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ORIGINAL ARTICLE

Apseudopsis adami, a new species of tanaidacean (Crustacea: Peracarida) from the NW Iberian Peninsula: postmarsupial development and remarks on morphological characters

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Abstract A new species of apseudomorph tanaidacean, *Apseudopsis adami* sp. nov., is described, including intraspecific variation, from specimens collected in the seagrass meadows of O Grove inlet (NW Iberian Peninsula, NE Atlantic). The new species is characterized by the unique combination of the following characters: pointed rostrum with rounded shoulders, four ventral propodal spines on pereopod 1, and posterolateral pointed apophyses on pereonites 2–5, regardless of the developmental stage of the individual. Two juvenile stages were identified before reaching maturity; early juvenile limbs are scarcely ornamented in comparison to the adults. Advanced juveniles represent the vast majority of the studied population, and the limb ornamentation is similar to that of the adults. Males show two different cheliped morphologies. After a preparatory stage, females pass through a sequence of copulatory instars followed by intermediate stages in which the female loses the ovisac after manca release. The number of segments of the antennular and antennal flagella and uropod endopods, as well as the development and ornamentation of the mandibular palp, are meristic changes that occur during development and allow rapid identification of the developmental instar.

Keywords Apseudomorpha · *Apseudopsis* · Sexual dimorphism · New species · Identification · Taxonomic characters · Development · Life history

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Introduction

Tanaidacea is a group of peracarid crustaceans of ecological importance owing to their wide distribution and abundance in sedimentary and crevicial habitats (Bamber 2011). Despite being a morphologically conservative taxon at the generic level, tanaidacean species present high intraspecific variability depending on the gender and developmental stage of the individual. Such variability can make identification to species level difficult, especially when juveniles represent the majority of the individuals within a population and when sympatric species of the same genus are found (Bamber 2010; Larsen and Froufe 2010; Esquete et al. 2012). Therefore, complete descriptions that include intraspecific variation are especially important in such species, and the definition of characters that allow positive, unequivocal identification of the specimens to species level are crucial for accurate faunistic and ecological studies.

The genus *Apseudopsis* was proposed by Norman (1899) to accommodate those apseudomorph species with eye lobes fused to the carapace; this feature differentiates this genus from the closely related *Apseudes* Leach 1814. *Apseudopsis* was invalidated by Lang (1955) and reinstated by Guţu in a recent paper (2006), who listed 19 extant species worldwide (see Anderson and Bird 2011). The genus is common and widely distributed on the shallow sedimentary bottoms of the North Atlantic and the Mediterranean Sea (see Guţu 2002 (as *Apseudes*); Bamber et al. 2009; Bamber 2011). The only species known to date from the Atlantic coasts of Europe is *Apseudopsis latreillii* (Milne-Edwards 1828), which is considered common to abundant and therefore represents an important component of soft bottom assemblages (Riggio 1996; De-la-Ossa-Carretero et al. 2010 [as *Apseudes*]; Bamber 2011; Esquete et al. 2011, 2012).

In this study, a new species of *Apseudopsis* Norman 1899 is described, including its intraspecific variation and the taxonomic characters that allow the unequivocal identification of the species. Useful characters to determine the developmental stage of any individual of the species are defined. Additionally, a putative scheme of the life history of the new species, and ecological remarks are included.

Materials and methods

In December 1996, benthic samples were taken in O Grove inlet (NW Iberian Peninsula; 42°41′–42°28′N 9°01′–8°44′W) using a van Veen grab, in order to characterize the macrofaunal assemblages inhabiting the seagrass *(Zostera)* meadows of its sedimentary bottoms. Five replicate samples were taken at each site, representing a total sampled area of 0.28 m^2 for each site. Samples were sieved through a 0.5 mm mesh and fixed in 10% formalin for later sorting and identification of the fauna. An additional sample was taken at each site to determine calcium carbonate (%) and total organic matter content (%) and for granulometric analyses. Mean grain size (Q_{50}) and sorting coefficient (S_0) were determined for each sample.

Line drawings were done using a camera lucida connected to a microscope. The total lengths (from the tip of the rostrum to the end of the pleotelson) of all the specimens found in one site (642 individuals, excluding incomplete and heavily damaged specimens) were measured. Measurements were made using a stereomicroscope connected to a computer with an image analyzer at the ECIMAT marine station (University of Vigo).

Fecundity was calculated according to Messing (1983), as the mean number of offspring per ovigerous female in one sample. Females having a damaged marsupium were excluded because part of the brood may have been lost.

Statistical calculations and size-frequency distribution graphs were performed using the IBM SPSS 19 software package.

Morphological terminology follows that of Bamber and Sheader (2005); serially repetitive body parts, such as the subdivisions of the antennal flagella and those of the uropodal rami are segments, while those with independent musculature (such as the parts of the pereopods) are articles. Measurements were made axially, dorsally on the body and antennae, and laterally on other appendages.

Identification of the postmarsupial developmental stages follows Esquete et al. (2012), as:

Juvenile I: All pereopods developed. Hyposphenia often absent; oostegites absent.
Juvenile II: Hyposphenia present, but no oostegites. Cheliped slender.
Preparatory female: Oostegites present. Cheliped slender.
Copulatory female: Complete marsupium.
Male I: Rudimentary hyposphenia. Penial tubercle present. “Intermediate” cheliped.
Male II: Penial tubercle present. Cheliped robust.

Females with adult characteristics but presenting neither oostegites nor marsupium have been considered intermediate females (according to Shiino 1937).

Type material was deposited in the Museo Nacional de Ciencias Naturales, Madrid (MNCN).

Results

Systematics

Order TANAIDACEA Dana 1849
Suborder APSEUDOMORPHA Sieg 1980
Family APSEUDIDAE Leach 1814
Subfamily APSEUDINAE Leach 1814
Genus *APSEUDOPSIS* Norman 1899
Apseudopsis adami Esquete & Bamber, sp. nov.
(Figs. 1, 2, 3, 4, 5, 6, 7, 8 and 9)

Material examined

Type material *O Grove (NW Iberian Peninsula)*.- Holotype: ♀, 4.7 mm (MNCN 20.04/8789); allotype: ♂, 5.1 mm (MNCN 20.04/8790); paratypes: 4 ♂♂, 4 ♀♀, 6 juveniles (MNCN 20.04/8791), 42°29.12′N 08°50.25′W, mud with *Zostera marina*, 0.8 m, coll. J.S. Troncoso, 11 December 1996.

Additional examined material *O Grove (NW Iberian Peninsula)* 0.130♀♀, 68♂♂, 405 juveniles, 42°29.12′N 08°50.25′W, mud with *Zostera marina*, 0.8 m, coll. J.S. Troncoso, 11 December 1996; 254♀♀, 39♂♂, 277 juveniles, 42°28.75′N 08°50.75′W, fine sand with shells and *Z. marina*, 0.3 m, coll. J.S. Troncoso, 4 December 1996; 161♀♀, 44♂♂, 371 juveniles, 42°28.25′N 08°50.75′W, fine sand with *Z. marina*, 0.3 m, coll. J.S. Troncoso, 11 December 1996; 17♀♀, 3♂♂, 5 juveniles, 42°27.75′N 08°51.25′W, fine sand with *Z. noltii*, 0.3 m, coll. J.S. Troncoso, 11 December 1996; 10♀♀, 4♂♂, 90 juveniles,

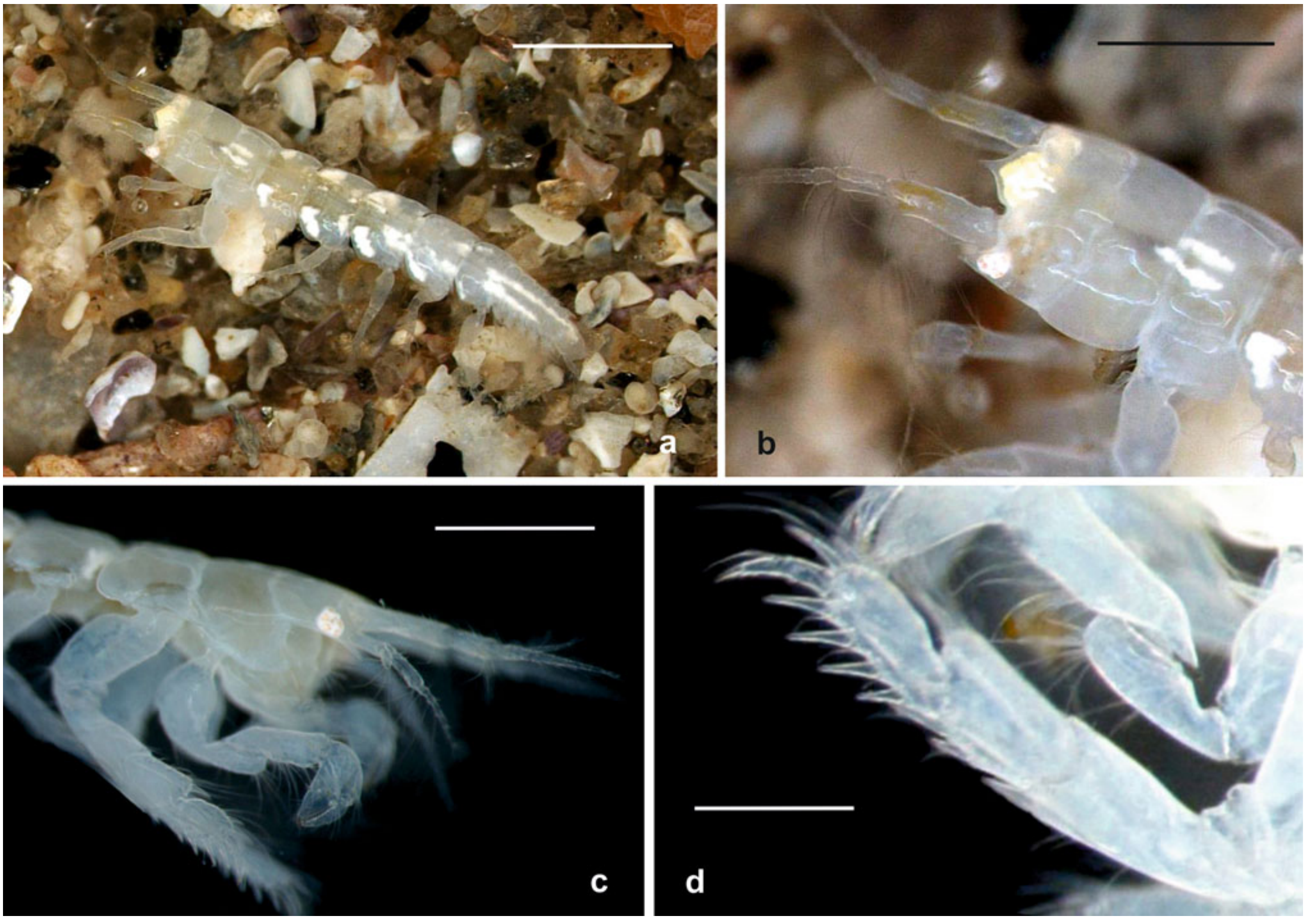

Fig. 1 *Apseudopsis adami* sp. nov. **a** Habitus. **b** Detail of the head. **c** Anterior part, lateral view. **d** Detail of pereopod 1. *Scale bar*: **a**, 1 mm. **b**, **c**, 0.5 mm. **d**, 0.2 mm

42°27.25′N 08°51.75′W, mud with *Z. marina* and *Z. noltii*, 0.3 m, coll. J.S. Troncoso, 18 December 1996. *Baiona (NW Iberian Peninsula).* 11♀♀, 5♂♂, 18 juveniles, 42°08.83′N 08°50.25′W, fine sand with *Z. marina,* 7 m, coll. J.S. Troncoso, 6 September 2011; 3♀♀, 1♂, 2 juveniles, 42°07.50′N 08°50.25′W, sand with shell fragments, 7 m, coll. J.S. Troncoso, 6 September 2011.

Diagnosis *Apseudopsis* with posterolateral apophyses on pereonites 2–6; rostrum pointed, slightly downturned; antennular accessory flagellum 3-segmented, main flagellum 10- or 11-segmented in adults; pereopod 1 bearing 4 ventral spines on the propodus; uropod endopod about 25- to 30-segmented, exopod 3-segmented.

Description

Female with oostegites (preparatory female)

Total length 3.1–4.8 mm. Body (Fig. 2a, b) dorsoventrally flattened, elongated, slightly narrowed posteriorly, 5.7 times as long as wide. Living specimens whitish, with yellowish and white patches on rostrum, pereonites and pleonites (Fig. 1a). Cephalothorax about as long as broad, about 1/6 of total body length; rostrum with rounded “shoulders”, pointed and downturned. Ocular lobes present, pointed. Eyes present, with orange pigment (Figs. 1b–c and 2a, b). Pereonites bearing simple lateral setae. First pereonite about 2.6 times as broad as long, extended into two posterolateral lobes with rounded posterolateral corners. Pereonites 2–5 with posterolateral apophyses, distally angulate on pereonites 3–5. Second pereonite narrower proximally, twice as broad as long. Third pereonite 1.5 times as broad as long. Pereonites 4 and 5 subrectangular. Sixth pereonite 1.8 times as broad as long, with angulate posterolateral corners. Hyposphenium present on pereonite 6. Pleon about one-quarter of total length. Pleonites subequal, posterior pleonites narrower. Lateral margins of all pleonites produced posteriorly, bearing ventrally oriented pointed apophyses. Pleotelson 1.2 times as long as broad, bearing two groups of four lateral setae and two setae on two lateral protuberances, one pair of subterminal long setae each with adjacent penicillate seta, and one pair of terminal setae (Fig. 2c).

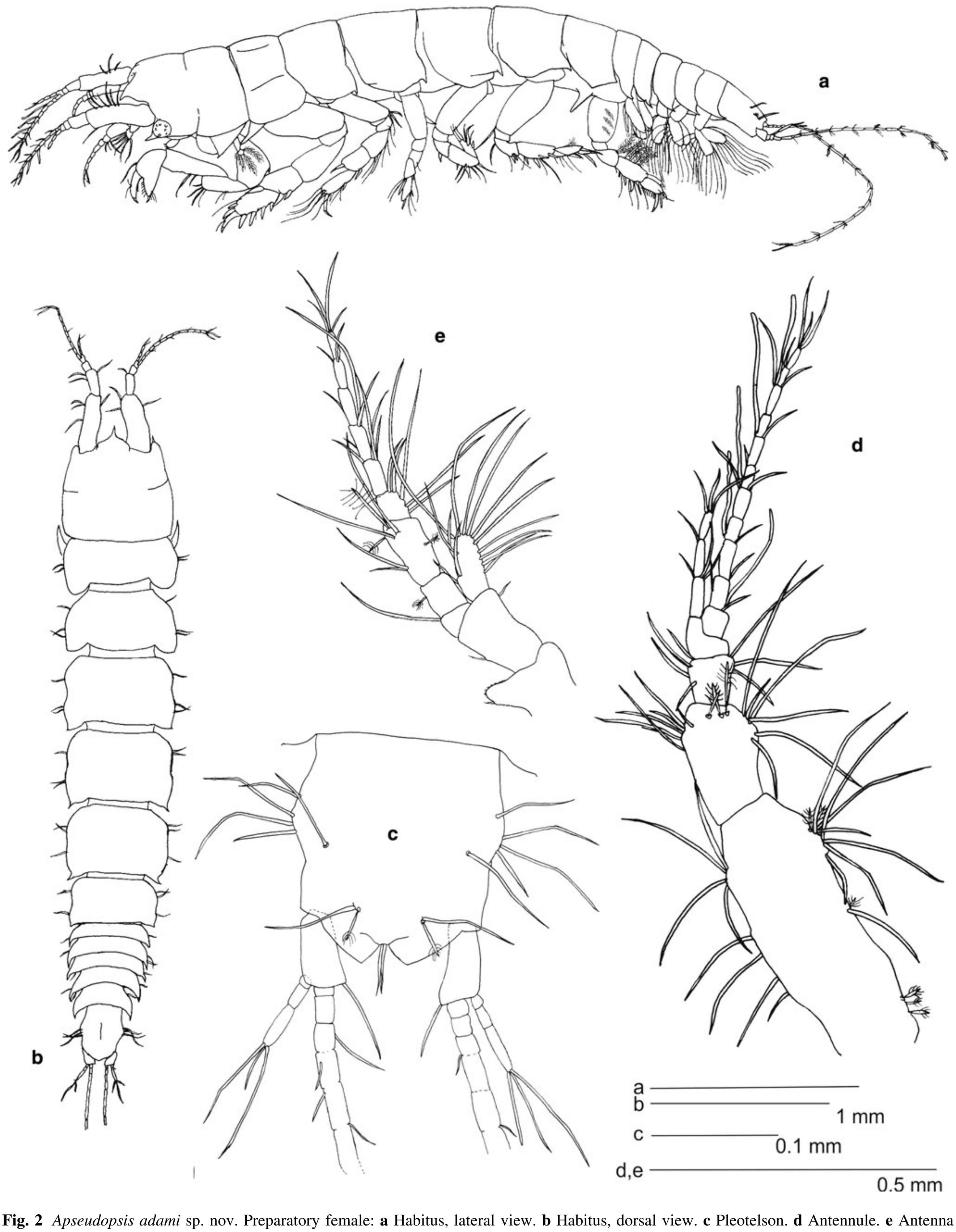

Fig. 2 *Apseudopsis adami* sp. nov. Preparatory female: **a** Habitus, lateral view. **b** Habitus, dorsal view. **c** Pleotelson. **d** Antennule. **e** Antenna

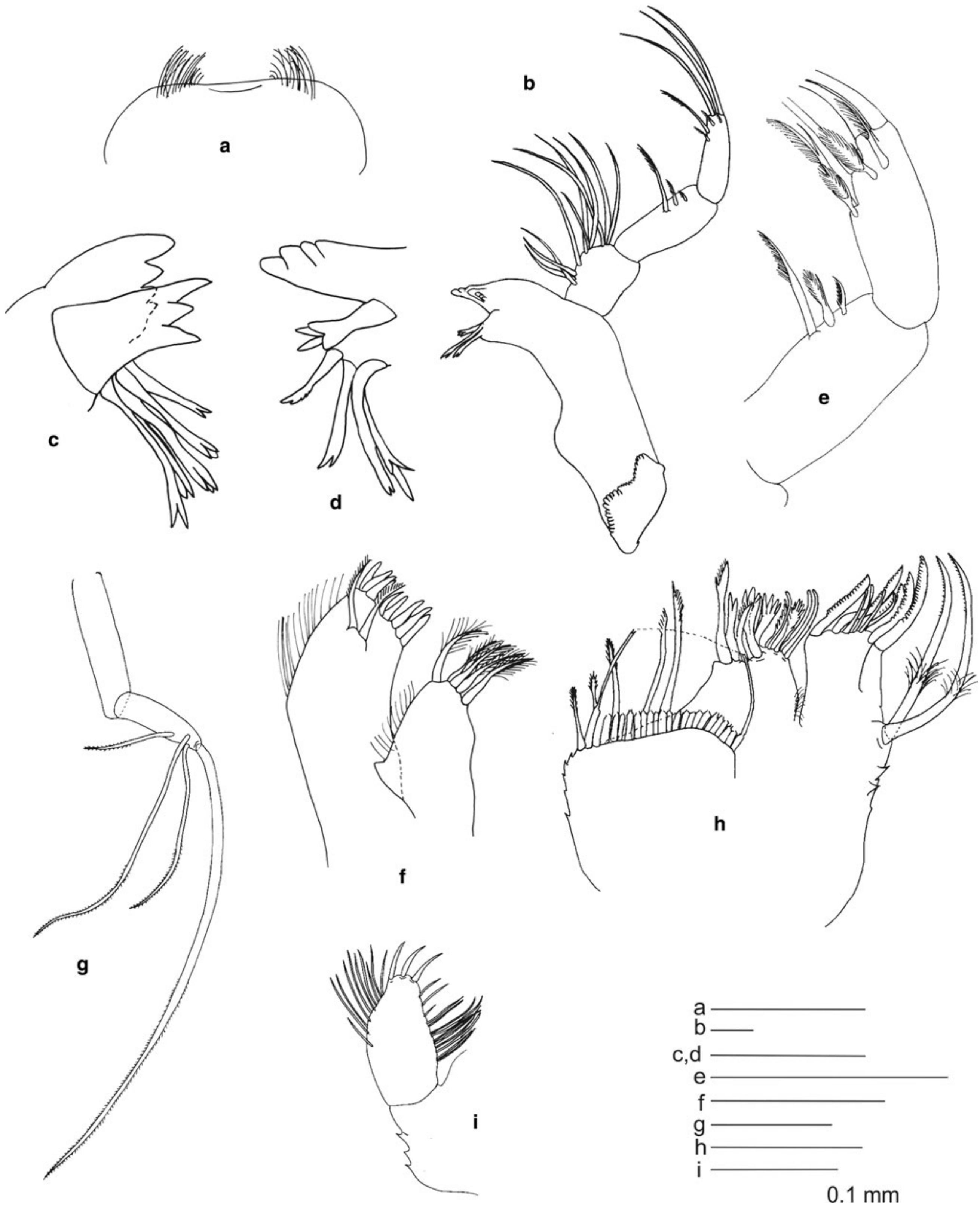

Fig. 3 *Apseudopsis adami* sp. nov. Preparatory female: **a** Labrum. **b** Left mandible. **c** Detail of the *left* mandible. **d** Detail of the *right* mandible. **e** Detail of the medial and distal segments of the mandibular palp. **f** Maxillule. **g** Maxillular palp. **h** Maxilla. **i** Labium

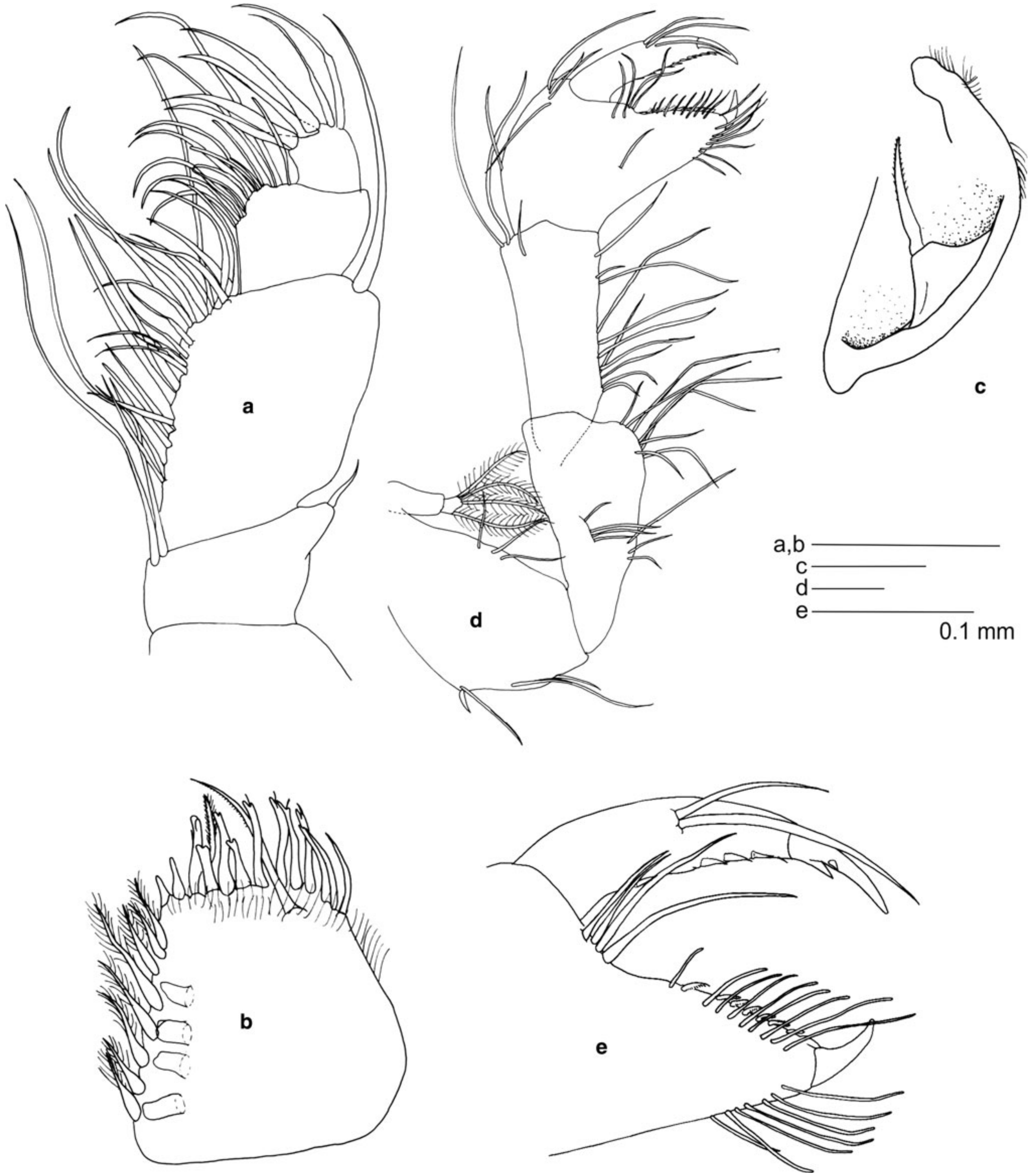

Fig. 4 *Apseudopsis adami* sp. nov. Preparatory female: **a** Maxilliped. **b** Maxilliped endite. **c** Epignath. **d** Cheliped. **e** Chela

Antennule (Fig. 2d) peduncle first article 2.7 times as long as wide, outer margin bearing three proximal and two medial penicillate setae, and subdistal tuft of simple setae and two penicillate setae, inner margin with simple setae. Second article about half length of first, twice as long as wide, with inner and outer subdistal tufts of simple setae, and three medial subdistal penicillate setae. Third article half length of second, with inner and outer simple setae.

Fig. 5 *Apseudopsis adami* sp. nov. Preparatory female: **a** Pereopod 1. **b** Pereopod 2. **c** Pereopod 3. **d** Pereopod 4

Fourth article as long as third, naked. Main flagellum of 11 segments, with five aesthethascs. Accessory flagellum three-segmented.

Antenna (Fig. 2e) peduncle first article as long as wide, with inner lobe bearing one to three small setae. Second article 1.5 times as long as first, 1.5 times as long as wide, bearing outer squama with long marginal setae. Third article one-third length of second, with inner-distal seta almost reaching tip of peduncle. Fourth article about twice as long as third, bearing one penicillate seta on inner

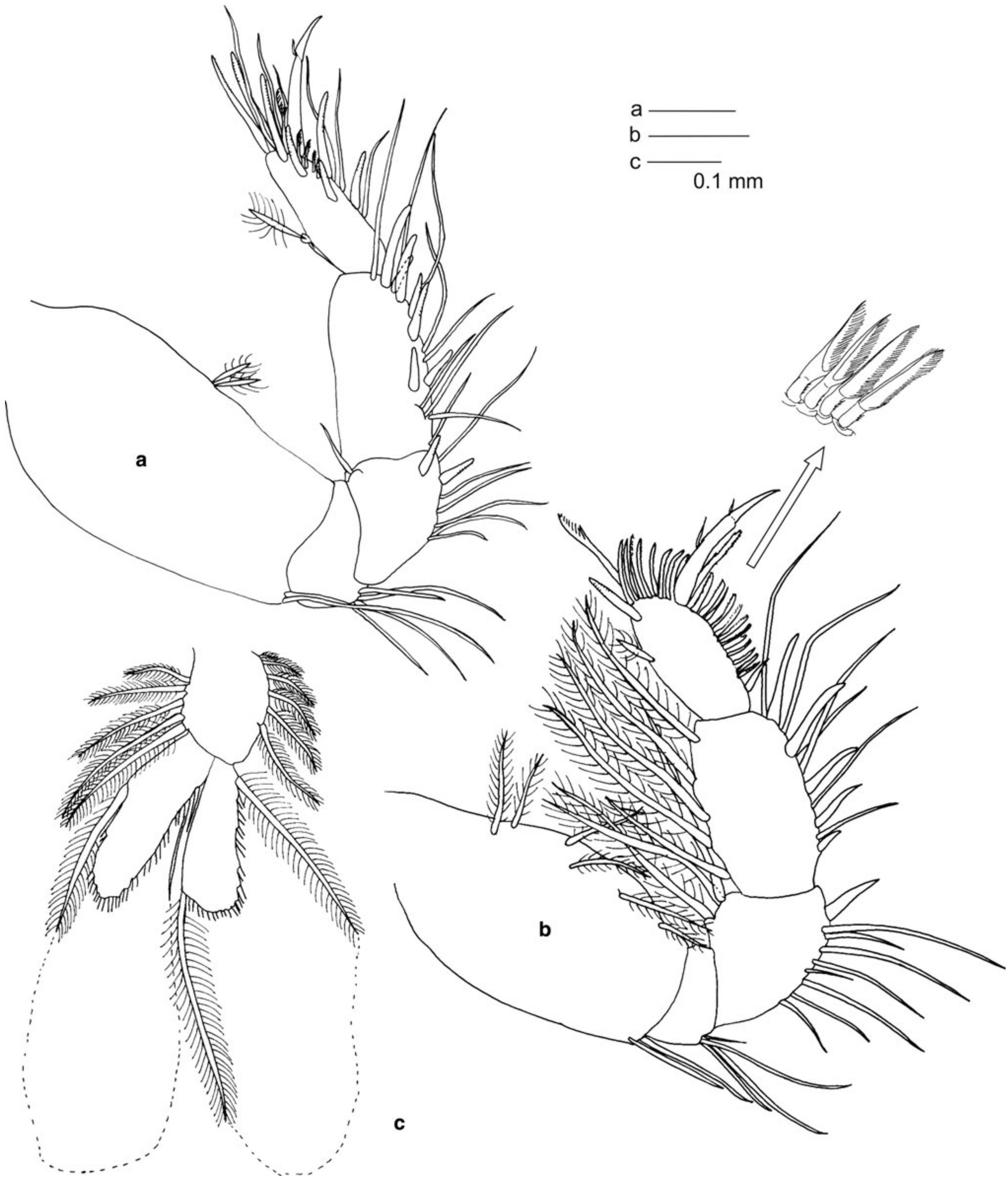

Fig. 6 *Apseudopsis adami* sp. nov. Preparatory female: **a** Pereopod 5. **b** Pereopod 6. **c** Pleopod 1

margin. Fifth article 1.3 times as long as two preceding articles together, bearing simple setae, and one medial and two subdistal penicillate setae. Flagellum of six segments, first segment bearing long simple setae on outer margin.

Mouthparts Labrum (Fig. 3a) bilobed, setulose. Left mandible (Fig. 3b, c) with strongly dentate pars incisiva, lacinia mobilis tridentate; setiferous lobe with five bifurcate and trifurcate setae; pars molaris triturative. Right

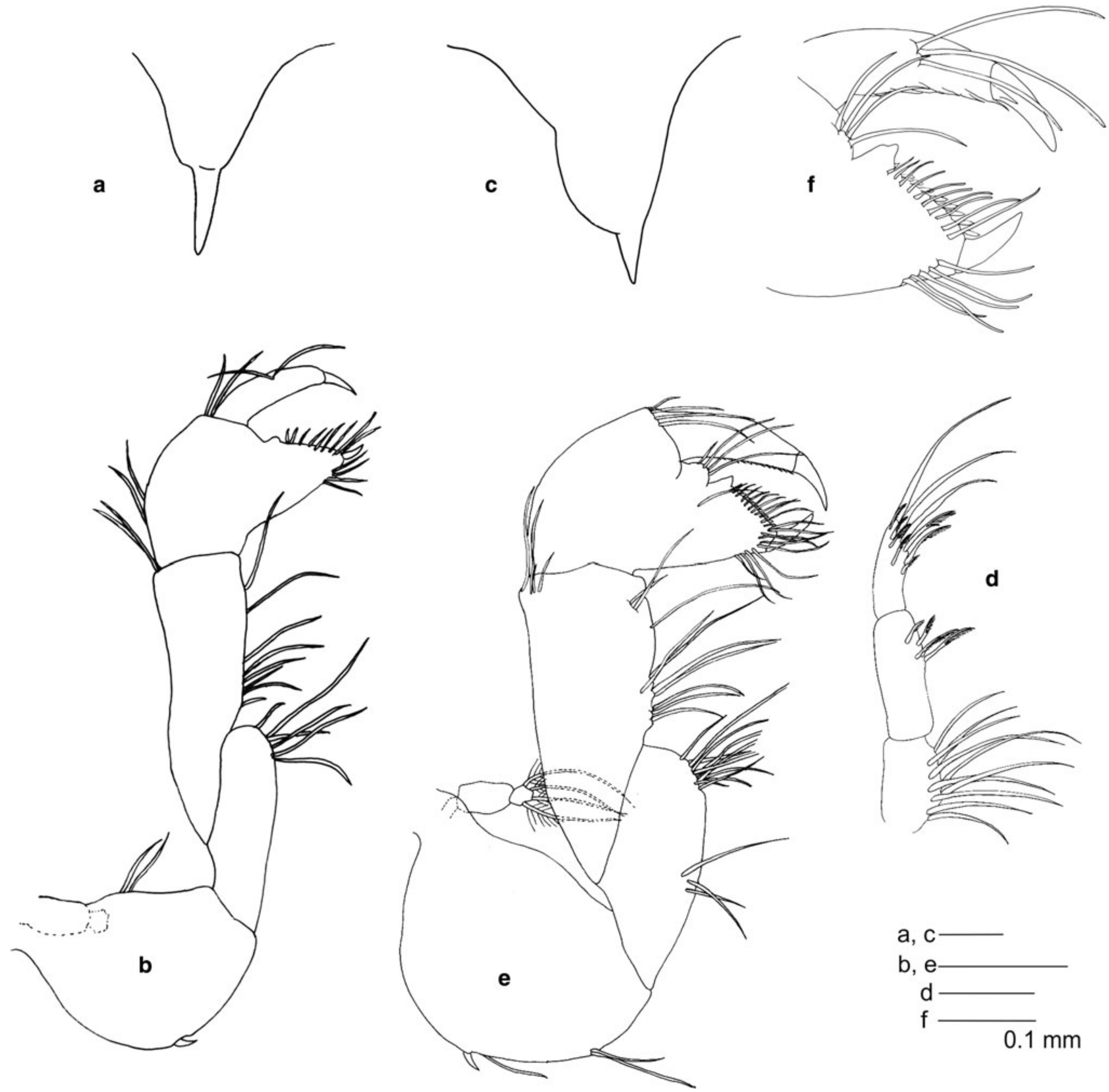

Fig. 7 *Apseudopsis adami* sp. nov. Male I: **a** Penial tubercle. **b** Cheliped. Male II: **c** Penial tubercle. **d** Mandibular palp. **e** Cheliped. **f** Chela

mandible (Fig. 3d) as left but without lacinia mobilis; distal spine trifurcate, shorter and stouter than rest. Mandibular palp (Fig. 3b, e) three-articled; first article about as long as broad, bearing numerous setae on inner margin; second article twice as long as first, bearing three pectinate setae, proximal seta significantly longer; distal article bearing subterminal pectinate spines, one pectinate seta and three terminal simple setae. Maxillule (Fig. 3f) inner endite with marginal apophysis and fine setae on outer margin, bearing five distal setulose setae; outer endite bearing 11 distal spines and two subdistal pectinate setae, outer margin with fine setae; palp (Fig. 3g) bearing three subterminal and one terminal minutely plumose setae. Maxilla (Fig. 3h) with margins serrated, outer lobe of fixed endite with simple setae, and bifurcate, trifurcate and pectinate spines. Inner lobe of fixed endite with a row of numerous simple setae in front of four pectinate setae, and one pectinate seta on the inner corner. Outer lobe of moveable endite with serrate setae, simple setae, and two strong, pectinate setae with medial setules on the outer margin. Labium (Fig. 2i) with outer margin serrated, palp with three distal setae and marginal setae and setules.

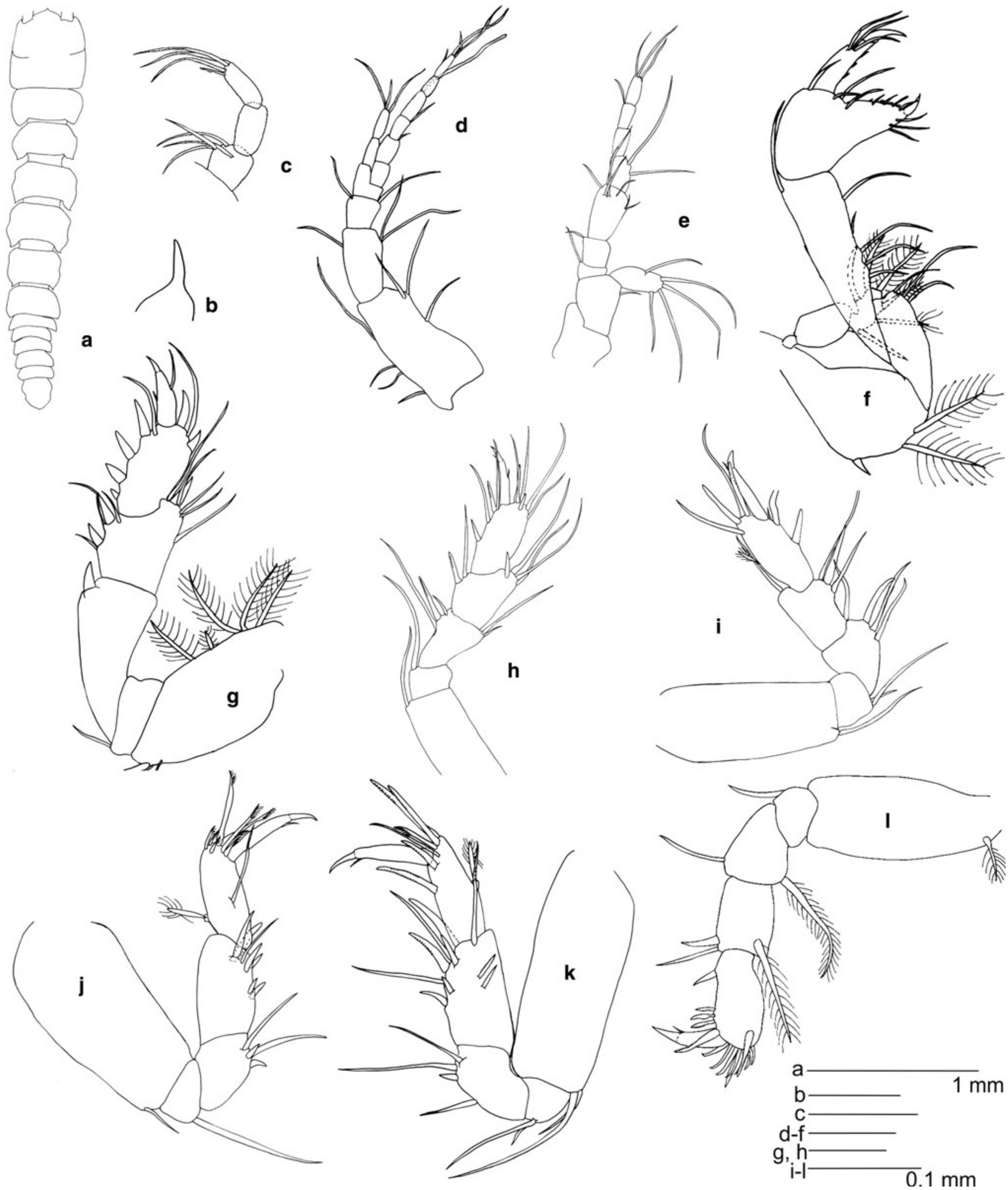

Fig. 8 *Apseudopsis adami* sp. nov. Juvenile I: **a** dorsal view, appendages not shown. **b** Undifferentiated structure on sternite 6. **c** Mandibular palp. **d** Antennule. **e** Antenna. **f** Cheliped. **g** Pereopod 1. **h** Pereopod 2. **i** Pereopod 3. **j** Pereopod 4. **k** Pereopod 5. **l** Pereopod 6

Maxilliped (Fig. 4a) basis simple: palp first article with one longer and one shorter inner setae and outer distal spine; second article inner margin with numerous setae, outer margin with one distal seta; third article with setae along inner margin; distal article with distal setae, four setae stronger than rest. Maxilliped endite (Fig. 4b) with

Fig. 9 *Apseudopsis adami* sp. nov. Juvenile II. **a–d** Development of antennule. **e** Antenna. **f** Mandibular palp

subdistal setules; inner margin with eight setulose setae and four coupling-hooks, distal margin with simple, bifurcate, trifurcate and pectinate setae; inner caudodistal seta slender, tapering, finely pectinate. Epignath (Fig. 3c) bearing a long, distally setulose spine; border sparsely setulose.

Cheliped slender (Fig. 4d) Basis 1.9 times as long as broad, with mid-ventral stout spine, and simple setae on ventral and dorsal margins. Exopodite present, three-articled: first article small, second article cylindrical, naked, distal article with four or five long, plumose setae. Merus elongate, narrower proximally, with medial and ventro-distal groups of setae. Carpus slender, 2.5 times as long as wide with simple setae along the ventral margin and on dorsodistal corner. Chela (Fig. 4e) twice as long as wide; palm region about as long as wide, with dorsal and lateral simple setae; fixed finger with row of ventrodistal setae; cutting edge almost straight, bearing row of pinnate spines and adjacent row of simple setae, shorter towards insertion of dactylus. Dactylus as long as fixed finger, with three medial simple setae; cutting edge with small spines.

Pereopod 1 (Figs. 1d and 5a) with oostegite Coxa with pronounced anterodistal apophysis. Basis twice as long as wide, bearing ventrodistal spine accompanied by four or five setae; exopodite as on cheliped. Ischium naked. Merus narrower proximally, 1.8 times as long as wide, bearing dorsodistal setae, ventral setae and a ventrodistal spine. Carpus 0.7 times as long as merus, bearing marginal setae, two ventral spines and one dorsodistal spine. Propodus about as long as carpus, bearing marginal setae, four ventral spines and two dorsodistal spines. Dactylus with two mid-dorsal fine setae and one mid-ventral spinule. Unguis about one-quarter of length of dactylus.

Pereopod 2 (Fig. 5b) with oostegite Basis 2.2 times as long as wide, with one dorsal penicillate seta, proximal and ventral simple setae, and a tuft of ventrodistal setae. Ischium with ventrodistal setae. Merus, carpus and propodus with long marginal setae. Merus narrower at base, 1.4 times as long as wide, with one ventrodistal, long spine. Carpus about as long as merus, bearing one ventral spine and one dorsodistal, slender spine. Propodus 2.7 times as long as wide, with two ventral, slender spines and two terminal spines. Dactylus 0.6 times as long as propodus, with one mid-dorsal fine seta and one subterminal, ventral setule. Unguis about one-quarter of length of dactylus.

Pereopod 3 (Fig. 5c) with oostegite Basis 2.4 times as long as wide, with pair of medial, long setae and tuft of long ventrodistal setae. Ischium with ventrodistal setae. Merus, carpus and propodus with long ventral and lateral setae. Merus narrower at base, about as long as wide, with one long ventrodistal spine and two shorter ventrolateral shorter spines. Carpus 1.5 times as long as wide, with one long ventrodistal spine, one long dorsodistal spine and two stouter lateral spines. Propodus slender, narrower at base, 2.7 times as long as wide and 1.3 times as long as carpus, with one dorsal penicillate seta, two long ventral spines, two long and slender distal spines, and a row of lateral spines increasing in length distally. Dactylus very slender, 1.2 times as long as propodus, with one short setule near unguis. Unguis about one-fifth of length of dactylus.

Pereopod 4 (Fig. 5d) with oostegite Basis twice as long as broad, with paired ventrodistal setae. Ischium with ventrodistal tuft of setae. Merus, carpus and propodus with long ventral setae. Merus with one pair of ventral spines. Carpus about twice as long as merus, bearing two rows of five ventral spines becoming longer approaching propodus. Propodus 2.2 times as long as wide and 0.8 times as long as carpus, with one dorsal penicillate seta, a row of subterminal pectinate spines, and long pectinate terminal setae. Dactylus about as long as propodus, with one fine short setule near unguis. Unguis one-quarter of length of dactylus.

Pereopod 5 (Fig. 6a) Basis twice as long as broad, with two medial penicillate setae and two ventrodistal simple setae. Ischium with ventrodistal setae. Merus, carpus and propodus with ventral setae. Merus with one pair of ventral spines. Carpus twice as long as merus, with two rows of three spines, becoming longer approaching propodus. Propodus 1.7 times as long as wide and 0.8 times as long as carpus, with one dorsal penicillate seta, two pairs of ventral spines, three terminal, long spines and some subdistal and terminal pectinate setae and pectinate spines.

Pereopod 6 (Fig. 6b) Basis fusiform, twice as long as wide, with six dorsal plumose setae and ventrodistal simple setae. Ischium with a ventrodistal tuft of simple setae. Merus and carpus with ventral simple setae. Merus narrower proximally, with one ventral spine and three long plumose dorsal setae. Carpus with five ventral spines, longer towards propodus, and five long plumose dorsal setae. Propodus ovate, 0.8 times as long as carpus, with one dorsal penicillate seta, one dorsodistal spine, one long, pectinate terminal seta and row of lanceolate, pinnate spines along ventral and terminal border. Dactylus about as long as propodus, with one medial and one distal dorsal setules. Unguis about one-third of length of dactylus.

Pleopods 1 and 2, basis with six inner and five outer plumose setae; pleopods 3 and 4 (Fig. 6c) with five inner and five outer, and pleopod 5 with four inner and four outer plumose setae. Both rami with numerous distal and outer marginal plumose setae, endopod with two inner marginal setae.

Uropod (Fig. 2c) basis with one inner-distal seta. Endopod with 25 to 30 segments, some with simple or penicillate setae. Exopod three-segmented; distal segment significantly longer than the other two together, bearing three long distal setae.

Copulatory female

Adult females with complete marsupium. Total length: 3.6–4.8 mm.

Intermediate female

Adult females with neither marsupium nor oostegites. Total length: 3.5–4.7 mm.

Male I

Total length: 3.0–5.1 mm. Mostly similar to adult female, with penial tubercle on pereonite 6 (Fig. 7a). Cheliped slender (Fig. 7b), with triangular apophysis on cutting edge of fixed finger.

Male II

Total length 4.2–5.4 mm. Penial tubercle on pereonite 6 (Fig. 7c). Pereonites and limbs more setose in general than in female.

Mandibular palp (Fig. 7d) bearing four pectinate setae on second article, terminal article with two pectinate setae, five pectinate spines and three terminal simple setae. Other mouthparts as in female.

Cheliped (Fig. 7e) more robust than that of female: basis 1.2 times as long as wide, with one medial spine and simple setae on ventral margin. Merus about as long as basis, with a dense distal tuft of setae on ventral margin. Carpus 1.3 times as long as merus, 2.2 times as long as wide, with setae along ventral margin and dorsodistal corner. Chela (Fig. 6f) robust, 1.7 times as long as wide. Cutting edge of fixed finger straight, with triangular proximal apophysis; spination and ornamentation as in female.

Juvenile I

Total length 1.4–2.6 mm. Shape of pereonites as in adult (Fig. 8a). Less setose in general than adult. Cephalothorax about 1/5 of total length, rudimentary copulatory structure not differentiated (Fig. 8b).

Mouthparts as in adult, apart from mandibular palp (Fig. 8c): proximal article bearing four simple setae; second article naked; distal article bearing three terminal simple setae and one pectinate spine.

Antennular accessory flagellum two-segmented, main flagellum six-segmented, with one aesthetasc on fifth segment (Fig. 8d). Antennal flagellum four-segmented (Fig. 8e).

Cheliped (Fig. 8f) slender, similar to that of female, exopod proportionally larger, basis bearing two long, plumose setae.

Pereopods 1–6 (Fig. 8g–l) sparsely setose by comparison with adult. Pereopod 1 (Fig. 8g) spination as in adult; exopodite (not figured) proportionally larger; basis bearing long, plumose setae on dorsal margin.

Pereopod 2 (Fig. 8h) spination similar to adult. Pereopod 3 (Fig. 8i) merus with one long ventral spine; carpus bearing one long, ventral spine; propodus bearing two ventral and two long terminal spines.

Pereopod 4 (Fig. 8j) merus with two ventral spines; carpus with three pairs of ventral spines, distal pair longest; propodus as in adult, but with fewer spines and setae. Pereopod 5 (Fig. 8k) merus with one ventral spine; carpus with two pairs of ventral spines and one subterminal, long spine; propodus with two ventral and two long, distal spines, and one distal pectinate seta.

Pereopod 6 (Fig. 8l) basis with one proximal plumose seta; merus with one dorsal and one ventral plumose setae; carpus with one ventral spine and one dorsal plumose seta; propodus with one ventroproximal spine, one dorsal subdistal spine, and row of lanceolate pinnate spines around terminal border.

Pleopods similar to those of adult, but basis with two plumose setae on outer margin and one plumose seta on inner margin, and fewer plumose setae on rami than adult.

Uropod endopod of 15–18 segments.

Juvenile II

Total length: 2.0–4.2 mm. Males differing from females by the presence of penial tubercle on pereonite 6. Setation of appendages variable, spination as in adults.

Antennular accessory flagellum three-segmented, main flagellum seven- to nine-segmented (Fig. 9a–d). Antennal flagellum generally five-segmented, six-segmented in largest specimens with nine-segmented outer antennular flagellum (Fig. 9e).

Mandibular palp (Fig. 9f) proximal article with about seven simple setae, medial article with one pectinate seta, distal article with one pectinate seta and three terminal simple setae. Cheliped as in adult female.

Pleopod setation variable.

Uropod endopod of 22–28 segments.

Other appendages and mouthparts as in adult.

Remarks

Apseudopsis adami sp. nov. differs from the sympatric *A. latreillii* (co-occurring in some samples) in having posterolateral apophyses on pereonites 2–6, and pereopod 1 with four ventral spines on the propodus (three in *A. latreillii*) and no dorsal spine on the merus. It mostly resembles *A. mediterraneus*, but that species has posterolateral apophyses on pereonites 1–6, while *A. adami* lacks apophyses on pereonite 1; additionally, the number of segments of the antennular main flagellum is higher in the new species (ten) than in *A. mediterraneus* (seven).

Apseudopsis adami resembles other Mediterranean species of the genus which share the shape of the rostrum and four ventral spines on the pereopod 1 propodus, such as *Apseudospsis bacescui* (Guţu 2002) and *Apseudopsis ostroumovi* (Bacescu and Carausu 1947), but these have apophyses on the first pereonite, a maximum of eight segments on the antennular main flagellum and hyposphenia on several sternites, *inter alia.*

Other species with ten segments on the main flagellum of the antennule include: *Apseudopsis tridens* (Guţu 2002), but this species has a characteristic trident-shaped rostrum, hyposphenia on pereonites 3–6 and apophyses on pereonite 1; *Apseudopsis apocryphus* (Guţu 2002), but this species has only three ventral propodal spines on pereopod 1 and no apophyses on the pereonites; *Apseudopsis caribbeanus* Guţu 2006, but this has four articles on the accessory flagellum, as well as lateral invaginations on the pereonites, a cephalothorax distinctly longer than wide, and angular shoulders on the rostrum.

A summary of the principal diagnostic characters of the North Atlantic and Mediterranean species of the genus is detailed on Table 1.

Etymology

The new species is named after “ADAM”, the acronym of the “Adaptaciones de Animales Marinos” (Marine Animals Adaptations) laboratory of the University of Vigo, past and present team members from which have collaborated with sampling, sorting and preserving of the specimens examined for this work.

Development

Three developmental stages (juveniles I, juveniles II and adults) and five types of adults (preparatory, copulatory and intermediate females, males I and II) were distinguished in the studied population. No postmarsupial manca stages were found in the samples, although mancas I (sensu Messing 1981: individuals with neither pleopods nor pereopod 6) were found inside the marsupium of several copulatory females.

Besides a general increase in setation and spination of the appendages, meristic changes through the life history of *Apseudopsis adami* include an increase in the number of articles of the antennular and antennal flagella and of the endopod of the uropod. Notable morphometric changes (as described above) include the size of the cephalothorax in relation to the total length, and of the exopodites of the cheliped and pereopod 1. Although the mouthpart ornamentation is in general stable and characteristic of the genus, an increase in the setation and spination of the mandibular palp occurs in a stable way from the juveniles I to the adults; in addition, the palp morphology differs among stages of development and shows sexual dimorphism. Conversely, a number of characters that show interspecific variation within the genus remain stable from the early stages to the largest adults, namely: the shape of the rostrum, the apophyses of the pereonites, the ornamentation of the mouthparts (with the exception of the mandibular palp) and the spination of the first pereopod.

Size-frequency distribution

Total body length of juvenile stages ranged from 1.46 to 4.18 mm; adult females ranged from 3.09 to 4.87 mm, and males were generally slightly larger (Table 2; Fig. 10). Separation into the two juvenile stages and the adults demonstrates that these age classes form single normal distributions (Fig. 11).

Fecundity

Fecundity ranged from 7 to 18 potential offspring per brood (mean: 11.5; standard deviation: 3.2).

Ecology

Apseudopsis adami has been found in sandy and muddy bottoms with the seagrasses *Zostera marina* and *Z. noltii*, and in sandy bottoms with shell fragments, at 3–7 m depth.

In O Grove inlet, salinity values were relatively low, ranging from 20 to 33‰, and the temperature of the bottom water ranged from 13.0 to 16.7°C during the sampling period (winter). Sediments were composed mainly of muddy sand (Q_{50}: 0.11–0.19 mm; S_0: 1.52–1.61), with relatively high percentages of fine and very fine sand (up to 64.6 and 47.9%, respectively) and silt/clay (up to 61.6%). Although total organic matter content was high (up to 15.5%), *A. adami* was present only in sites with values between 1.32 and 3.39%. Carbonate content was relatively low (7.58–10.46%). For detailed information on environmental variables see Esquete et al. (2010).

In Baiona inlet, *Apseudopsis adami* was found in sandy bottoms with scattered mats of *Z. marina* and in a sandy bottom with shell fragments, near the harbour of Baiona. Previous studies (Moreira et al. 2008) showed values of 89.9% of sand in the *Zostera* bed, and 84.2% of sand in the site near the harbour. Values of total organic matter content in these sites were similar to those found in O Grove (1.91 and 3.18%, respectively), and carbonate content was comparatively higher (32.39 and 72.35%, respectively).

Table 1 Relevant taxonomic characters of the North Atlantic and Mediterranean species of the genus *Apseudopsis*

	Rostrum	Pereonites with apophyses	P1 propodus ventral spines	P1 merus dorsal spine	Antennular flagella (adults)	Pereonites with hyposphenia (females)
A. adami sp. nov.	Pointed, rounded shoulders	2–6: Posterior corners	4	No	Inner: 3 Outer: 10	6
A. acutifrons (Sars 1882)	Long, acute	1, 2: Posterior corners. 3–6: Anterior and posterior corners	4	No	Inner: 3 Outer: 6–7	2, 3, 5, 6
A. annabensis (Guţu 2002)	Pointed, rounded shoulders	1–6: Posterior corners	5	No	Inner: 3 Outer: 6–7	6
A. apocryphus (Guţu 2002)	Pointed, rounded shoulders	No	3	No	Inner: 3 Outer: 8–10	3, 6
A. arguinensis (Guţu 2002)	Short, acute	2–6: Posterior corners	6	No	Inner: 3 Outer: 7–8	2, 6
A. bacescui (Guţu 2002)	Pointed, rounded shoulders	1–6: Posterior corners	4	No	Inner: 3 Outer: 6–7	2, 3, 6
A. elisae (Bacescu 1961)	Pointed, rounded shoulders	1–2: Posterior corners. 3–6: Anterior and posterior corners	5	Yes	Inner: 4 Outer: 8	2–6
A. hastifrons (Norman and Stebbing 1886)	Pointed, rounded shoulders	1: Posterior corners. 3–6: Anterior and posterior corners	6	No	Inner: 3 Outer: 7	2, 3, 5, 6
A. latreillii (Milne-Edwards 1828)	Pointed, rounded shoulders	No	3	Yes	Inner: 4 Outer: 10	2–6
A. mediterraneus (Băcescu 1961)	Pointed, rounded shoulders	1–6: Posterior corners	4	No	Inner: 3 Outer: 6–8	2, 6
A. minimus (Guţu 2002)	Pointed, rounded lobes	1–6: Posterior corners	3	No	Inner: 3 Outer: 6	n. d.
A. ostroumovi Bacescu and Carausu 1947	Pointed, rounded shoulders	1–6: Posterior corners	4	No	Inner: 3 Outer: 7–8	1–6
A. robustus (Sars 1882)	Pointed	No	4	Yes	Inner: 7–9 Outer: 15–16	1–6
A. tridens (Guţu 2002)	Long, with pointed shoulders	1–6: Posterior corners	4	No	Inner: 3 Outer: 10	3–6
A. uncidigitatus (Norman and Stebbing 1886)	Small, rounded	4, 5: Posterior corners	4	No	Inner: 5 Outer: 9	6

nd no data available

Table 2 Body lengths (mean and standard deviation, maximum and minimum) for every developmental stage of *Apseudopsis adami* sp. nov.

	N	Minimum	Maximum	Mean	Standard deviation
Juvenile I	79	1.46	2.59	2.24	0.2
Juvenile II	326	2.04	4.18	3.03	0.38
Preparatory female	48	3.14	4.78	4.03	0.38
Copulatory female	49	3.63	4.87	4.13	0.29
Intermediate female	33	3.09	4.7	4	0.41
Males I	47	3.01	5.16	4.14	0.57
Males II	21	4.18	5.36	4.69	0.37

Values in mm

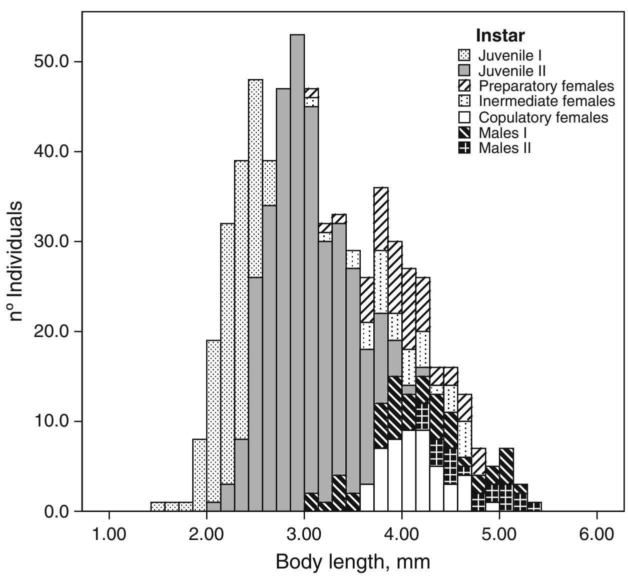

Fig. 10 Size/frequency histogram of total body length of the specimens of *Apseudopsis adami* sp. nov. found in one sample from O Grove

In both inlets, the new species is sympatric with the congeneric species *Apseudopsis latreillii*, and in O Grove also with the apseudomorph *Apseudes talpa* (Montagu 1808).

Discussion

Species identification

The relevance of different morphological characters in distinguishing species of the genus *Apseudopsis* has been largely discussed. Norman (1899) proposed the spination of the pereopod 1 as a stable, diagnostic character. Lang (1955) agreed on the stability of this character, but considered the shape and armature of the pereonites as highly variable within individuals of the same species, thus invalidating *A. hastifrons* and *A. ostroumovi* and synonymizing them with *A. acutifrons*.

Guţu (2002) proposed a number of characters as useful for identification of species of the genus *Apseudopsis* (as *Apseudes* Leach 1814), revalidating species synonymized with *A. acutifrons* by Lang (1955), but included characters that vary intraspecifically between instars (see above, and Esquete et al. 2011), and thus are valid solely for adults. Among the characters that remain stable throughout the life history of *A. adami* sp. nov. we have selected those that show interspecific variation, namely: the shape of the rostrum, the number and position of pereonite apophyses, and the spination of pereopod 1. These characters are stable in other species of the genus where sufficient material has been studied, e.g., *A. mediterraneus*; *A. latreilli* (pers. obs.; Esquete et al. 2012) and their combination allows the positive identification of these species, regardless of the developmental stage of the individual. Other characters considered reliable for identification in previous studies (i.e. the number of segments of the antennular main flagellum and the number and position of hyposphenia) are useful for adults and/or preparatory females (see Table 1).

Size-frequency distribution

In Crustacea, the existence of several normal distributions in a length-frequency histogram usually indicates different age groups within the samples (Schmidt et al. 2002). The existence of three normal distributions supports the separation of the population in three developmental stages (juveniles I, juveniles II and adults) and the inclusion of the males I within the adults. On the other hand, the large size ranges suggest several moults are involved (Schmidt et al. 2002; Blazewicz-Paszkowycz 2001); in juveniles II, subsequent moults involve meristic changes (addition of segments in antennal flagella and uropodal rami), while in adult males, several moults lead to an increase in the body size, without the occurrence of significant meristic changes. In the adult females, every copulatory instar implies one moult (Lang 1953).

Life history and development

Several characters have been proposed as indicative of the developmental stage of an individual in tanaidacean species, e.g., the number of segments of the antennular and uropodal flagella (Vengayil et al. 1988), the presence of hyposphenia (Guţu 2002, 2006) and the ornamentation of the mandibular palp (Esquete et al. 2011). Although the number of segments and the type of ornamentation in each

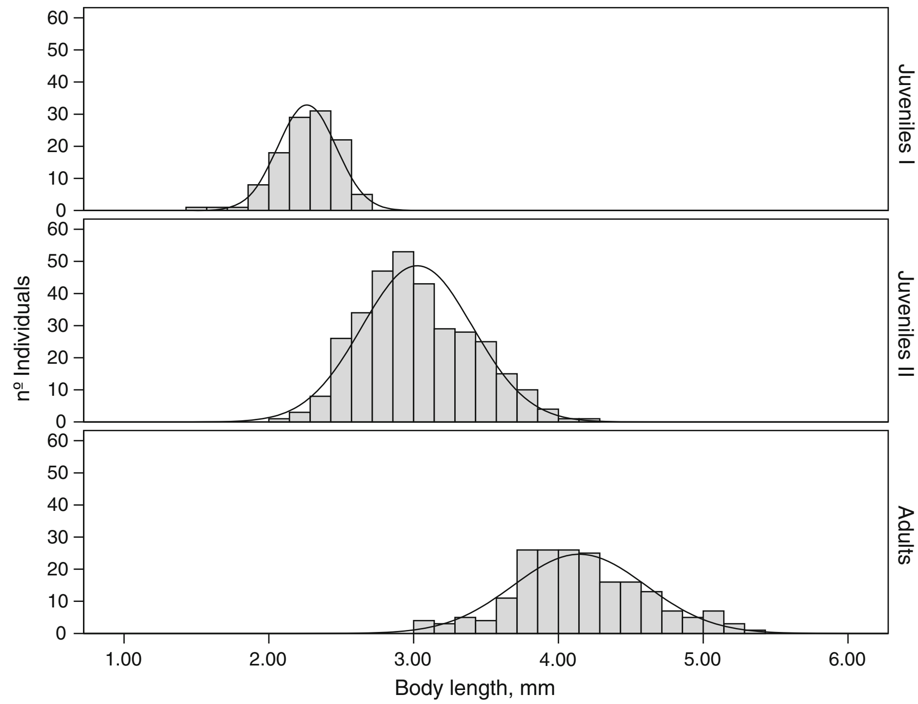

Fig. 11 Size/frequency distribution of total body length of the developmental stages of *Apseudopsis adami* sp. nov. found in one sample from O Grove

stage varies from one species to another, these characters are stable within each developmental stage. Nevertheless, such characters might be different depending on the family. For instance, Messing (1983) found in *Pagurotanais largoensis* (McSweeny 1982) that most of the above-mentioned characters remained stable from the first manca stage. In *Apseudopsis adami*, the number of segments of the antennule, the ornamentation of the mandibular palp, and the presence of penial tubercle, oostegites or marsupium allow the identification of the developmental stage.

Although mancas I were found inside the marsupium of several copulatory females, no manca II appeared in the population. This absence might be due to: (1) the absence of a manca II stage; (2) seasonality in the manca release, such that mancas II appeared before or after sampling was done; (3) the moult from manca II to juveniles occurs immediately, so manca II is never found in the population. The presence of at least one postmarsupial manca stage (sensu Messing 1981) is generalized not only among tanaidaceans but in all peracaridans (see Gardiner 1975). On the other hand, the presence of females carrying eggs and mancas I in the marsupium as well as juveniles and adults of all sizes and developmental range discards reproductive seasonality as an explanation. Experimental work would be needed to solve this question definitely.

Male dimorphism is common among tanaidaceans (see for example Gardiner 1973; Sieg 1978; Messing 1983; Vengayil et al. 1988; Pereira Leite and Pereira Leite 1997; Schmidt et al. 2002; Pennafirme and Soares-Gomes 2009). Secondary males have been shown to derive from protogynous development in some cases (Lang 1958; Gardiner 1975), while in other species, they derive from males I which are simply subadults (Bamber 2010), and in other cases, all types of males are reproductive (Hamers and Franke 2000; Fonseca and D'Incao 2003). In *Apseudopsis adami* the penial tubercle is differentiated in the juvenile stage, and there is no particular reason to consider protogyny. Males I can be considered subadults on the basis of their adult-like morphology together with a penial tubercle that is rudimentary by comparison with that of the males II. This is supported by the size range of males I (Fig. 10), within the range of the adults but not reaching the size of the largest males II. Nevertheless, experimental rearing or histological analyses would be needed to demonstrate whether males I are reproductive or not and to discard protogyny.

The occurrence of intermediate females in a wide range of sizes indicates that there is a stage after every manca release in which the female is without marsupium or oostegites that may involve a moult. This sequence (preparatory-copulatory-intermediate) was proposed by Lang (1953) for the Apseudidae, and Shiino (1937), Blazewicz-Paszkowycz (2001) and Johnson and Attramadal (1982) related the intermediate instar with parental care in *Apseudes nipponicus* (Shiino 1937), *Nototanais antarcticus* (Hodgson 1902) and *Tanais dulongii* (Audouin 1826), respectively, the last through experimental research.

A proposed life history sequence for *Apseudopsis adami* based on the results obtained from this study is presented in Fig. 12. Within the general life history scheme common to the peracaridans, species of tanaidaceans present different strategies (Gardiner 1975; Hamers and Franke 2000).

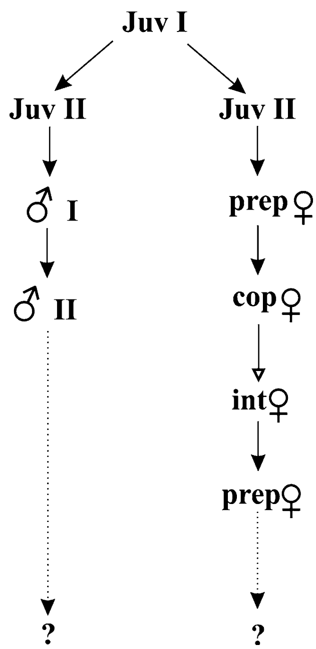

Fig. 12 Proposed life history diagram for *Apseudopsis adami* sp. nov. Juv I, Juveniles I. Juv II, Juveniles II. prep♀, preparatory females. int♀, intermediate females, cop♀, copulatory females. ♂I, males I. ♂II, males II. *White arrow* indicates no moult necessarily involved

Furthermore, experimental and field work has proved that sequence of instars in one species might vary depending on the environmental conditions (Schmidt et al. 2002), especially sex reversal (Lang 1958; Bückle-Ramírez 1965; Highsmith 1983; Blazewicz-Paszkowycz 2001). Interestingly, Stoner (1986) indicated that sex reversal, ratios and distributional patterns of two sympatric species of *Leptochelia* Dana 1849 were influenced by interspecific interactions between them. Considering that *A. adami* was found in a estuarine ecosystem where it was sympatric with *A. latreilli,* we can expect that both species influence each other depending on the changing environmental conditions of the estuary. Consequently, the scheme proposed here and the population structure of both species would experience seasonal variations within the inlet.

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