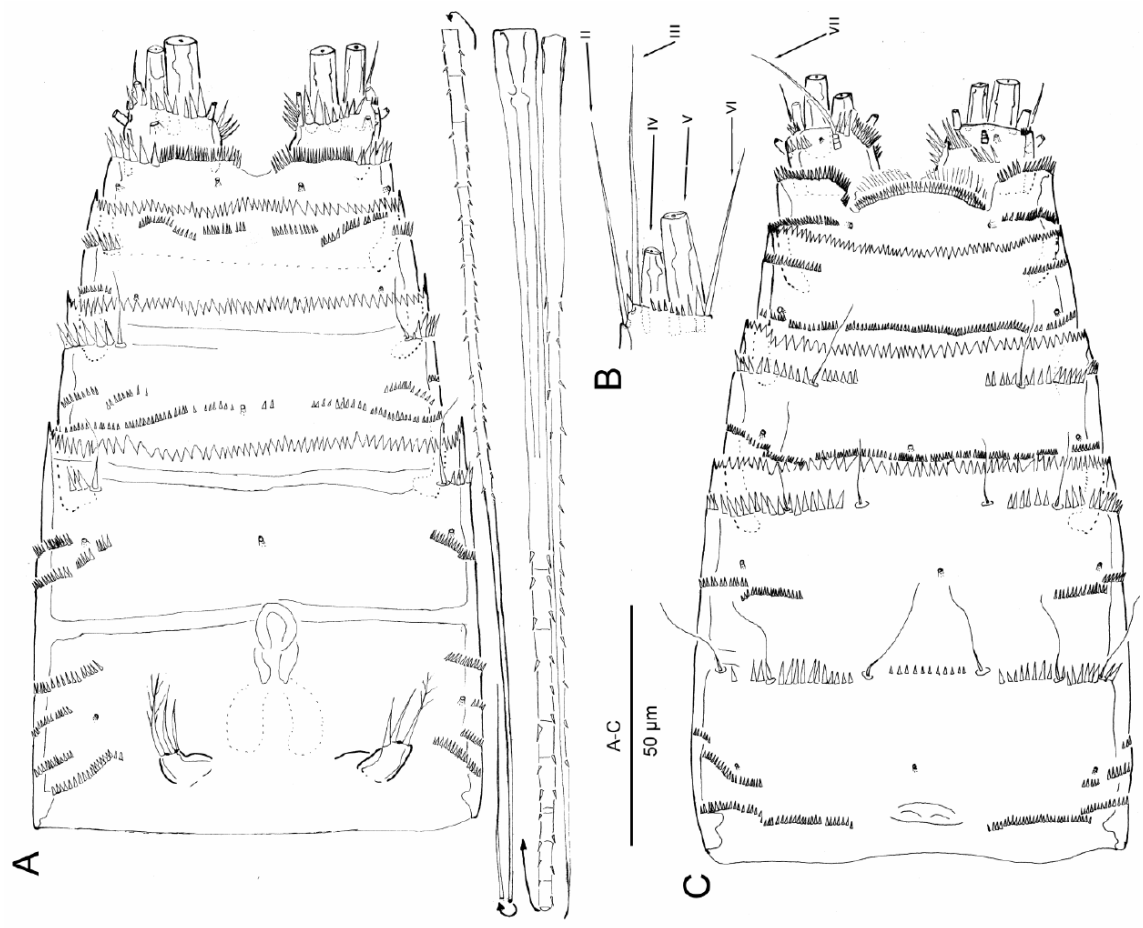

Figure 2. *P. aydini* sp. nov. ♀. A, ♀ urosome and P6, ventral; B, caudal ramus, ventral; C, urosome, dorsal.

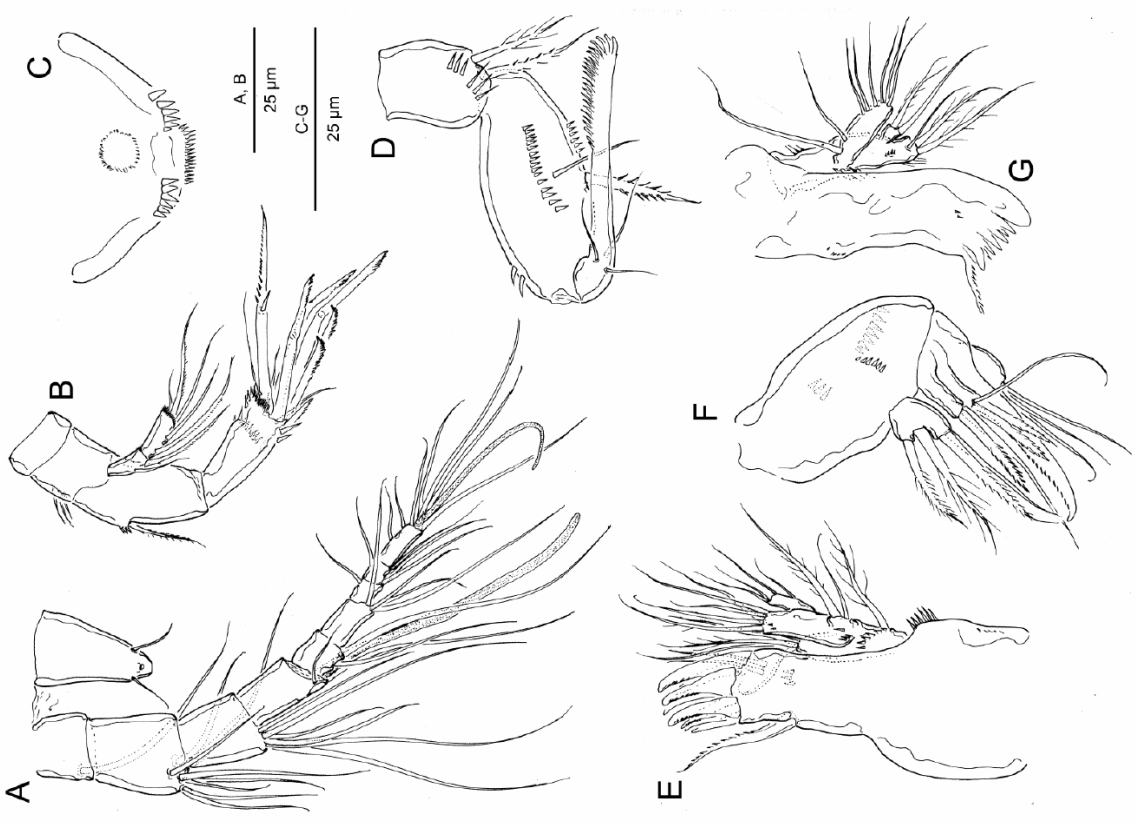

Figure 3. *P. aydini* sp. nov. ♀. A, antennule and rostrum, dorsal; B, antenna, lateral; C, labrum, anterior; D, maxilliped, anterior; E, maxillule, anterior; F, maxilla, anterior; G, mandible, anterior.

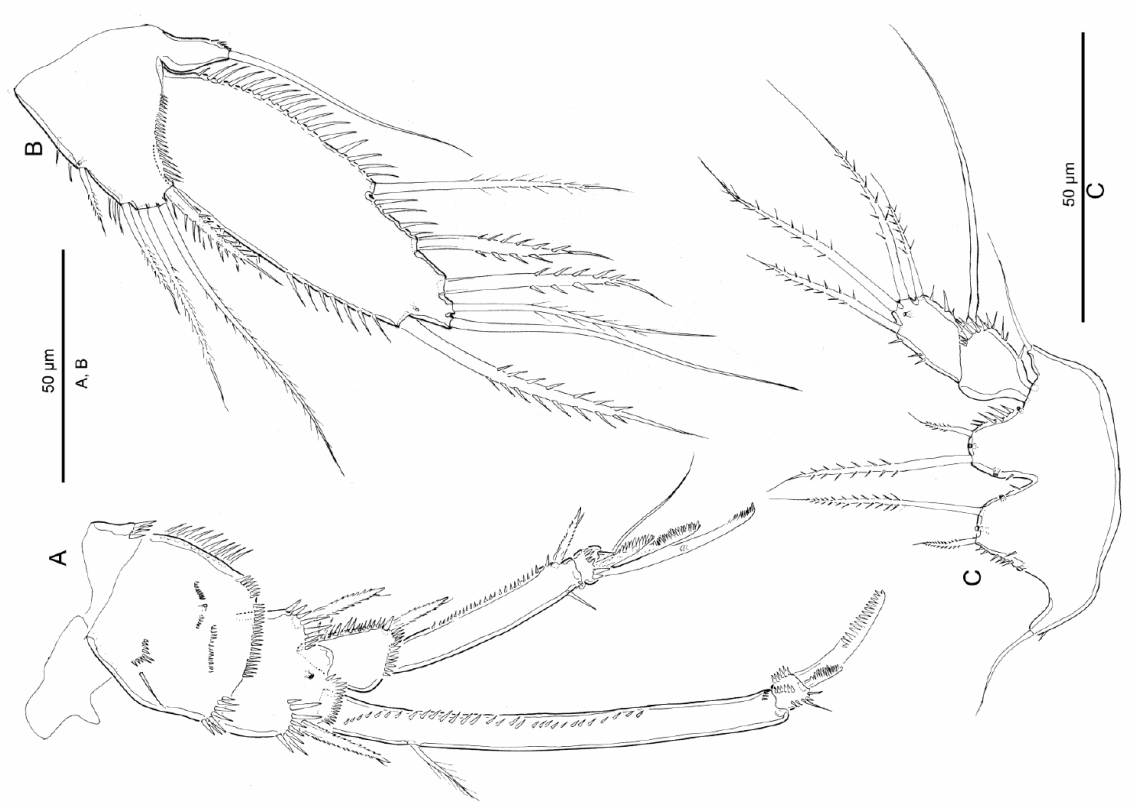

Figure 4. *P. aydini* sp. nov. ♀. A, P1, anterior; B, P5, anteriolateral; C, ♂, P5, anterior.

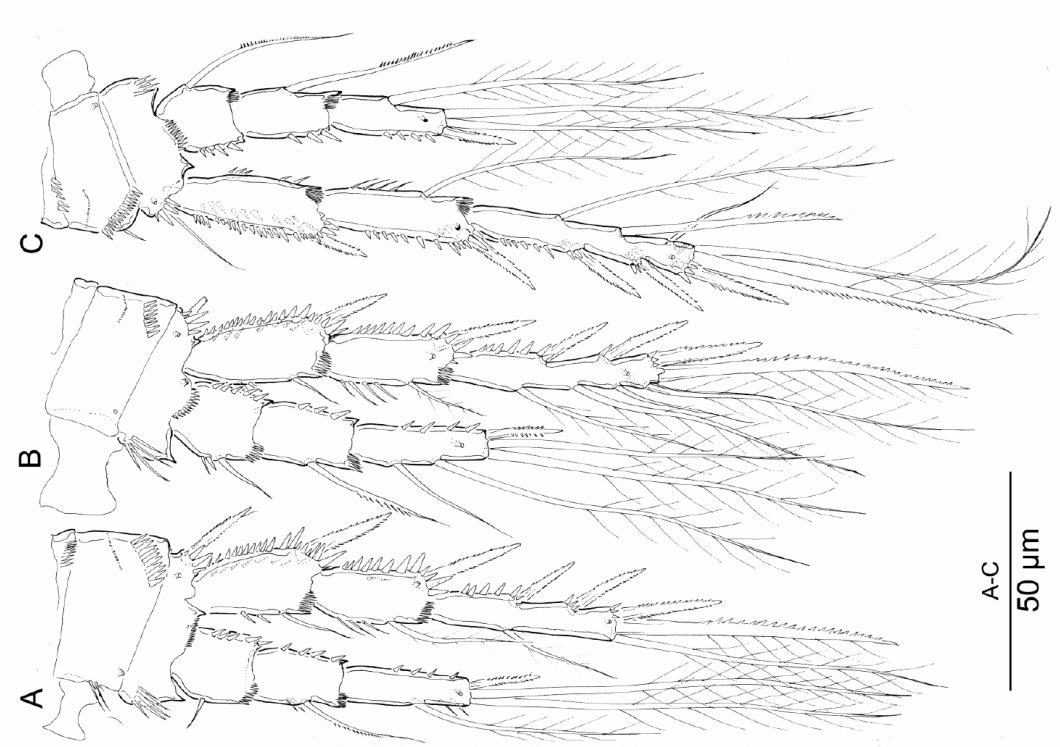

Figure 5. *P. aydini* sp. nov. ♀, anterior. A, P2; B, P3; C, P4.

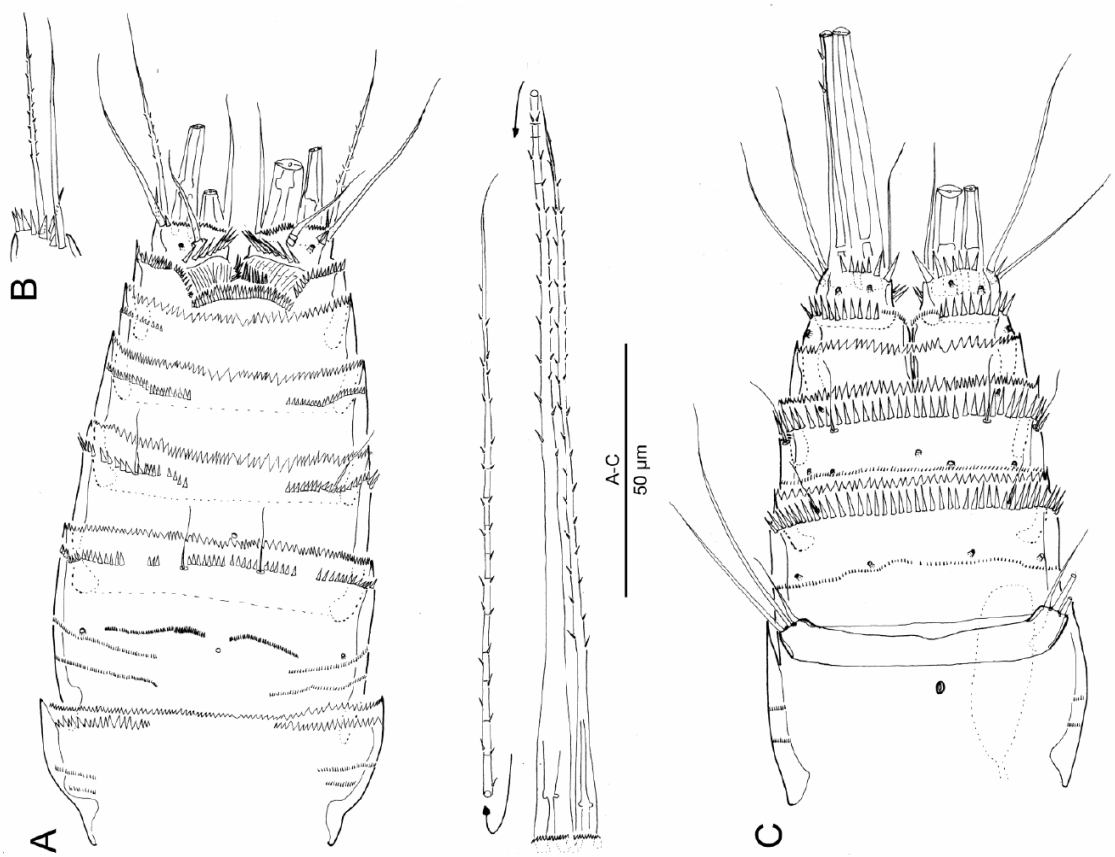

Figure 6. *P. aydini* sp. nov. ♂. A, urosome, dorsal; B, tip of caudal ramus, ventral; C, urosome and P6, ventral.

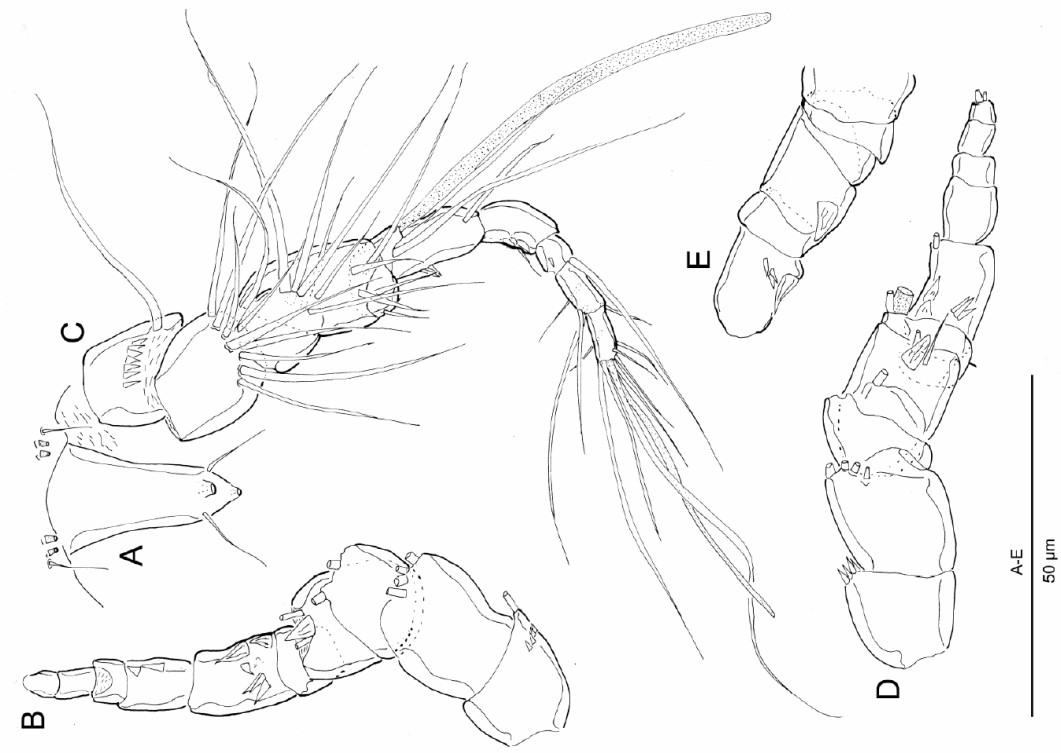

Figure 7. *P. aydini* sp. nov. ♂. A, rostrum, dorsal; B, antennule, ventrolateral; C, antennule, ventral; D, antennule, ventral; E, lateral view of segments 2-7.

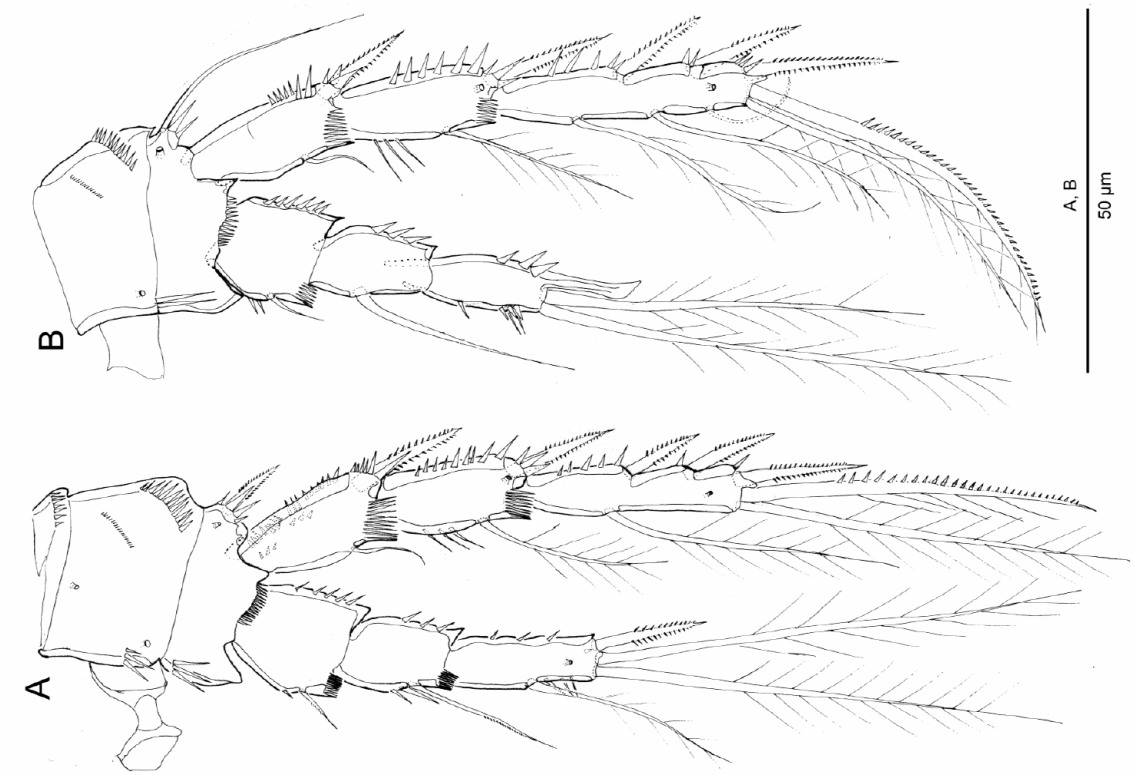

Figure 8. *P. aydini* sp. nov. ♂, anterior. A, P2; B, P3.

gin; seta III implanted at distal outer corner; terminal seta IV moderately slender; terminal seta V robust, large without noticeably swollen base; terminal, inner seta VI small and slender and triarticulated seta VII implanted on dorsal surface.

Antennule (Fig. 3A). Distinctly nine-segmented, all segments without pinnate setae, aesthetascs on segments 4 and 9. Setal formula as follows: 1-[1], 2-[9], 3-[6], 4-[2+(1+ae)], 5-

[2], 6-[4], 7-[3], 8-[2], 9-[6+(acrotek)].

Antenna (Fig. 3B). Basis with spinule row on abexopodal margin. Exopod two-segmented: proximal segment with two setae. Distal segment with five setae and with a subdistal row of spinules. Endopod two-segmented: proximal endopod segment with few spinules near the base of plumose seta. distal endopod segment laterally with one unipinnate spine in distal third; apical armature of enp-2 consisting of two unipinnate spines, one naked seta and four geniculate setae; inner geniculate seta with spinules and fused at base to short naked seta; segment with various spinule rows as figured.

Mandible (Fig. 3G). Coxal gnathobase well developed with bicuspid and unicuspid teeth and a pinnate seta at distal corner. Basis with rows of spinules and with two plumose setae and one plain seta on distal margin; endopod one-segmented, with eight naked setae; exopod small, one-segmented, with one plumose seta and one plain seta.

Maxillule (Fig. 3E). Praecoxal arthrite with seven elements on distal margin, one semispinulose seta on inner margin and two bare setae near distal margin. Coxal endite with five setae on distal margin; coxal epipodite represented by one seta. Basis with five setae on distal margin; rami partially fused to basis, endopod one-segmented, with one plumose seta and one bare seta; exopod one-segmented with four bare setae.

Maxilla (Fig. 3F). Coxa with three endites on inner margin, with spinular rows as figured, proximal endite broad and bicuspid with two pinnate setae on inner cusp and one naked seta and one pinnate seta on outer cusp; middle endite with one spinulose seta and one bare seta; outer endite with two spinulose and one bare seta; allobasal endite with one fused spine; endopod with three setae.

Maxilliped (Fig. 3D). Syncoxa with six fine spinules and one pinnate seta and one plumose seta on distal margin. Basis with two row of spinules, with one medial naked seta and one pinnate seta. Endopod represented by a well-developed claw with prolonged teeth on distal inner margin and three accessory setae proximally.

Labrum (Fig. 3C) strongly developed, trilobate; median lobe with spinules along free margin; with median circular small spinules.

P1 (Fig. 4A). Intercoxal sclerite, naked. Praecoxa, small, triangular with row of spinules on outer distal margin. Coxa almost square with rows of spinules on outer distal margin and three rows of minute spinules, a pore and long spinule on anterior surface. Basis with row of spinules at base of inner and outer spinulose spines and on distal margin at base of endopod and with a pore anterior surface medially. Exopod three-segmented, proximal segment with row of spinules on outer and distal margin and a spinulose spine at outer distal corner; middle segment markedly elongate, three times longer than proximal segment, with row of spinules on outer margin, a spinulose spine at outer distal corner and a small plain seta at inner distal corner; distal segment very small, bearing a long naked seta and one relatively long geniculate and two non-geniculate, short, strong spines. Endopod two-segmented, proximal segment longer than entire exopod with a small, plumose seta implanted within proximal third of segment; distal segment small with a few spinules, one minute seta and two short, slender, dentate spines.

P2 (Fig 5A). Intercoxal sclerite small and without spinules. Praecoxa a small sclerite with anterior spinules. Coxa with two rows of spinules (one row consist of very small spinules) near outer margin, with two long spinules midway along the inner margin, with a pore near distal inner corner; basis with a pore near distal corner, inner margin forming lobate expansion with few spinules proximally; with spinules around distal and outer margin as figured; outer basal seta spinulose with flagellated tip. Endopod shorter than exopod, reaching halfway of the terminal exopod segment; rami 3-segmented; exp-1 and -2, and enp-1 and -2 typically with anterior spinule patches along distal margin. Inner margin of exp-1 and -2, and enp-1-3 few spinules as figured; spinular ornamentation around distal and outer segment margins as figured. Exp-2 and -3, and enp-3 with a pore anteriorly near distal margin.

P3 (Fig 5B). Similar to P2 in general except that. Intercoxal sclerite larger. Praecoxa without anterior spinules. Coxa without spinules midway along the inner margin; outer basal seta of basis slender and naked. Enp-1 with two small spinules near the base of inner seta and enp-2 without inner spinules. Endopod shorter than exopod.

P4 (Fig 5C). Similar to P2 in general except that. Coxa without spinules midway along the inner margin; outer basal seta of basis slender and naked. Endopod shorter than exopod, reaching only end of second exopod segment; exp-1 and -2 more slender.

The setal formula is as follows:

	Exopod	Endopod
P1	0.1.022	1.111
P2	1.1.123	1.1.121
P3	1.1.323	1.1.221 (1.1.02+apophysis)
P4	0.1.323	1.1.121

P5 (Fig. 4B). Baseoendopod with well-developed inner expansion, triangular in shape with five pinnate setae, with row of spinules near the insertion of exopod, with few spinules along inner margin, with few minute spinules near the base of naked outer basal seta. Exopod elongated, tapering distally, three times longer than wide, with row of spinules on outer margin and inner margin, and bearing six setae (one strong pinnate seta on inner margin; one plain and one plumose setae on distal margin; two strong pinnate and one plumose setae on outer margin). P6 (Fig. 2A) represented by a small segment with two naked and one plumose setae.

Description of male

As in female except for urosome, caudal ramus, antennule, P2, P3, P5 and P6. Body (length 277 μm) slightly smaller than female (Fig. 1B). Rostrum with two pores both apically and on anterior surface (Fig.7A). Setae III of caudal ramus pinnate (Fig. 6A, B).

Antennule (Fig. 7B-E). Indistinctly eleven-segmented and haplocer; aesthetascs on segments 6 and 11 and all setae naked; thorn-like modified elements on segments 5, 7 and 8 (Fig. 7B,D); setal formula as follows: 1-[1], 2-[10], 3-[5], 4-[6], 5-[3], 6-[1+(1+ae)], 7-[1+6 modified], 8[1+ 2 modified], 9,[1], 10-[4], 11-[6+acrotek].

P2 (Fig. 8A). Similar to that of female, but differs only in its slightly more robust structure.

P3 (Fig. 8B). The outer spine of enp-3 fused to the segment to form an apophysis at outer distal corner.

P5 (Fig. 4C). Baseoendopod inner expansion with two pores, with two pinnate setae, with a naked outer basal seta. Exopod two-segmented: exp-1 with one naked seta and row of spinules on outer margin; exp-2 with four pinnate setae on outer margin and a pore on anterior surface.

P6 (Fig. 6C). Completely fused to form a plate like structure with 3 naked setae.

Etymology

The specific epithet is given in honour of Prof. Dr. Süha AYDIN.

Discussion

Parastenhelia aydini sp. nov is unique in the genus by having 2-segmented P5 exopod with total of five setae in the male. The new species is morphologically most similar to *P. spinosa*. But the new species differ from *P. spinosa* by the combination of the following features in female: i) the antennule is 9-segmented, ii) spinular rows near outer margin of the basis of P1-P4 significantly reduced, iii) P4 enp-3 with four setae, iv) ornamentations on the baseoendopod and exopod of P5 setae different, v) inner terminal seta (seta V) not swollen at the base; differences observed in the male as follows: i) modified element on the seventh segment of the male antennule not present; apophysis on P3 enp-3 notched, ii) P4 enp-3 with four setae.

The main problem surrounding morphology-based parastenheliid taxonomy lies in the outdated morphological description of defining species. This has resulted in confusion about the justification of the genera. For example, the type genus *Parastenhelia* is housing unnatural, polyphyletic assemblages of species (Gee, 2006). It is now widely accepted that a genus should constitute a monophyletic group and there should be convincing phylogenetic reasons before a new genus is established (Holm & Schoeman 1999). But, the insufficient descriptions of many species are a main obstacle in testing the monophyletic status of several genera in the family Parastenheliidae. The most problematic species within the genus *Parastenhelia* is the type species *P. spinosa* which was first described as *Harpacticus spinosus* by Fischer (1860) from the island of Madeira but the description is insufficient and vague so that only the drawing of the P1 could justify that it belongs to *Parastenhelia*. Detailed redescription of *P. spinosa* are therefore urgently needed in order to support a robust phylogeny-based classification and to identify more accurate diagnostic characters for this genus (Gee 2006). The revision of so called *P. spinosa*-complex has been initiated by the present authors and the preliminary results showed that the Langian concept of *P. spinosa* as a variable, cosmopolitan species is wrong (personal observations). It is also clear that several lineages can be identified among the species of *Parastenhelia*. Whether each of these lineages belongs to a different taxonomic category should be re-examined when more detailed morphological data becomes available. Sexual dimorphism displayed by the male appendages, especially those of sexually dimorphic antennule, should provide a considerable number of significant characters that are valuable for both taxonomic identification and phylogenetic inferences (Kaymak & Karaytuğ 2014). For example, there are three modified thorn-like elements on segment 6 (personal observations), one of which is very distinctive, large and valuable both for taxonomic and phylogenetic uses. It can be concluded that detailed redescriptions of both sexes of *P. spinosa* will certainly help in solving the taxonomic problem surrounding the genus.

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