

Three new species of *Ryocalanus* from the eastern tropical Pacific (Crustacea, Copepoda: Ryocalanidae)

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Females of *Ryocalanus asymmetricus* sp. n., *R. bicornis* sp. n. and male of *R. bowmani* sp. n. from the eastern tropical Pacific are described. *R. asymmetricus* is well distinguished from the other species of the genus by the shape of genital segment, *R. bicornis* by the shape of the last segment of prosome and *R. bowmani* by the shape of the last segment of prosome and geniculate right A1.

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The genus *Ryocalanus* includes 2 species, *R. infelix* Tanaka, 1956 (female unknown) from the Pacific Ocean near Japan and *R. admirabilis* Andronov, 1992 from the central tropical Atlantic. Three new species are described below.

The following abbreviations are used in the descriptions: A1, antennule; A2, antenna; Md, mandible; Mx1, maxillule; Mx2, maxilla; Mxp, maxilliped; P1-P5, swimming legs of first-fifth pairs; Re1-Re7, first-seventh joints of exopodite; Ri1-Ri3, first-third joints of endopodite. All scale lines - 0.1 mm.

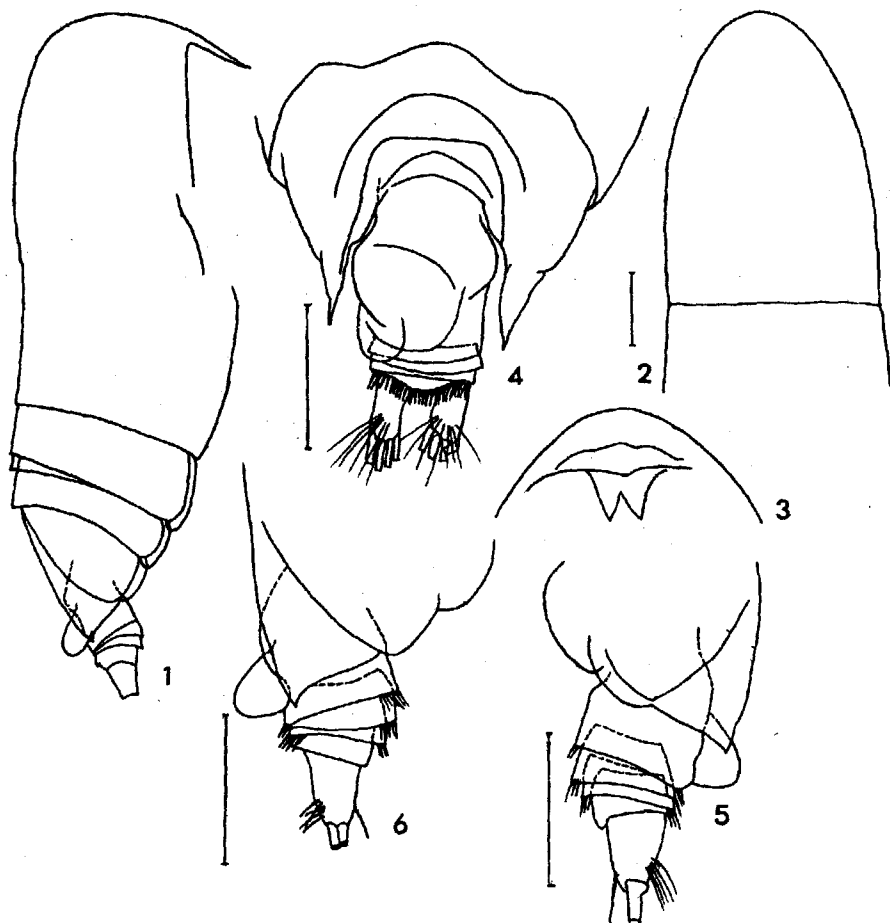
Ryocalanus asymmetricus sp. n. (Figs 1-13)

Holotype. USNM 264035, female, eastern tropical Pacific, seamount (Volcano 7), from net tows taken by submersible Alvin (K. Wishner), 13° 23.9' N 102° 35.0' W, min depth 2973 m, max depth 2992 m, within 1-5 m from the bottom, dive 2147 was made in 1988, kept in the National Museum of Natural History (Washington).

Description. Female. Total length 0.95 mm. Prosome 4.9 times as long as urosome. Rostrum present, with 2 symmetrical points. Points of posterior corners of the last segment of prosome elongated into triangular lobes, not reaching the posterior border of genital segment (dorsal and lateral view). Genital segment

strongly asymmetrical, with large projection on the left, reaching the posterior border of second segment of urosome (dorsal view). Caudal ramus with 4 large apical setae, 1 small lateral and 1 inner seta. A1 broken. A2 coxopodite with 1, basipodite with 2 setae. Re1 with 1, Re2 A2 with 3 setae, Re3-Re6 with 1 seta each, Re7 with 1 medial and 3 terminal setae. Ri1 A2 with 1 seta and spinules near its base. Md palp base with 2 setae (3 in *R. admirabilis*), Ri1 Md with 2 (3 in *R. admirabilis*). Second and third Mx1 internal lobes with 6 and 4 setae respectively. Mx1 basis plus Ri together have at least 21 setae, Re with 11 setae, external lobe with 8 setae. Mx2 first endite with 5 setae, second-fifth endites with 3 setae each, sixth endite with 2 setae and Mx2 terminal part with 5 setae. Mxp syncoxa with 7 setae, basis with 3 medial and 2 distal-medial setae; Ri with 4, 4, 3, 4, 4 setae on 5 segments, proximal to distal. Segmentation of P1-P4 typical of Ryocalanidae. Re1-Re3 P1 with an external spine each. It seems that an additional external spine at Re3 P1 (figured for *R. admirabilis*: fig. 2 (6) by Andronov (1992)) absent. P4 coxopodite with 2 spines typical of *Ryocalanus* and an internal seta.

Comparison. The new species is well distinguished from the other species of the genus by the asymmetrical genital segment, number of setae at some Md and Mx2 joints.



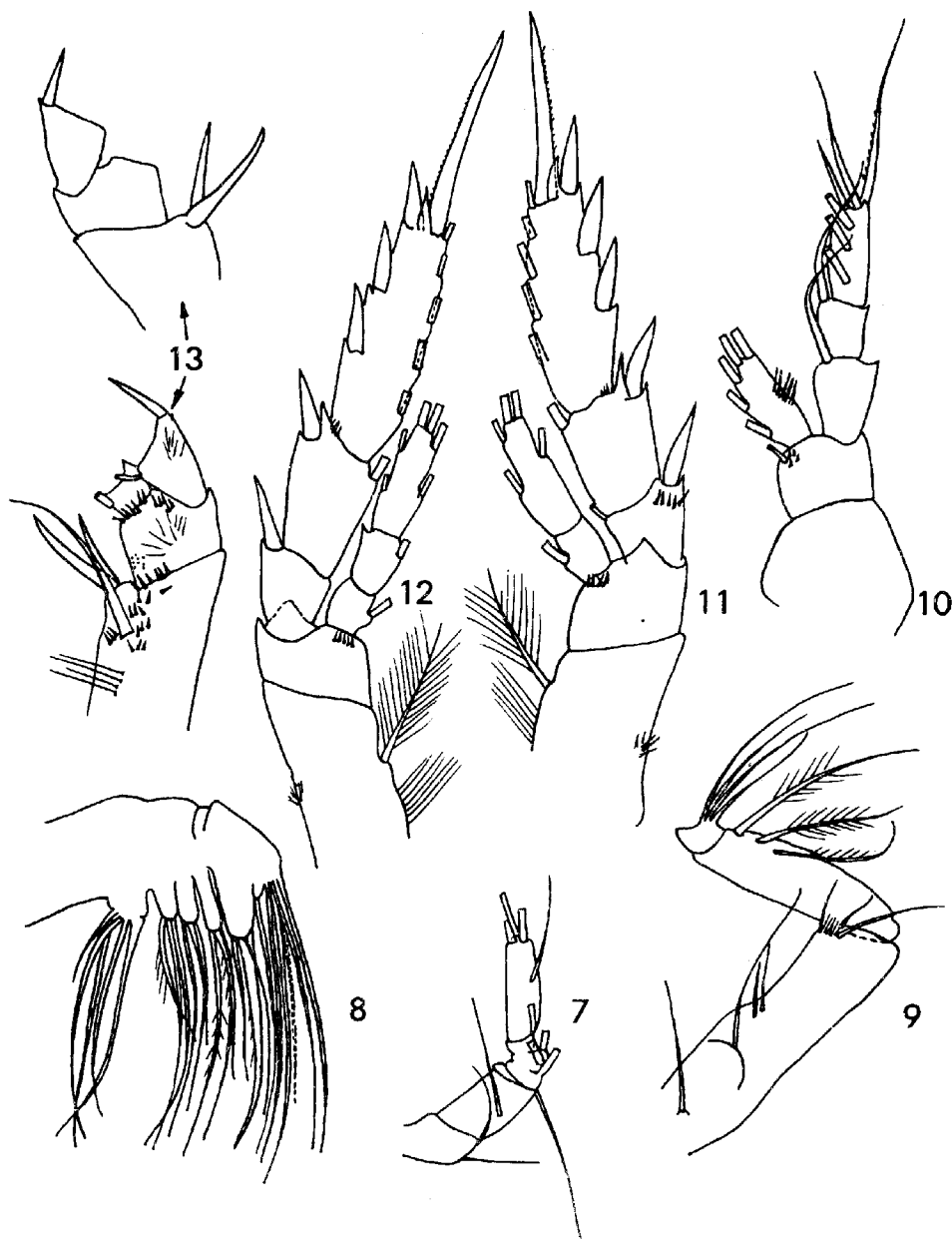
Figs 1-6. *Ryocalanus asymmetricus* sp. n., female (holotype). 1, right lateral view; 2, anterior part of prosome; 3, rostrum (ventral view); 4, last segment of prosome and urosome (dorsal view); 5, last segment of prosome and urosome (left lateral view); 6, the same (right lateral view).

***Ryocalanus bicornis* sp. n.**
(Figs 14-28)

Holotype. USNM 264034, female, eastern tropical Pacific, seamount (Volcano 7), from net tows taken by submersible Alvin (K. Wishner), 13° 22.8' N 102° 29.3' W, min depth 1291 m, max depth 1316 m with the altitude from about 1-5 m above the bottom, dive 2145 was made in 1988, kept in the National Museum of Natural History (Washington).

Description. Female. Total length 1.55 mm. Prosome 4.4 times as long as urosome. Caudal ramus with 4 large apical setae, 1 inner seta, and small lateral seta. Rostrum present, with 2 asymmetrical points. Posterior corners of prosome bicornous, exceeding the middle length of genital segment (dorsal and lateral view). Genital segment with lateral swellings on both sides (dorsal view) in its middle length. A1

25-jointed. A2 coxopodite with 1 seta, basi-podite with 2 setae. Re1 with 1, Re2 A2 with 3 setae, Re3-Re6 with 1 seta each, Re7 with 1 medial and 3 terminal setae. Ri1 A2 with 1, Ri2 with 6 terminal setae plus 1 posterior seta at external and 8 terminal and 1 posterior setae at internal lobe. Md palp base with 2 setae (3 in *R. admirabilis*), Ri1 Md with 3 setae, Ri2 Md with 9 terminal and 1 posterior setae (11 in *R. admirabilis*) setae. Mx1 first internal lobe (gnathobase) with 7 thick and 1 thin apical setae, 2 proximal subapical setae, 3 posterior setae, and 1 anterior seta. Mx1 second and third internal lobes with 6 (5 in *R. admirabilis*) and 4 setae respectively. Mx1 basis plus Ri together have at least 21 setae, Re with 11 setae on left Re and 10 setae on right Re, external lobe with 7 setae. Mx2 first endite with 5 setae,

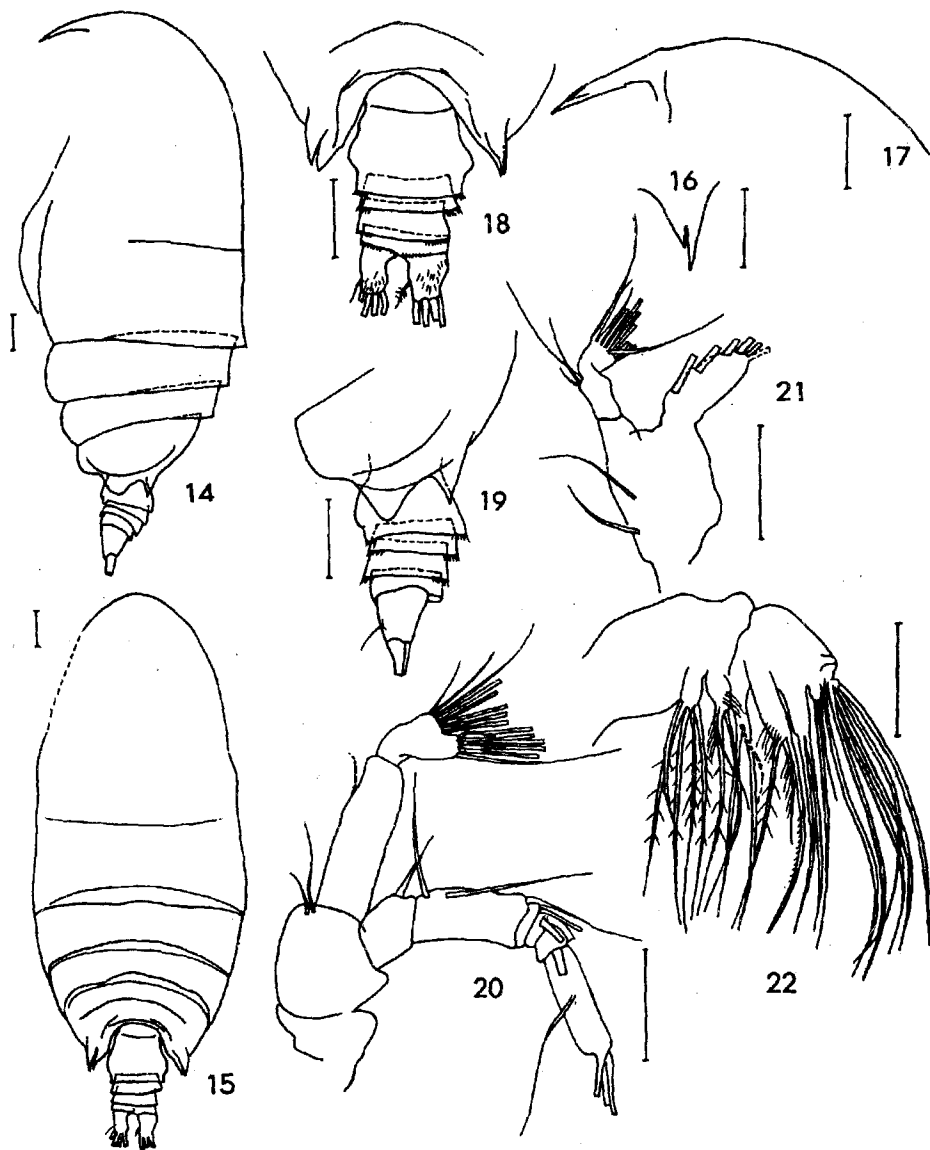


Figs 7-13. *Ryocalanus asymmetricus* sp. n., female (holotype). 7, Re A2; 8, Mx2; 9, Mxp (syncoxa and basis); 10, P1; 11, P2; 12, P3; 13, coxopodite, basipodite, Ri and Re1 P4.

Mx2 second-fifth endites with 3 setae each, sixth endite with 2 setae, and Mx2 terminal part with 5 setae. Mxp syncoxa with 7 setae, basis with 3 medial and 2 distal-medial setae; Ri with 4, 4, 3, 4, 4 setae on 5 segments, proximal to distal. Segmentation of P1-P4 typical of *Ryocalanidae*. Re1-Re3 P1 with an external spine each. An additional external spine at Re3 P1

absent. P4 coxopodite with 2 spines typical of *Ryocalanus* and an internal seta.

Comparison. The new species is well distinguished from the other species of the genus by the bicornous posterior corners of the last segment of prosome, number of setae at some Md, A2 and Mx2 joints.

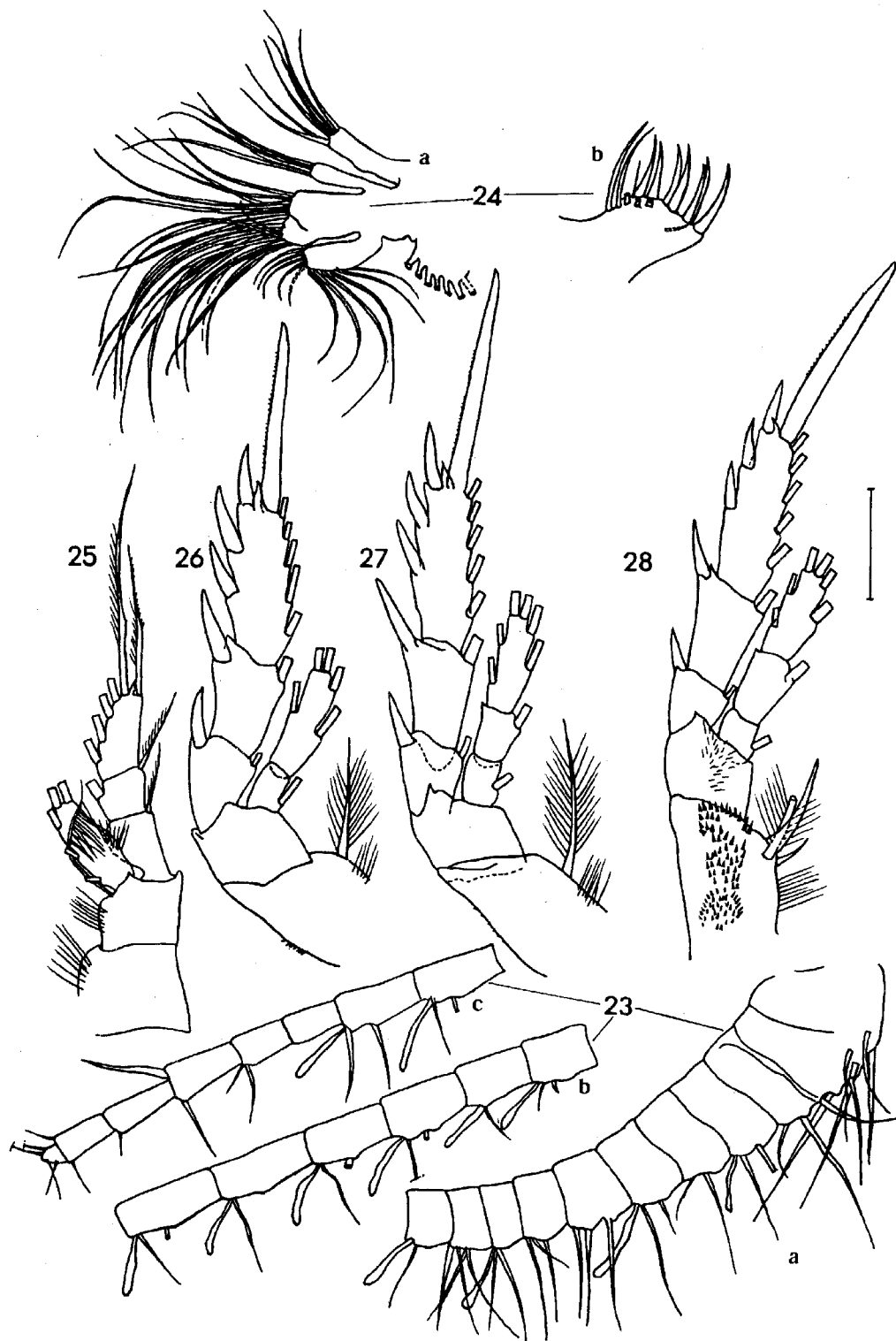


Figs 14-22. *Ryocalanus bicornis* sp. n., female (holotype). 14, left lateral view; 15, dorsal view; 16, rostrum (ventral view); 17, anterior part of prosome (left lateral view); 18, last segment of prosome and urosome (dorsal view); 19, the same (left lateral view); 20, A2 (right); 21, P. md (right; with dotted line figured addition from the left limb, also in further figures); 22, Mx2.

***Ryocalanus bowmani* sp. n.**
(Figs 29-44)

Holotype. USNM 268291, male, eastern tropical Pacific, seamount (Volcano 7), from net tows taken by submersible Alvin (K. Wishner), 13° 23.9' N 102° 35.0' W, min depth 3022 m, max depth 3100 m, with the altitude from about 1-5 m above the bottom, dive 2146 was made in 1988, kept in the National Museum of Natural History (Washington).

Description. Male. Total length 1.9 mm. Prosome nearly 5.6 times as long as urosome. Rostrum one-pointed. Posterior corners of the last segment of prosome rounded, reaching the posterior border of genital segment. Genital segment slightly asymmetrical. Caudal ramus with 4 large apical setae, 1 small lateral seta. Left A1 25-jointed, 8th and 9th joints partly fused. Right A1 geniculated, 25-jointed, with



Figs 23-28. *Ryocalanus bicornis* sp. n., female (holotype). 23, A1: a, 1st-11th joints; b, 12th-17th joints; c, 18th-25th joints; 24, Mx1: a, Mx1 without gnathobase; b, gnathobase; 25, P1; 26, P2; 27, P3; 28, P4.

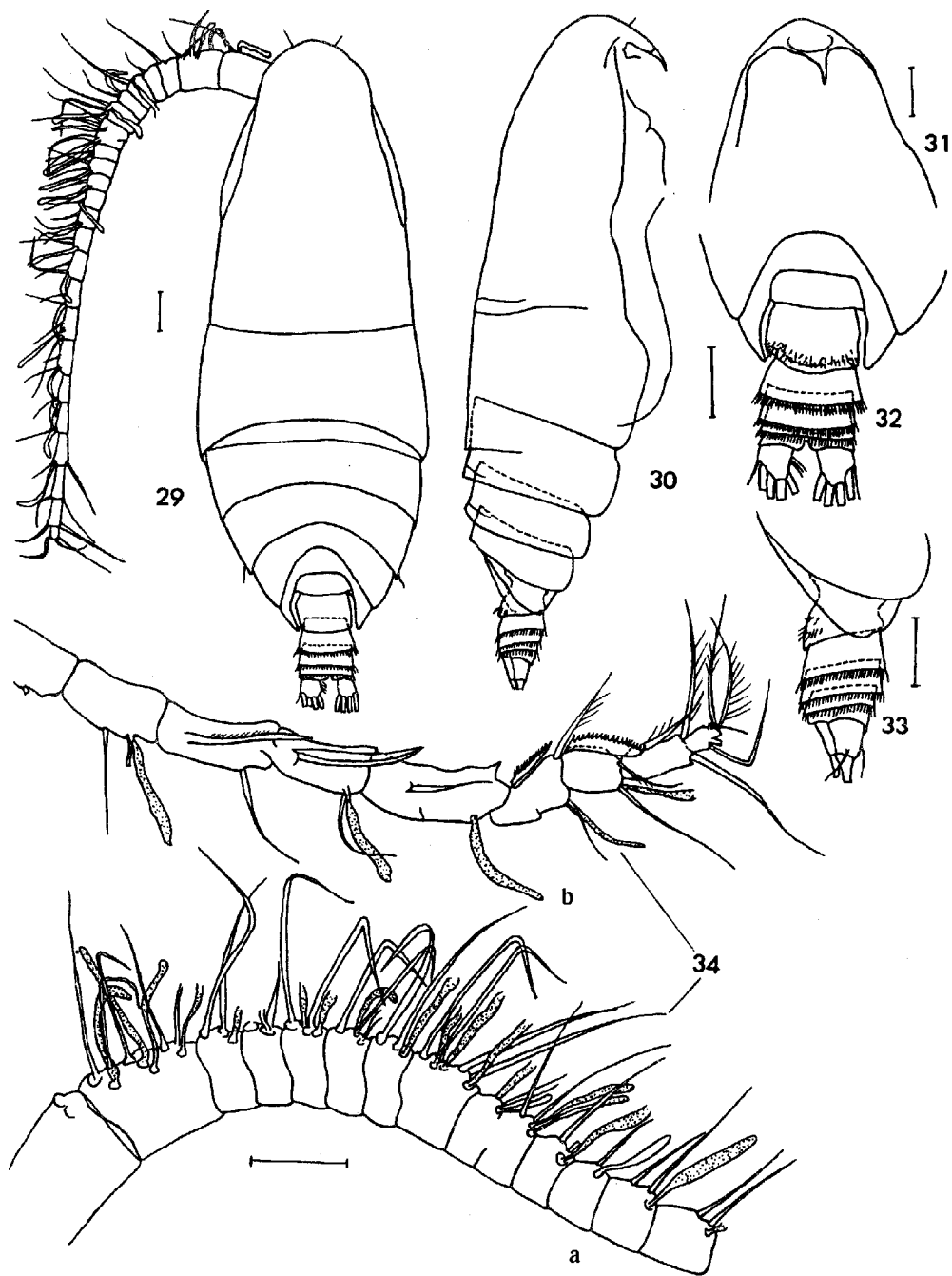


Fig. 29-34. *Ryocalanus bowmani* sp. n., male (holotype). 29, dorsal view; 30, lateral view; 31, rostrum (ventral view); 32, last segment of prosome and urosome (dorsal view); 33, the same, right lateral view; 34, A1: a, 1st-14th joints; b, 15th-24th joints.

8th-9th joints fused; 3 joints proximal to the geniculation each have a thick and stiff proximal seta, the 2 joints distal to the geniculation each have comb spines; all these joints inflated

(Fig. 34, a-b). A2 Re nearly as long as Ri. A2 coxopodite with 1, basipodite with 2 setae, Re1 with 1, Re2 with 3 setae. A2 Ri1 with 2 distal setae and hairs on internal side and Ri2 with 6

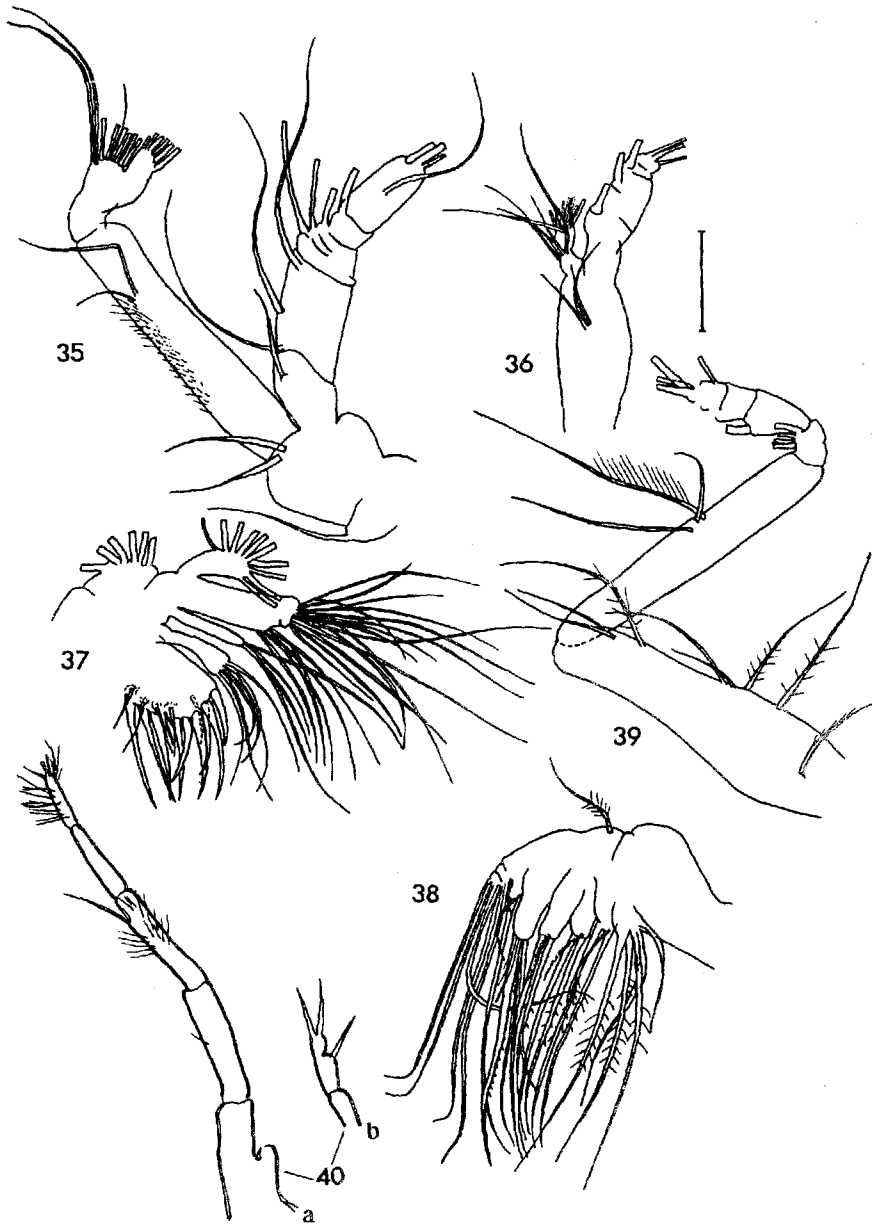


Fig. 35-40. *Ryocalanus bowmani* sp. n., (holotype). 35, A2; 36, P. md; 37, Mx1; 38, Mx2; 39, Mxp; 40 (a, b), P5.

setae at external and 8 terminal and 1 posterior setae at internal lobe. Md palp base with 3 setae; Ri1 Md with 4 setae, Ri2 with 10 setae. Mx1 gnathobase with 7 apical thick spines, 2 subapical spines, 1 short thin apical seta, 1 anterior seta and 4 posterior setae; second and third internal lobes with 6 and 4 setae respectively. Mx1 basis and Ri have 21 setae, Re with

10 setae, and external lobe with 6 setae. Mx2 first endite with 5 setae, second-fourth endites with 3 setae each, fifth endite with 4 setae, one of which is thickened into spine, sixth endite with 2 setae (1 long and 1 short), and terminal part of Mx2 with 5 long thick setae plus 1 short thin seta proximal to the thick ones. Mxp syncoxa with 8 setae (Fig. 39), basis with 3 setae.

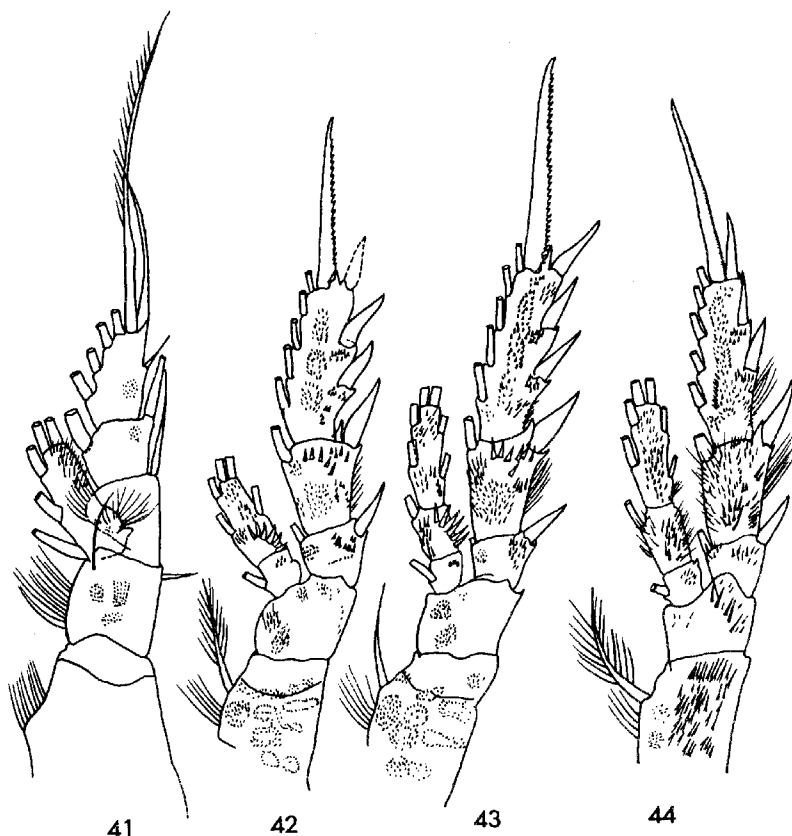


Fig. 41-44. *Ryocalanus bowmani* sp. n., 41, P1; 42, P2; 43, P3; 44, P4.

Segmentation of P1-P4 typical of Ryocalanidae. P1 basipodite with external spine in distal external part of the joint, Re1 and Re2 with 1 external spine each, Re3 have 2 external spines. Ri P1 1-jointed, with the process in external side proximally, which may be the trace of former subdivision into 2 joints. P2-P4 supplied with numerous surface spinules (Figs 42-44). P4 coxopodite lacking spines near internal seta, typical of *Ryocalanus* females. P5 uniramous, left leg 3-jointed, longer than right 2-jointed leg. Left Re1 P5 with external spine and hairs, Re3 with terminal 3 setae and hairs. Right Re1 with 1 and Re2 with 2 terminal spines.

Comparison. *Ryocalanus bowmani* sp. n. is well distinguished from the other species of the genus by the shape of the posterior corners of the last segment of prosome, structure of grasp-

ing right A1, segmentation and armament of right P5 and setation of some joints of oral parts.

Acknowledgements

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