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A new *Argyrodiaptomus* (Copepoda: Calanoida: Diaptomidae) from the southwestern Brazilian Amazon

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Abstract

Argyrodiaptomus paggii **n. sp.** is described from specimens collected in the Igarapé Boa Esperança, in the vicinity of the Samuel Reservoir, State of Rondônia, Brazil. The new species differs from its congeners by the following autapomorphies: (1) Schmeil's organ large at apex, constricted at medial portion; (2) row of setules on the outer margin of basis first leg; (3) a peculiar disposition and structure of the spinules on the inner border of the basis of male's left and right fifth leg; and (4) female's second urosomite partially fused and telescoped into the genital somite. We provide a discussion about some aspects of the morphology and geographical distribution of all members of the genus.

Key words: *Argyrodiaptomus*, Copepoda, Neotropical region, southwestern Amazon Basin, new species, taxonomy, systematic, zoogeography, zooplankton

Introduction

The genus *Argyrodiaptomus* was first proposed by Brehm (1933), with *A. granulosus* Brehm, 1933, from Uruguay, as its type species, and the diagnostic characters of the genus being: "...characteristics of the fifth feet of the male: (1) inner border of second basal segment of left foot covered with tubercles or spinules, or both; (2) terminal spine (or seta) of left foot longer than terminal digitiform process; (3) inner distal angle of second basal segment of right foot bears a small rounded process; and (4) posterior face of first segment of exopodite of right foot bears a conical or digitiform process." (Brehm 1933: p. 285) Since then, several additions and changes were made to this taxon, including the description of new species and the reallocation or synonymization of others (e.g., Wright 1935; Kiefer 1936; Wright 1938a; Ringuelet 1958; Dussart 1985a & b; Dussart & Matsumura-Tundisi 1986; Reid & Pinto-Coelho 1994; Reid 1997; Paggi 2006). However, the taxonomy of this diverse genus, currently containing 10 species, still needs revision.

The distribution of *Argyrodiaptomus* is exclusively Neotropical. It occurs in the entire pre-Andean South America, except Patagonia. The current geographical distribution of the known species in this genus is presented in table 1.

Despite knowledge of the geographical distribution of the species within *Argyrodiaptomus*, the geographical origin of this genus remains unclear. Wright (1938b) presumed the genus probably originated in eastern Brazil and invaded the southern region of South America. However, the presence of *Argyrodiaptomus* in the northern region of this continent could suggest otherwise (viz. Brandorff 1978; Santos-Silva *et al.* 1989; Reid 1997).

In this work we describe a new species of *Argyrodiaptomus* from specimens collected in the southeastern region of the Amazon Basin. The morphological similarities among its congeners, as well as the importance of this new record are analyzed and discussed.

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Material and methods

Zooplankton samples were collected in Igarapé Boa Viagem (08º43'45"S, 63º24'26"W), a tributary of the Jamari River, located 47 km east of the city of Porto Velho, in the state of Rondônia, Brazil. The samples were collected on 02 Dec. 1986 and 20 Aug. 1987, by Dr. Assad Darwich, prior to the construction of the Samuel hydroelectric dam: this locality is now flooded.

The samples were collected by hauling a 56-micron-mesh plankton net, with an aperture diameter of 25 cm, through the limnetic portion of the water column. The material was concentrated and preserved in 4% formalin. Specimens have been deposited in the invertebrate collection of the Instituto Nacional de Pesquisas da Amazônia (INPA).

TABLE 1. Valid species of the genus *Argyrodiaptomus* and their geographic distribution.

Species	Author	Year	Type locality	Other localities
A. azevedoi	Wright	1935	Brazil (Rio Grande do Norte)	Brazil: Amazonas, Bahia, Ceará, Pará, Paraíba, Pernambuco, São Paulo, Sergipe
A. bergi	Richard	1897	Argentina (Buenos Aires)	Uruguay
A. denticulatus	Pesta	1927	Argentina (Buenos Aires)	Brazil: Rio Grande do Sul, Distrito Federal
A. falcifer	Daday	1905	Argentina (Buenos Aires)	Argentina: Chaco, Córdoba, Corrientes, Entre Ríos, Formosa, Santa Fé
A. furcatus	Sars	1901	Brazil (São Paulo)	Brazil: Mato Grosso do Sul, Minas Gerais, Rio de Janeiro, Paraná
A. granulosus	Brehm	1933	Uruguay	
A. macrochaetus	Brehm	1937	Brazil (Rio Grande do Sul)	
A. neglectus	Wright	1938a	Brazil (Minas Gerais)	
A. nhumirim	Reid	1997	Brazil (Mato Grosso)	Brazil: Amazonas
A. robertsonae	Dussart	1985b	Brazil (Amazonas)	Brazil: Pará

For the taxonomic examination, specimens were mounted on slides in lactophenol and glycerin. The total length was measured (with the aid of a micrometered ocular) from the anterior end of the cephalothorax to the distal margin of the caudal rami (excluding the caudal setae). Drawings of the habitus were made (dorsal and lateral) prior to the dissection. Dissected appendages were mounted on slides, in glycerin, and coverslips were sealed with polyvinyl. All drawings were made with a Wild Leitz Laborlux K microscope equipped with camera lucida. Preparations were made for scanning electron microscopy (SEM) with a Phillips XL-30, following protocols used by Felgenhauer (1987) and Huys and Boxshall (1991).

Terminology followed Huys and Boxshall (1991) and Santos-Silva *et al.* (1999). Abbreviations: thoracic segments (Th); urosome segments (Ur); genital somite (GS); antennule (A1); antenna (A2); mandible (Md); maxillule (Mxl); maxilla (Mx); maxilliped (Mxp); first to fourth swimming legs (P1–P4); and fifth leg (P5); endopod (Enp); exopod (Exp). Exp-1 (-2, -3) refers to the first, second and third segments of the exopod. The abbreviation Enp-1 (-2, -3) refers to segments 1–3 of the endopod. The definitions for some of the terms used in the descriptions are as follows:

Cirrose: format of the apex of a structure that ends with an abrupt, hair-like thickening.

Intercoxal plate: structure present between the coxae, connecting right and left legs. It is also called an *intercoxal sclerite* or *coupler* by Huys and Boxshall (1991).

Nucal organ: according to Nishida (1989), a modified region adjacent to the suture of cephalosome, at the dorsal region, that seems to be depressed, similar to an integumental window. It can be well defined or not, and with at least two different forms: broader than long (rectangular transverse or *rectangularis vel oblongus*)

3:2 or broader than long 3:1 (numbers indicate the geometric-allometrical relationship between the borders of the rectangle). Martin and Laverack (1992) also name it as "dorsal organ".

Spiniform sensillum: modified rigid sensillum, with variable size, normally at the apex of expansions like lateral wings or the posterior surface of coxa of P5. Also known as a “sensorial spine” (Dussart 1985a).

Results

Family Diaptomidae Baird, 1850

Subfamily Diaptominae Kiefer, 1932

Genus *Argyrodiaptomus* Brehm, 1933

Argyrodiaptomus paggii n. sp.

Figs 1–21

Material examined: Holotype ♂, dissected and mounted on slide in glycerin (INPA 1451), Igarapé Boa Viagem, 08°43'45"S, 63°24'26"W, right tributary of Jamari river, 6 km upstream of Samuel hydroelectric dam, 47 km east of the city of Porto Velho, in the state of Rondônia, Brazil.

Paratypes: 5 ♂ dissected and mounted on slides in glycerin (INPA 1445–1449); 5 ♀ dissected and mounted on slides in glycerin (INPA 1440–1444); 50 ♀ and 50 ♂ (INPA 1450) undissected, kept in 4% formalin. All collected from Igarapé Boa Viagem, State of Rondônia, Brazil, 02 Dec 1986 and 20 Aug 1987.

Diagnosis. Cephalosome with dorsal depression at suture, with a nucal organ broader than long (ratio = 3:2) and soft angles. Outer margin of A2, Enp 1, with patch of spinules (15 approx.). Group of spinules between first and second coxal endites of Mxp. Right basis of P5 of ♂ with 5 patches of spinules of similar number and shape. Exp 1 with expansion strongly sclerotized, located posteriorly at distal margin (projected over second segment); expansion with digitiform, blunt tip, larger than endopod and perpendicularly inserted to segment; ovoid process adjacent to expansion; outer distal region of segment with additional triangular expansion, terminally acute. Left basis of P5 of ♂ with 6 patches of spinules of similar number and shape. Spinose seta on P5 Exp 2 (left) of ♂ 4 times length of digitiform process. Enp of left P5 of ♂ with complete suture. Suture between Th4 and Th5 of ♀ incomplete dorsally. ♀ lateral wings symmetrical formed by 1 pair of lobes. Left lateral wing posteriorly directed, unarmed, inwardly curved over the GS, with posterior margin continuous with lateral wings. Dorsal lobes absent. Ornamentation composed by small, spiniform sensillum, 1 at each end of lobes. GS of ♀ symmetric, with lateral expansions at anterior portion. Ur2 of ♀ partially fused into the GS. Coxa of P5 of ♀ without conical process at posterior face. In same region, 1 small, spiniform sensillum with rounded apex. P5 Enp of ♀ long, as long as or longer than Exp-1, with complete, well-defined suture.

Description. Male (figs 1–15): Length of holotype, excluding caudal setae, 1887 µm. Mean length ♂: 1856.8 µm (n = 20, s.d. = ± 40.7, range = 1794–1932 µm). Body smaller and more slender than ♀. Widest region is at distal portion of Th2.

Cephalosome with incomplete dorsal suture. Modified region forming thin depression at suture level, with nucal organ broader than long (width/length ratio 3:2) and soft angles (fig. 2B). Rostrum with paired filaments; rostrum asymmetrical, with process on right side of basal part; defined from frontal margin of dorsal cephalic shield by complete suture; with pair of sensilla adjacent to suture (fig. 2A–B).

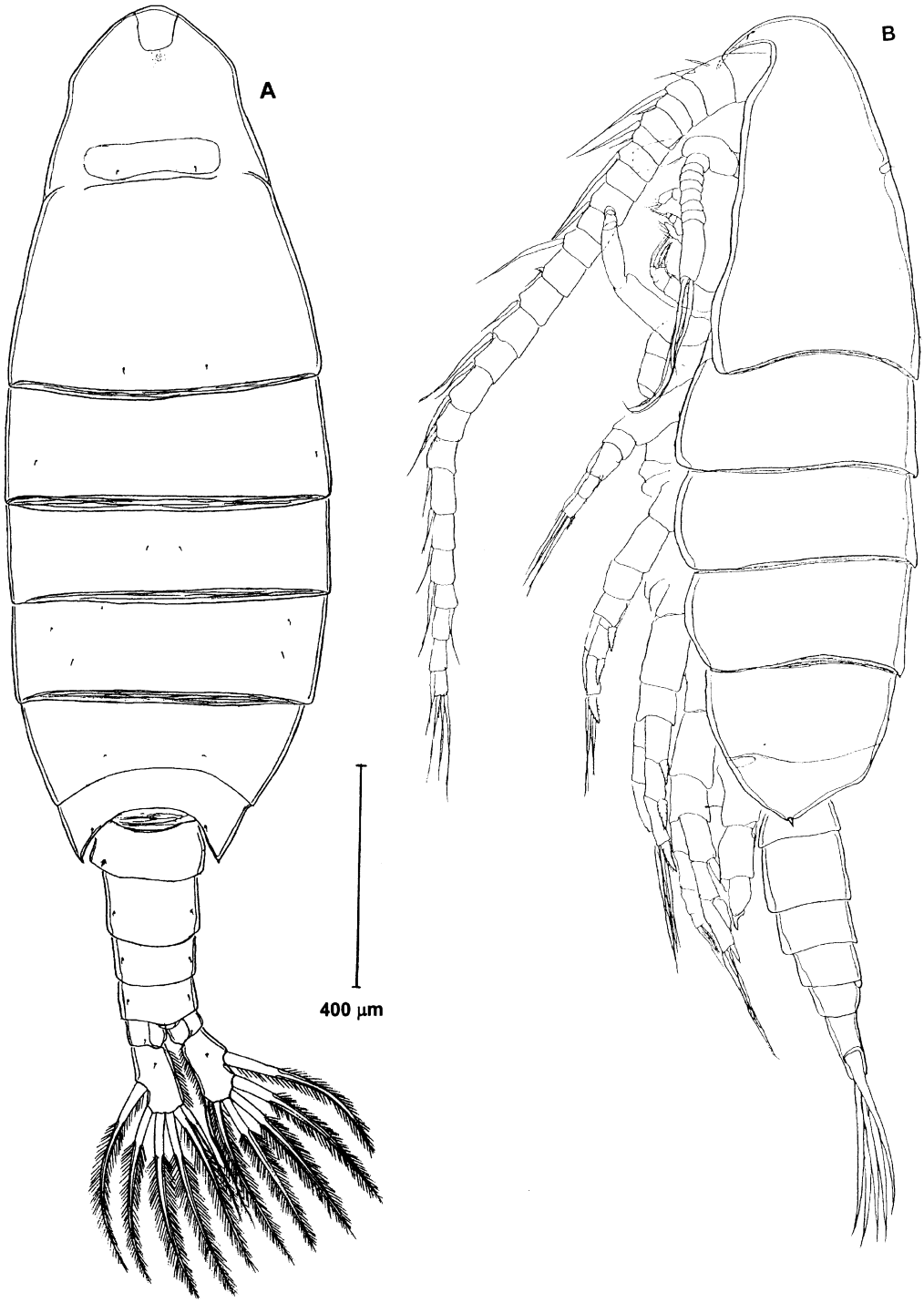

FIGURE 1. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – habitus, dorsal view. **B** – habitus, left lateral view.

Prosome 5-segmented. Th4 and Th5 distinct, separated by complete suture. Lateral surface (dorsal view) of the suture deeper than on medial region. Th5 smaller and more curved than on the posterior edge, also bearing a small spine on each posterior side of the dorsal extremity. Hyaline frill between Th5 and GS. Lateral wings formed by 1 pair of lobes. Lateral wings posteriorly directed, without spines. Ornamentation composed by spiniform sensilla, 1 at each end of lobes.

Urosome formed by 4 urosomites, followed by the anal somite and caudal rami. Genital somite asymmetrical, with 2 sensilla, 1 at right/posterior region and 1 at left/posterior region, more medial than right. Genital aperture on ventral/lateral posterior corner of GS on left side. Caudal rami symmetrical, longer than wide, with 6 setae; setules along medial margin.

Antennules asymmetrical, extending beyond prosome but not extending past distal portion of second urosomite. Ancestral segments II–IV, XXI–XXIII, XXIV–XXV and XXVII–XXVIII completely fused. Tip of setae on segments 3 (V), 7 (IX), 9 (XI) and 14 (XVI) acute.

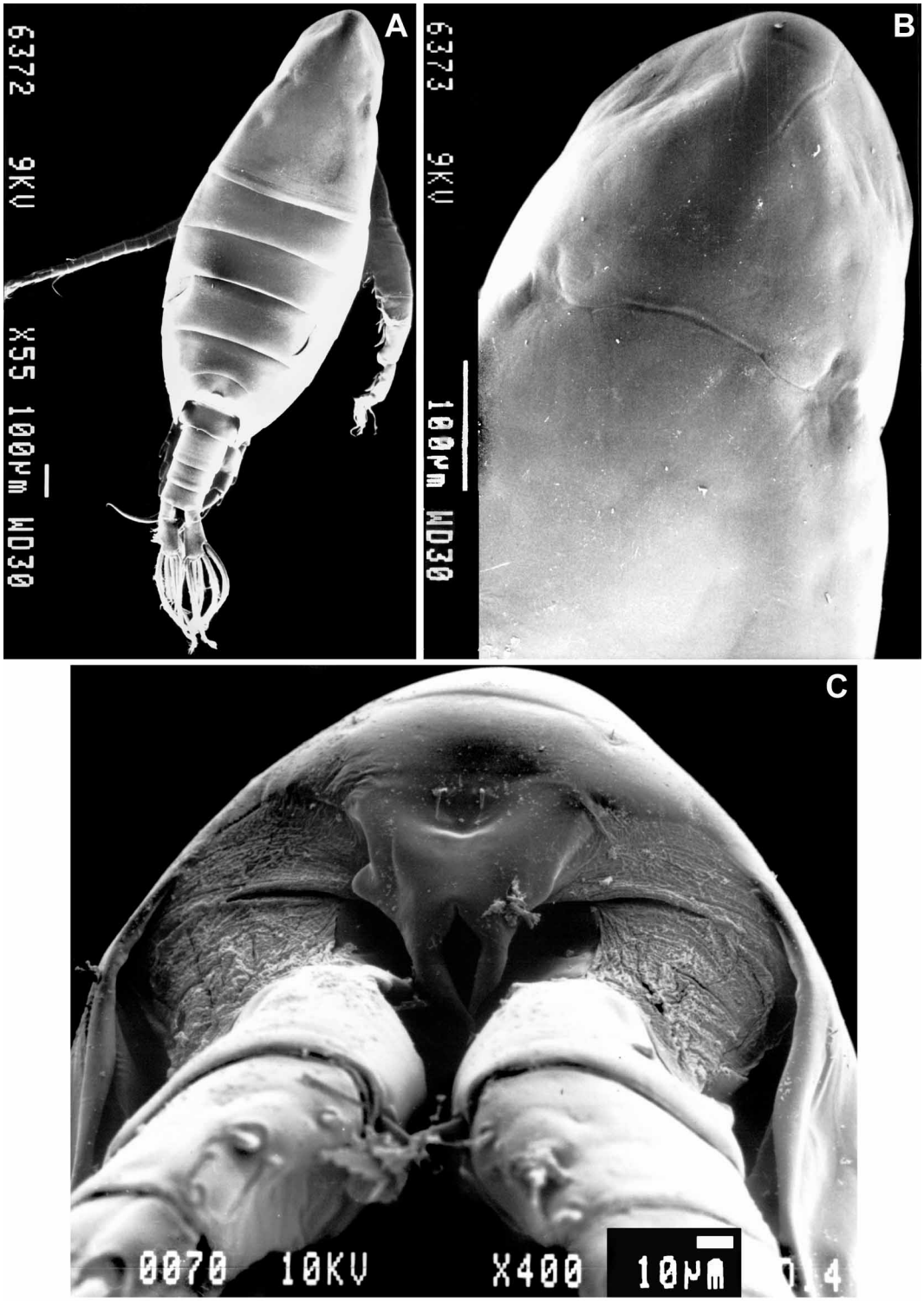

FIGURE 2. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult, scanning electron microscopy (SEM): **A** – habitus, dorsal view. **B** – Cephalosome, dorsal view. **C** – rostrum, ventral view.

Right A1 22-segmented (figs 3 & 5), geniculate between segments 18 and 19. Number of armature elements presented in table 2. In posterior view, for segment 8–12, space between each segment obtuse relative to the

TABLE 2. Segmentation pattern and armature of the antennules in *Argyrodiaptomus paggii* **n. sp.**. Legend: A, ancestral segments; N, number of actual segments; s, seta; ae, aesthetasc; vc, vestigial seta; ms, modified seta; p, process.

A	N	♂ right antennule	N	♂ left antennule	♀ antennules
I	1	1s + 1ae	1	1s + 1ae	1s + 1ae
II	2	3s + 1ae + 1vs	2	3s + 1ae + 1vs	3s + 1ae + 1vs
III					
IV					
V	3	1s + 1ae + 1vs	3	1s + 1ae + 1vs	1s + 1ae + 1vs
VI	4	1s	4	1s	1s
VII	5	1s + 1ae + 1 vs	5	1s + 1ae + 1 vs	1s + 1ae + 1 vs
VIII	6	1s	6	1s	1s
IX	7	1s + 1ae	7	1s + 1ae	1s + 1ae
X	8	1s + 1cs	8	1s + 1cs	1s + 1cs
XI	9	2s + 1ae	9	2s + 1ae	2s + 1ae
XII	10	1s + 1ms	10	1s	1s
XIII	11	1s + 1ms + 1ae	11	1s	1s
XIV	12	1s + 1ae + 1cs	12	1s + 1ae + 1cs	1s + 1ae + 1cs
XV	13	1s + 1ae + 1ms	13	1s	1s
XVI	14	2s + 1ae	14	1s + 1ae	1s + 1ae
XVII	15	2s + 1ae + 1p	15	1s	1s
XVIII	16	2s + 1ae	16	1s + 1ae	1s + 1ae
XIX	17	2s + 1ms	17	1s	1s
XX	18	1s + 1 ms	18	1s	1s
XXI	19	2s + 1ae + 2ms	19	1s + 1ae	1s + 1ae
XXII			20	1s	1s
XXIII			21	1s	1s
XXIV	20	4s + 1p	22	2s	2s
XXV			23	2s	2s
XXVI	21	2s	24	2s	2s
XXVII	22	4s + 1ae	25	4s + 1ae	4s + 1ae
XXVIII					

other segments, hyaline membrane also present (fig. 5B–C). In anterior view this membrane is smaller and space is parallel relative to the other segments. Posterior surface of segment 12 with incomplete cuticle, partially separating the internal region of the surface (fig. 5B–C). Segment 13 with grooves at posterior surface (fig. 5C). Modified region (posterior view) comprising segments 13 (XV) to 18 (XX). Widest region at segment 14 (XVI), longer at segment 19 (XXI–XXIII). Segment 3 (V) with 1 aesthetasc. Segments 4 (VI), 14 (XVI), 15 (XVII), 16 (XVIII) and 17 (XIX) with outer margin ornamented with thin tubercles. Vestigial setae on segments 2 (III), 3 (V) and 5 (VII). Segments 8 (X) and 12 (XIV) with small conical setae (smaller than modified setae of segments 10 (XII) and 11 (XIII)), forming a strong spiniform process. Conical seta of segment 8 smaller than conical seta of segment 12. Segments 10 and 11 with modified setae parallel to main axis of antennule. Seta of segment 11 larger than seta on segment 10, but smaller than modified seta of segment 13 (XV). Segment 11 with 1 aesthetasc. Modified seta on segment 13 different from modified setae on segments 17 (XIX), 18 (XX) and 19 (XXI–XXIII), forming a strong process, reaching or exceeding the distal margin of

the next segment (14). Tip of modified seta acute. Spinouse process at outer margin of segment 15 (XVII) always present. Segments 17 (XIX) and 18 (XX) with 1 seta-like aesthetasc. Segment 18 with modified seta of similar size to the aesthetasc. Segment 19 (XXI–XXIII) with distal seta, as long as or longer than segment size. Segment 20 (XXIV–XXV) with 2 setae inserted posteriorly, process on distal margin always present. Process curved, not exceeding half the length of the next segment. Segment 21 (XXVI) with seta inserted ventrally.

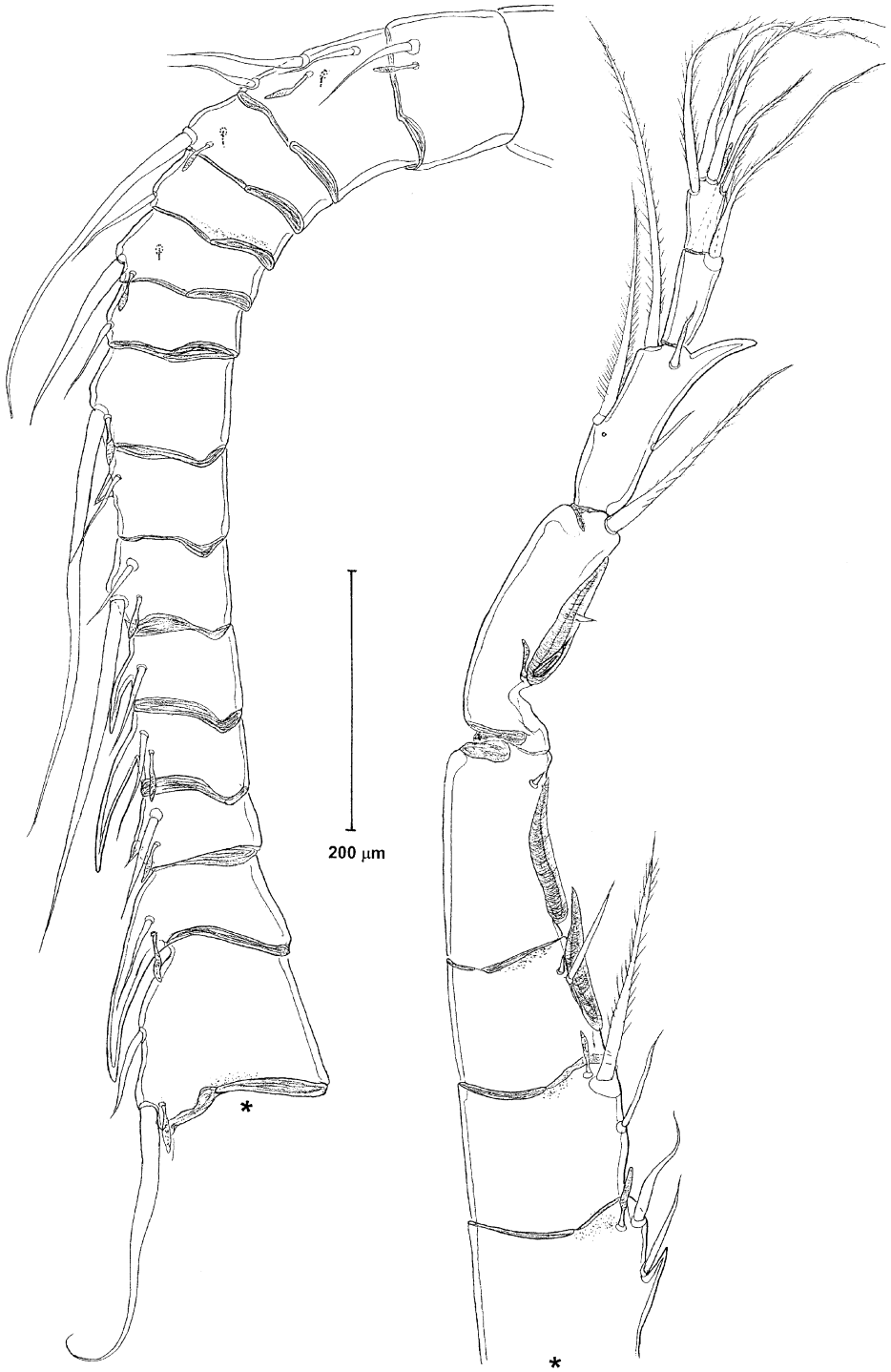

FIGURE 3. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: A1 right, anterior view.

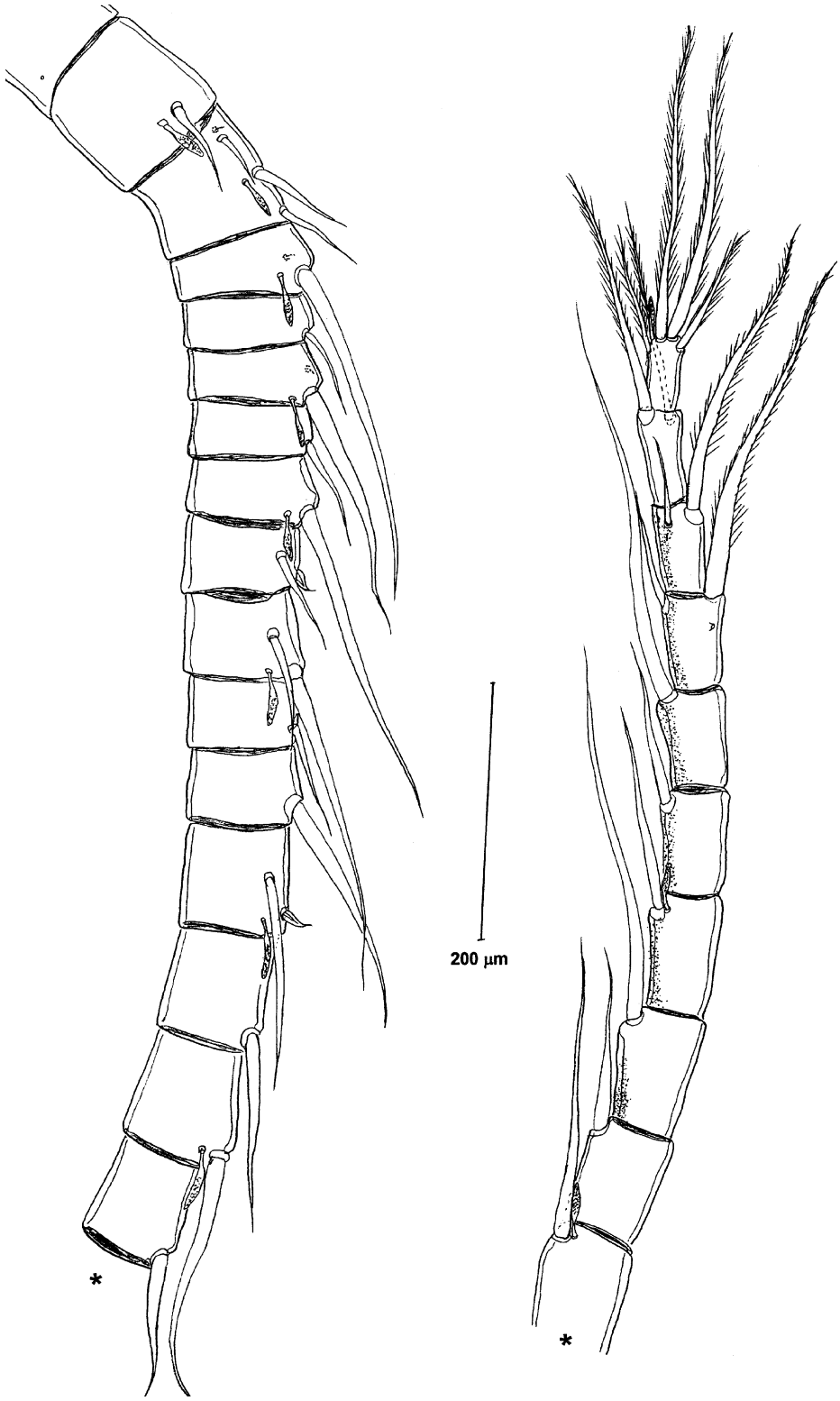

FIGURE 4. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: A1 left, anterior view.

Left A1 25-segmented (fig. 4). Number of armature elements as shown in table 2. Segment 11 (XIII) with single seta. Modified setae on segments 8 (X) and 12 (XIV) similar to those on corresponding segments of right A1. One of the setae of segments 22 (XXIV) and 23 (XXV) inserted dorsally on distal inner margin. Seta of segment 24 (XXVI) inserted ventrally at distal outer margin.

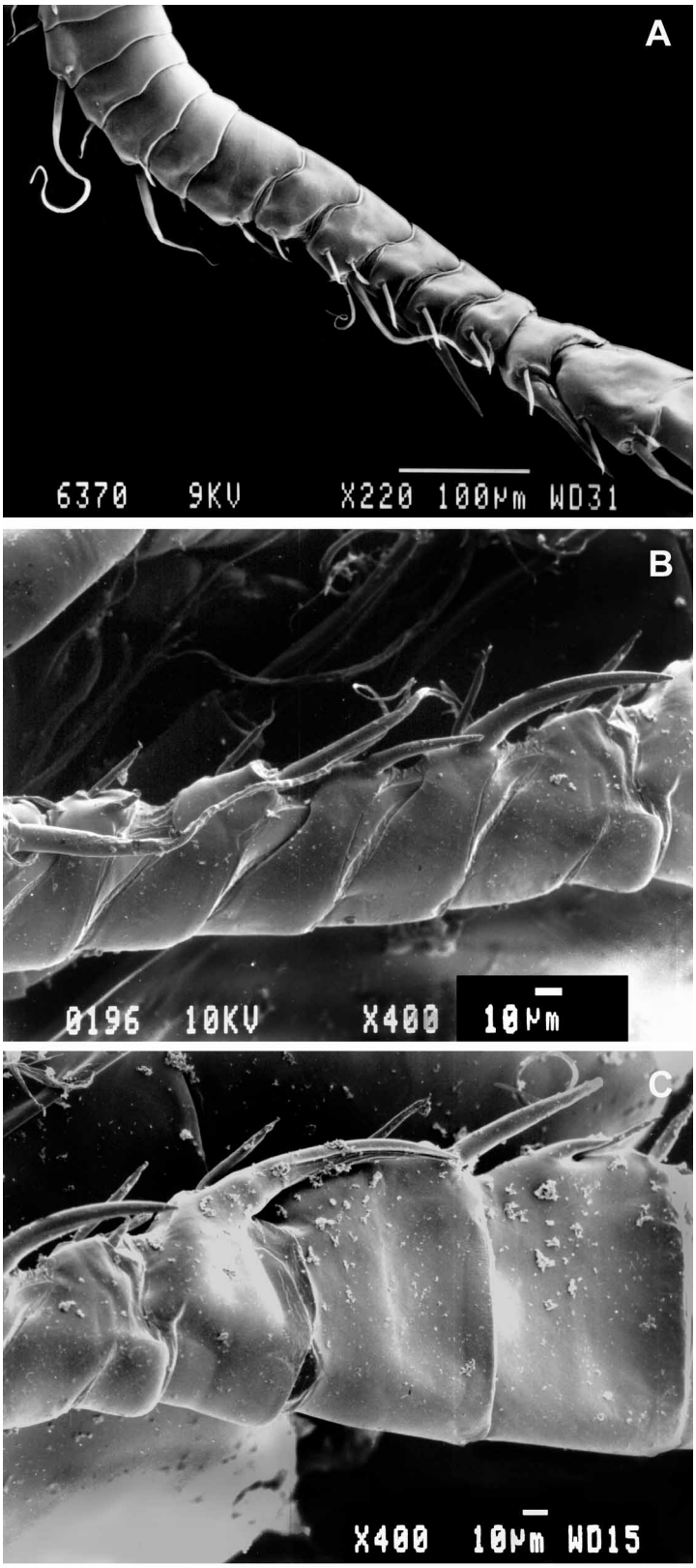

FIGURE 5. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult, SEM: **A** – A1 right, segments 1–16, anterior view. **B** – A1, right, segments 8–13, posterior view. **C** – A1 right, segments 12–15, posterior view.

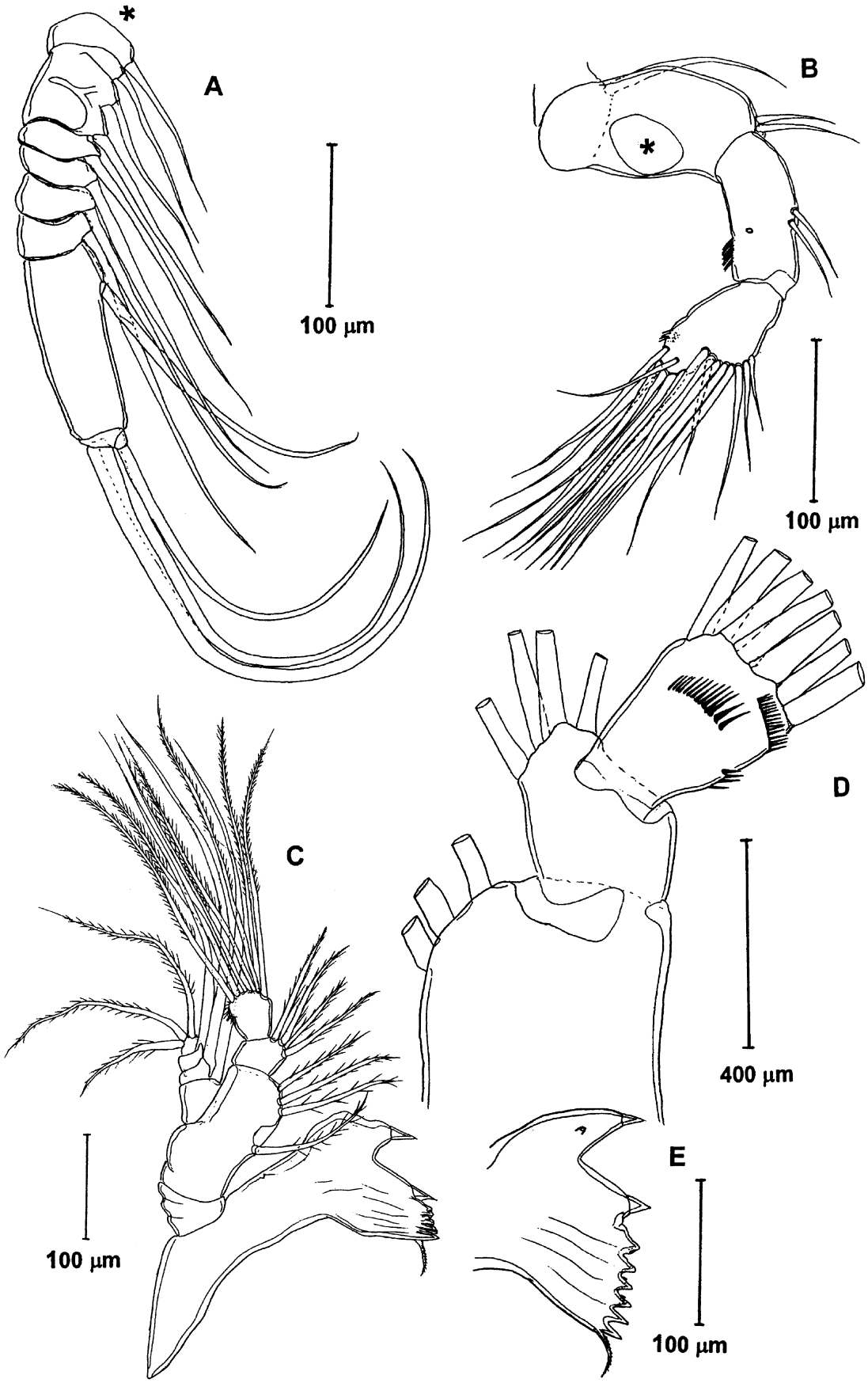

FIGURE 6. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – A2 right, Exp, posterior view. **B** – A2 right Enp, posterior view (ornament of setae not figured). **C** – Md right, posterior view. **D** – endites of mandibular palp, anterior view (setae not completely figured). **E** – cutting blade of mandibular gnathobase.

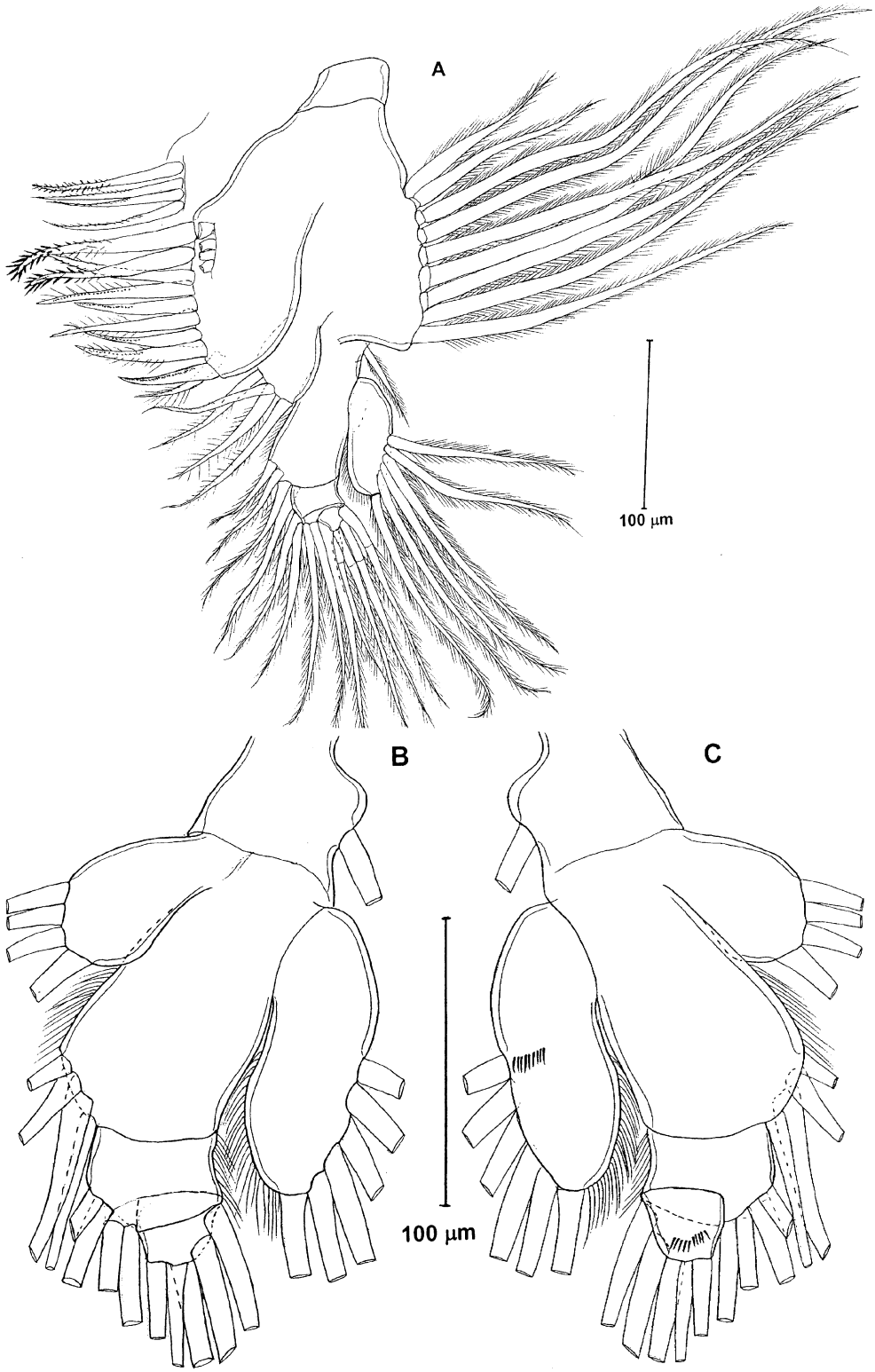

FIGURE 7. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** –Mxl right, posterior view. **B** – maxillular palp, posterior view. **C** – maxillular palp, anterior view.

A2 biramous (fig. 6A–B). Coxa with inner seta. Basis with 2 setae on the inner face, inserted posteriorly. Exopod 8-segmented; second (II–IV) and penultimate (IX–X) segments compounded with regions of discontinuous cuticle surface, forming grooves; penultimate segment elongated; distal segment small, with 3 long, apical setae. Endopod 2-segmented; outer margin of first segment ornamented with 1 patch of spinules

(approx. 15); inner margin with 2 setae and pore between patch of spinules and setae; second segment bilobed, with groove between lobes; outer lobe with 7 distal setae and 1 group of spinules on dorsal/outer margin; inner lobe with 8 distal setae.

Mandible divided into praecoxa, coxa, basis, Enp and Exp (fig. 6C). Gnathobase strongly sclerotized, transformed into a prominent lobe on caudal margin. Gnathal blade separated from lobe by deep diastema, with 1 sub-triangular tooth plus 6 multicuspidal teeth (fig. 6C & E). Dorsal seta unique, inserted at apical margin. Mandibular palp biramous. Basis of the palp with 4 inner setae (3 distal). Exp with 4 segments; setal formula 1, 1, 1, 3. Enp 2-segmented; first segment with distal lobe and 4 setae; second segment with 7 distal setae and 3 patches of spinules on posterior margin (1 line situated sub-terminally, 1 patch on outer margin and 1 distal: fig. 6D).

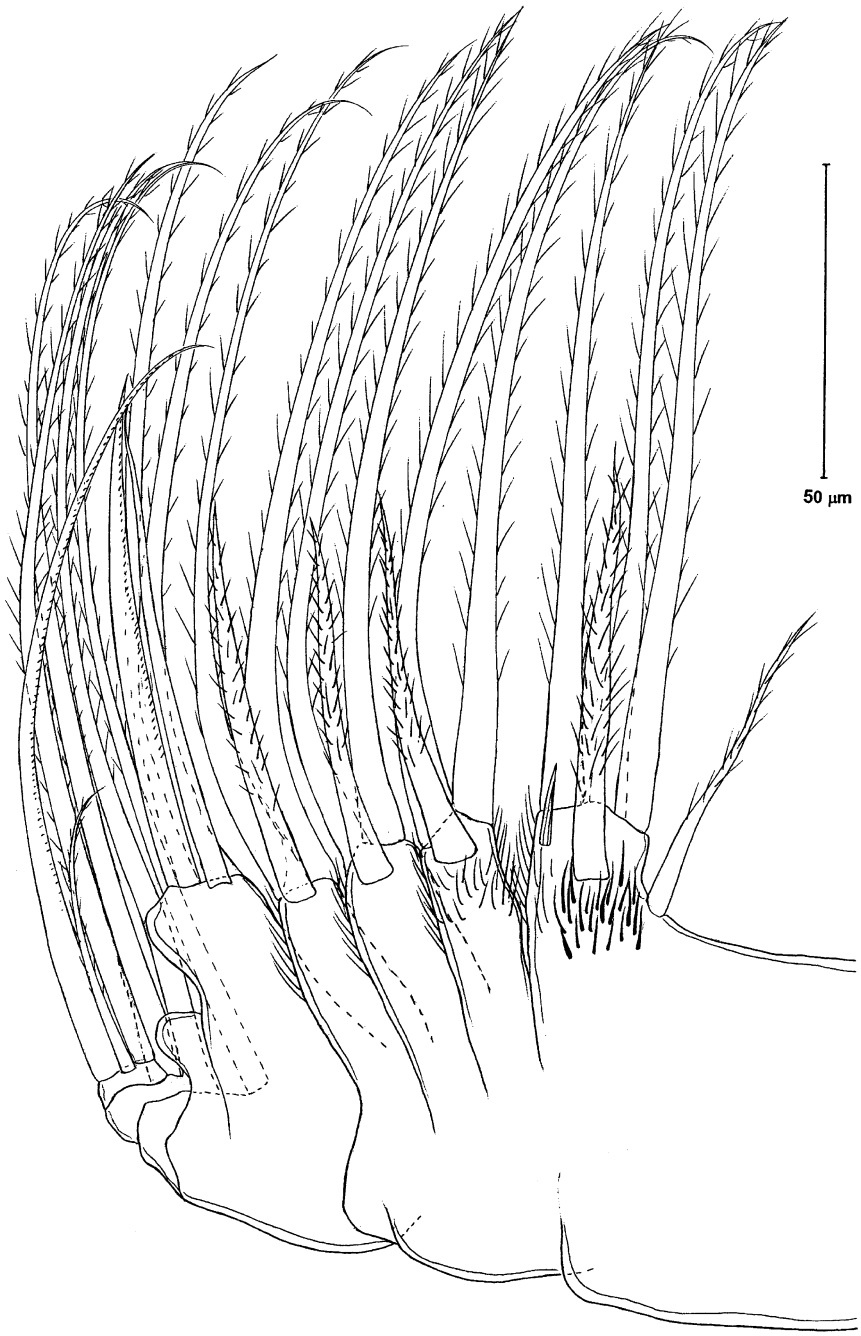

FIGURE 8. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: Mx, posterior view.

Mxl (fig. 7A) praecoxal arthrite bearing 10 marginal setae, 2 armed with sub-distal spines; sub-marginally, 5 setae inserted—4 naked, 1 spinulated. Epipod of coxa bearing 9 setae; coxal endite with 4 distal setae. Basal exite represented by outer seta; basal proximal endite well defined, with 4 setae. Distal endite fused with basis, with 4 setae and row of marginal spinules. Exp fused, bearing 6 distal setae and a group of spinules on anterior surface. Enp 2-segmented; first segment with 3 distal setae, Enp-2 with 5 setae and row of spinules on anterior surface (fig. 7B–C).

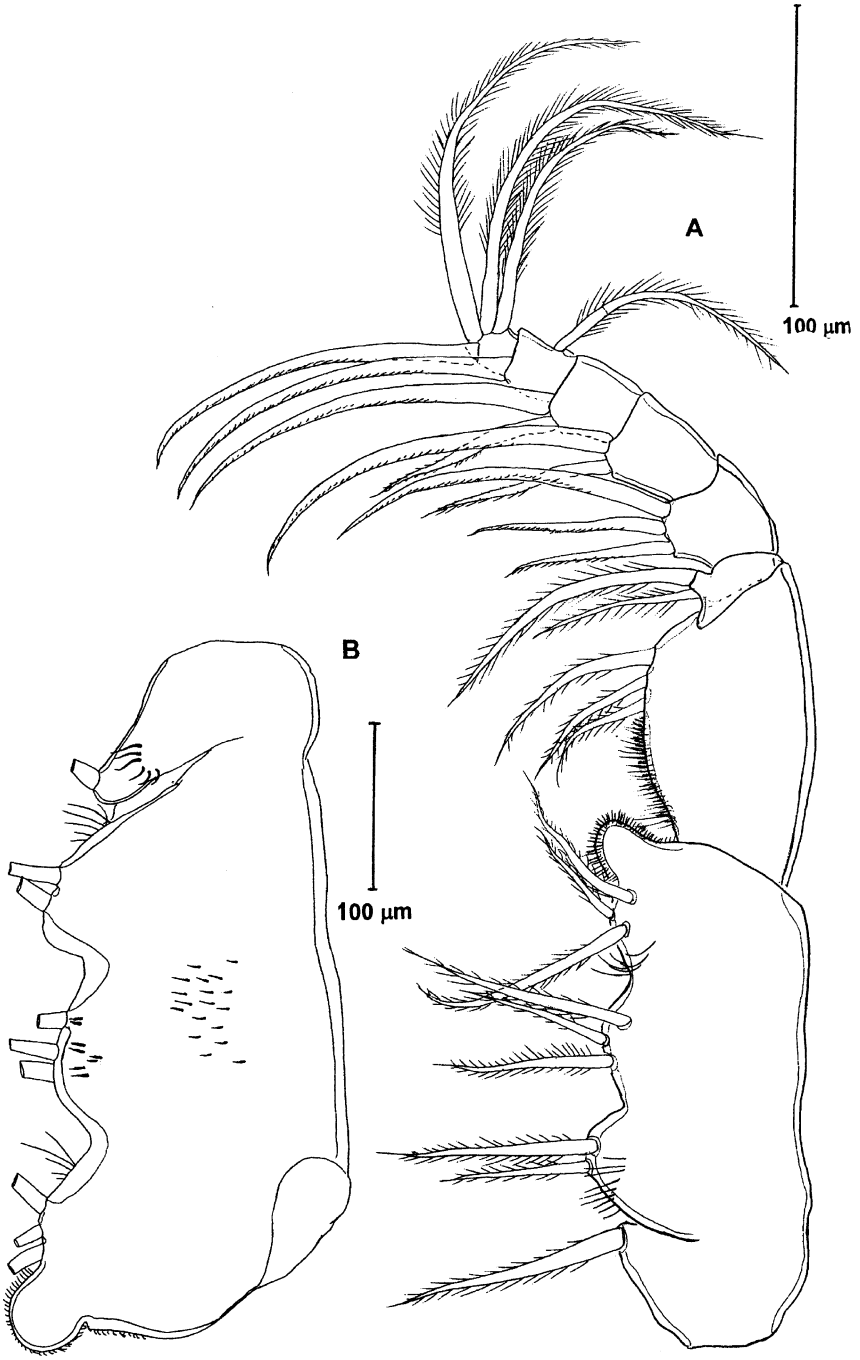

FIGURE 9. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – Mxp, posterior view. **B** – praecoxa and coxa of Mxp, anterior view.

Mx (fig. 8) with praecoxa and coxa fused medially, separated laterally. Proximal praecoxal endite with 5 setae and 1 spine. Distal praecoxal endite naked. Coxal endites with 3 setae and distal row of spinules. Allobasis well developed, bearing 4 setae. First endopod partially segmented, with a lobe on posterior surface. Endo-

pod 3-segmented with 5 setae (1, 1, 3).

Mxp well developed, comprising syncoxa, basis and 6 free endopod segments. Praecoxal endite with 1 seta and a group of spinules on posterior surface. Coxal endites not developed, represented by 8 setae, distributed in 3 medial patches. Setal formula: 2, 3, 3 (fig. 9A). Ornamentation: proximal group of setules adjacent to the group of setae on first coxal endite, 1 group of spinules between first and second coxal endites, 1 group of spinules (longer and more numerous than previous), on anterior surface of the second coxal endite, adjacent to setal group, 1 group of setules between the groups of setae of first and second coxal endites. Distal angle of syncoxa with setules along margin. Basis with 3 setae at medial margin (fig. 9B). Ornamentation represented by row of sub-medial spinules on one side and setules on the other. Enp-1 distinct but reduced. Setal formula of the endopod as: 2, 3, 2, 2, 1 + 1, 4.

P1–P4 symmetrical and biramous. Armature formula in table 3.

TABLE 3. *Argyrodiaptomus paggii* **n. sp.**, holotype ♂. Spine and seta formula.

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	0-0	I-1; 0-1; I,I,4	0-1; 1,2,3
Leg 2	0-1	0-0	I-1; I-1; I,I,5	0-1; 0-2; 2,2,3
Leg 3	0-1	0-0	I-1; I-1; I,I,5	0-1; 0-2; 2,2,3
Leg 4	0-1	1-0	I-1; I-1; I,I,5	0-1; 0-2; 2,2,3

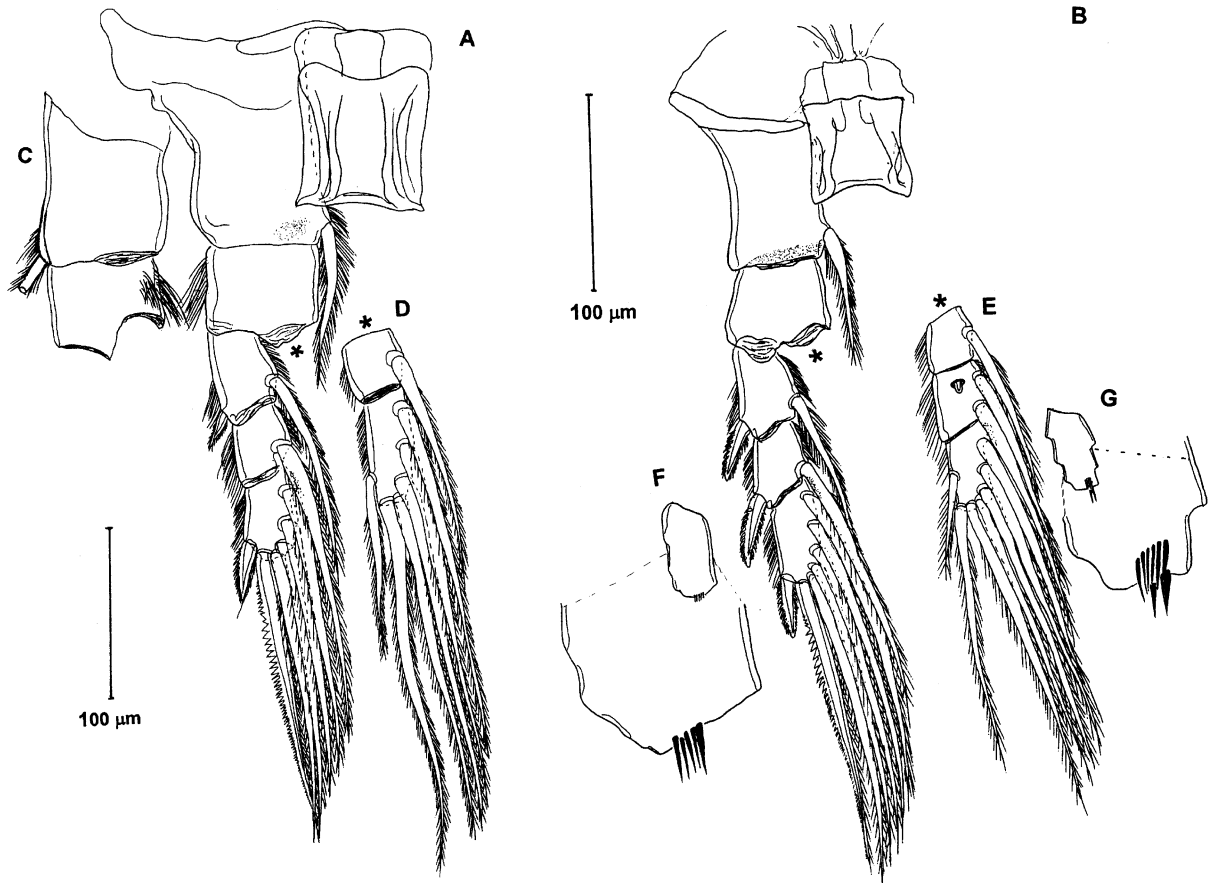

FIGURE 10. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – P1 left, posterior view. **B** – P2 left, posterior view. **C** – coxa and basis of left, anterior view. **D** – P1 left, Enp, posterior view. **E** – P2 left, Enp, posterior view. **F** – P2 left, Exp-3, anterior view. **G** – P2 left, Enp-3, anterior view.

P1: Coxa with setules on inner margin; no spines on posterior surface. Basis with setules at proximal margin (fig. 10A & C). Exp 3-segmented (fig. 10A); setules along inner and outer margins of all segments. Exp-3 spine with cirrose apex (fig. 10A), anterior surface Exp-3 with line of spinules. Enp 2-segmented; setules present along all outer margins and inner margin of second segment (fig. 10D).

P2: Lateral and posterior portion of basis smooth (not ornamented with setules). Exp 3-segmented; setules along inner and outer margins of all segments (fig. 10B). Anterior surface Exp-3 with distal row of spinules (fig. 10F). Enp 3-segmented. Schmeil's organ present on posterior surface of segment 2. Setules along outer margin of all segments and at inner margin of segments 2 and 3 (fig. 10E). Enp-3 anterior surface with 2 distal rows of spinules. Groups of spinules in different sizes and numbers (distal ones larger, but less numerous than proximal ones) (fig. 10G).

P3: Setules along inner margin of all segments and on outer margin of segments 2 and 3 (fig. 11A). Anterior surface of Enp-3 with 2 lines of spinules at distal portion. Groups of spinules with different sizes and numbers (distal ones larger, but less in number than proximal ones) (fig. 11E). Remaining characteristics similar to P2.

P4: Basis with seta on posterior surface. Exp 3-segmented. Setules on inner margin of all segments and outer margin of segments 2 and 3 (fig. 11B). Anterior surface of Exp-3 segment with 1 line of spinules at distal portion (fig. 11G). Enp with 3 segments. Setules on outer margin of all segments and inner margin of segments 2 and 3 (fig. 11F). Anterior surface of Enp-3 with 2 lines of spinules on distal portion. Groups of spinules with different sizes and numbers (distal ones larger, but fewer than proximal ones) (fig. 11H).

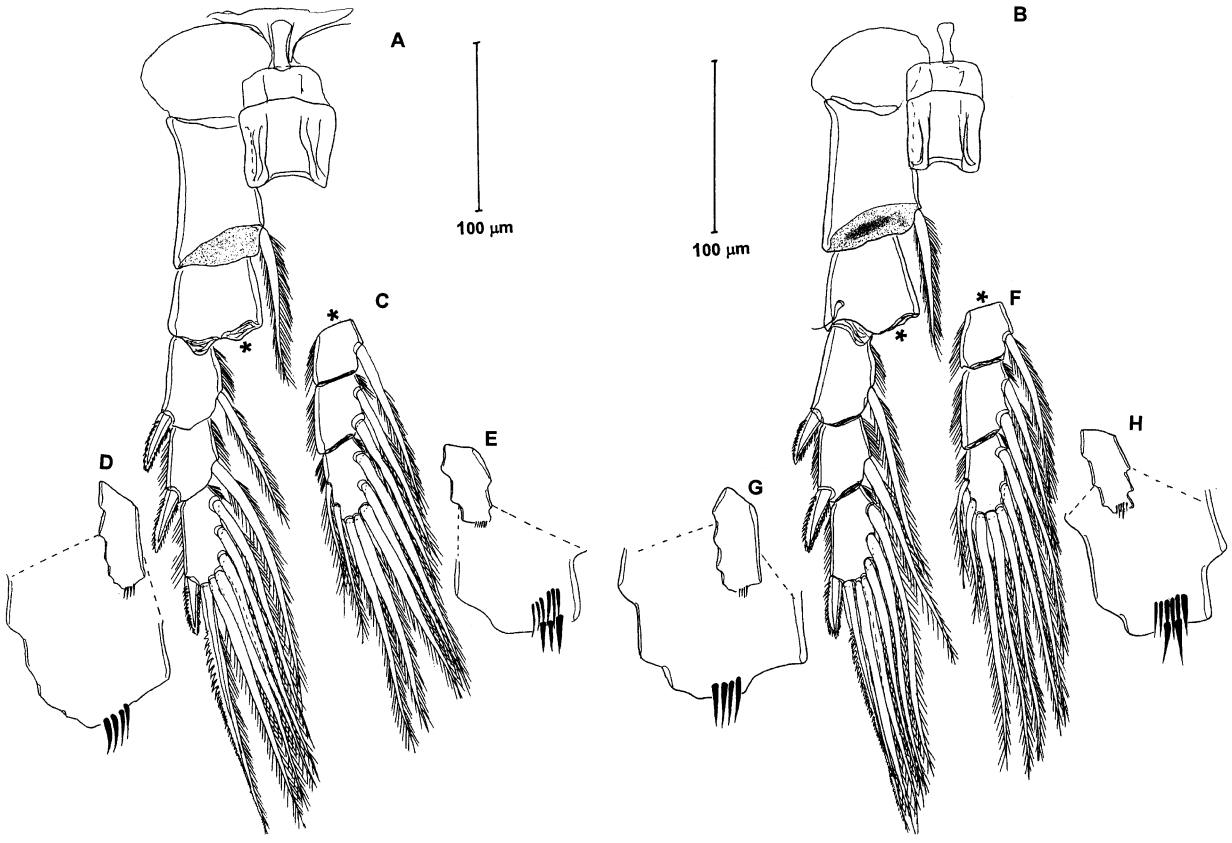

FIGURE 11. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – P3 left, posterior view. **B** – P4 left, posterior view. **C** – P3 left, Enp, posterior view. **D** – P3 left, Exp-3, anterior view. **E** – P3 left, Enp-3, anterior view. **F** – P4 left, Enp, posterior view. **G** – P4 left, Exp-3, anterior view. **H** – P4 left, Enp, anterior view.

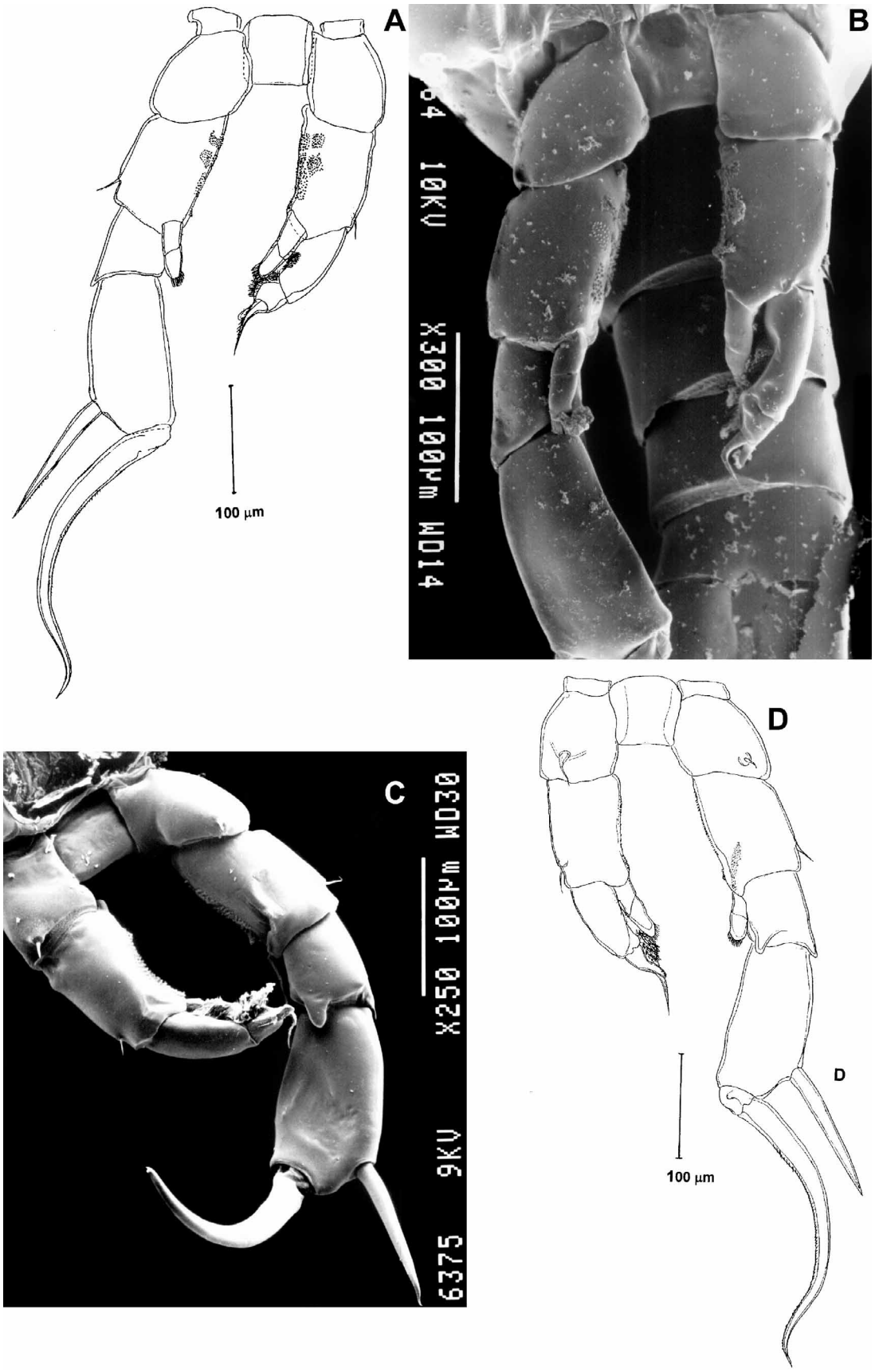

FIGURE 12. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – P5, anterior view. **B** – P5, anterior view (SEM). **C** – P5, posterior view. **D –** P5, posterior view (SEM).

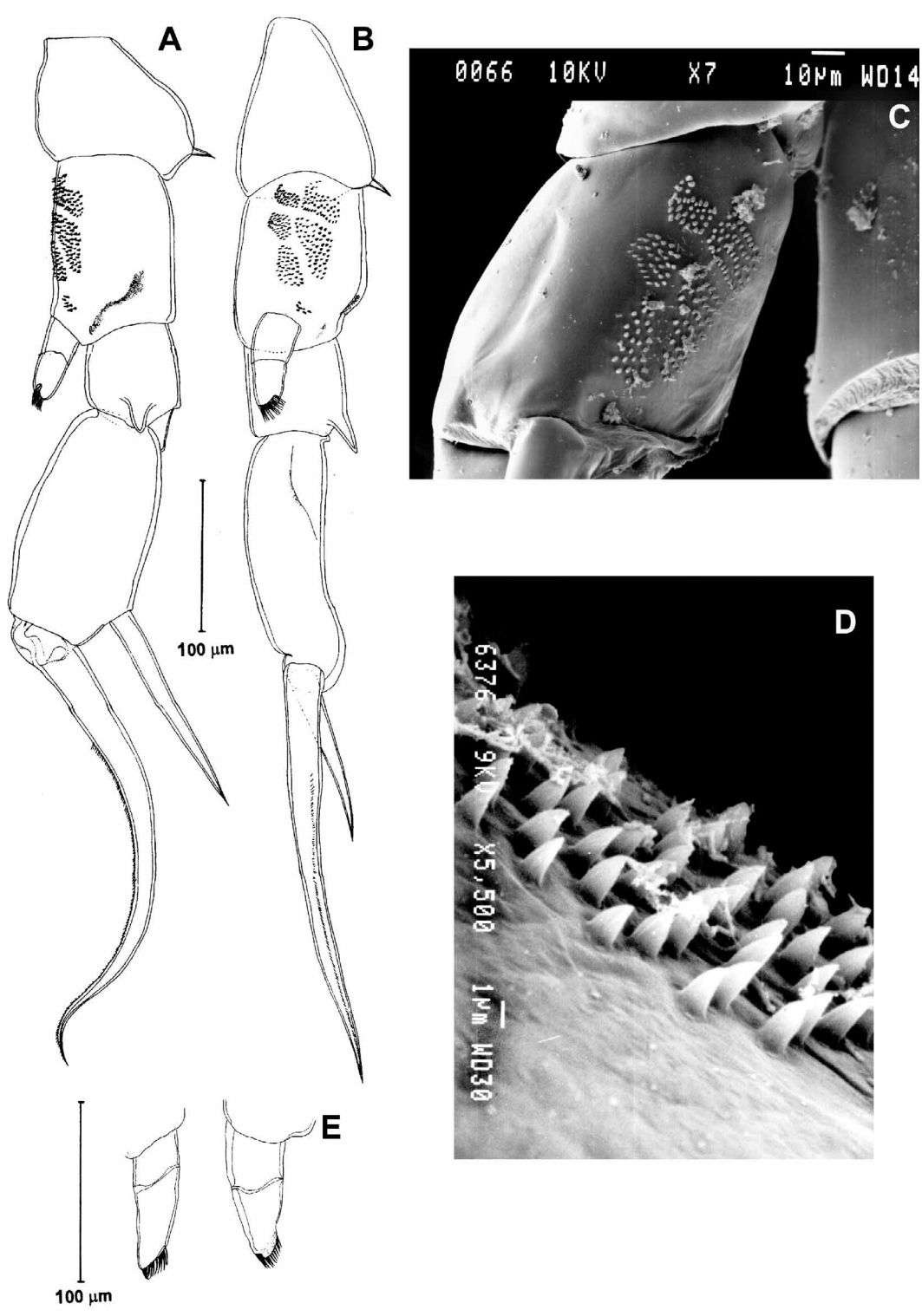

FIGURE 13. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – P5 right, posterior view. **B** – P5 right, lateral/inner view. **C** – P5 right, basis, lateral/inner view (SEM). **D –** detail of the spinules of basis of right P5 (SEM). **E –** P5 right Enp, lateral/inner view (at right) and outer (at left).

P5 asymmetrical, biramous (figs 12–15). Intercoxal plate (coupler) as long as it is wide, equally wide as coxa, inserted laterally (not overlapping plate).

Right P5: Rudimentary praecoxa present. Coxa with conical process, posteriorly directed, not projected above basis. Conical process reduced. Apex of the process with small sensillum, acute at tip. Basis without

expansion on posterior surface. Posterior surface with oblique groove, ornamented with small spinules along distal rim. Inner margin ornamented with small spinules, forming patches of similar number and shape (fig. 13). Seta of outer margin inserted posteriorly. Semicircular lamella present on inner margin of basis. Exp 2-segmented. First segment cylindrical; expansion strongly sclerotized, located posteriorly at distal margin (projected over the second segment); expansion digitiform, blunt tip, larger than Enp and inserted perpendicularly inserted to the segment; ovoid process adjacent to the expansion; outer distal region of segment present another expansion with triangular shape and acute apex. Enp-2 wide and sub–triangular; lateral spine straight; length of spine reaching between half and 2/3 of terminal claw; ornamentation composed by 1 row of spinules along inner margin. Terminal claw strong, inserted distally, curved in tree planes. Presence of a row of spines from second half of the inner margin; apex acute and curved. Enp distinct from basis, with 2 incompletely separated segments; distal portion of segment 2 ornamented with terminal spinules, arranged in crown on anterior inner surface (fig. 13E).

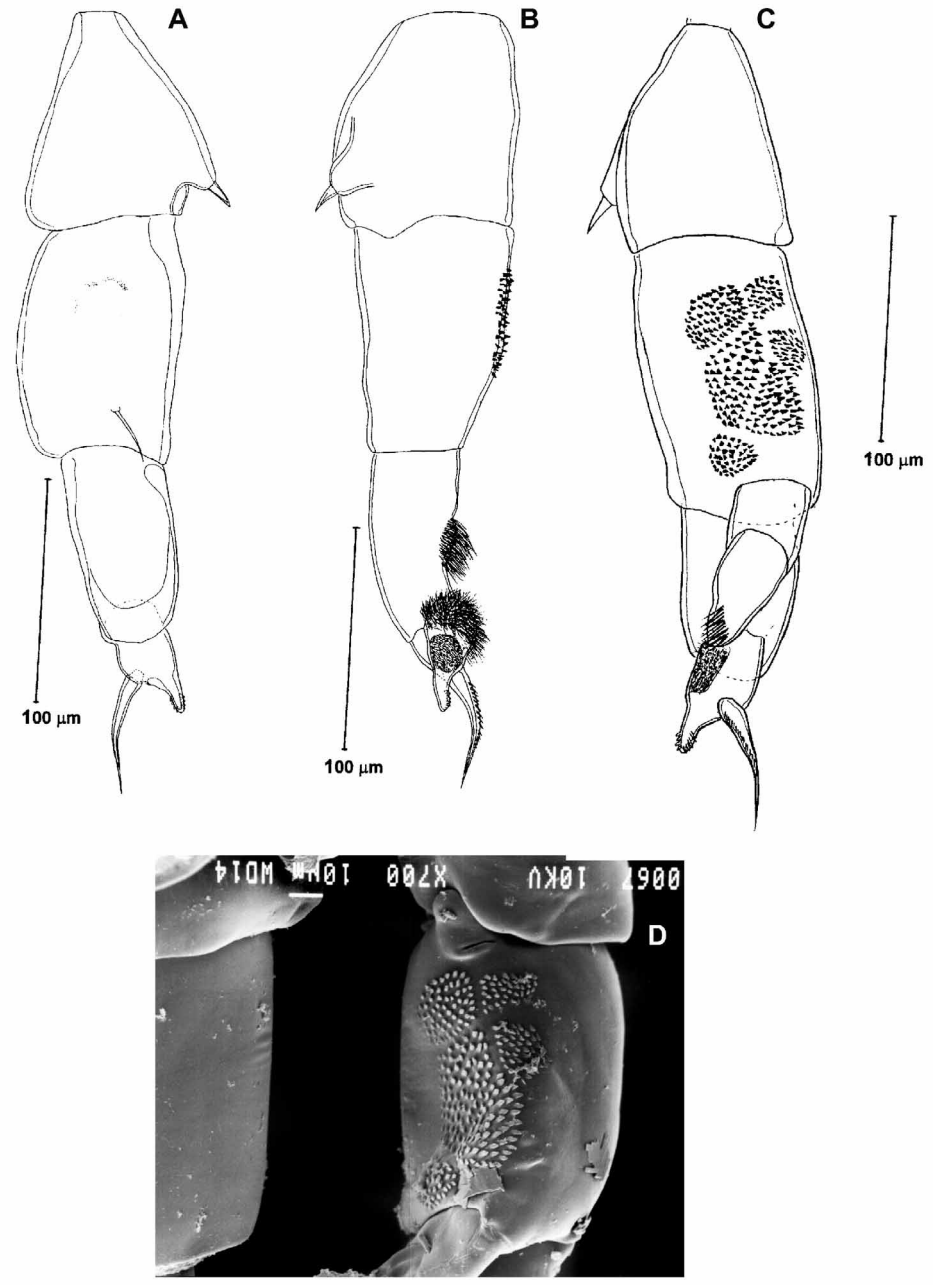

FIGURE 14. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – P5 left, lateral/outer view. **B** – P5 left, posterior view (Enp not figured). **C** – P5 left, lateral/inner view. **D –** P5 left, basis, lateral/inner view (SEM).

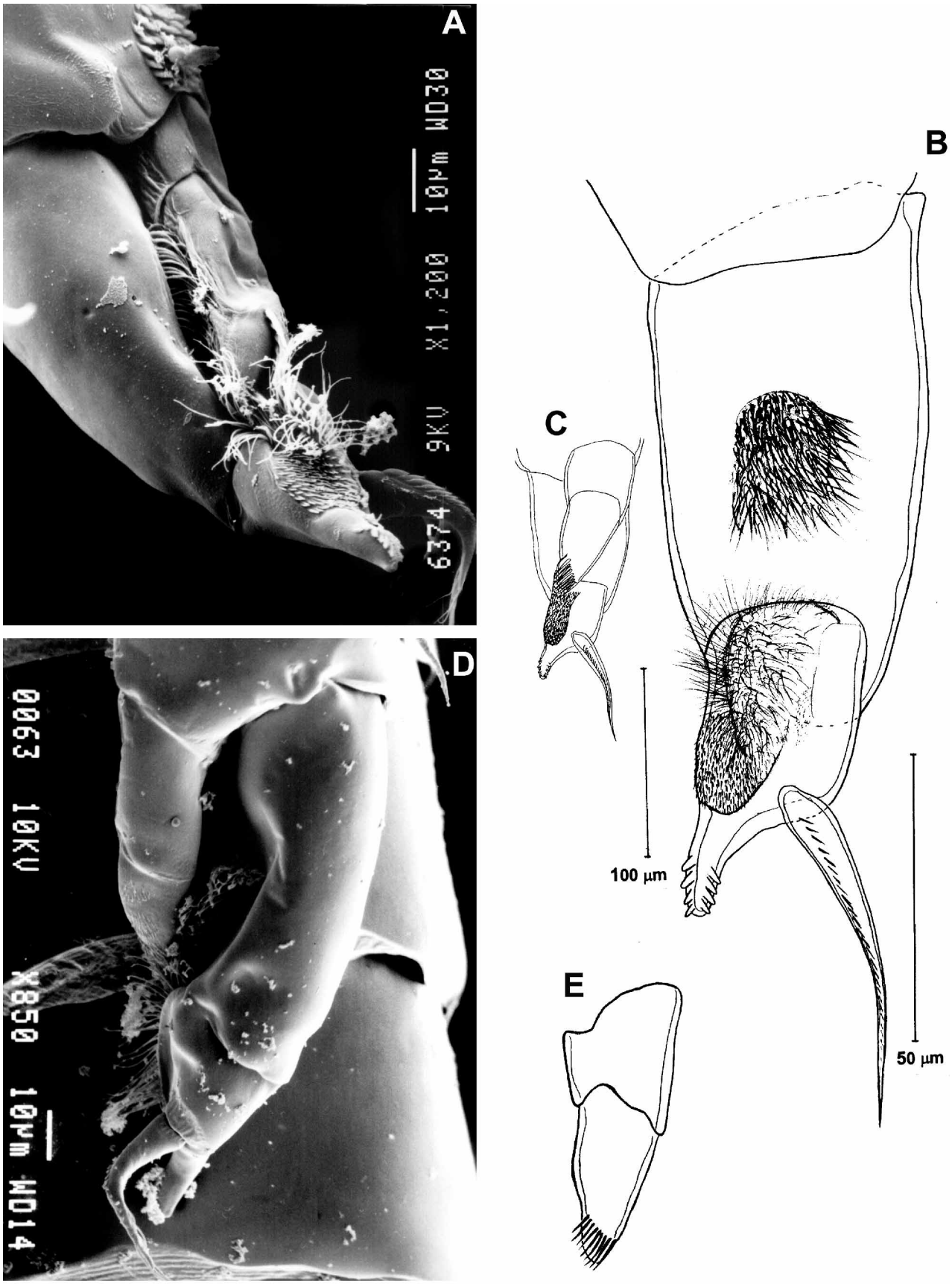

FIGURE 15. *Argyrodiaptomus paggii* **n. sp.**, ♂ adult: **A** – P5 left, lateral/inner view (SEM). **B** – P5 left, lateral/inner view (Enp not figured). **C** – P5 left, lateral/inner view. **D** – P5 left, lateral/outer view (SEM). **E** – P5 left Enp, lateral/inner view.

P5 left: well developed, reaching distal margin of right Exp-1 (fig. 12). Coxa with a small conical process (smaller than on the right coxa), directed posteriorly directed, on distal outer margin; apex of conical process with sensillum similar to that on right coxa, but smaller. Basis with seta on outer margin; inner margin lightly curved; inner surface with spinules, forming similar patches but different from those on right basis (fig. 14). Exopod 2-segmented; first segment sub–triangular, outer margin curved; semicircular process on inner margin armed with long setules; second segment with inner margin expanded; ornamented with setules and a group of spinules; distal portion with digitiform process strongly sclerotized; process ornamented with small number of spinules; spiniform seta well developed, distally inserted on anterior surface, reaching far beyond (more than double) digitiform process; length ratio of length/width of spinulouse seta 4:1. Endopod conical; 2-segmented, suture complete; proximal portion ornamented with distal row of spinules; segment 2 as long and as wide as segment 1 (fig. 15).

Adult ♀ (figs 16–21): Length excluding caudal setae: 2070 µm. Mean length ♀ (n=20) 2068.3 µm, s.d. ± 48.6, range =1955–2150 µm. Body wider and longer than ♂, widest at distal portion of Th2.

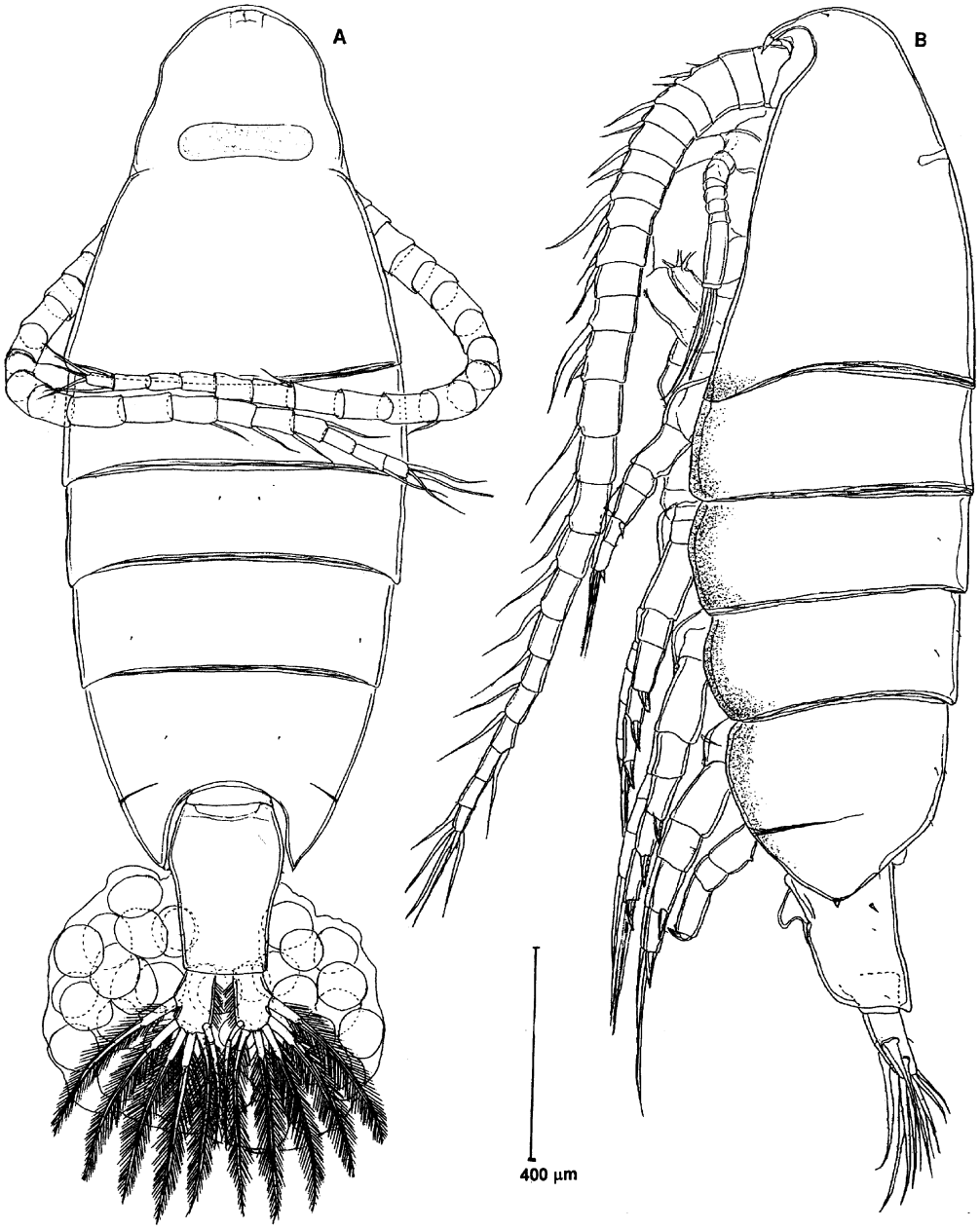

FIGURE 16. *Argyrodiaptomus paggii* **n. sp.**, ♀ adult: **A –** habitus, dorsal view. **B** – habitus, lateral view.

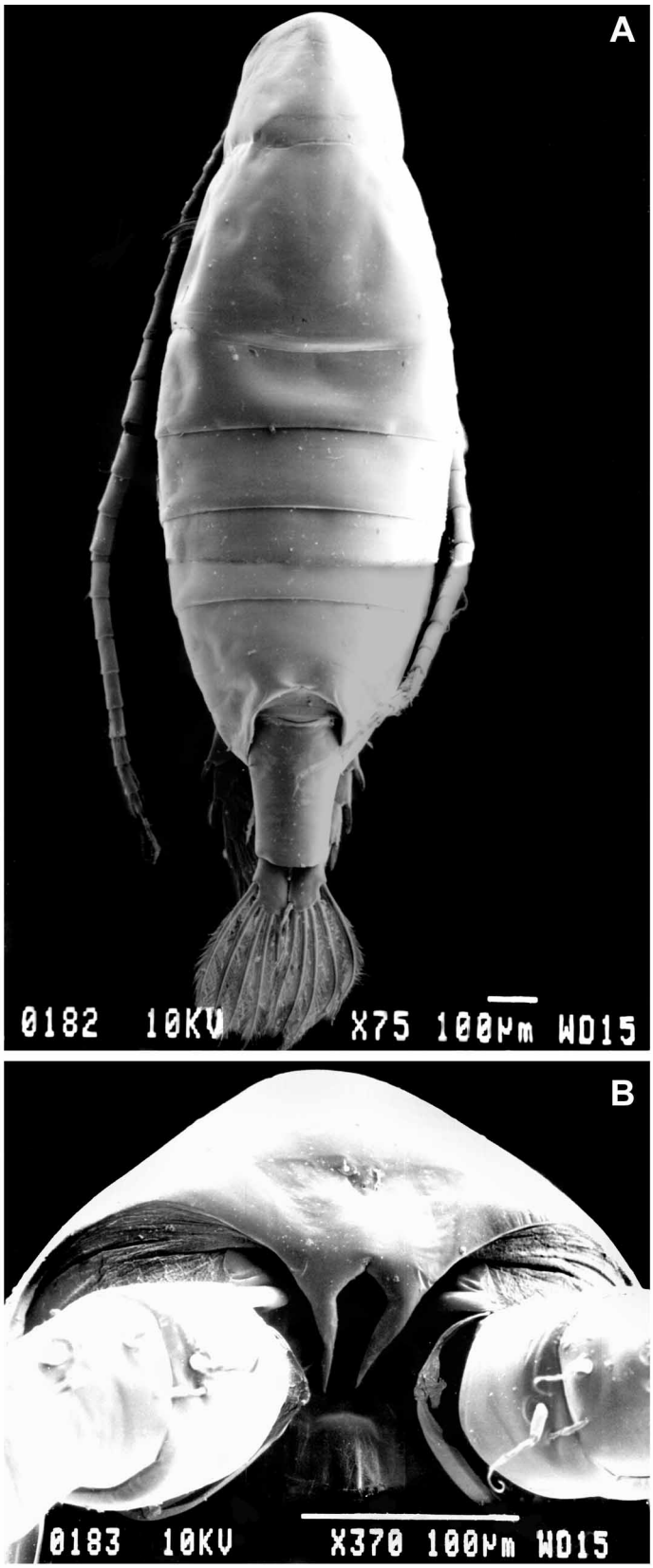

FIGURE 17. *Argyrodiaptomus paggii* **n. sp.**, ♀ adult, SEM: **A** – habitus, dorsal view. **B** – rostrum, ventral view.

Cephalosome with dorsal suture incomplete; modified region forming a thin depression at suture level, with nucal organ broader than long (ratio = 3:2) and soft-shaped angles (figs 16A & 17A). Rostrum broader than in ♂, with paired filaments; symmetrical; defined from frontal margin of dorsal cephalic shield by complete suture; presence of pair of sensilla adjacent to suture (fig. 17B).

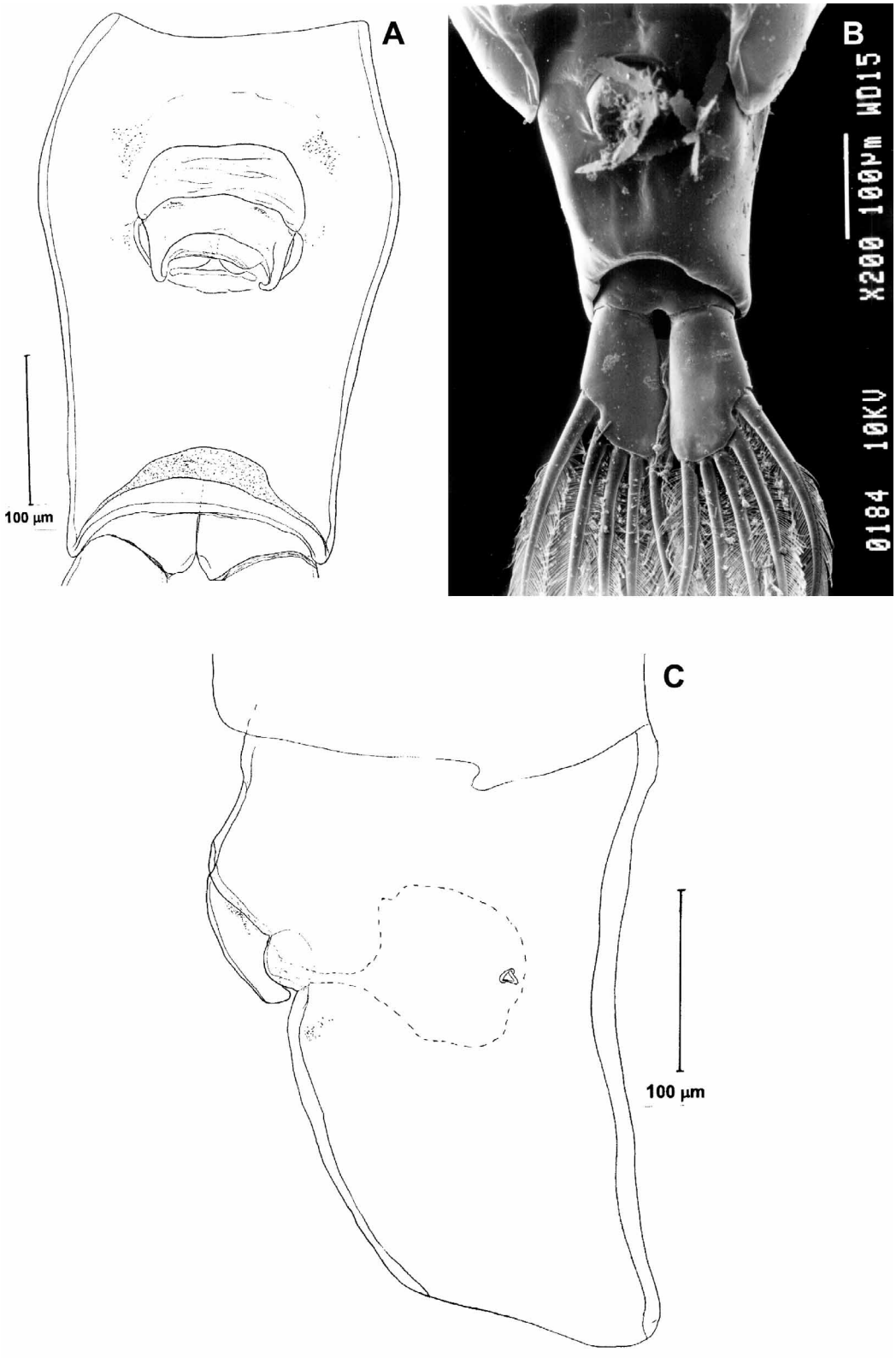

FIGURE 18. *Argyrodiaptomus paggii* **n. sp.**, ♀ adult: **A** – genital segment, ventral view. **B** – genital segment, ventral view (SEM). **C** – genital segment, lateral view.

Prosome 5-segmented. Th4 and Th5 distinctly defined; suture between them incomplete in dorsal surface; in lateral view, suture conspicuous. Hyaline frill between Th5 and GS. Lateral wings symmetrical, formed by single pair of lobes; left lateral wing posteriorly directed, without spines, inwardly curved against GS, with posterior margin continuous with lateral wings. Dorsal lobes absent. Ornamentation including small spiniform sensilla, one at each extremity of the lobes and sensilla distributed as shown in figure 16A.

Urosome with 2 somites followed by the anal somite and caudal rami. Genital somite saddle shaped at lateral view longer than wide, covering the other urosomites. Lateral sensillum on each side (dorsal view), small and acute at apex. Integument reduced ventrally. Outer genital area delimited by large, symmetrical operculum. Lateral processes well developed, posteriorly directed, with area of flexible cuticle, adjacent to the opercular area. Gonoporal plates located medially between lateral processes (fig. 18). Second urosomite small, partially fused, telescoped and covered by GS. Anal somite with operculum not completely covering the anal opening and with 1 sensillum on each side. Caudal rami symmetrical, 2.5 times longer than wide, with setules along inner margins (fig. 18B).

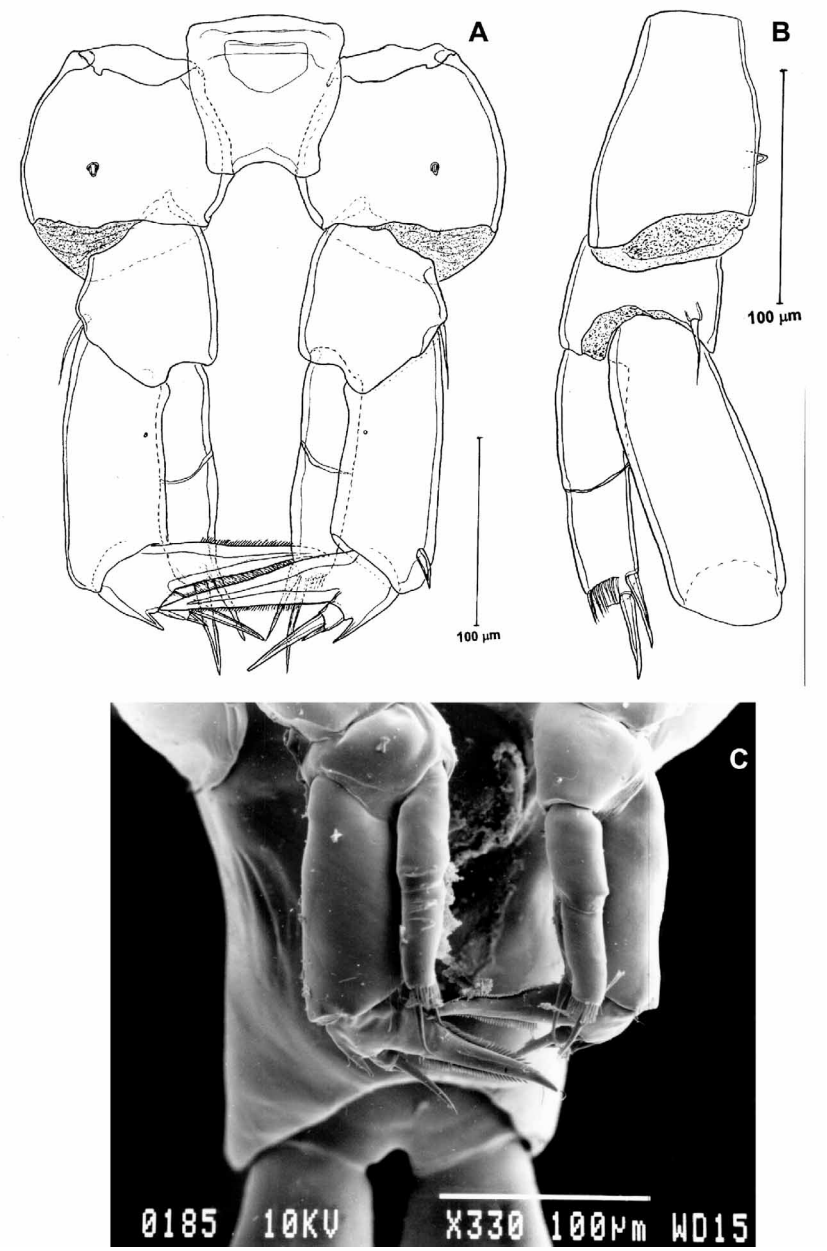

FIGURE 19. *Argyrodiaptomus paggii* **n. sp.**, ♀ adult: **A** – P5, posterior view. **B** – P5 left, lateral view. **C** – P5, posterior view (SEM).

Antennules: symmetrical, 25-segmented, armature and structure similar to ♂ left antennule. Antennules extending beyond prosome, but not reaching beyond half of the genital somite. Number of armature elements as in table 2.

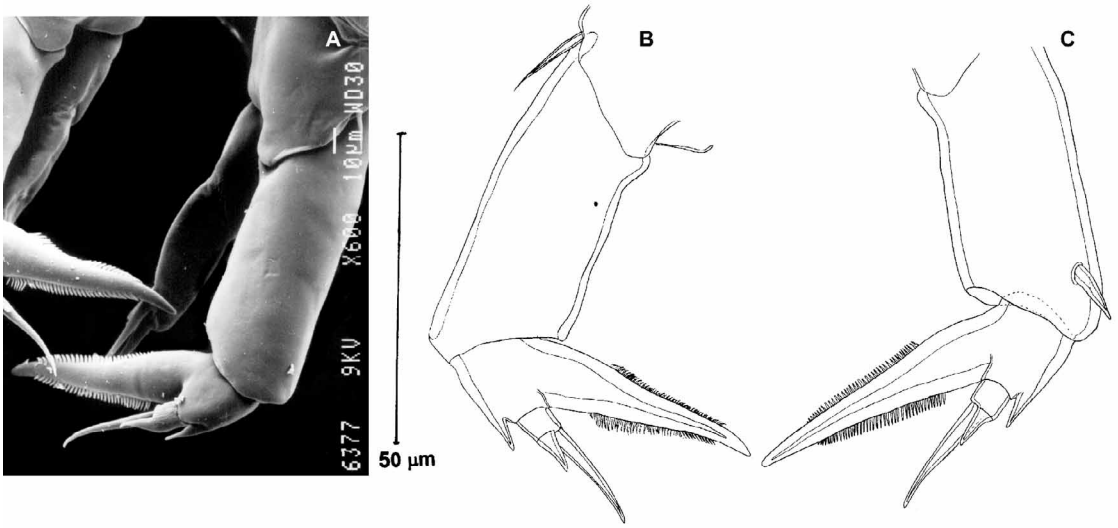

FIGURE 20. *Argyrodiaptomus paggii* **n. sp.**, ♀ adult: **A** – P5 right, posterior view (SEM). **B** – P5 left, posterior view. **C** – P5 right, posterior view.

P5 (figs 19–21) symmetrical. Coxa without conical processes on posterior surface, coxa with small, spiniform sensillum with rounded apex. Sub-triangular basis (outer margin smaller than inner margin) with seta on outer margin, seta not reaching beyond half the length of Exp-1. Exp-1 segment longer than Exp-2. Exp-2, right, armed with lateral spine (most species do not have this ornament) (figs 19A & 20). Segment 3 distinct, armed with 2 setae; medial seta reaching beyond half the length of terminal claw; lateral seta not reaching beyond half of medial seta; terminal claw symmetrical, straight, with row of lateral/medial spinules. Enp with 2 long segments, as long or longer than Exp-1; suture between segments well defined; distal portion of second segment with 2 rows of setae and subterminal crown of spinules; setae with different length, 1 of them equal or more than 2/3 length of the other.

Distribution. only known from the type locality (fig. 22). As mentioned above, the scarcity of information on the distribution of freshwater copepods from this region prevents us from speculating on the potential distribution of the species. In samples collected from the same river, in an adjacent locality, *Notodiaptomus coniferoides* (Wright, 1927) and one species of *Rhacodiaptomus* Kiefer, 1973 (*R. besti* Santos-Silva & Robertson, 1993) were found. More studies are needed to define the real distributional limits of these species.

Etymology. The species is named in honor of the Argentinean copepodologist Dr. Juan Cesar Paggi, one of the most important specialists in Latin America, for his overall contribution to the knowledge of the freshwater copepods in South America.

Discussion

The new species has all the diagnostic characters of *Argyrodiaptomus* proposed by Brehm (1933). These same characteristics, all of them regarding the male's fifth leg, were also presented by Wright (1938a), who recognized them as diagnostic of the originally proposed *bergi* group. His reluctance in accepting the genus was based on recognition of the incompleteness and inexactness of the information concerning the species of *Diaptomus* in South America at the time. Other authors (viz. Kiefer 1936; Dussart 1985b; Reid 1997) have included additional characteristics that reinforce subgroups within the species of the genus.

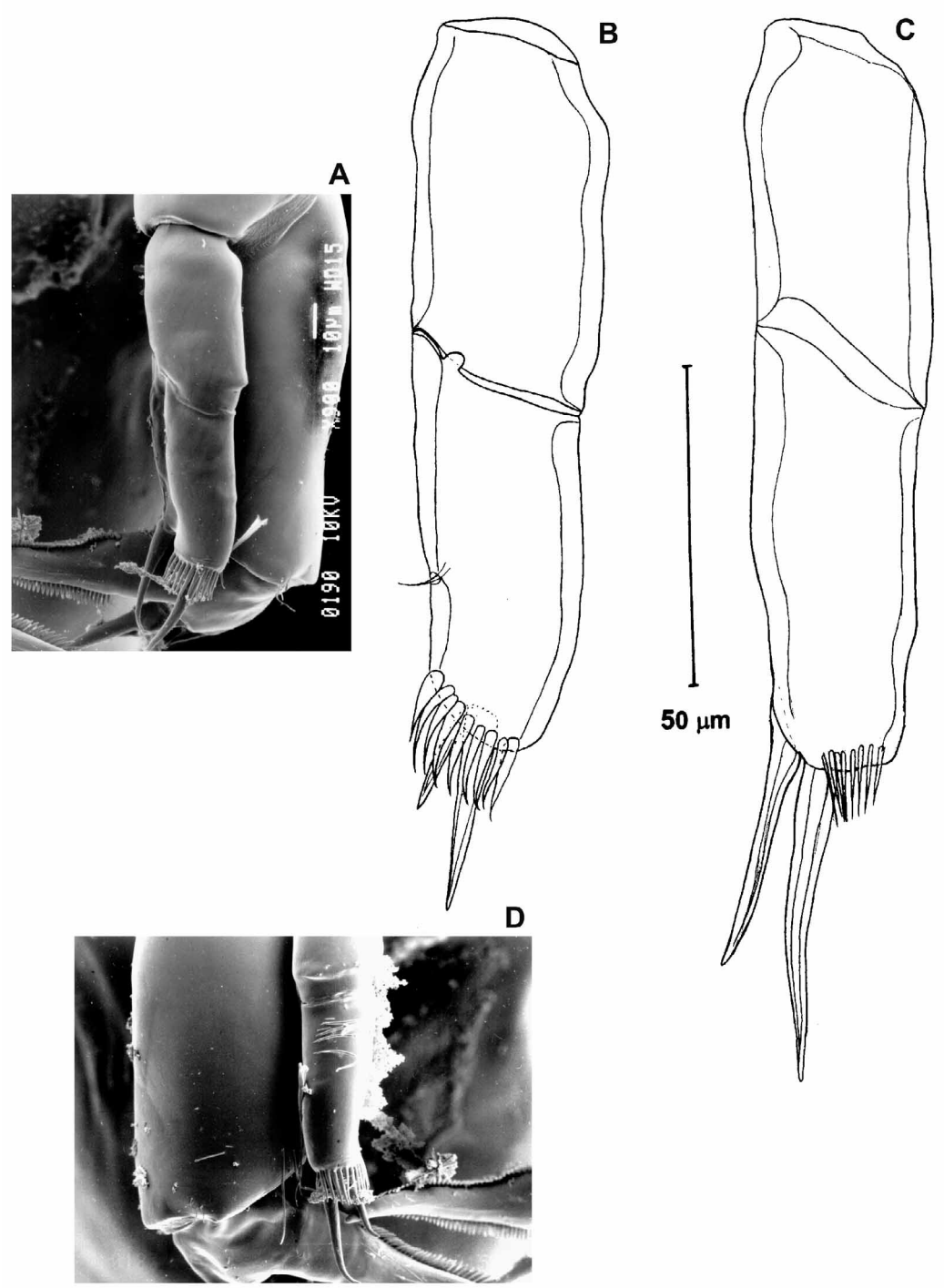

FIGURE 21. *Argyrodiaptomus paggii* **n. sp.**, ♀ adult: **A** – P5 right, posterior view (SEM). **B** – right Enp, posterior view. **C** – right Enp, lateral/inner view. **D** – P5 left, posterior view (SEM).

What is remarkable in *Argyrodiaptomus paggii* **n. sp.** is the asymmetric spine on the outer margin of the exopod of the right P5 of the female. Four of the 20 females examined showed this asymmetry. Reid (1997) noted a similar variation in *Austrinodiaptomus kleerekoperi* Reid, 1997. This character was observed only for these two species. It seems probable that this peculiar character could be interpreted as a homoplasy, since *A. kleerekoperi* does not share with *Argyrodiaptomus* any of the described generic synapomorphies. Considering this, further studies are needed in order to clarify the level of variability of these morphological characters within different genera and species, as well as to clarify their systematic status.

FIGURE 22. Map showing the type locality of *Argyrodiaptomus paggii* **n. sp.**

For *A. paggii*, the size of the female's GS, relative to total body length, and urosome length, is larger than any of its known congeners. This is considered one of the most important diagnostic characters for this species. The average length of the prosome, GS and urosome of *A. paggii*, and *Argyrodiaptomus robertsonae* Dussart, 1985b is shown in table 4. In addition, the Ur2 of *A. paggii* is remarkably telescoped into the GS (figs 16, 17A, 18A–B & 19C), which constitutes a common character among members of the genus, although not that telescoped.

Another striking specific character of *A. paggii* is the occurrence of five patches of spinules on the right basis of male's P5, and six patches on the left basis, all with similar number of spinules and shape. Other members of the genus have different combinations of those patches. We can distinguish two basic forms: patches only at the right leg, like in *Argyrodiaptomus furcatus* Sars, 1901, *Argyrodiaptomus macrochaetus* Brehm, 1937, and *Argyrodiaptomus falcifer* (von Daday, 1905), and patches at both legs, like in *A. robertsonae*, *Argyrodiaptomus nhumirim* Reid, 1997, and the new species.

The intercoxal plate of P5 is also proportionally larger with respect to the coxa (figs 14A–C), specially if compared with *A. denticulatus* (Pesta, 1927), *A. falcifer* and *A. macrochaetus*. The intercoxal plate of these species is half of the width of the coxa and displays some degree of overlapping. The result is that the right and left P5s are placed very closely or even touching each other.

Additionally in the same leg is relevant for *A. paggii*: the expansion of the Exp1 projected over the second segment and with blunt tip (figs 12C & 12D); the spinouse seta of Exp-2 of left P5 reaching far beyond (more than double) the digitiform process (figs 14A–C & 15B); and the Enp of left P5 with complete suture (fig. 15B).

Argyrodiaptomus paggii **n. sp.** is most closely related, morphologically, to *A. nhumirim*, sharing the following characters as potential synapomorphies: ornamentation of the coxa of P1; the symmetry of the GS of female and the general number and distribution of the patches of spinules on the inner margin of the P5 of the

male. However they differ in the shape of the terminal spine on the left P5 exopod of the male. Further comparisons would raise other similarities that thus, could clarify our knowledge about how different characters evolved within the genus. Together with *A. robertsonae* and *Argyrodiaptomus azevedoi* (Wright, 1935), these species probably form a monophyletic group within *Argyrodiaptomus*, sharing the following synapomorphies: nucal organ broader than long (ratio = 3:2); presence of a patch of spinules on the Enp-1 of A2; presence of a patch of spinules between the first and second endites of the Mxp coxa; patches of spinules on the basis of the right and left coxa of the P5 of the male, with similar form and size; the expansion of the Exp-1 of the right P5 of the male is longer than the Enp and the insertion is perpendicular to the segment; a complete suture on the Enp of the left P5 of the male; a small spiniform sensillum on the coxa of P5 of female; and the relative length of the Enp of P5 of the female as long as Exp-1 and with a well defined suture.

TABLE 4. Comparisons of the average lengths, in millimeters, and the standard derivation of 20 females of *A. paggii* and 20 of *A. robertsonae*.

	Total	Prosome	GS	GS/Total (%)	Ur	Ur/Total (%)	GS/Ur (%)
A. paggii	2.07 ±0.04	1.624 ±0.03	0.334 ±0.02	16.08	0.449 ±0.02	21.63	74.36
A. robertsonae	2.04 ±0.1	1.480 ±0.06	0.252 ±0.03	12.29	0.565 ±0.05	27.56	44.61

These four species (*Argyrodiaptomus paggii* **n. sp.**, *A. nhumirim*, *A. robertsonae* and *A. azevedoi*) also have some geographical congruencies being distributed in northern South America. *Argyrodiaptomus paggii* **n. sp.**, *A. nhumirim* and *A. azevedoi* are known from different regions of the Amazon Basin, while *A. azevedoi* occurs in the eastern portion of the basin, near the delta of the Amazon River. *Argyrodiaptomus robertsonae* has a more central distribution, whereas *A. paggii* **n. sp.** is known only from the type locality, situated in the southeastern portion of the Amazon Basin. *Argyrodiaptomus nhumirim* is also known only from its type locality, in the northwestern portion of the Paraná Basin. Therefore, all the four previously mentioned species seem to be distributed in the northern portion in the South America.

Zoogeography

A more extensive view of the zoogeography of the freshwater Calanoida reveals that two families co-occur in the South American continent. The Centropagidae Giesbrecht, 1892 ranges from Patagonia to the Andes, and the Diaptomidae are distributed in the rest of the subcontinent. Between the areas of exclusive distribution of these two families, there is an overlapping zone ranging from the delta of the Paraná River to northern Patagonia (Wright 1938b; Brandorff 1976; Bănărescu 1990).

According to Wright (1938b), the history of the occupation of South America by the Diaptomidae agrees with the Archamazonia and Archiplata theory (von Ihering 1900), where portions of the continent were separated by an epicontinental sea during the Tertiary. The Diaptomidae would have, originally, an *Archamazonia* distribution, while the Centropagidae occupied the Andes/Patagonia region, corresponding to the original *Archiplata* distribution.

The recent work of Suárez-Morales *et al.* (2005) discusses the diversity and distribution of the genera of Diaptomidae in the neotropics. They presented a list of 12 species of *Argyrodiaptomus* for South America and a map with the distribution of this genus. In accordance with these authors, this genus would range from the central Amazon to the eastern portion of the continent and from the northern limit of the Amazon Basin to southernmost South America. To the best of our knowledge, this distribution of *Argyrodiaptomus* should be corrected because of the lack of records from the Patagonia and Andes regions. This paper focused on defin-

ing affinities between the Neotropical-Neogean (NNEO) and Neotropical-Caribbean (NCAR) copepod fauna (Dussart & Defaye 2002), and the South American distributional patterns of the distribution were not considered, specially the von Ihering's Archamazonia and Archiplata theory and the latest theories about the biogeography of the southern neotropical region.

As hypothesized by Wright (1938b) and Brandorff (1976), the discovery of another Diaptomidae in the southeastern region of the Amazon basin region corroborates the current limits of the family and increases the range of *Argyrodiaptomus* to a easternmost area. The type locality is situated at the southwest limit of the Amazon Basin, a region regarded as a potential source of new taxa.

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