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ROBERTSONIA GLOMERATA NEW SPECIES (COPEPODA: HARPACTICOIDA) FROM A NORTH CAROLINA ESTUARINE SALT MARSH

Frank Fiers

ABSTRACT

A new diosaccid harpacticoid, *Robertsonia glomerata* new species, found in a *Spartina alterniflora* marsh in a North Carolina National Estuarine Research Reserve, is described. Key characters are the highly modified outer furcal spines in the female and the short first endopodal segment of the first leg. The setal armament of the exopodites of the natatorial legs of the new species unifies it with the species group including *R. propinqua, R. barnesi, R. knoxi* and *R. salsa*. Based on a review of the entire literature, an updated listing of the P2-P4 armature is given and a new key to the species of the genus is compiled.

During the course of an investigation of a *Spartina alterniflora* marsh on Masonboro Island, which forms part of the North Carolina National Estuarine Research Reserve, specimens of a diosaccid harpacticoid of the genus *Robertsonia* Brady were encountered. The specimens were brought to my attention by Dr. Bruce C. Coull of the Belle W. Baruch Institute for Marine Biology and Coastal Research (South Carolina). It turned out that the specimens represented an unknown species of the genus *Robertsonia,* described herein as *R. glomerata* new species.

To my knowledge, species of the genus *Robertsonia* have been mentioned from the North American Atlantic coast on several occasions. Willey described *R. hamata* and *R. flavidula* from Agar Island (Bermudas). *R. propinqua* has been reported from the Bermudas (Willey, 1930), North Scituate (Massachusetts: Rosenberg, 1967 in Coull, 1977), North Inlet Estuary (South Carolina: Coull and Dudley, 1985) and Mustang Island (Texas: Kern, 1990) while *R. hamata* was found in Tampa Bay (Florida: Bell et al. 1989). One record of *R. knoxi* is known from the continental shelf edge off North Carolina (Coull, 1971, 1973). Unidentified *Robertsonia*-species were reported by Service and Bell (1987) from Tampa Bay (Florida) and by Kern (1990) from Mustang Island (Texas).

A review of the literature on the different species assigned to *Robertsonia* revealed that the morphology of several of its species is only superficially known. Moreover, we are often puzzled regarding the correct setal armature of the legs as they were not described in detail and were cited erroneously (Lang, 1948: table XI, p. 630; Nogueira, 1961: table I, p. 6). Not only is a detailed study needed for *R. propinqua* (see for discussions: Hamond, 1973; Wells and Rao, 1987) but a general update of this genus is urgently required as the representatives are frequently encountered in ecological studies of estuarine systems. In this context the most recent key (Hamond, 1973) is emended.

MATERIAL AND METHODS

Samples were collected using a 5.08 cm diameter × 10 cm PVC core and retained on a 250 μm sieve. The animals were fixed for 48 hours in 10% formalin. Dissected animals are mounted in glycerine, sealed with varnish. Stored specimens are kept in 75% denatured ethylalcohol. Observations were made on a stereo lightmicroscope equipped with phase contrast and drawings were made using a camera lucida. Chaetotaxy of the legs is according to Lang (1948).

Robertsonia glomerata new species
Table 1, Figures 1–7

Type Locality.—Masonboro Island, New Hanover County, North Carolina (34°07′35″N, 77°49′48″W). Intertidal depositional bank (sediments sandy-mud, anoxic below ±1 cm) of a creek in *Spartina alterniflora* marsh. Collected by Robert J. Miltner (Center for Marine Science, Wilmington, North Carolina).

Type Material.—Holotype: a dissected female mounted on three slides and labelled COP 3790 A, B, C; allotype: dissected and mounted on two slides (COP 3791 A, B); paratypes: one dissected female (COP 3789 A, B, C) and 10 specimens preserved in alcohol (COP 3792: 4 ♀♀, U.S.N.M. 259913: 5 ♀♀ and 1 ♂); one slide (COP 3793) with 3 partially dissected ♀♀ and 3 partially dissected ♀♀ of *Pseudonychocamptus wilsoni* Coull, 1976. Specimens deposited in the collections of the Invertebrates Section (COP) of the "Koninklijk Belgisch Instituut voor Natuurwetenschappen", Brussels and the United States National Museum of Natural History, Smithsonian Institution (U.S.N.M.), Washington D.C.

Etymology.—The specific name is derived from the Latin word *glomerare,* meaning amalgamate, and refers to the particular placement of the conical furcal setae alongside the principal setae.

Description

Female.—Habitus (Fig. 1a, d). Body fusiform, slightly depressed, with distinct articulation between prosome and urosome. Length: 890–920 μm (holotype: 908 μm). Largest width near posterior margin of cephalothorax, latter about ¼ of entire body length. Thoracic somites tapering smoothly posteriad in dorsal view. Pleural regions of somite 2–3 not extended posteriad. Genital double somite entirely fused, with slightly sclerotized dorsolateral internal fusion line.

Integument of cephalothorax smooth. Pleurotergites of thoracic somites with dorsally one or more undulating transversal rows of minute spinules, and with smooth hyaline fringe. Fringe of fifth thoracic somite indented laterally. Genital double somite with two to three lateral rows of spinules and two dorsolateral transversal rows near fusion line. Abdominal somites set with single posterior transversal row of spinules interrupted ventrally on first abdominal somite (Fig. 2e), dorsally on third abdominal somite. Fringes of abdominal somites deeply indented. Fringe of third abdominal somite protruded dorsally, covering most of anal operculum (pseudoperculum).

Anal somite with distinctly protruded and rounded operculum. Margin of latter with minute hairs.

Furcal rami (Fig. 2a, b, d) cylindrical, only ¾ as long as wide. Except for dorsal seta, arising on small basal part near inner distal edge of dorsal surface, all setae (6) being located along distal margin. Two outer setae extremely short, conical-shaped and furnished with minute spinules near their apex. Inner and ventral setae arising from small cylindrical protuberance. Outer principal seta in all specimens broken near breaking plane. Inner principal seta 350–360 μm long, distinctly swollen in proximal part of stem (Fig. 1d). Rami furnished with long spinules along lateral and ventral distal margin and near implantation of dorsal seta. Pore orifices on ventral, dorsal and lateral margins.

Rostrum (Fig. 1d) articulating with cephalothorax, slightly deflected, bell-shaped with pore-orifice at the apex and one pair of sensory setae in the distal fourth.

Antennule five-segmented with aesthetasc typically arising from third segment (Fig. 3a). Armature arrangement of setae and heavily armed spines: 1-11-12+Aest-1-15. Distalmost setae (one short and one long) of ultimate segment fused near base.

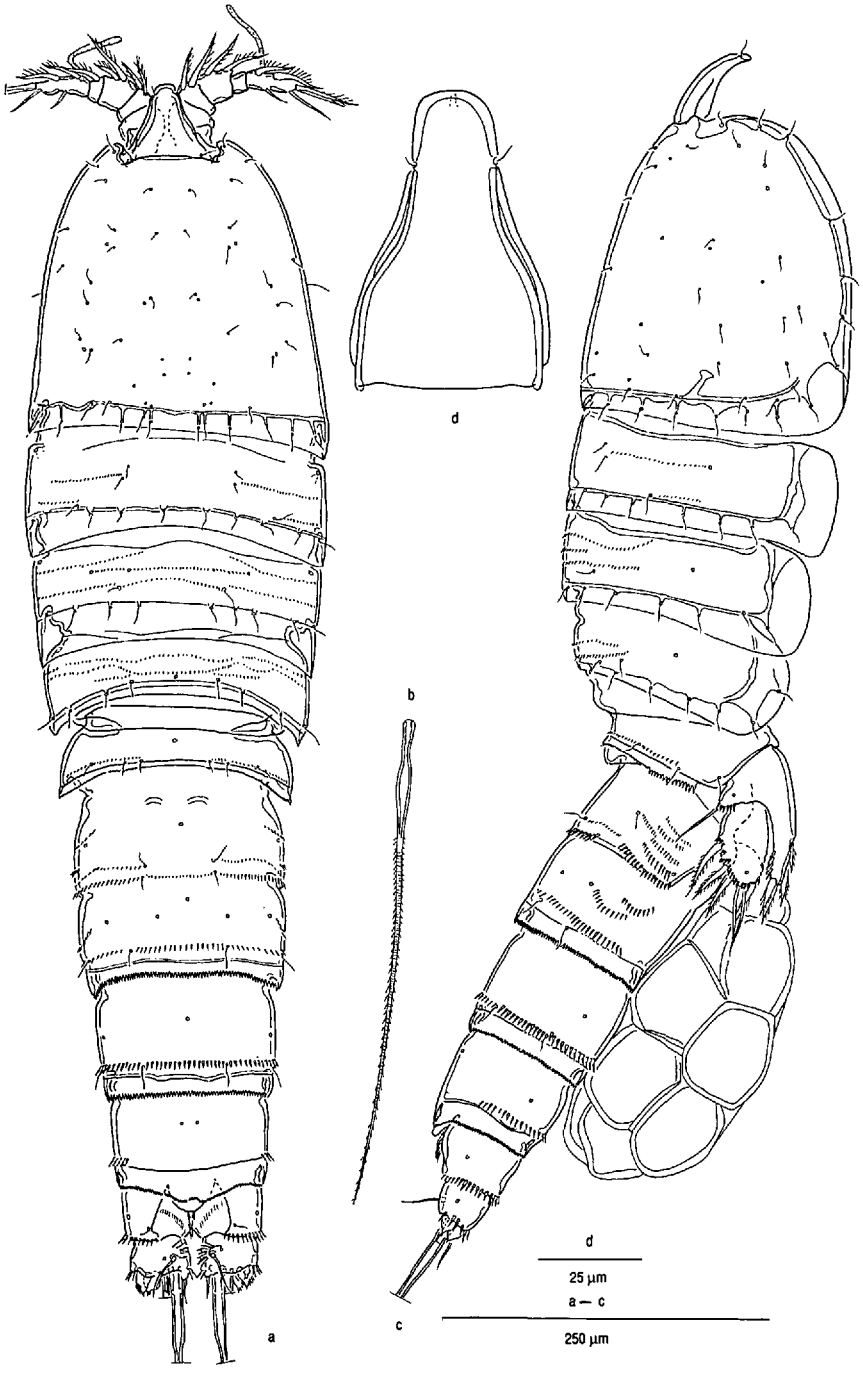

Figure 1. *Robertsonia glomerata* new species, a, female habitus, dorsal view; b, inner principal furcal seta; c, female habitus, lateral view; d, rostrum.

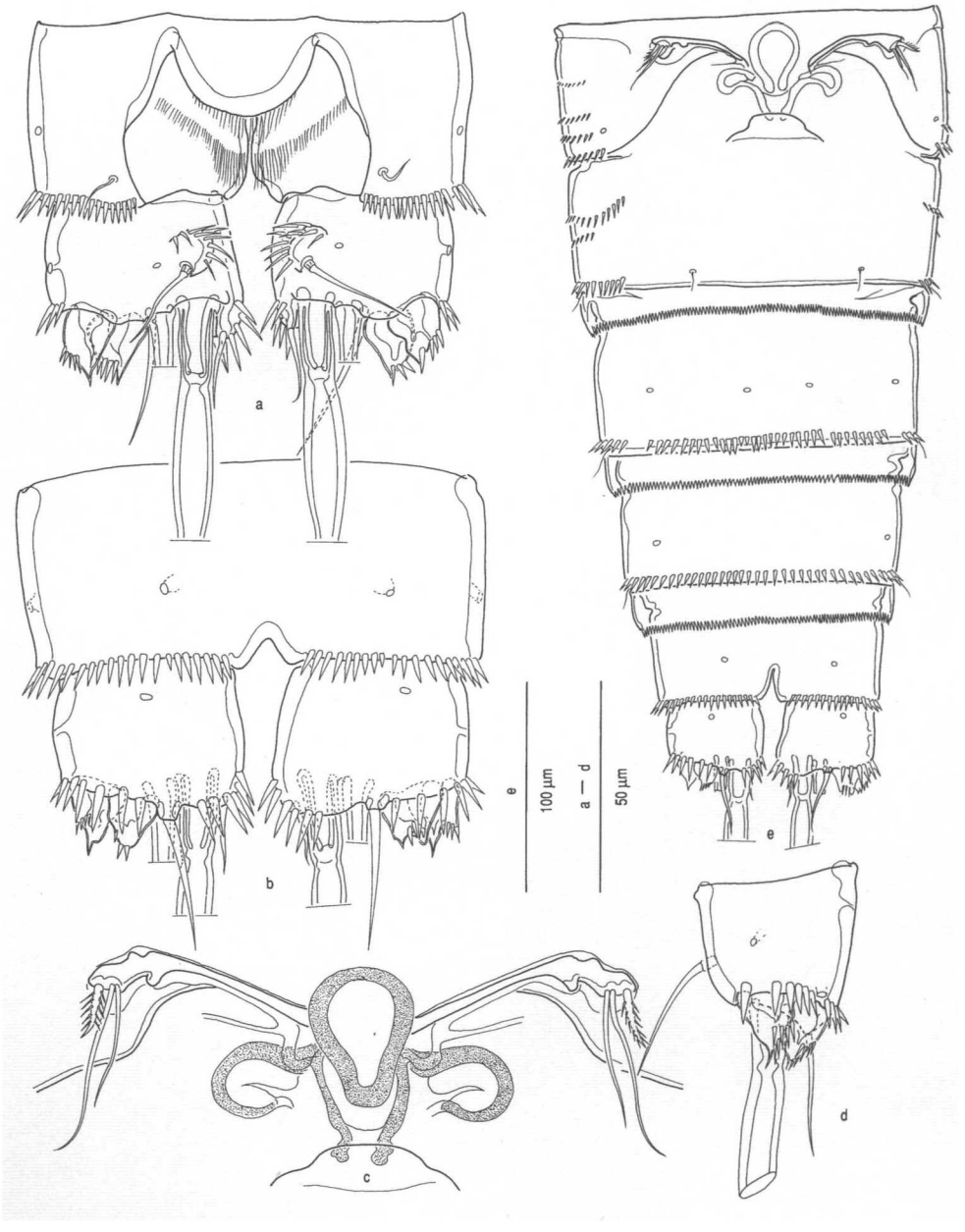

Figure 2. *Robertsonia glomerata* new species, a, female anal somite and furcal rami, dorsal view; b, idem, ventral view; c, genital field; d, right furcal ramus, lateral view; e, female abdomen, ventral view.

Antenna (Fig. 4a) typically with allobasis, bearing three-segmented exopodite and strongly armed marginal seta. Endopodal segment with two lateral flagellated spines and two slender setae on surface (Fig. 4b). Distal endopodal margin armed with seven setae/spines, two outermost fused near their base. Proximal exopodal segment with one seta, median segment small, without armature, and ultimate

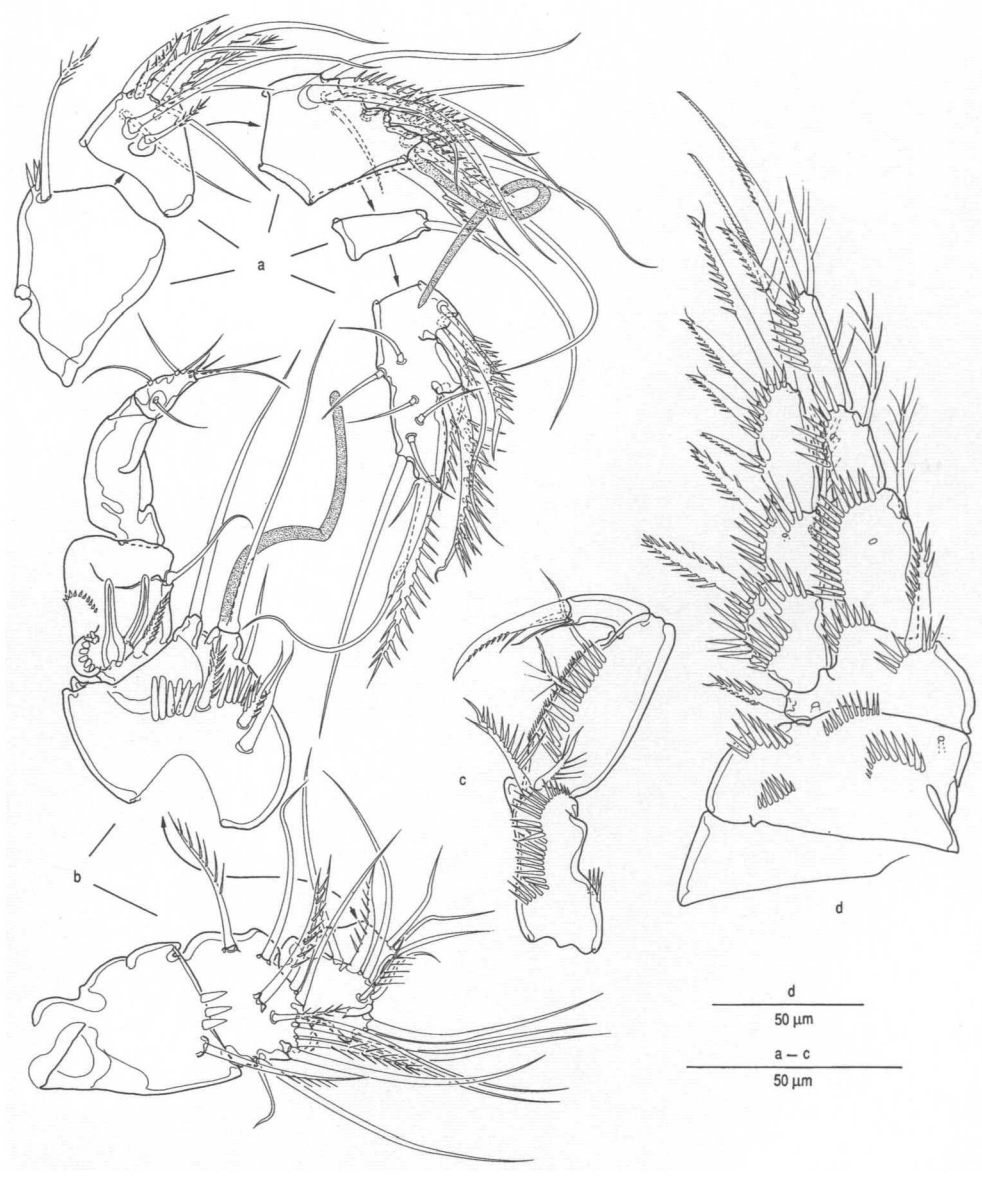

Figure 3. *Robertsonia glomerata* new species, a, female antennule; b, male antennule; c, maxilliped; d, female P1.

exopodal segment with one proximal seta and three apical ones (two long ones and one minute and smooth). Ultimate exopodal segment furnished with two additional subdistal spinules.

Labrum (Fig. 4c) with distinct apical broad lobe densely covered with minute hairs. Medio-lateral and sub-distal portion with two short rows of spinules. Surface furnished with pattern of short rows of fragile hairs.

Mandible (Fig. 4d). Coxa short, robust, heavily sclerotized. Biting edge formed by rounded, non-articulating teeth, arranged in two planes (Fig. 4g), and pinnate

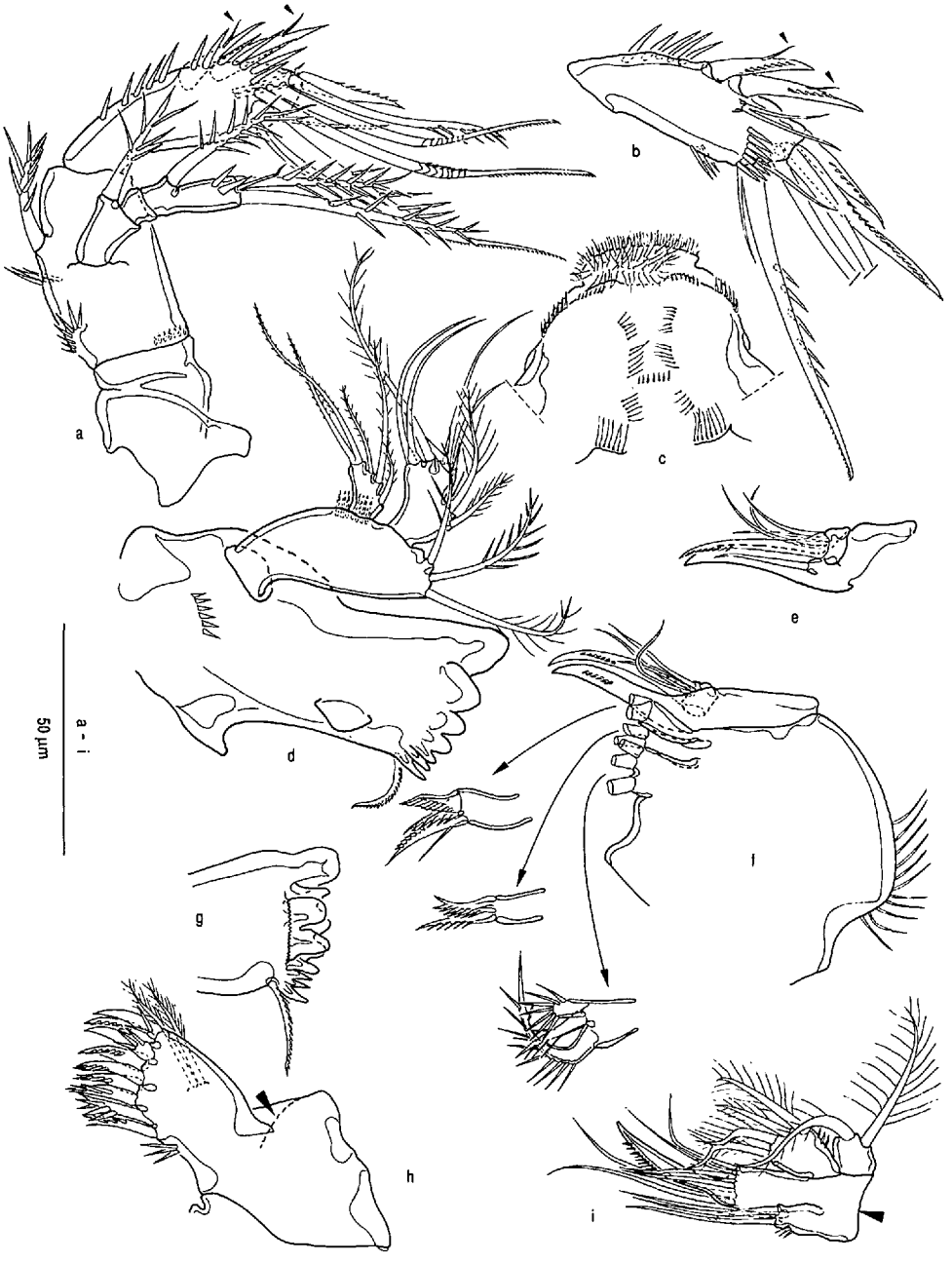

Figure 4. *Robertsonia glomerata* new species, a, antenna; b, endopodal segment of antenna, inner view; c, labrum; d, mandible; e, maxillar basis; f, maxilla; g, mandibular biting edge, dorsal view; h, arthrite of maxillule; i, maxillular rami (arrow indicating articulation with h).

seta at inner distal corner. Basis with row of spinules near articulation of exopodite and with 1 feathered and 2 pinnate setae at distal margin. One-segmented exopodite and endopodite. Former with 3 pinnate lateral setae and 2 apical ones, fused basally. Endopodite 4 lateral setae (proximal 2 pinnate, distal 2 smooth) and 3 apical smooth setae.

Praecoxal arthrite of maxillule (Fig. 4h) with two feathered setae on anterior surface and 9 dentate spines along distal margin. Coxal endite with 3 distal smooth setae. Basis with 4 and 2 subdistal setae on anterior and posterior surface respectively. Distal edge of basis with strong and pinnate seta. Rami one-segmented with 2 feathered setae on exopodite and 4 feathered setae on endopodite (Fig. 4i).

Maxilla (Fig. 4f) with large syncoxal element, furnished with long setules along outer margin, and three endites. Proximal endite with 3, median endite with 2, and distal endite with 3 pinnate spines. Basis with 1 surface seta and armed claw. Endopodite one-segmented with pinnate spine as long as basal claw, and 4 slender setae (Fig. 4e).

Syncoxa of maxilliped (Fig. 3c) with curved outer margin, having tuft of spinules in proximal half, and bearing two pinnate distal setae. Surface furnished with longitudinal row of coarse spines. Inner margin of basis with median pinnate and subdistal smooth seta and furnished with minute spinules, row of coarse spinules parallel to inner margin. Endopodal segment with claw armed in distal half and with 3 setae.

P1 (Fig. 3d) with rectangular and smooth intercoxal coupler (Fig. 6g). Coxal anterior surface with 4 curved rows of spinules. Basis with, on anterior surface, spinules near the implantation of inner spine, and between articulations with rami. Rami three-segmented with each segment ornamented with coarse outward directed spinules along the outer margins. Spines on second and third segments flagellated. First endopodal segment twice as long as broad, reaching slightly beyond second exopodal segment. Second endopodal segment half as long as first one. Third segment 1.5 times longer than preceding one, bearing outer subdistal flagellated spine, and distally geniculated and feathered seta. Outer lateral and outer distal margins of endopodal segments and inner margin of third segment with coarse spines.

P2-P4 (Fig. 5a, b, c) with mitre-shaped intercoxal coupler in P2 and P3 (Fig. 6h, i) and squarish intercoxal coupler in P4. All couplers with smooth surfaces. Coxae with several short rows of spinules on anterior surface. Bases with spinules on inner margin, between articulation with rami and at basis of outer seta. Inner distal edge extended in P2 and P3, rounded in P4. Rami three-segmented with endopodites reaching beyond middle of third exopodal segment in P2 and P3 or up to middle of third exopodal segment in P4. All outward directed margins of segments, except for P4 third endopodal segment, with coarse spines. Outer distal edges of first two segments in both rami more or less produced in large sharp process. Inner distal margins of first and second segments in both rami having finely crenulate hyaline fringe. Outer exopodal spines not flagellated. Inner median seta of third P3 endopodal segment and third P4 exopodal segment pectinate. Chaetotaxy of legs in table 1.

P5 (Fig. 6a) with large baseoendopodal lobe, bearing 5 armed short spines and furnished with spinules along the outer margin of endopodal process, between insertions of spines and near basis of outer seta. Surface smooth, with pore orifice near outer seta and group of pore orifices in inner proximal region. Exopodite ovate, bearing three outer armed spines, two apical smooth setae and inner subdistal armed spine. Several groups of spinules near implantations of armature and along inner margin.

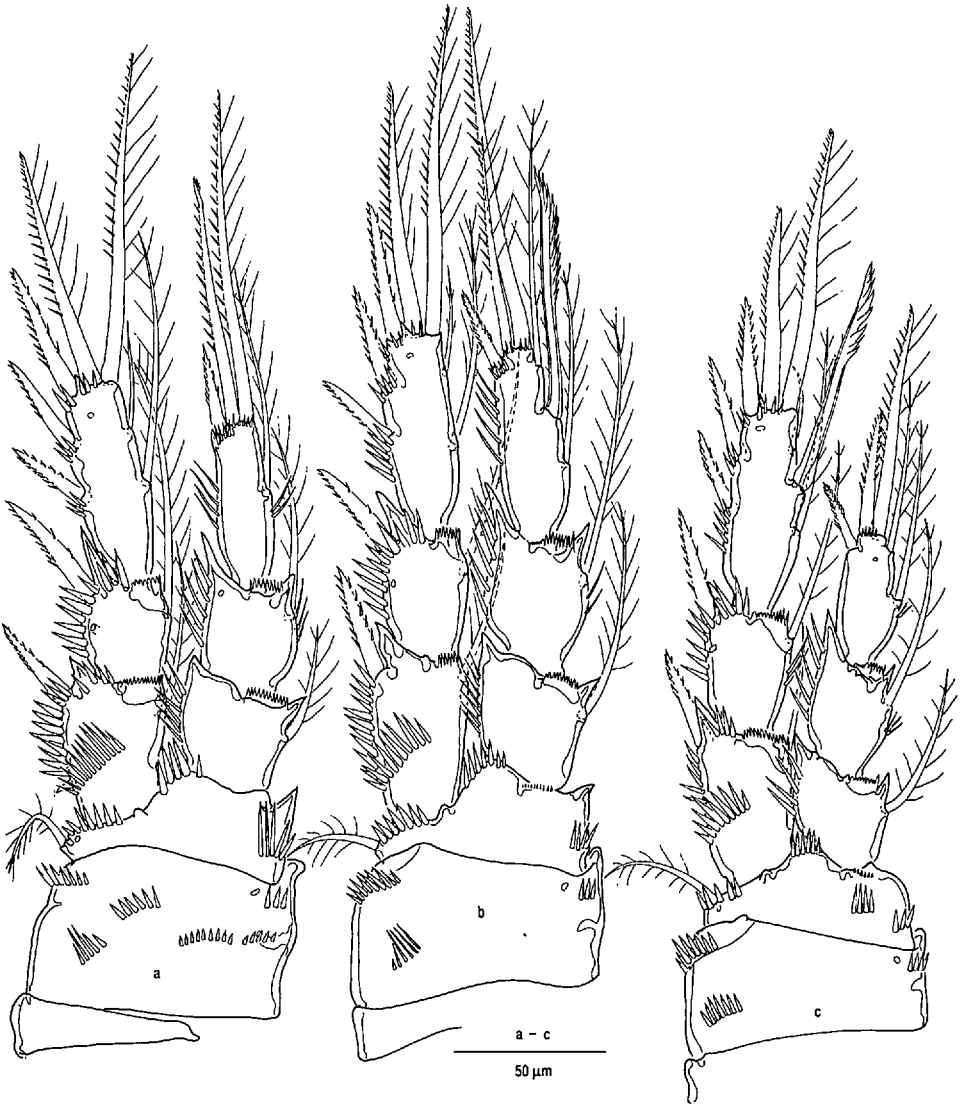

Figure 5. *Robertsonia glomerata* new species, a, female P2, b, female P3, c, female P4.

P6 (Fig. 2c) represented as rectangular extension, bearing outer pinnate seta and median and inner smooth seta. Inner proximal edge of extension with rounded process.

Male.—Habitus (Fig. 7a) resembles female habitus closely, differs from latter in antennule, discrete genital somites and unmodified furcal setae. Length 630 µm (628–654 µm). Cephalothorax slightly less than ⅓ of entire body length (Fig. 7a).

Integumental structures of pleurotergites identical as in female, but less developed. Ventral surface of abdominal somites with posterior transversal row of long spinules, arranged in discrete groups.

Furcal rami ¾ times as long as wide, with principal setae, dorsal, ventral, and

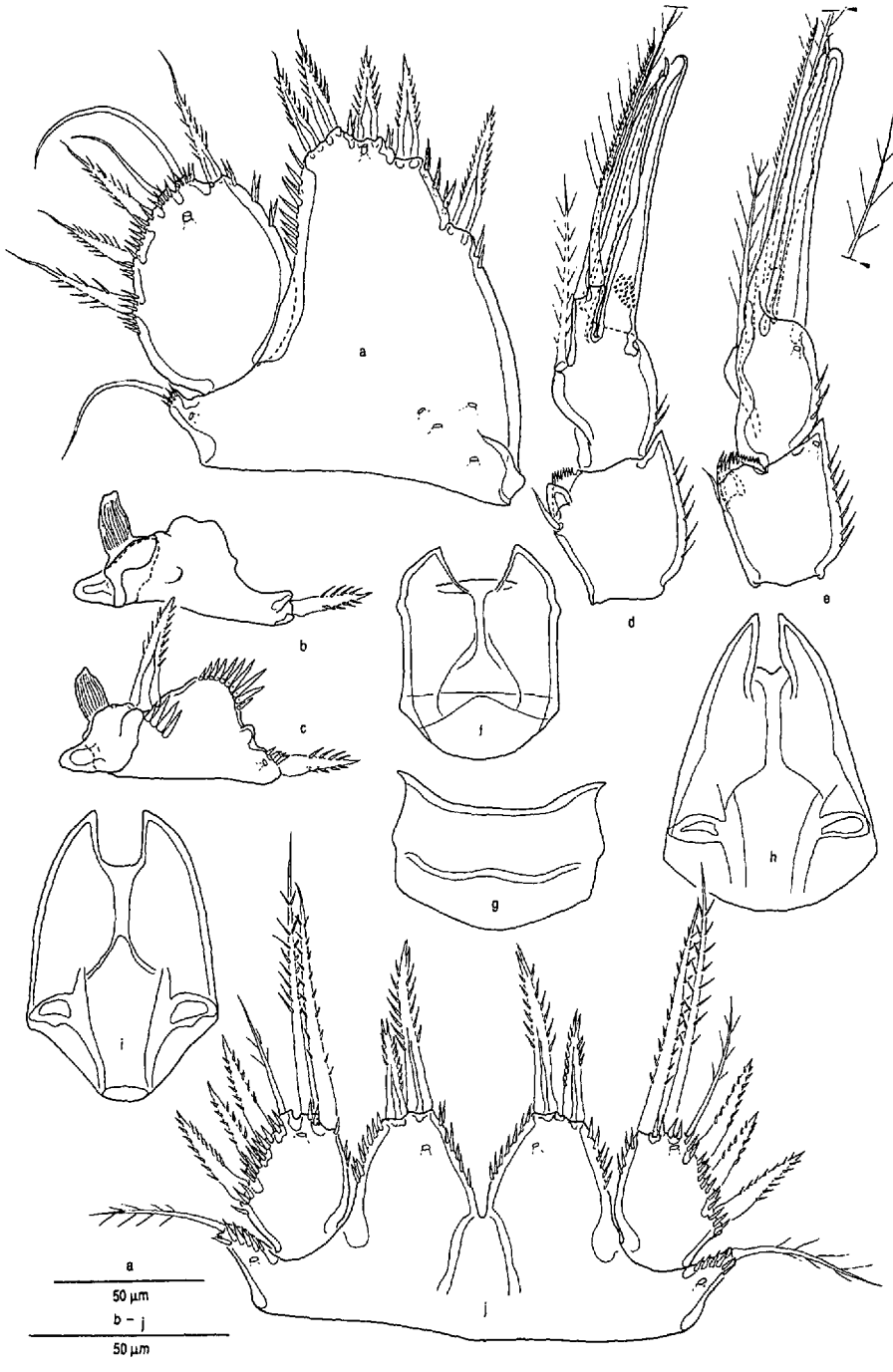

Figure 6. *Robertsonia glomerata* new species, a, female P5; male P1 basis, posterior; c, male P1 basis, anterior; d, male P2 endopodite, posterior; e, male P2 endopodite, anterior; f, P4 intercoxal coupler; g, P1 intercoxal coupler; h, P2 intercoxal coupler; i, P3 intercoxal coupler; j, male P5.

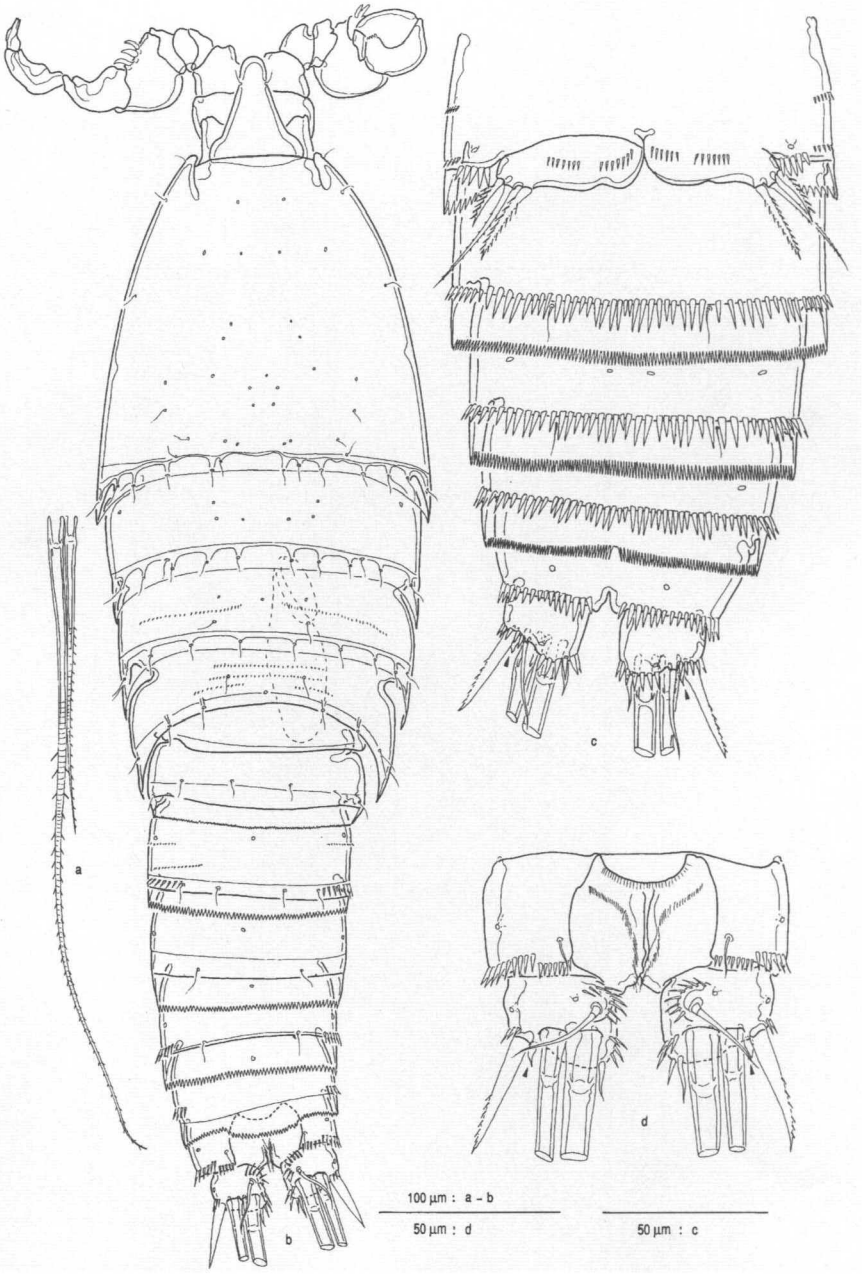

Figure 7. *Robertsonia glomerata* new species, a, inner and outer principal furcal setae of male; b, male habitus, dorsal view; c, male abdomen, ventral view; d, anal somite and furcal rami of male, dorsal view.

inner seta as in female. Outer edge with long armed spine and dwarfed seta (indicated with arrow in Fig. 7d).

Antennule (Fig. 3b) sub-chirocer and 8-segmented with armature: 1-12-7-3-6+aesth-4-0-8. Fifth segment globulous, bearing the aesthetasc. Palmate surface

Table 1. Chaetotaxy of the natatorial legs of *Robertsonia* species

	P2		P3		P4	
	exo	end	exo	end	exo	end
R. hamata	0-1-123	1-1-121	0-1-123	1-1-321	0-1-223	1-1-221
R. mourei	0-1-123	1-1-121	0-1-123	1-1-321	0-1-223	1-1-221
R. flavidula	0-1-223	1-1-121	0-1-123	0-1-321	0-1-223	0-1-221
R. adduensis	0-1-223	1-1-121	0-1-123	1-1-321	0-1-223	1-1-221
R. monardi	0-1-223	1-1-121	0-1-123	1-1-321	0-1-223	1-1-221
R. celtica	0-1-223	1-1-121	0-1-123[1]/223[2]	1-1-321	0-1-223	1-1-221
R. tenuis	0-1-223	1-1-121	0-1-223	1-1-321	0-1-223	1-1-221
R. irrasa	0-1-223	1-1-121	0-1-223	1-1-321	0-1-223	1-1-221
R. angolensis	0-1-223	1-1-121	0-1-223	1-1-321	0-1-223	1-1-221[3]
R. curtisii	0-1-223	1-1-121	0-1-223	1-1-321	0-1-323	1-1-221
R. diademata	0-1-223	1-1-121	0-1-223	1-1-321	0-1-323	1-1-221
R. robusta	0-1-223	1-1-121	0-1-223	1-1-321	0-1-323	1-1-221
R. propinqua	1-1-223	1-1-121	1-1-223	1-1-321	1-1-323	1-1-221
R. barnesi	1-1-223	1-1-121	1-1-223	1-1-321	1-1-323	1-1-221
R. knoxi[4]	1-1-223	1-1-121	1-1-223	1-1-321	1-1-323	1-1-221
R. salsa	1-1-223	1-1-121	1-1-223	1-1-321	1-1-323	1-1-221
R. glomerata	1-1-223	1-1-121	1-1-223	1-1-321	1-1-323	1-1-221

Notes: [1] after Roe, 1959; [2] after Monard, 1935; [3] after Lang, 1948; [4] after Gurney, 1927.

with transversal row of blunt scales. Palmate surface of sixth segment with two curved rows of coarse spinules and three rigid setae/spines (one armed, other smooth). Ultimate segment conical with 5 setae articulating on basal socket and two fused terminal setae. All setae on ultimate segment smooth.

P1 basis (Fig. 6b, c) with rigid inner edge, extended proximally with inwards directed blunt process and upwards directed ovate and striated knob. Inner spine less strongly armed as in female and only slightly bent.

P2 endopodite (Fig. 6d, e) two-segmented and typically transformed. Inner margin of proximal segment with dwarfed inner smooth seta and sub-distal conical rigid process. Second segment with 1 inner median, 1 subapical and 1 apical pinnate seta. Outer armature arising sub-apically. Outer structure forming slit enveloping inner structure. Former with blunt apex and field of minute spinules in proximal half, the latter with hyaline fine tip and globulous medially.

Both P5 baseoendopodites unified (Fig. 6j). Endopodal lobe with two armed apical spines and spinulose lateral margins. Exopodite, articulating and reaching up to apical margin of endopodite, nearly ovate and bearing 6 setae/spines: apically 2 long pinnate and 1 feathered, and laterally 3 pinnate spines. Lateral margins of exopodite spinulose.

Both P6 (Fig. 7c) nearly equal. Right one defined, left one fused with somite. Both with three pinnate setae, median one longest. Surface of each leg with two transversal rows of spinules.

Discussion

Because of the presence of inner armature on the first exopodal segments of P2–P4, *R. glomerata* n. sp. keys out in Hamond (1973) to *R. knoxi* (including *R. salsa,* see Por, 1973; Wells and Rao, 1987), *R. propinqua,* and *R. barnesi* (Table 1). Females of *R. glomerata* n. sp. are easily distinguishable from these species by the unique conical-shaped outer setae on the furcal rami, the short first endopodal segment of P1, only reaching up to the articulation between second and third exopodal segment, and the stout appearance of the P5 baseoendopodal armature.

However, with respect to the male morphology, showing no particular modifications of the outer furcal setae, *R. glomerata* new species is most easily distinguishable from its congeners by the short proximal endopodal segment of P1.

R. glomerata n. sp. shares with *R. propinqua* and *R. barnesi* (Pallares, 1970; Hamond, 1973) the pectinate setae on the distal segments of the endopodite P3 and exopodite P4. So far, such setal modifications have not been described in detail in most of the species of the genus. Only Sewell (1940) shows this setal modification on the P4 of *R. adduensis* while the illustrations of the distal P4 exopodal segment given by Nicholls (1945, fig. 4) for *R. paramonardi* (=*R. monardi, vide* Noodt, 1955) and by Roe (1958, fig. 124) for *R. celtica* show slight indications of the possible presence of pectinate setae.

Since Hamond (1973) compiled a key to the species of the genus, two more species, *R. curtisii* Greenwood and Tucker, 1982 and *R. robusta* Wells and Rao, 1987, were assigned to the genus. *R. knoxi* (Thompson and A. Scott) and *R. salsa* Gurney are now considered as two distinct species, clearly distinguishable in morphology and ecology (Por, 1973; Wells and Rao, 1987). Unfortunately, the specificity of *R. diademata* remains unsolved. Gurney (1932) as well as Lang (1948) presumed *R. diademata* synonymous with *R. knoxi,* as the only difference between both species seems to be the presence or absence of inner armature on the first exopodal segments. In contrast, Klie (1941) mentioned the presence of such armature after examination of specimens of *R. diademata* from the Adriatic Sea. But his argumentations to distinguish both species based on the number of antennular segments (6 in *R. knoxi,* 5 in *R. diademata*) and the occurence of the latter at greater depths (25–28 m) seem not that important. The question remains however whether Monard (1926) overlooked the inner setae on the first exopodal segments or whether Klie's specimens of *R. diademata* from the Adriatic are conspecific with *R. knoxi.* Both species are mentioned in the key: *R. knoxi* with inner armature on the first exopodal segments of P2–P4, *R. diademata* without.

Including the presently described *R. glomerata* n. sp., 17 species are currently assigned to the genus *Robertsonia.* In the key presented below, *R. celtica* appears twice. Roe (1959) considered the *Robertsonia* specimens she encountered as conspecific with *R. celtica.* However, Roe's specimens possess only one inner seta on the third exopodal segment of the P3 while Monard (1935: 26) described all legs with 7 (=223 configuration) appendages on the ultimate exopodal segments. In addition it should be mentioned that Monard (1935) reversed the P2 for P4 in his original description (Lang, 1948).

It should be noted that the illustration of the P3 of *R. angolensis* in Marques (1961: pl. III, fig. f) lacks the distalmost inner seta on the third exopodal segment. The insertion place, however, is clearly marked.

KEY TO THE SPECIES OF *ROBERTSONIA*

1a. First and second endopodal segments of P1 subequal: ..... *R. tenuis*
1b. First endopodal segment of P1 distinctly longer than second one: 2
2a. First exopodal segments of P2-P4 with inner seta: 3
2b. First exopodal segments of P2-P4 without inner seta: 6
3a. Female with outer furcal spines short and conical; first endopodal segment P1 reaching only to articulation between second and third exopodal segments: ..... *R. glomerata*
3b. Female with normal spiniform outer furcal armature; first endopodal segment P1 reaching to the middle of third exopodal segment: 4
3c. Female with normal spiniform outer furcal armature; first endopodal segment P1 reaching at least to end of third exopodal segment: 5
4a. Inner setae on first P1 endopodal segment longer than supporting segment; female genital field with spirally curled seminal receptacles; female P6 with one inner long and two outer short appendages: ..... *R. salsa*

4b. Inner setae on first P1 endopodal segment only as long as the width of the supporting segment; seminal receptacles not spirally curled; female P6 with two long inner and one short outer appendage: ..... *R. knoxi*
5a. Lateral surfaces of abdominal somites heavily ornamented with 3 to 5 parallel rows of spines: ..... *R. propinqua*
5b. Lateral surfaces of abdominal somites not ornamented; only a row of spines occuring medio-ventrally and along the postero-lateral margin of each somite: ..... *R. barnesi*
6a. Third exopodal segment P2 and P3 with one inner seta: 7
6b. Third exopodal segment P2 with two inner setae, of P3 with one inner seta: 8
6c. Third exopodal segment P2 and P3 with two inner setae: 11
7a. First endopodal segment P1 reaching to distal margin of third exopodal segment; second and third endopodal segments of P1 as long as broad; margins of first endopodal segment P1 straight: ..... *R. mourei*
7b. First endopodal segment P1 reaching beyond exopodite; second and third endopodal segments of P1 distinctly shorter than wide; margins of first endopodal segment P1 curved: *R. hamata*
8a. First endopodal segment of P3 and P4 without inner seta: ..... *R. flavidula*
8b. First endopodal segment of P3 and P4 with inner seta: 9
9a. First endopodal segment P1 shorter than exopodite: ..... *R. celtica sensu* Roe
9b. First endopodal segment P1 much longer than exopodite: 10
10a. Principal furcal seta in female markedly tickened at the base; inner seta on first endopodal segment of P1 subdistally implanted and as long as second segment: ..... *R. adduensis*
10b. Principal furcal seta in female without marked modifications; inner seta on first endopodal segment of P1 implanted medially and minute: ..... *R. monardi*
11a. First endopodal segment P1 shorter than exopodite: 12
11b. First endopodal segment P1 longer than exopodite: 13
12a. First endopodal segment P1 about twice as long as wide, reaching only to the proximal half of third exopodal segment; antennule five-segmented: ..... *R. diademata*
12b. First endopodal segment P1 about three times as long as wide, reaching the distal half of third exopodal segment; antennule six-segmented: ..... *R. celtica sensu* Monard
13a. Third segment endopodite P1 twice as long as second one; female P5 baseoendopodite with spiniform apical and subapical armature: ..... *R. irrasa*
13b. Third and second segments of endopodite P1 subequal; female P5 baseoendopodite with setiform apical and subapical armature: 14
14a. Third and second segments of endopodite P1 both as long as wide; innermost baseoendopodal spines of female P5 as long as apical setae: ..... *R. angolensis*
14b. Third and second segments of endopodite P1 short, distinctly wider than long; innermost baseoendopodal spines of female P5 much shorter than apical ones and with a bifid tip: 15
15a. Exopodite P1 reaching only slightly beyond the middle of first endopodal segment; inner margin of first endopodal segment P1 convex, outer margin flattened showing transversal striae: ..... *R. curtisii*
15b. Exopodite P1 reaching to subdistal fourth of first endopodal segment; inner margin of first endopodal segment P1 straight, outer margin unmodified and set with setules: ..... *R. robusta*

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ADDRESS: *Koninklijk Belgisch Instituut voor Natuurwetenschappen, Invertebrate Section, Vautierstraat 29, B-1040 Brussels, Belgium.*