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ORIGINAL ARTICLE

Apodopsyllus gabesensis n. sp.: a new species of Paramesochridae (Copepoda: Harpacticoida) from the Gulf of Gabès (south-eastern Tunisia)

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Abstract Several specimens belonging to a new species of *Apodopsyllus* were collected during a study on the diversity of meiobenthic communities in the Gulf of Gabès, a Mediterranean shallow-water bay at the south-eastern coast of Tunisia in July 2005. The new species *Apodopsyllus gabesensis* n. sp. shares the characteristics of the genus such as the lack of endopods from P2 to P4 and the soft and slightly cuticularized body. *Apodopsyllus gabesensis* n. sp. belongs to the few known species of *Apodopsyllus* that are described to have comparably distinct patterns of dorsal and lateral cuticular plates and pores. Besides a typical combination of characters that clearly distinguishes the new species from its congeners, the new species shows the following unique single characters: female P5 with a hitherto unknown combination of shape of the exopodal part and shape and setation of the baseoendopodal lobe with two small stout spines; male P6 with a particular shape, and a distinct armature of the exopodal spines in P2–P4 in the male that are pinnate with very short spinules contrary to the female where spines are smooth. The genus *Apodopsyllus* contains 26 species with the inclusion of the new species.

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Introduction

Adaptation to life in the interstices of sandy sediments has resulted in the independent evolution of similar morphological features within many taxa, among others in harpacticoid copepods (Huys 1988). One of these taxa is Paramesochridae Lang, 1944. The great majority of the paramesochrid species (over 80% of the 120 or more known species) are interstitial forms that have colonized the mesopsammic environment of sandy beach ground water, the intertidal and shallow waters. Miniaturization of the body has been the most important step within the adaptations to this habitat. Most species are small ranging from 0.2 to 0.5 mm in body length (Boxshall and Halsey 2004). Their body shapes are variable: mostly cylindrical, sometimes cyclopiform, ranging from slightly to markedly dorsoventrally depressed, as in the monospecific genus *Caligopsyllus* Kunz, 1975. Many species of Paramesochridae are among the smallest harpacticoids known from the interstitial environment. The genus *Apodopsyllus* Huys, 2009 (before Huys (2009) named *Apodopsyllus* Kunz, 1962) is commonly found in the interstices of fine sands. Its members attained a vermiform body shape, which is accompanied by a conspicuous reduction in the swimming legs. They adapted a gliding way of movement in order to facilitate wriggling around and between the sand grains (Huys 1988).

Apodopsyllus was informally erected by Kunz (1962) and recently formally put to nomenclatural correctness by Huys (2009). Here, we adapt the new generic names for the family Paramesochridae given by Huys (2009); however, we give the former names for reasons of clarity as well.

The genus *Apodospyllus* belongs to the family Paramesochridae, which according to Huys (1987) consists of two subfamilies. One subfamily Diarthrodellinae Huys, 1987 is considered to be more plesiomorphic due to the presence of a 3-segmented antennary exopod, 3-segmented endopods in P2–P4, an inner seta on the proximal segment of the exopods of P2–P4 and a primitive setation of the distal exopodal and endopodal segments of P2–P4. Diarthrodellinae contain the genera *Diarthrodella* Klie, 1949, *Tisbisoma* Božić, 1964 and *Rossopsyllus* Soyer, 1975. The apomorphous and more derived subfamily Paramesochrinae Huys, 1987 is characterized by a 2-segmented antennary exopod, 2-segmented endopods in P2–P4, the absence of the inner seta on the proximal segment of the exopod of P2–P4 and a reduction in the distal exopodal and endopodal segments of P2–P4. Paramesochrinae contains the *Paramesochra* group (*Paramesochra* T. Scott, 1892; *Emertonia* Wilson, 1932 (before Huys (2009) named *Kliopsyllus* Kunz, 1962); *Kunzia* Wells, 1967; *Meiopsyllus* Cottarelli and Forniz, 1994), the *Wellsopsyllus* group (before Huys (2009) named *Scottopsyllus* group) containing *Wellsopsyllus* (*Scottopsyllus*) Apostolov & Marinov, 1988, *Wellsopsyllus* (*Intermedopsyllus*) Huys, 2009 and *Wellsopsyllus* (*Wellsopsyllus*) Kunz, 1981 (before Huys (2009) named *Scottopsyllus* (*Scottopsyllus*) Kunz, 1962; *Scottopsyllus* (*Intermedopsyllus*) Kunz, 1962; *Scottopsyllus* (*Wellsopsyllus*) Kunz, 1981), *Leptopsyllus* (*Leptopsyllus*) T. Scott, 1894, *Leptopsyllus* (*Paraleptopsyllus*) Lang, 1944, *Apodopsyllus* Huys, 2009 and *Caligopsyllus* Kunz, 1975 (after Huys (1987)) as well as the genus *Remanea* Klie, 1929. The monospecific genus *Biuncus* Huys, 1996 belongs to the *Scottopsyllus* group and is closely related to *Leptopsyllus* (Huys 1995). Especially, in the *Scottopsyllus* group, there is evidence that certain taxa have undergone paedomorphic evolution. *Scottopsyllus*, *Leptopsyllus* (*Leptopsyllus*), *Leptopsyllus* (*Paraleptopsyllus*) and *Apodopsyllus* can easily be included in a morphological series with increasingly pronounced larval characters (Huys 1987).

Meiobenthic communities from the Tunisian coast (Western Mediterranean) have been extensively investigated during pollution monitoring studies with focus on free-living Nematoda (Beyrem and Aïssa 2000; Hermi and Aïssa 2002, Mahmoudi et al. 2003a,b; Mahmoudi et al. 2005; Boufahja et al. 2007a,b; Hedfi et al. 2007; Mahmoudi et al. 2007; Beyrem et al. 2007; Mahmoudi et al. 2008). Benthic copepod communities have not received the same attention, and the harpacticoid fauna of Tunisia remains poorly known. The effects of anthropogenic influences on sediments (Amorri et al. 2009) and the distribution and abundance of meiofauna with focus on the benthic copepods were studied in the polluted area of the Gulf of Gabès in July 2005 (Fig. 1). In this study, at least 32 species of harpacticoid copepods were recovered from the sediment samples of which five were new to science. One of these belonged to the genus *Apodopsyllus*. Chappuis (1954) previously reported *Apodopsyllus littoralis* from Sfax, Gulf of Gabès (Nicholls, 1939), a species that was originally described from Scotland (Nicholls 1939). However, the present contribution deals with the description of a new species of *Apodopsyllus* collected in the same region.

Materials and methods

Samples were taken by SCUBA divers at nine stations (Fig. 1). At each station four replicate sediment cores (10 cm^2) were taken by means of a push corer. Samples were immediately preserved in 5% buffered formalin and meiofaunal taxa were separated by the resuspension–decantation method (Vivier 1978) and stained with Rose Bengal (Guo et al. 2001). Meiofauna was sorted to the higher taxon level, and copepods were subsequently transferred to glycerin. Specimens of *Apodopsyllus* were detected with the aid of a Leica MZ 12.5 stereo microscope and a Leica DMR microscope. Before dissection, the holotype of *Apodopsyllus gabesensis* n. sp. was drawn from the dorsal side and lateral side. An additional drawing of the ventral side of the abdomen was made. The paratype

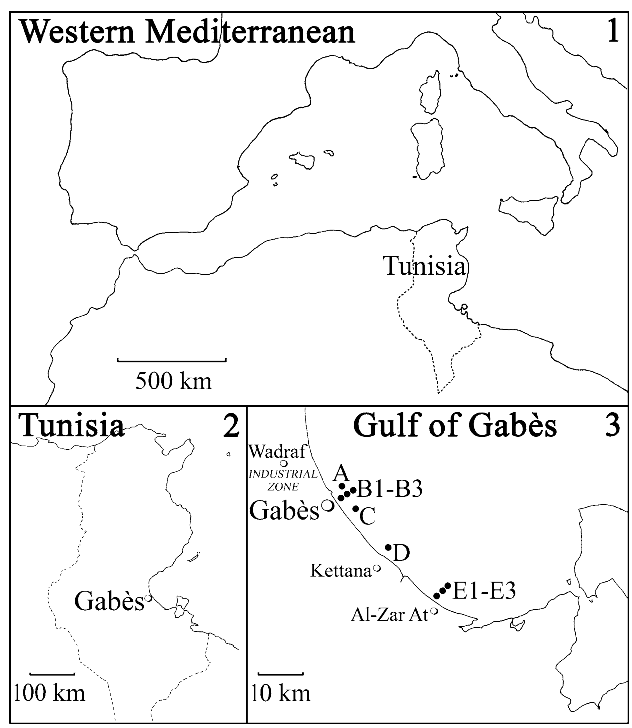

Fig. 1 Map showing the sampling station (A) in the gulf of Gabès **(3)** in south-eastern Tunisia **(2)**. An overview of the western Mediterranean is shown in **(1)**

was dissected without previous drawings. The dissected parts were mounted in glycerin on several slides. Drawings were made with the aid of a camera lucida on a Leica DMR microscope equipped with differential interference contrast (DIC) at 1,000× magnification.

Abbreviations used in the text are aes, aesthetasc; exp, exopod; enp, endopod; benp, baseoendopod; P1–P6, swimming legs 1–6; and enp1, the first segment of the endopodite.

Material examined

Apodopsyllus gabesensis n. sp.:

Type material:

Female holotype: SMF 34,734 (dissected on 7 slides), male allotype: SMF 34,735 (dissected on 6 slides), male paratype: SMF 34,736 (undissected on 1 slide).

Additional material:

Female: FSB-LBE-LR 01ES14-01 (undissected), female: FSB-LBE-LR 01ES14-02 (undissected), male: FSB-LBE-LR 01ES14-03 (undissected), male: FSB- LBE-LR 01ES14-04 (undissected).

All specimens from the type locality: Gulf of Gabès, station A (Fig. 1), south-eastern coast of Tunisia, Western Mediterranean Sea, 33°56. 37′N, 10° 05. 24′E, depth 5 m. The species has been collected from fine sandy sediment (0.42% clay, 2.37% silt and 97.21% fine sand) on 15 July 2005.

The type material is registered in the collection of the Senckenberg Forschungsinstitut und Naturmuseum Frankfurt (SMF), Germany and kept at Senckenberg—German Centre for Marine Biodiversity Research (DZMB) in Wilhelmshaven, Germany. Full details can be found and future developments followed up in the online database SeSam at the URL: sesam.senckenberg.de (see also Brandis et al. 2007). The additional material is kept in the collection of the University of 7 November-Carthage, Sciences Faculty of Bizerte (FSB), Environmental Biomonitoring Research Laboratory (LBE-LR 01ES14), Zarzouna-Bizerte, Tunisia.

Etymology

The species name *gabesensis* refers to the sampling area: the Gulf of Gabès.

Results

Paramesochridae Lang, 1944.

Apodopsyllus Kunz, 1962.

Apodopsyllus gabesensis n. sp.

Description of female holotype

Total body length measured from anterior tip of rostrum to posterior margin of anal somite (Holotype): 0.48 mm (values of additional females: 0.46 and 0.47 mm). Including the caudal rami: 0.52 mm (values of additional females: 0.50 and 0.51 mm).

Rostrum (Fig. 2a). Not demarcated, short, blunt, hyaline, with no visible sensilla.

Body (Fig. 2a–c). Slender, tapering posteriorly, slightly depressed dorsoventrally and with prosome as wide as urosome (carrying a single (empty) egg sac). Whole body very hyaline. Cephalosome (Fig. 2a) decorated with cuticularized structures and depressions of different sizes and forms. All somites with distinct patterns of dorsal, ventral and lateral cuticularized plates and round depressions. Free pedigerous somites with lateral plates connected to the origin of swimming legs, pedigerous somites P3–P4 with additional dorsal plates. P5 bearing somite with dorsal and lateral plates, ventral plates connected to P5. Completely fused genital double somite with plate surrounding genital area and small ventral pates near posterior corners, dorsolateral plates of former segments of double somite fused. All other urosomal somites with dorsolateral and ventrolateral pairs of plates. No visible sensilla on body surface. Pores present in small numbers, distributed dorsally and laterally on cephalothorax, three free pedigerous somites of prosome and all free urosomites. Anal somite short, about as long as wide.

Antennule (Fig. 3). Eight-segmented, segment I with row of short spinules and segment II with depression.

Armature formula: I (0); II (7): 6 pinnate setae, 1 of which stout, with distinct brushlike pinnation and blunt tip, and 1 slender naked seta; III (8): 2 slender pinnate setae and 6 naked setae; IV (2 + (1 + aes)): 2 slender and naked setae and 1 long slender seta fused at basis with aesthetasc; V (1): 1 long slender naked setae; VI (0); VII (5): 2 slender pinnate setae, 2 slender naked setae and 1 long slender pinnate seta situated on elevation; and VIII (6 + (1 + aes)): 1 pinnate seta, 6 slender naked setae of different sizes, one of which fused at base with terminal aesthetasc.

Antenna (Fig. 4b). Coxa short. Basis asetose with a row of small spinules. Endopod 2-segmented. Enp1 with long pinnate abexopodal seta. Enp2 armed with several spinule rows, subapically with 3 setae, 2 of which stout, spine-like and one of which slender and naked. Apical margin with 6 setae, 4 of which geniculate and 2 of which fused at base. Lateral margin with 2 inner stout elements. Exopod 1-segmented with lateral spinule row, furnished with 4 elements: 1 strong pinnate seta, 1 seta with bifid tip with additional spinule, 1 strong bifid terminal seta and 1 smaller naked slender seta.

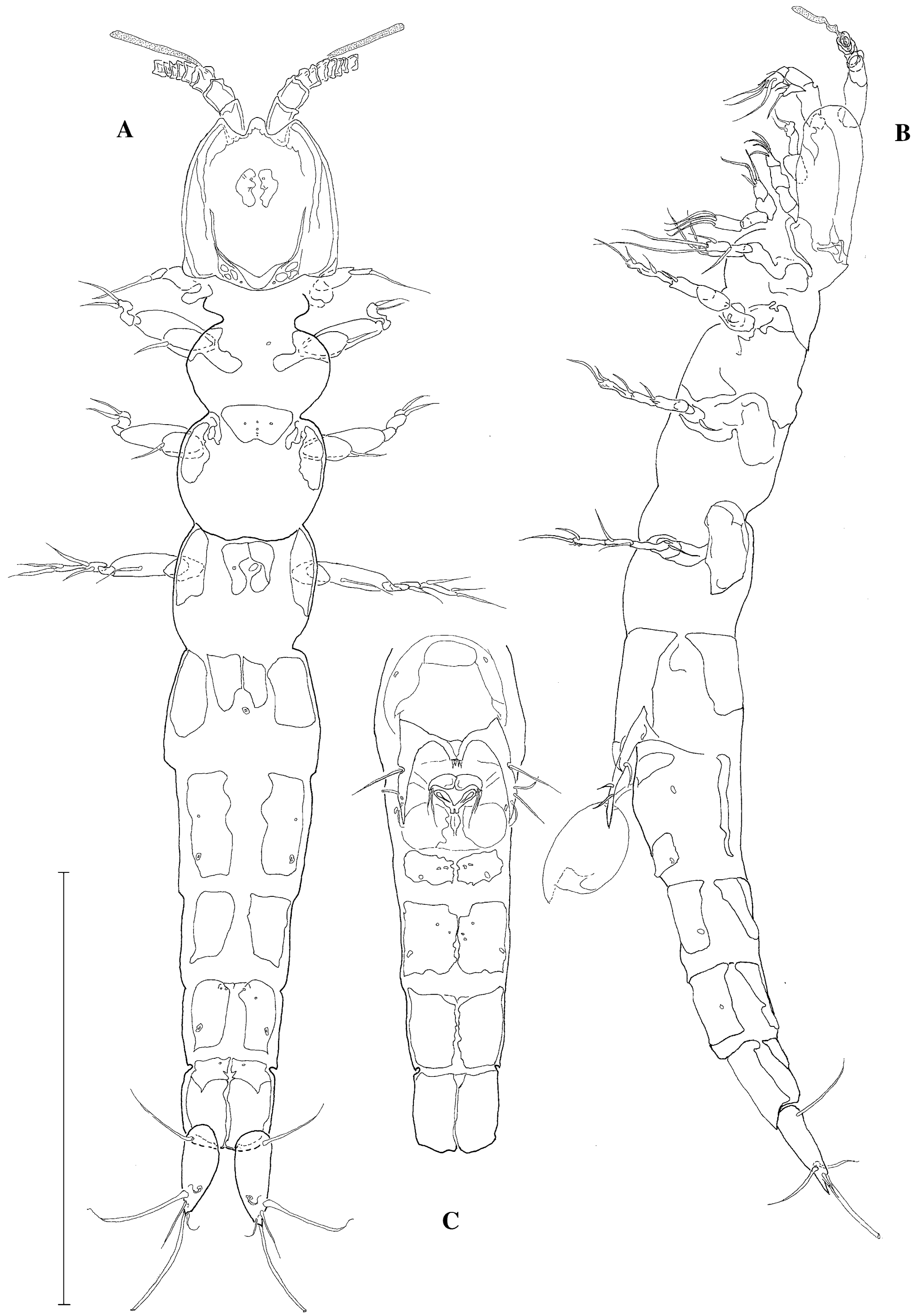

Fig. 2 *Apodopsyllus gabesensis* n. sp., female holotype. **a** Habitus in dorsal view; **b** habitus in lateral view and **c** abdomen in ventral view, *scale bar* 0.2 mm

Mandible (Fig. 4a). Coxa with elongated gnathobasis. Cutting edge with large tooth surrounded by 6 smaller teeth. Basis with 2 pinnate inner setae. Palp biramous. Enp 3-segmented: first segment bearing 2 slender setae, second one unarmed and third one apically furnished with 4 naked slender setae. Exp half the length of enp, 1-segmented, with 2 lateral and 2 apical naked slender setae.

Maxillule (Fig. 4e). Praecoxal arthrite with 2 juxtaposed slender setae. Inner margin of arthrite with 7 strong, stout spines and 1 strong seta. Coxal endite with 4 setal elements one of which is strong and pinnate. Basis with endite armed with 6 slender setae two of which pinnate. Enp 1-segmented with 6 slender naked setae. Exp represented by 2 slender setae, one of which pinnate.

Maxilla (Fig. 4c). Praecoxa and coxa fused to form syncoxa bearing 3 endites. Proximal endite with 3 naked setal elements, one of which is stout. Middle endite with 2 naked setae and 1 pinnate stout spine. Distal endite armed

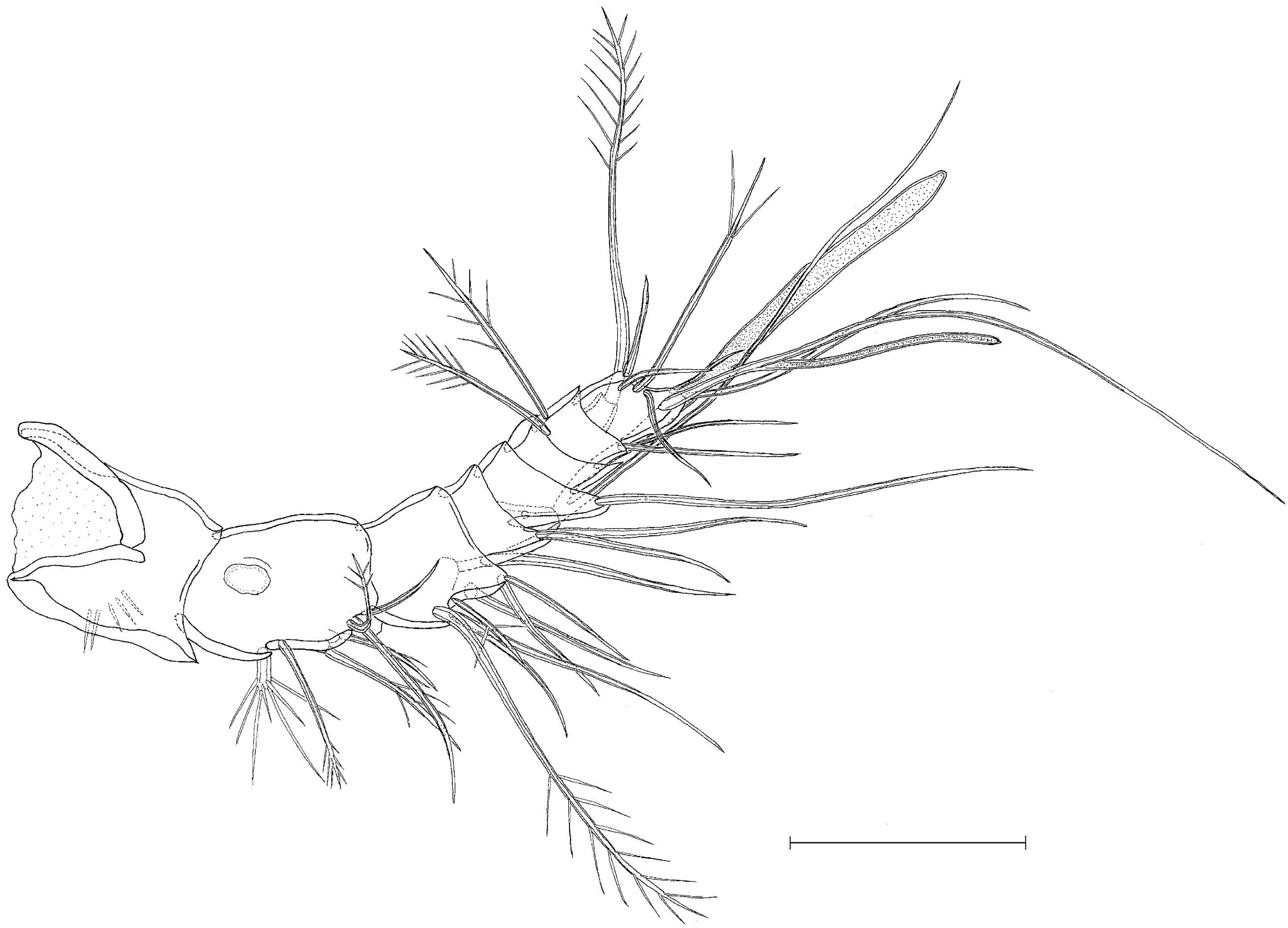

Fig. 3 *Apodopsyllus gabesensis* n. sp., female holotype. Antennule in dorsal view, *scale bar* 0.02 mm

with 2 strong spinulose spines and 1 naked seta. Basis with 2 strong spinulose spines. Enp 2-segmented, first segment with 1 small and 2 strong setae, one of which is pinnate, 3 naked setae on second segment.

Maxilliped (Fig. 4d). Syncoxa without armature. Basis long with a row of small spinules at the distal inner margin and 2 outer spinules. Enp 1-segmented with 1 strong naked seta, 2 small setae and 2 straight slender, naked apical setae.

Swimming legs (Fig. 5a, b, d, e) Setal formula see Table 1.

P1 (Fig. 5a). Coxa bare. Basis with inner naked seta and row of spinules on outer margin. Enp as long as exp, both 2-segmented. Enp1 elongate, bare, enp2 with outer spinules and 2 slender apical setae. Exp1 with outer spinulose seta and some spinule rows. Exp2 with several spinules and 2 apical and 2 outer slender spinulose setae.

P2–P4 (Fig. 5b, d, e). Coxa bare. Basis of P2–P4 bearing plumose outer seta. In P2 and P3 basis with large pore, P4 with additional small seta on inner margin. Endopods of P2–P4 absent. Three-segmented exopods. Segments slender and elongate. Distal inner margin of exp2 prolonged into acute projection, exp3 proximally more slender than distally. Exp1 of P2–P4, with a row of short spinules along outer margin and short spinules accompanying naked outer spine. Exp1 of P2 and P4 with additional anterior row of spinules. Exp2 P2–P4 with outer spine accompanied by short spinules. Exp2 of P2 and P3 with additional spinule row apically. Outer spine in exp2 of P4 placed medially on segment. Exp3 of P2–P4 with short apical spinules, 1 long terminal and 1 short outer spine. Terminal spines of exp3 P2 and P3 geniculated.

P5 (Fig. 6a) with elongated pointed exopod. Exp completely fused with baseoendopod. Benp with small endopodal lobe bearing 2 apical very short spine-like setae. Legs linked by medial plate. Surface of exp covered by small round depressions, outer margin with 4 slender naked setae, one of which placed near the middle of the outer margin and 3 inserted in distal third of the leg.

Genital complex and P6 (Fig. 6b). P6 represented by very delicate plates, touching medially, each with 2 slender naked setae.

Caudal rami (Figs. 2a, 6c, d). Subpyriform, almost three times longer than wide, with pointed end and 6 setae: seta I absent; seta II slender, dorsally displaced; seta III

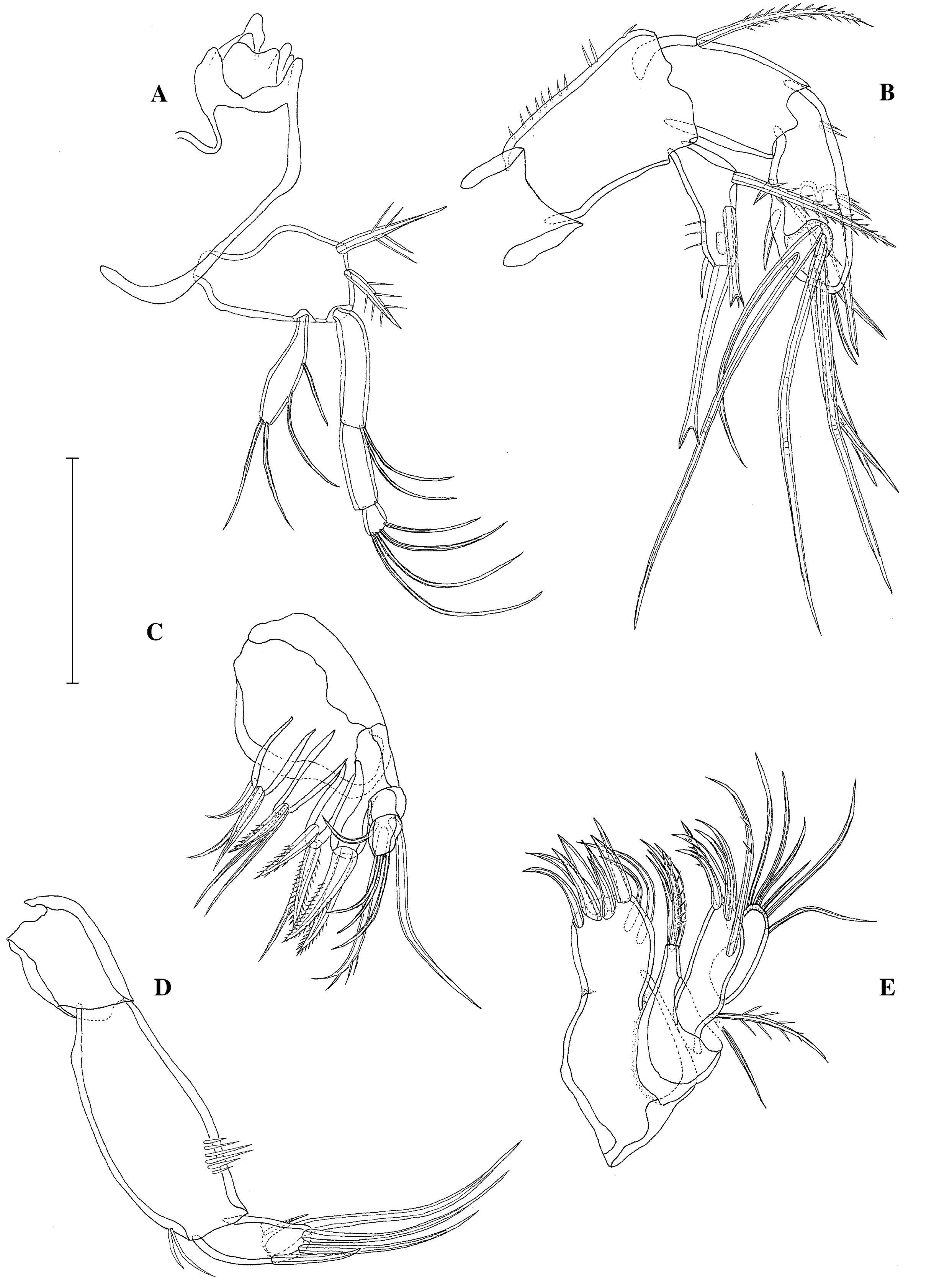

Fig. 4 *Apodopsyllus gabesensis* n. sp., female holotype. **a** Mandible and mandibular palp; **b** antenna; **c** maxilla; **d** maxilliped and **e** maxillule, *scale bar* 0.02 mm

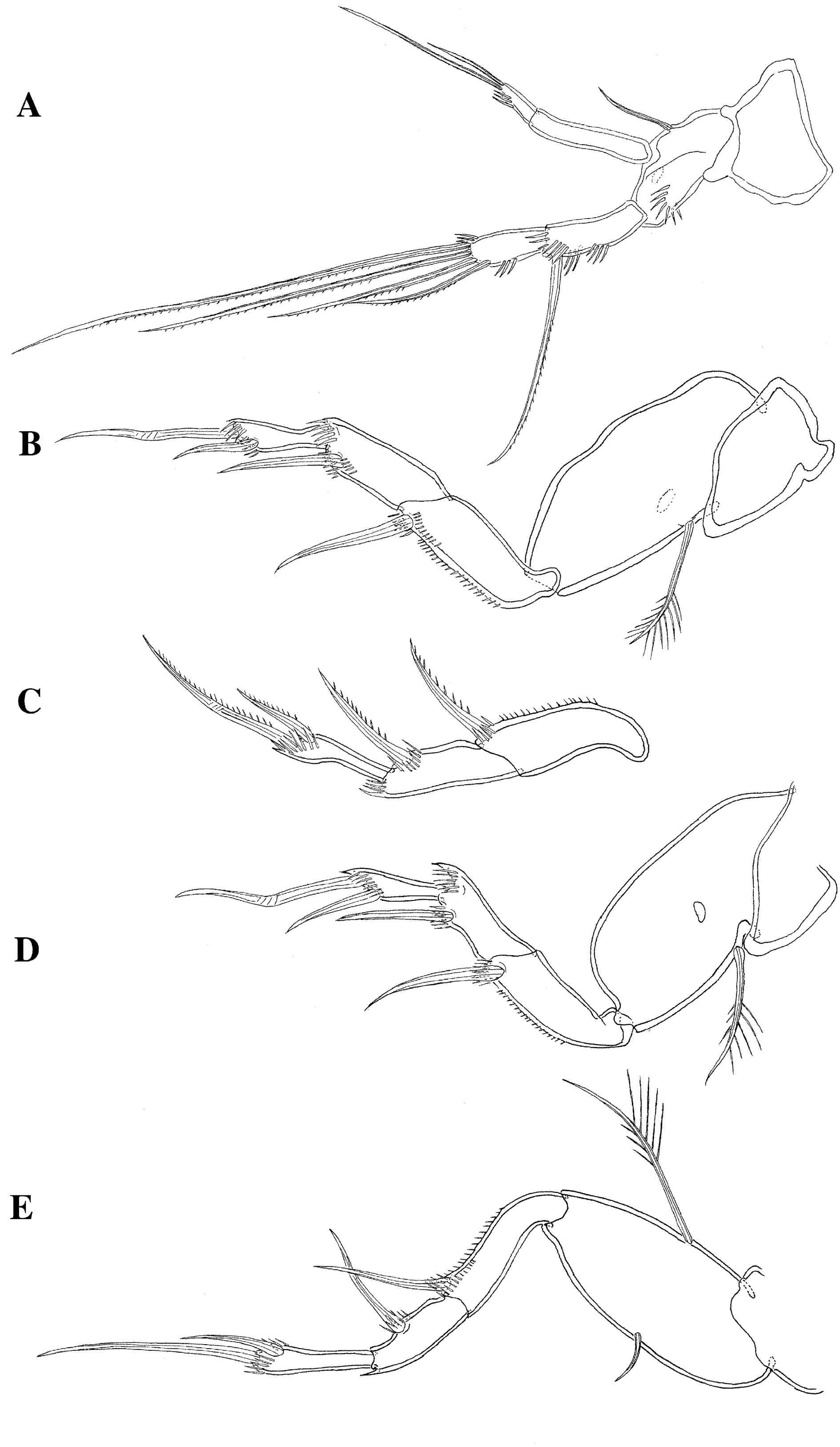

Fig. 5 *Apodopsyllus gabesensis* n. sp. **a** Female holotype P1; **b** female holotype P2; **c** male allotype P2 exopod; **d** female holotype P3 and **e** female holotype P4, *scale bar* 0.05 mm

Table 1 Setal formula of swimming legs of *Apodopsyllus gabesensis* n. sp.

	Basis	Exopod	Endopod
P1	1.0	0.022	0.011
P2	0.1	0.0.011	Absent
P3	0.1	0.0.011	Absent
P4	0.1	0.0.011	1

slender, slightly smaller than II, situated dorsolaterally, near posterior end; seta IV slender and smaller than III; seta V, long and slender, situated terminally on dorsal surface; seta VI small, accompanying V; and seta VII small, inserted on dorsal surface.

Description of male allotype

Habitus as in female but slightly smaller and second and third urosomites separate. Total body length measured from anterior tip of rostrum to posterior margin of anal somite (allotype): 0.47 mm (values of three additional males measured: 0.44, 0.45, 0.46 mm). Including the caudal rami: 0.51 mm (values of three additional males measured: 0.48, 0.49, 0.50 mm). Spermatophore voluminous, situated in prosome.

Antennule (Fig. 7) 6-Segmented and subchirocer. Segment I with several long spinules along inner margin, segment V rounded and bulbous, following segments not completely separated forming segment VI.

Armature formula: I (0); II (7): 3 slender naked setae, 3 strong pinnate setae and 1 stout seta with distinct brushlike pinnation and blunt tip; III (3): 1 small pinnate seta, 2 slender naked setae, one of which is very long; IV (5): 1 slender naked seta, 4 pinnate setae; V (4 + (1 + aes)): 5 slender naked setae one of which fused at base with aesthetasc; VI nearly entirely fused with former segment VII (11 + (1 + aes)): one pinnate and 11 slender naked setae one of which fused at base with terminal aesthetasc.

Mouthparts and swimming legs: as in female, sexual dimorphism in antennule, P5 and P6, and in slight differences in armature of P2–P4 where all exopodal spines are armed with very short spinules (see Fig. 5c).

P5 (Fig. 8a) both sides not fused. Benp confluent with elongated exopod covered with small pores. Outer margin with four setae, like in female P5, one of which longer and placed medially. Endopodal lobe is absent.

P6 (Fig. 8b). Sixth pair of legs are well developed, represented by bean-like oval shaped plates decorated with 3 naked setae. Setae gradually changing from slender flexible outermost seta to rugged apical seta and thick wrinkled seta at inner apical margin of the plate.

Discussion

Systematics

Characterization of Apodopsyllus

Apodopsyllus is characterized as follows (Kunz 1962): body cylindrical and elongate, rostrum small, first segment of antenna enp with seta, antenna exp 1- or 2-segmented, P1 biramous with 1- or 2-segmented exp, enp P1 present, P2–P4 with 3-segmented exp (exp3 carrying two setae), enp of P2–P4 lacking, exp P5 demarcated or fused with benp and caudal rami with only one well-developed terminal seta. After Boxshall and Halsey (2004), additional characteristics are a soft and only slightly cuticularized body, confluent basoendopodal lobes of P5 that form a large well-developed plate in both sexes and weakly expressed urosomites that are not demarcated from each other. The podoplean boundary between prosome and urosome is extremely poorly defined in this derived genus. Huys (1988) pointed out that the genus *Apodopsyllus* (excluding *Apodopsyllus aberrans* Mielke, 1984b) is defined by five autapomorphies: Coxa and basis of P4 fused; rostrum diminutive, not defined at base; Enp P4 represented as a minute hyaline structure; outer terminal seta (IV) of caudal rami reduced [posterior margin forming a ventral triangular lappet covering the basis of the inner terminal seta (V)]; reduction in the integument and partial fusion of body somites allowing a maximum wriggling ability in the interstitial habitat.

Wells (1971) discussed the possible adaptative significance of the fusion of body somites of members of the genus *Apodopsyllus* and supposed that it provided maximum wriggling ability for these interstitial organisms. Additionally, the extreme reduction in the pereiopods is helpful to move in their preferred habitat. Kunz (1981) considered *Apodopsyllus* a highly specialized genus of Paramesochridae. Later, Huys (1988) stated that the vermiform body shape as well as the reduction and the position of the swimming legs enhance wriggling ability and allow for a gliding movement in the interstitial habitat.

Subdivisions within the genus Apodopsyllus

Different opinions were given by taxonomists about the possibility of the existence of any subdivision within the genus *Apodopsyllus*. Coull and Hogue (1978) used two characters in their key in order to define two species groups of *Apodopsyllus* based on the relative length of the P1 endopod to the length of the P1 exopod and the shape of the two endopodal setae. The *madrasensis* group was defined by a P1 enp being at least two times longer than the exp and two short apical claws in the enp2. At that time, it

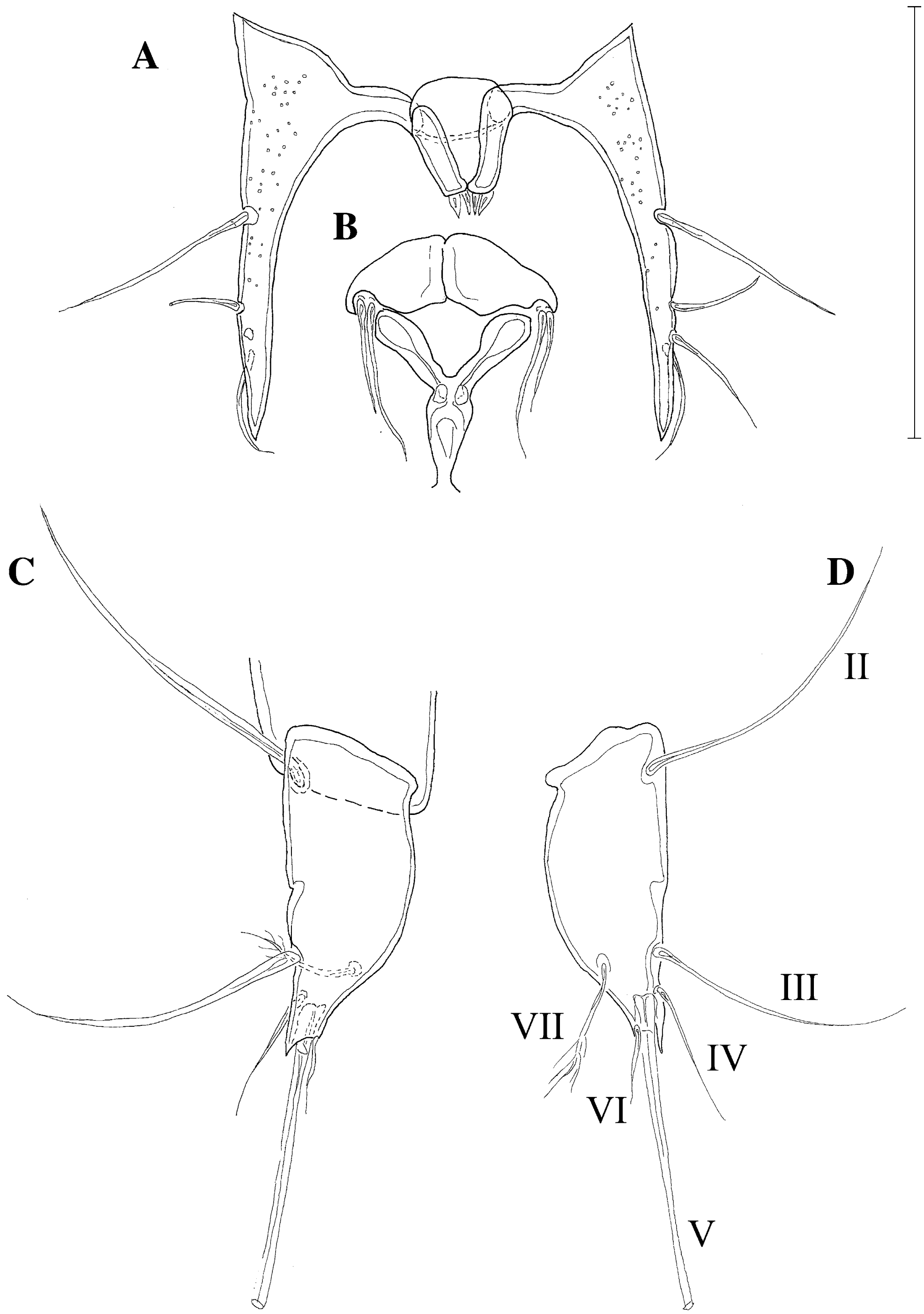

Fig. 6 *Apodopsyllus gabesensis* n. sp., female holotype. **a** P5; **b** P6 and genital field; **c** caudal ramus in ventral view and **d** caudal ramus in dorsal view, *scale bar* 0.05 mm

consisted of two species: *Apodopsyllus madrasensis* (Krishnaswamy, 1951) and *Apodopsyllus unguiformis* Coull and Hogue, 1978. The *littoralis* group was defined by a P1 enp being 1–1.7 times longer than the exp and two long filiform setae in the enp2. At that time, it contained 10 species: *Apodopsyllus adaptatus* (Krishnaswamy, 1957), *Apodopsyllus africanus* Kunz, 1962, *Apodopsyllus arenicolus* (Chappuis, 1954), *Apodopsyllus bermudensis* Coull and Hogue, 1978, *Apodopsyllus camptus* Wells, 1971, *Apodopsyllus depressus* (Krishnaswamy, 1957), *Apodopsyllus littoralis* (Nicholls, 1939), *Apodopsyllus schulzi* (Noodt, 1964), *Apodopsyllus spinipes* (Nicholls, 1939) and *Apodopsyllus vermiculiformis* Lang, 1965. They made this subdivision with the P1 endopod as the primary

Fig. 7 *Apodopsyllus gabesensis* n. sp., male allotype. Antennule, *scale bar* 0.02 mm

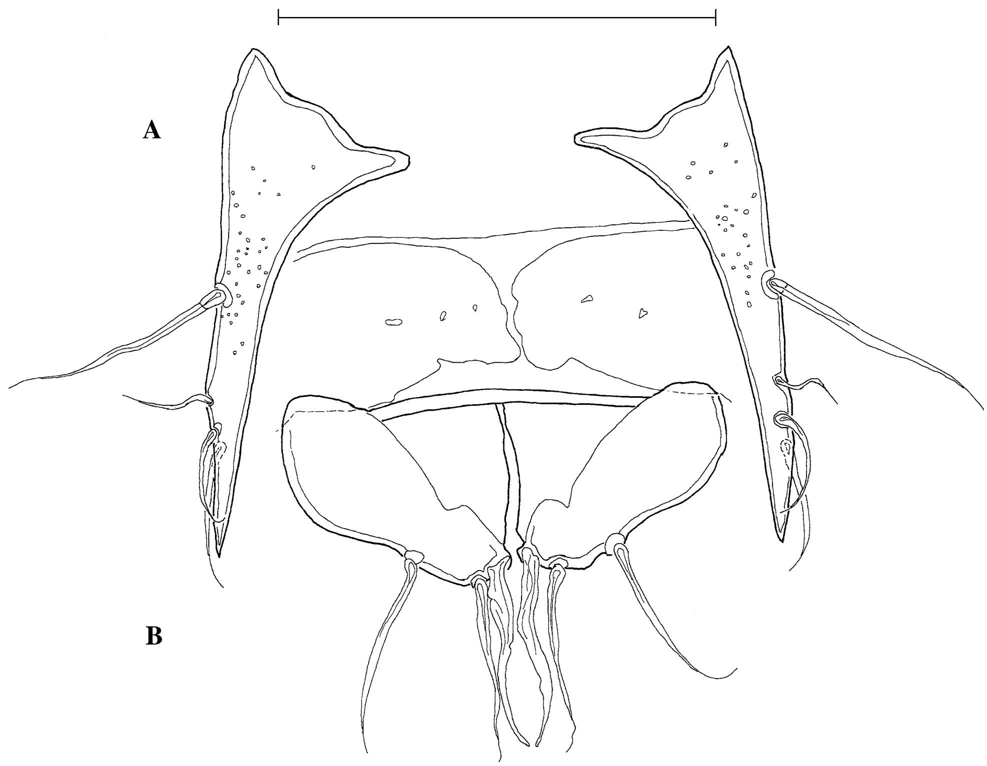

Fig. 8 *Apodopsyllus gabesensis* n. sp., male allotype. **a** P5 and **b** P6, *scale bar* 0.05 mm

character because it was a readily visible structure, and there were accurate drawings of this feature in all the species descriptions. However, they pointed out that these species groups served mainly to illustrate a potential division within the genus without any nomenclatural or taxonomic status. Recently, Gómez (2002) challenged this subdivision. Additionally, Kunz (1981) mentioned that the presence or absence of a seta in the place of the absent enp

P4 or the P5 being 1- or 2-segmented was not valid as possible characters to define species groups because the two plesiomorphic characters were not linked.

Mielke (1984, 1987, 1988) described, within studies about new harpacticoids from the neotropics, the three new species *Apodopsyllus arcuatus* Mielke 1984, *Apodopsyllus chilensis* Mielke, 1987 and *Apodopsyllus cubensis* Mielke, 1988. These species are characterized by the presence of well-defined dorsal and ventral plate structures on the body somites. Thus, Gómez (2002) considered this a synapomorphy for these species and stated that they belonged to an exclusively neotropical lineage he called the *arcuatus-chilensis-cubensis* clade. Moreover, he added two new species of the Mexican paramesochrid fauna, *Apodopsyllus samuelgomezi* Gómez, 2002 and *Apodopsyllus pseudocubensis* Gómez, 2002 to this clade that is united by this synapomorphic character state.

Placement of A. gabesensis n. sp. and differentiation from congeners

At present, *Apodopsyllus* contains 26 species (including the one described in this paper). *Apodopsyllus gabesensis* n. sp. can be separated from its congeners by the following exclusive characters [comparisons were made using original descriptions and additional literature (Bodin 1997)]:

(1) female P5 with elongated exp with four external setae fused with the benp combined with a small endopodal lobe of benp with two small apical spines, (2) well-developed P6 in the male with very particular shape not described before in any species of *Apodopsyllus*, (3) armature of P2–P4 in male slightly different from the female as all exopodal spines are pinnate with very short spinules.

The question is whether this last character is a unique character of the new species *Apodopsyllus gabesensis* n. sp. or this particular feature has been overlooked by other describers. Perhaps other species also show this character that must be considered in future descriptions and studies.

Furthermore, *Apodopsyllus gabesensis* n. sp. can be distinguished from its congeners by the unique combination of the following characters: Distinct pattern of dorsal, lateral and ventral cuticular plates on prosome and urosome; antennule 8-segmented in female and 6-segmented in male; antennary exopod 1-segmented; P1 exp 2-segmented, P1 enp2 with two apical slender setae; exopodal spines of P2–P4 in male pinnate with very short spinules but naked in female; P4 enp represented by small seta; female P5 with unique shape and setation; and male P6 with unique shape.

There are four formerly described *Apodopsyllus* species from regions that are geographically more or less close to the type locality of *Apodopsyllus gabesensis* n. sp. (i.e. the Gabès region, Gulf of Gabès, south-eastern coast of Tunisia). The new species, however, can be distinguished from the species *Apodopsyllus littoralis* (among others collected from the Sfax region, Gulf of Gabès), the African species *Apodopsyllus africanus africanus* Kunz, 1962, the Italian species *Apodopsyllus lynceorum* Cottarelli, 1971 and the Mediterranean species *Apodopsyllus arenicolus*. The differences are many, but the most important and easily recognizable are the following: (1) Distinct patterns of plates and pores in dorsal, ventral, and lateral position on the body somites of *A. gabesensis* n. sp. absent (or not shown) in the other species; (2) female A1 9-segmented in *A. littoralis* and *A. lynceorum,* 8-segmented in *A. gabesensis* n. sp. and 7-segmented in *A. arenicolus* and *A. africanus africanus;* (3) A2 exp 1-segmented in *A. gabesensis* n. sp., *A. africanus africanus*, *A. littoralis* and *A. lynceorum*, but 2-segmented in *A. arenicolus;* (4) *A. gabesensis* n. sp. and *A. africanus africanus* have a 2-segmented P1 exp bearing 4 setae in its distal segment (the other species have a 1-segmented P1 exp bearing 5 setae); (5) female P5 exopods of similar elongated shape with 4 outer setae like in *A. gabesensis* n. sp. are found in *A. arenicolus* and *A. lynceorum*. However, differences appear in the position of the former basal seta that is placed farther away from the following former exopodal setae in *A. gabesensis* n. sp. Furthermore, the female P5 exp is covered by small depressions, and the endopodal lobe of the baseoendopod is small in *A. gabesensis* n. sp., while these features are absent or not shown in those two species; (6) male P5 of *A. gabesensis* n. sp. is similar to *A. littoralis*, *A. lynceorum* and *A. arenicolus*, but it differs in shape from *A. africanus africanus;* (7) female genital fields (not described for *A. africanus africanus*) of the compared species are differing greatly from each other in dimension and structure.

As *Apodopsyllus gabesensis* n. sp. has well-defined dorsal and ventral plate structures on the body somites, we can place it tentatively in the *arcuatus-chilensis-cubensis* clade proposed by Gómez (2002). It is not the scope of this paper to review the validity of the neotropical lineage proposed by Gómez (2002). However, it has to be taken into account that the fine plate structures observed in the members of this clade and in *Apodopsyllus gabesensis* n. sp. might have been overlooked by some authors.

Apodopsyllus gabesensis n. sp. differs from the hitherto known species from the *arcuatus-chilensis-cubensis* group. The comparison made between the species has the following results: (1) Female A1 7-segmented in *A. cubensis*, 7 to 8-segmented in *A. chilensis*; 8-segmented in *A. arcuatus*, *A. samuelgomezi*, *A. pseudocubensis* and *A. gabesensis* n. sp.; (2) *A. gabesensis* n. sp., *A. cubensis*, *A. arcuatus* and *A. chilensis* have similar caudal rami with respect to shape and setation. *A. samuelgomezi* and *A. pseudocubensis* have different caudal rami in setae position or length; (3) female P5 of *A. gabesensis* n. sp. is not similar in shape of exp in combination with the dimensions of the baseoendopodal lobe to any of the species of the clade (P5 not given for *A. samuelgomezi*). The surface of P5 exp of *A. gabesensis* n. sp. is covered by small depressions; (4) female genital fields of the compared species are different from each other in shape (not shown in *A. arcuatus* and *A. samuelgomezi*).

Thus, *Apodopsyllus gabesensis* n. sp. belongs to the subfamily Paramesochrinae, therein to the *Scottopsyllus* group and to the *arcuatus-chilensis-cubensis* clade within the genus *Apodopsyllus*. This is the first non-neotropical and Mediterranean *Apodopsyllus* species that belongs to the *arcuatus-chilensis-cubensis* clade. So far, all other species (*A. arcuatus*, *A. chilensis*, *A. cubensis*, *A. samuelgomezi*, and *A. pseudocubensis*) that are grouped in this lineage have been found in the neotropics. Until *A. gabesensis* n. sp. was discovered the clade was considered to be exclusively neotropical. Only a phylogenetic analysis and thorough check of deposited type material will shed light on these remarkable biogeographic relationships between the species *Apodopsyllus gabesensis* n. sp. from Tunisia and its congeners from the neotropics.

Remarks on the morphology of A. gabesensis n. sp.

In our specimens, we noted a structure in the basis of P2–P4 that is also shown in the descriptions of the species *Apodopsyllus africanus africanus* (in P2 and P4), *Apodopsyllus africanus* Kunz *listensis* Mielke, 1975, *Apodopsyllus biarticulatus* Cottarelli and Altamura, 1986, *Apodopsyllus littoralis*, *Apodopsyllus lynceorum*, *Apodopsyllus melitae* Kunz, 1992, *Apodopsyllus reductus* (Petkovski, 1955), *Apodopsyllus schulzi* and *Apodopsyllus unguiformis*.

Most authors do not mention this structure in the text descriptions, but certain authors have described it as a tubercule that extends into a small setule (Cottarelli and Altamura 1986), a short spine near the exopod (Cottarelli 1971) or have interpreted it as a rudimentary endopod (Petkovski 1955). We verified this rudimentary enp in the legs of all our specimens, and it appeared that this structure is internal. It seems to be the inserting point of a muscle or a ligament. The actual position of this structure must have been misinterpreted by some authors, because it is difficult to distinguish between surface and interior in copepods of the size and the softness of *Apodopsyllus*. We abstained from drawing this internal structure, as we decided to picture surface structures only.

Another minute feature is the seta on the inner part of the P4 basis of *Apodopsyllus unguiformis* as observed by Coull and Hogue (1978). They stated that it is very important to note its presence or absence for any subsequent investigator of *Apodopsyllus* as they were sceptic about the character. They supposed that this seta represented a strongly reduced endopod in P4. Huys (1988) considered this seta also as a highly reduced endopod of P4, represented by a minute hyaline structure. We agree with this interpretation and note the presence of this seta in the presently described new species *A. gabesensis* n. sp.

Ecological observations

Apodopsyllus gabesensis n.sp. was only found at site A (33°56. 37′N, 10°05. 24′E, 5 m depth, Figs. 1, 2, 3) from the nine prospected stations in the Gulf of Gabès (South-eastern coast of Tunisia) in July 2005. Among 32 copepod species collected from four replicate sediment cores at this site (A) (mean individual density 131.5 ± 17.67 ind. 10 cm^{-2}), only 7 individuals belonged to *Apodopsyllus gabesensis* n. sp. (3 females and 4 males). All specimens were found together in the same sample.

Apodopsyllus gabesensis n. sp. was observed to contribute only a small fraction to the harpacticoids of station A. This station was characterized by sandy bottoms that were not polluted by anthropogenic influences and had the least organically enriched sediment. *Apodopsyllus gabesensis* n. sp. was the only member of the family Paramesochridae found during the whole study (including all stations). However, due to the low individual densities of the species, it can be postulated that even more replicates would have been necessary to make a final statement about the real distribution of Paramesochridae in the Gulf of Gabès.

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