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## TWO NEW SPECIES OF COPEPODS (COPEPODA: HARPACTICOIDA: CANTHOCAMPTIDAE) OF PARTICULAR BIOGEOGRAPHICAL INTEREST FROM CENTRAL BRAZIL

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### ABSTRACT

Collections of copepod crustaceans from a wet campo (campo úmido) wetland in the savanna (cerrado) region of central Brazil yielded two previously undescribed species of unexpected biogeographical affinities. *Canthocamptus* sensu lato *campaneri*, new species is the first representative of the *Bryocamptus* species-group found in South America. *Attheyella* (*Delachauxiella*) *yemanjae*, new species is the second member of the *Delachauxiella* species-group collected in the non-Andean neotropical region. Wet campo wetlands play a role as tropical refugia for species with temperate zone affinities, contributing to the high species richness of these habitats.

The species *Bryocamptus broiensis* from São Paulo, Brazil is assigned to the *Attheyella* (*Delachauxiella*) species-group of *Canthocamptus* sensu lato and a written diagnosis provided. *Attheyella* (*D.*) *broiensis* was the first member of the *Delachauxiella* species-group collected in the lowland neotropics.

The known distribution of *Attheyella* (*D.*) *horvathi* is restricted to Patagonia.

**Keywords:** Copepoda, Harpacticoida, Taxonomy, Biogeography, Brazil.

### INTRODUCTION

Collections of copepod crustaceans from wet campo (campo úmido) wetlands in the savanna (cerrado) region of central Brazil demonstrated the existence of a species-rich, principally endemic fauna (Reid, 1984, 1992a,b). The best-investigated wet campo, Campo Úmido da Onça in the protected ecological reserve of the Fazenda Água Limpa, the experimental farm administered by the Universidade de Brasília, Distrito Federal, Brazil yielded two species of surprising biogeographical affinities. These two species and the geographical relations of their species-groups are described herein. Examination of specimens from the Collectio Dadayana ascribed to members of the *Attheyella* (*Delachauxiella*) species-group provided new information regarding the distribution of one species, *Attheyella* (*D.*) *horvathi* (Chappuis, 1924), which is restricted to Patagonia.

Rocha and Matsumura-Tundisi (1976) provided figures but no written descriptions of two species of canthocamptid harpacticoid copepods from the Broa (Lobo) Reservoir, State of São Paulo, Brazil. Their name for one species, *Mesochra sancarlensis*, is a junior synonym of *Attheyella* sensu lato *jureiae* Por and Hadel, 1976, as elucidated by Reid (1990). The name *Bryocamptus broiensis* assigned to the other species remains unavailable because of the lack of a written diagnosis (cf. Reid, 1990; International Commission on Zoological Nomenclature, 1985). Also, this species is a member of the *Attheyella* (*Delachauxiella*) rather than the *Bryocamptus* species-group. The present article provides a written diagnosis based on the figures given by Rocha and Matsumura-Tundisi (1976).

Hamond (1987), citing the present impenetrable confusion of generic and subgeneric diagnoses, returned 18 taxa of harpacticoid copepods of the Family Canthocamptidae including *Attheyella* Brady, 1880 sensu stricto, *Bryocamptus* Chappuis, 1929a, *Chappuisiella* Brehm, 1926, and *Delachauxiella* Brehm, 1926 to the genus *Canthocamptus* Westwood, 1836, sensu lato, pending eventual revision of the family. This necessary decision will facilitate future taxonomic treatments. In the present article I refer to the traditional superspecific taxa as "species-groups", in order to facilitate comparisons with related species and with no intention of re-erecting these taxa.

Specimens were collected according to the methods described by Reid (1984). Specimens were measured in glycerin. Whole specimens were drawn in glycerin and/or in lactic acid. Dissected specimens were permanently mounted in commercial polyvinyl lactophenol with a little chlorazol black E added. Specimens were deposited in the collections of the Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil (MZUSP) and of the National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A. (USNM).

### *Canthocamptus* Westwood, 1836, sensu lato

#### *Canthocamptus* sensu lato *campaneri*, new species

#### Figures 1-4

*Elaphoidella sewelli* ssp. a (partim).--Reid, 1984:104, 109, Table 4.

*Canthocamptus* s. l. a.--Reid, 1994a: Table I.

Type.--MZUSP 10479, female dissected and mounted on slide in polyvinyl lactophenol, Campo Úmido da Onça, Sample 183, 14 August 1981.

Type locality.—Campo Úmido da Onça, Fazenda Água Limpa, Distrito Federal, Brazil, 15°56'40"S 47°54'20"W.

Distribution.— Known only from type locality.

Description of Female.—Length 0.45 mm. Specimen dissected and mounted before drawings initiated. Habitus generally canthocamptid, with

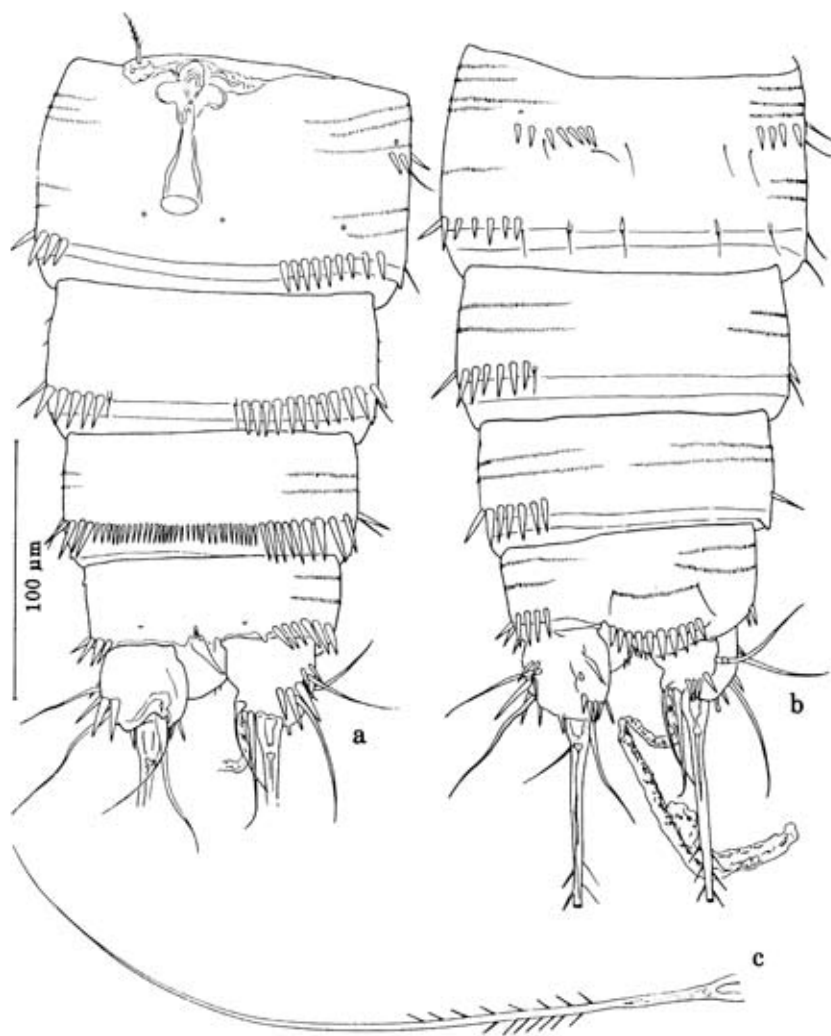


Fig. 1. *Canthocamptus campaneri*, type female, MZUSP 10479: a, Urosome, ventral; b, Urosome, dorsal, drawn through cleared mount; c, Lateralmost terminal caudal seta.



Fig. 2. *Canthocamptus campaneri*, type female, MZUSP 10479: a, Anal somite and caudal rami, ventral; b, Nuchal organ; c, Antennule and rostrum; d, Antenna.

pediger 1 completely fused with cephalosome. Urosome (Figs. 1 a-c, 2a, slightly depressed in permanent mount) with rows of large spines on posterolateral margin of each somite, spine row on urosomite 3 continued ventrally as row of smaller spines. Genital segment also with lateral row of 7 spines slightly anterior to midlength, 1 round pore anterior to each row of spines, and 2 round pores

lateral to posterior end of genital field. Anal operculum (Fig. 1b) weakly crescentic, with 10 spines on margin, medial spines slightly larger. Anal somite with small ventral papilla on each side near posterior margin; posterior margin ventrally with small triangular outgrowth on left side above caudal ramus, and laterally with about 8 spines. Caudal ramus (Figs. 1a,b, 2a) about as long as broad, with little-developed dorsal crest bearing biarticulate dorsal seta near

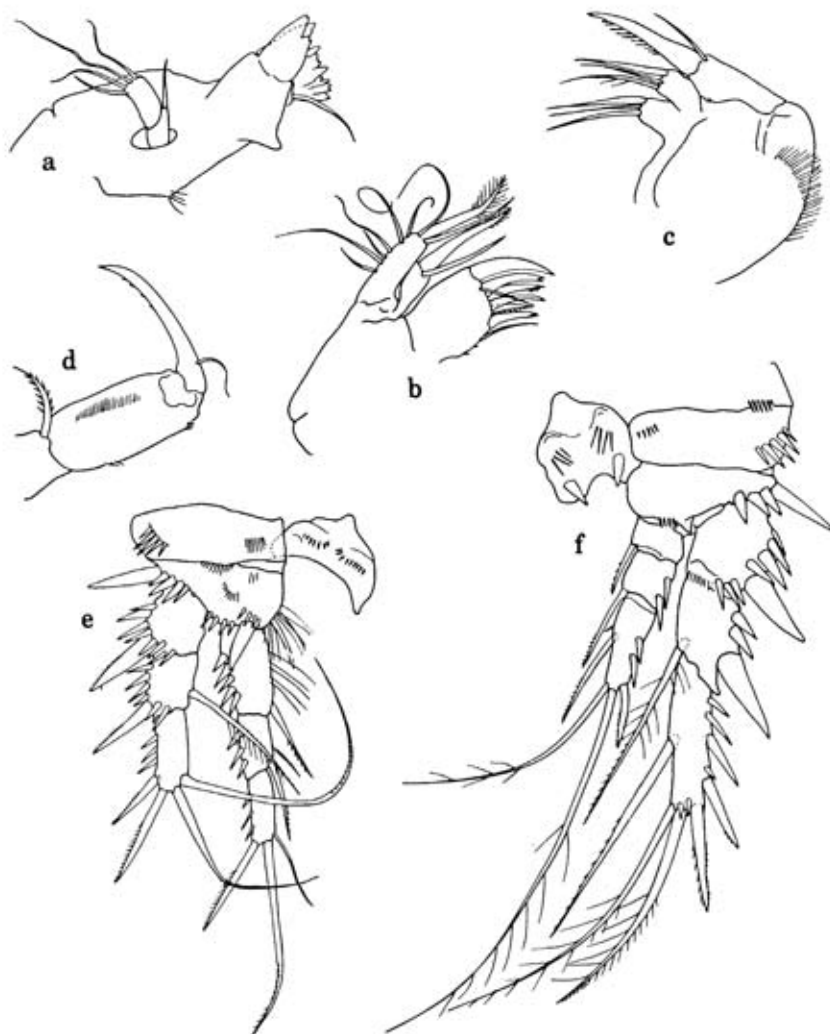


Fig. 3. *Canthocamptus campaneri*, type female, MZUSP 10479: a, Mandible; b, Maxillule; c, Maxilla; d, Maxilliped; e, Right leg 1 and coupler, anterior; f, Left leg 2 and coupler, anterior.

midlength and ending in dorsoventral row of 4-5 spines; ramus also with 2 lateral and 3 terminal setae. Lateralmost terminal seta (Fig. 1c) long, stout, with few coarse spinules; median terminal seta short, about 1/3 breadth of lateralmost seta at base, inserted partly ventrally to lateralmost seta; medialmost terminal seta inserted on subterminal posteriorly curved process. Caudal ramus also with small blunt terminal cuticular outgrowth lateral to lateralmost terminal seta. Left ramus with apparently mucoid strand issuing from between medialmost and median terminal setae. Nuchal organ (Fig. 2b) longer than broad, constricted near midlength, anterior 1/4 subtriangular.

Rostrum (Fig. 2c) subtriangular with rounded apex, no division from cephalosome evident. Antennule (Fig. 2c) shorter than cephalosome, of 8 articles, articles 4 and 8 each with narrow esthetasc. Antenna (Fig. 2d) with allobasis, exopodite of 1 article bearing 4 setae and row of small spines near base of proximalmost seta. Mandible (Fig. 3a) with article 1 (coxa- basis) bearing 1 seta and article 2 (endopodite) with 4 setae. Maxillule (Fig. 3b) with precoxal arthrite with 6 stout teeth and 2 slender setae, coxa with 1 stout plumose seta and 1 slender naked seta, and basis with 1 stout plumose terminal seta, 2 slender naked terminal setae and 6 slender naked setae on ventral margin. Maxilla (Fig. 3c), all setae on ventral margin of basis not visible; basis having at least stout terminal claw and 1 slender terminal seta; each endite terminally with 2 stout and 1 slender setae. Maxilliped (Fig. 3d) with stout terminal seta on basis; endopodite with comb of spinules on each side and 2 groups each composed of few spinules on dorsal margin.

Legs 1-4 (Figs. 3e,f, 4a,b) each with exopodite of 3 articles, legs 1-3 each with endopodite of 3 articles and leg 4 with endopodite of 2 articles. Endopodite of leg 1 not prehensile. Lateral and distal principal appendages of leg 1 basipodite and lateral principal appendage of leg 2 basipodite stout, spiniform; lateral spines of legs 2 and 3 exopodites 2 and 3 extremely stout. Couplers of legs 1-3 variously ornamented on anterior surfaces only; leg 4 coupler naked. Formula for principal armament of swimming legs:

Leg 1	basipodite 1-1	exopodite 0-1; 1-1; 0,2,2 endopodite 1-0; 1-0; 1,2,0
Leg 2	basipodite 0-1	exopodite 0-1; 1-1; 1,2,3 endopodite 1-0; 1-0; 1,2,1
Leg 3	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 1-0; 1-0; 2,2,1
Leg 4	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 1-0; 2,2,1

Leg 5 (Fig. 4c) with basoendopodites distinct, each with partial suture about midlength of medial margin and extending proximally across part of anterior, but not posterior surface; each basoendopodite with 6, each exopodite with 5 major setae.

Male.--Unknown.



Fig. 4. *Canthocamptus campaneri*, type female, MZUSP 10479: a, Left leg 3 and coupler, anterior; b, Left leg 4 and coupler, anterior; c, Left leg 5 and part of somite, anterior.



**Etymology.**--Named in memory of Prof. Dr. Antônio Frederico Campaner, copepodologist and friend.

**Discussion and Comparisons.**--The *Bryocamptus* sensu lato species-group is a fine example of taxonomic confusion within the Canthocamptidae, having had genera split from it and also having been subdivided several ways (Rouch, 1986). The two most generally accepted schemes are those of Borutskii (1952) and Lang (1948). According to both authors' criteria, *Canthocamptus campaneri* is a member of this species-group, and moreover of the group *Bryocamptus* sensu stricto, within which it falls most nearly within the *minutus*-group of Lang (1948). For example, likenesses to *Bryocamptus minutus* (Claus, 1863), according to the redescription by Gurney (1932), include a general similarity of the articulation and armament of legs 1-4, leg 5 setation, the strong spines of the anal operculum, and the row of small spines at the level of the proximalmost seta of the antennular exopodite. However, differences from *B. minutus* and many other members of the *minutus*-group include the antennular exopodite of 1, not 2 articles; the mandibular palp of 2 articles, i. e. with endopodite, rather than of 1 article, i. e. without endopodite; the caudal ramus with 1 rather than 2 well-developed

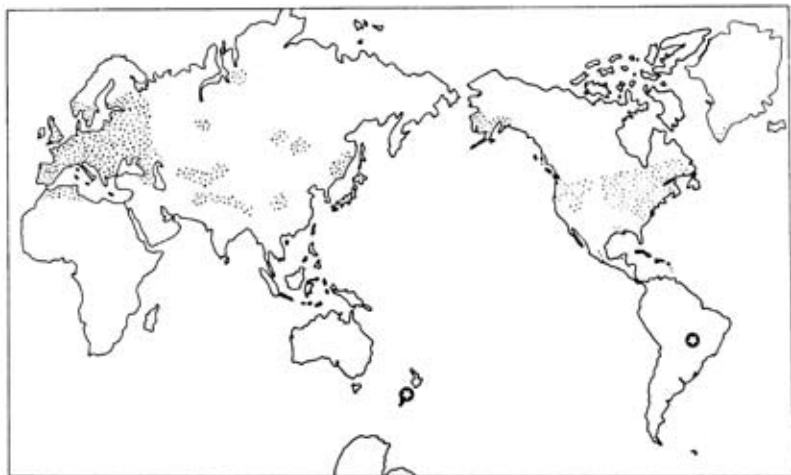


Fig. 5. World distribution of *Bryocamptus* sensu lato species group; stars indicate southern hemisphere records in New Zealand and Brazil.

terminal setae; and the unusual partial suture on the basoendopodite of leg 5. *Bryocamptus* (*Bryo.*) *vej dovskyi* (Mrázek, 1893) and related species have modifications of at least some caudal setae (Flössner, 1989), and it is likely that the preponderance of similar characters of *C. campaneri* will eventually indicate its placement in the *minutus*-group. However, in the absence of knowledge of the male of this species, and especially without information regarding the full range of modification of mouthparts within the *Bryocamptus*-group *sensu lato*, assignment to any subgroup of *Bryocamptus* is not presently possible.

The apparently mucoid strand issuing from the left caudal ramus of *C. campaneri* seems to indicate the existence of a secretory organ, although no perforation of the tegument at this location is visible on either ramus on the mounted specimen. Glands with associated external organs occur commonly in copepods (Lang, 1948; Von Vaupel Klein, 1982), and some of these produce mucus (Hicks and Grahame, 1979). Lang (1965: 136, Pl. II Figs. h,i) noted the presence of a cylindrical string of adhesive gelatinous substance issuing from a duct near the base of each principal terminal caudal seta in species of *Zausodes* (Family Harpacticidae). He suggested that these strings serve as an anchor on sandy bottoms. Within the Family Canthocamptidae, two glands were described on the caudal ramus of *Canthocamptus staphylinus* (Jurine, 1820) by Richard (1891), although external secretions were not observed. However in published SEM photographs of some members of the *Bryocamptus*-group (Flössner, 1989), cuticular structures indicating the presence of secretory glands are not visible.

*Canthocamptus campaneri* is the first species of the *Bryocamptus sensu lato* species-group found in South America. The group is basically boreal, with a few representatives known from New Zealand (Fig. 5). North American species have not been found south of the northern limit of the Eocene-Miocene submergence of Central America (Löffler, 1972). The record of *Bryocamptus* sp. from a lake in the state of Rio de Janeiro by Reid and Esteves (1984) was based on an erroneous determination by myself of *Attheyella* (*Chappuisiella*) *fuhmanni* (Thiébaud, 1914). The case of *Bryocamptus broiensis* of Rocha and Matsumura-Tundisi (1976) is discussed following.

### ***Attheyella* (*Delachauxiella*) *broiensis***

*Bryocamptus broiensis* Rocha and Matsumura-Tundisi, 1976:62-65, Pranchas XXXI, XXXII.

*Attheyella* (*Delachauxiella*) *hannae* (Kiefer, 1926)?, comb. nov.--Dussart and Defaye, 1990:112.

Diagnosis.--From figures of Rocha and Matsumura-Tundisi (1976): Hyaline frills of all somites except anal somite coarsely serrate dorsally, frill of genital segment also coarsely serrate ventrally; frills of urosomites 2 and 3

smooth ventrally. Seminal receptacle extending nearly entire length of genital segment. Genital segment with lateral rows of spines along posterior margin. Urosomites 2 and 3 each with lateral rows of spines along posterior margin, these continuous ventrally. Anal somite with ventral and lateral rows of spines along posterior margin. Anal operculum about 1/2 length of caudal ramus, broadly triangular with nearly straight sides, apex rounded, margins finely serrate. Caudal ramus slightly longer than broad, dorsal crest extending past midlength and bearing triarticulate seta. Caudal ramus with row or group of fine hairlike setae apparently inserted on protrusion medial to dorsal crest, caudal ramus also with 2 terminal setae, medial seta longest.

Antennule of 8 articles, articles 4 and 8 each with long slender esthetasc. Antenna with allobasis, exopodite with 4 setae. Mandible with biarticulate palp, article 1 (coxa-basis) without appendage, article 2 (endopodite) with 4 terminal setae. Maxillule, precoxal arthrite with 4 teeth on distal margin; basis with 5 ventral and 2 terminal setae, dorsal seta also apparent in figure (Rocha and Tundisi, 1976: Plancha XXXII, Fig. 9). Maxilla with normal 2 endites. Maxilliped with seta on basis.

Leg 1 with triarticulate rami and prehensile endopodite with article 1 about as long as entire exopodite. Legs 2-4 each with exopodite of 3 and endopodite with 2 articles. Principal appendages of legs 1 and 2 basipodites spiniform. Formula for major armament of legs 1-4 as follows:

Leg 1	basipodite 1-1	exopodite 0-1; 0-1; 0,2,2 endopodite 1-0; 1-0; 1,2,0
Leg 2	basipodite 0-1	exopodite 0-1; 1-1; 1,2,3 endopodite 1-0; 1,2,1
Leg 3	basipodite ?	exopodite 0-1; 1-1; 2,2,3 endopodite 1-0; 3,2,1
Leg 4	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 1-0; 2,2,1

Leg 5, exopodite extending well past basoendopodite; the former with 4, the latter with 6 slender setae.

Type Locality.--Broa (Lobo) Reservoir, State of São Paulo, Brazil.

Distribution.--Known only from type locality.

Discussion and Comparisons.--Rocha and Matsumura-Tundisi (1976) provided figures of a female canthocamptid from the Broa Reservoir, São Paulo, which they named *Bryocamptus broiensis*. The figures were done from a single specimen, presently stored in the collections of the Laboratório de Limnologia, Universidade Federal de São Carlos (Rocha, personal communication). The species illustrated is a member of the *Attheyella* (*Delachauxiella*) species-group. Although the authors indicated that the species was new, the figures alone without accompanying text do not constitute a description and the name is consequently not available (ICZN-International Commission on Zoological Nomenclature, 1985: Article 13.a.i). No subsequent description was published, nor have the authors responded to requests for material. The recent publication of the name in bibliographic form by Dussart and Defaye (1990) unfortunately still does not render the name available (ICZN, 1985: Article 11.d.ii). In order to remedy this nomenclatural problem, a diagnosis for the female was provided herein according to the figures of Rocha and Tundisi (1976), and the following discussion compares the species to its most closely related congeners. The *Delachauxiella* species-group has been treated either as a genus or as a subgenus of genus *Attheyella*. Because it seems simplest to retain the name given by Rocha and Matsumura-Tundisi (1976), I propose the name *Attheyella* (*Delachauxiella*) *broiensis*, noting that the species is formally a member of the genus *Canthocamptus* sensu lato.

Dussart and Defaye (1990) provisionally synonymized *A. (D.) broiensis* with *A. (D.) hanna*. However this synonymy is unacceptable because the latter species has the anal operculum with smooth margins in the female, no medial hairlike setae on the caudal ramus, and the urosomal spine rows discontinuous ventrally. Because sufficient material has not become available as yet to estimate the range of variability in this species-group, it seems more prudent to maintain distinctions between named taxa that differ in a suite of characters. *Attheyella (D.) hanna* is known from Valdivia (Kiefer, 1926) and Lake Llanquihue (Löffler, 1961) in Chile.

South American species of the *Delachauxiella*-group are similar in the armament of legs 1-5, which moreover tends to vary between and within populations and between both rami of the same individual. Species are most easily separated following Lang (1948) by the shape and ornament of the anal operculum and caudal ramus. Only a few known species have the caudal ramus short, that is about as long as broad, and the anal operculum shorter than the ramus and broadly triangular or subtriangular. Besides *A. (D.) hanna*, these include *A. (D.) dadayi* (Chappuis, 1924), *A. (D.) horvathi* (Chappuis, 1924), *A. (D.) insignis* (Delachaux, 1917), and *A. (D.) lanata* (Mrázek, 1901).

In *A. (D.) insignis* (Delachaux, 1917), the caudal ramus of the female is about 2 times longer than broad with spines on the medial surface, and the distal part of the caudal ramus is bent medially. *Attheyella (D.) insignis* is known only from the type locality, Lake Huaron, Naticocha, Peru (Delachaux, 1917).

*Attheyella (D.) dadayi* (Chappuis, 1924) has the short anal operculum broadly triangular and straight-sided, but it is edged with a delicate hyaline fringe rather than with sclerotized spines. Also the leg 1 exopodite article 2 bears a medial seta and the medial surface of the caudal ramus lacks ornament except for two large spines near the medialmost terminal seta. These previously unpublished details were confirmed by inspection of Slide No. III/P-318 from the Collectio Dadayana, held by the Hungarian Natural History Museum (Forró and Dussart, 1985). This slide contains a partly dissected female specimen from St. Cruz, Patagonia labeled by Daday as the European species *Canthocamptus northumbicus* Brady, 1880. Daday's determinations of his material from Patagonia were reviewed and partly corrected by Chappuis (1924), who among other new species described *Canthocamptus* (now *Attheyella*) *dadayi* from specimens initially identified as *C. northumbicus*.

Morphological and distributional knowledge of both *A. (D.) horvathi* and *A. (D.) lanata*, the two species closest to *A. (D.) broiensis*, is somewhat unclear. Mrázek (1901) described *A. (D.) lanata* from the female only, collected near Montevideo, Uruguay. Mrázek's description showed a female with a straight-sided, finely toothed anal operculum and a long hairlike seta on the medial surface of the caudal ramus. Specimens ascribed to this species were later described twice. Kiefer (1959) supplied figures of females from Lake Trafun, southern Chile showing the anal operculum as relatively little produced and straight-sided, and the caudal ramus with long hairs on the medial surface. Rouch's (1962) figures of specimens from Nahuel Huapi, Patagonia ascribed to *A. (D.) lanata* also show the anal operculum of the female with straight sides, but Rouch's specimens had no hairs on the medial surface of the caudal ramus. Whether these authors were dealing with one species or several sibling species, all descriptions of *A. (D.) lanata* differ from *A. (D.) broiensis* in showing the anal operculum of *A. (D.) lanata* less produced posteriorly, urosomite 2 with the marginal spines discontinuous ventrally, the leg 5 exopodite extending only to the level of the basoendopodite, and never any dorsomedial process indicated on the caudal ramus. The lack of a complete description of *A. (D.) lanata* exemplifies the desirability of illustrating "minor" characters.

The concept of the morphology and distribution of *A. (D.) horvathi* has also suffered from taxonomic confusions. Daday (1902) recorded the European species *Canthocamptus trispinosus* Brady, 1880, from Patagonia. Daday later (1905) recorded the same species from Paraguay. Chappuis (1924) described from Daday's Patagonian specimens a new species, *Canthocamptus horvathi*. Apparently Chappuis never inspected the specimens from Paraguay, as he did not mention them either in his 1925 article or in a later revision of the Canthocamptinae (Chappuis, 1929b). Lang (1948) cited both articles by Daday (1902, 1905) and uncritically extended the distribution of *A. (D.) horvathi* to Paraguay. Differences in Daday's 1902 and 1905 descriptions of *C. trispinosus* from Patagonia and from Paraguay raised the suspicion that Daday was actually dealing with two different species. This was confirmed by examination of specimens from the Collectio Dadayana. The collection presently contains two lots of copepods labeled *Canthocamptus trispinosus*. Slide No. III/P- 331

from St. Cruz, Patagonia contains a female and a male specimen of *A. (D.) horvathi*. However Slide No. III/P-330 from Paraguay contains eight whole-mounted females of a species of *Attheyella* (*Chappuisiella*-group) which I was unable to determine further. These have a somewhat produced but rounded anal operculum and lateral rows of large spines on the urosome, superficially similar to *A. (D.) horvathi*. Visible features agree with Daday's 1905 description and differ from *A. (D.) horvathi*, for instance in having the somitic hyaline frills smooth rather than serrate. Therefore the Paraguay record of *A. (D.) horvathi* is unsupported by available material.

Chappuis (1924) provided only a partial description of *A. (D.) horvathi*, which agrees with most characters of *A. (D.) broiensis*; however, urosomite 2 of *A. (D.) horvathi* has the marginal spines discontinuous ventrally while in *A. (D.) broiensis* they are continuous. Chappuis' description can be confirmed in some details and extended in others from the whole-mounted specimens on Slide No. III/P-331, although the slide is somewhat dried. Chappuis' figure of the leg 5 exopodite of the female (Chappuis, 1924: Fig. 2) is accurate in indicating rather slender setae. Also on the female, there are 4 lateral spines and a socket indicating an additional spine on the genital segment, rather than the 4 spines that Chappuis described. The sides of the anal operculum are slightly concave but the tip is directed straight posteriorly. The anal somite bears a row of slender hairlike spines along the posterolateral margin. Details of the ornament of the caudal rami are invisible due to drying. Of the swimming legs, only leg 1 of the female can be seen clearly; exopodite article 1 bears a long slender seta on the distomedial corner, and article 2 bears a short stout seta at the corresponding location. This last constitutes the most obvious difference from *A. (D.) broiensis*.

### ***Attheyella (Delachauxiella) yemanjae*, new species**

#### **Figures 6-11**

*Echinocamptus* a.--Reid, 1984:109, Tables 3, 4.

*Attheyella (Delachauxiella)* a.--Reid, 1994a:Table I.

Holotype.--MZUSP 10488, female, alcohol-preserved, Sample 75.

Allotype.--MZUSP 10489, male, in alcohol together with holotype specimen, Campo Úmido da Onça, Sample 75, 23 August 1979.

Paratypes.--MZUSP 10490, 2 females, 1 male, 1 copepodid, Sample 75; MZUSP 10491, 6 females 6 males, Sample 215, 3 February 1982; USNM 250296, 1 female and 1 male, each dissected and mounted on slide, and 1 male, Sample 75; USNM 250297, 1 female, Sample 50, 21 February 1979; USNM 250298, 1 male, Sample 131, 14 January 1981; USNM 250299, 6 females 6 males, Sample 215. Unmounted specimens preserved in 70% ethanol.

Type locality.—Campo Úmido da Onça, Fazenda Água Limpa, Distrito Federal, Brazil, 15°56'40"S 47°54'20"W.

Distribution.— Known only from type locality.

Description of Female.—Length of holotype 0.40 mm, lengths of paratypes 0.36 - 0.49 mm (median = 0.42 mm,  $n = 15$ ). Habitus (Fig. 6a) canthocamptid, urosome slightly tapering posteriorly. Cephalosome with short shallow anteroposterior groove anterior to and slightly more lateral than nuchal organ; cephalosome also shallowly grooved along posterior margin of nuchal organ. Pedigers 2-5 each with 2 shallow dorsal anteroposterior grooves. Nuchal organ (Fig. 6a,c) oval, less than half as long as length of cephalosome, heavily sclerotized with pitted surface. Cephalosome and pediger 2 without lateral hyaline windows. Posterior hyaline frills of all somites coarsely and irregularly serrate, except ventral parts of frills of urosomites 2 and 3 smooth. Genital segment (Fig. 6a,d) without trace of lateral suture; seminal receptacle extending nearly entire length of segment. Posterior margin of genital segment with lateral row of about 5 spines, posterior margins of urosomites 2 and 3 with longer lateral spine rows, row of urosomite 3 continuous ventrally as smaller spines. Posterior margin of anal somite (Figs. 6a,d, 7a,c,e) laterally with about 6 small spines, ventrally with 7-8 longer stout spines. Anal operculum (Figs. 6a,d, 7a-c,e) broadly triangular with concave margins, extending past level of dorsal caudal seta, tip of operculum in most specimens curved slightly left or right, marginal teeth coarse, sclerotized, more proximal teeth directed somewhat dorsally. Caudal ramus (Figs. 6a,d, 7a,c-e) slightly longer than broad, dorsal crest extending along 2/3 length of ramus; dorsal caudal seta inserted near rounded distal end of crest, seta with 2 basal articulations. Medial surface of ramus with dorsoventral row of fine hairlike setae; ramus also with dorsoventral row of 3-4 stout spines anterior to each lateral seta, and few small spines near posteroventral margin. Ramus of holotype (Fig. 7e) and most females with transverse dorsal row of few spines near posterior margin, dissected female from Sample 75 (USNM 250296, Figs. 6a, 7a,c) without spines at this location. Median terminal caudal seta nearly as long as body, with proximal breaking plane, setules along most of length. Medialmost terminal caudal seta (Figs. 6d, 7a) short, hairlike, inserted medially to median terminal seta. Lateralmost terminal caudal seta (Figs. 6a, 7a) about 1.5 times longer than ramus, spiniform, with proximal breaking plane and setules along most of lateral margin.

Rostrum (Fig. 6a,c) broadly triangular, with 2 subterminal sensilla. Antennule (Fig. 7f) of 8 articles, articles 4 and 8 each with long slender esthetasc. Antenna (Fig. 7g) with allobasis, exopodite of 1 article bearing 4 setae. Mandible (Fig. 8a) with biarticulate palp, article 1 with row of spines along margin and 1 distal seta, article 2 with 4 terminal setae. Maxillule (Fig. 8b), precoxal arthrite with 5 teeth and 4 setae on distal margin, and 2 setae near distal margin; basis with 6 setae along ventral margin and 2 naked distal setae at base of plumed setiform distal tooth. Maxilla (Fig. 8c), each endite with 2 slender naked setae and 1 setiform sparsely plumose tooth; basis with 2 setae

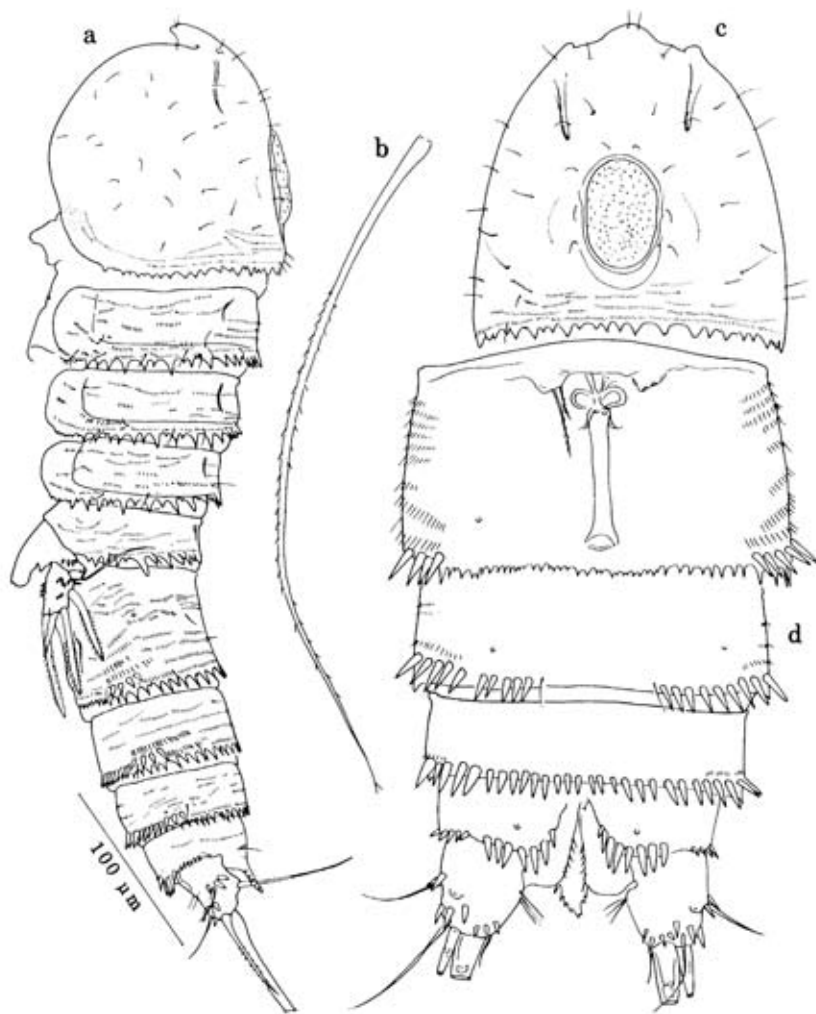


Fig. 6. *Attheyella* (*Delachauxiella*) *yemanjæ*, new species, female paratype USNM 250296: a, Habitus, left lateral; b, Median terminal caudal seta; c, Cephalosoma, dorsal; d, Urosome, ventral. Fig. 6a,b to same scale.



at base of tooth and 1 seta midway between base of tooth and endopodite; endopodite not appearing distinct from basis, with 2 setae. Maxilliped (Fig. 8d) with seta on basis.

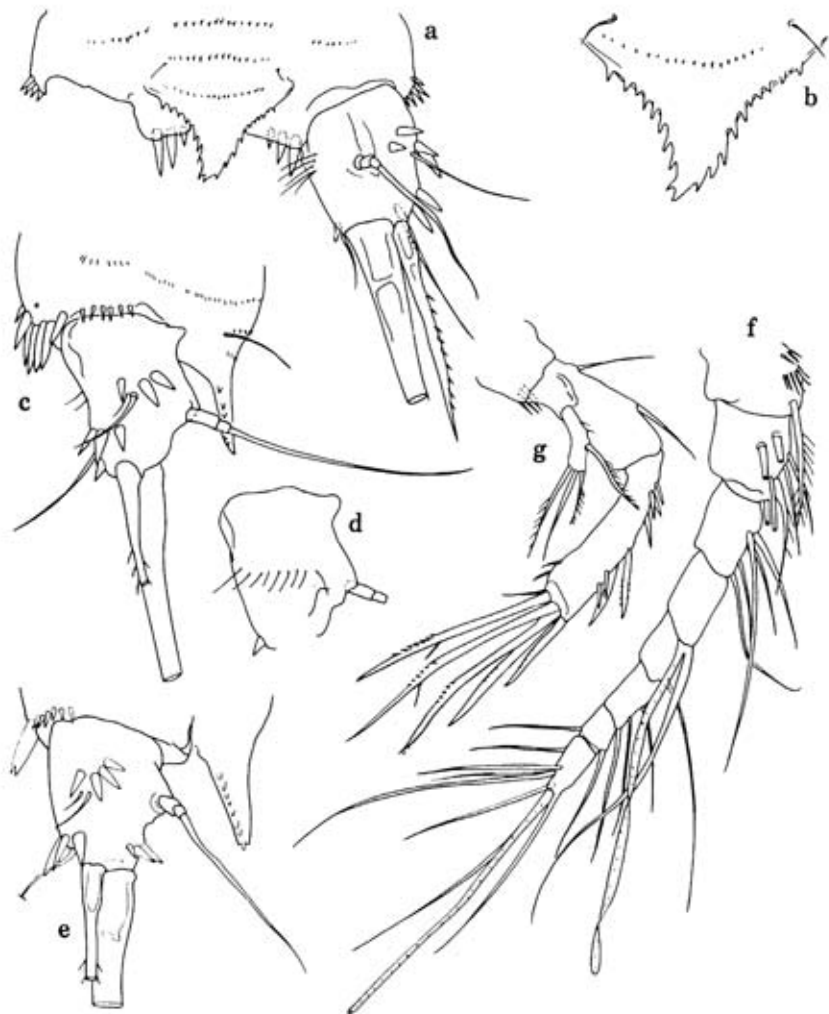


Fig. 7. *Attheyella* (*Delachauxiella*) *yemanjæ*, new species. Female paratype USNM 250296: a, Anal somite and right caudal ramus, dorsal; b, Anal operculum; c, Anal somite and caudal ramus, left lateral; d, Right caudal ramus, mediolateral. Female holotype MZUSP 10488: e, Caudal ramus, left lateral.

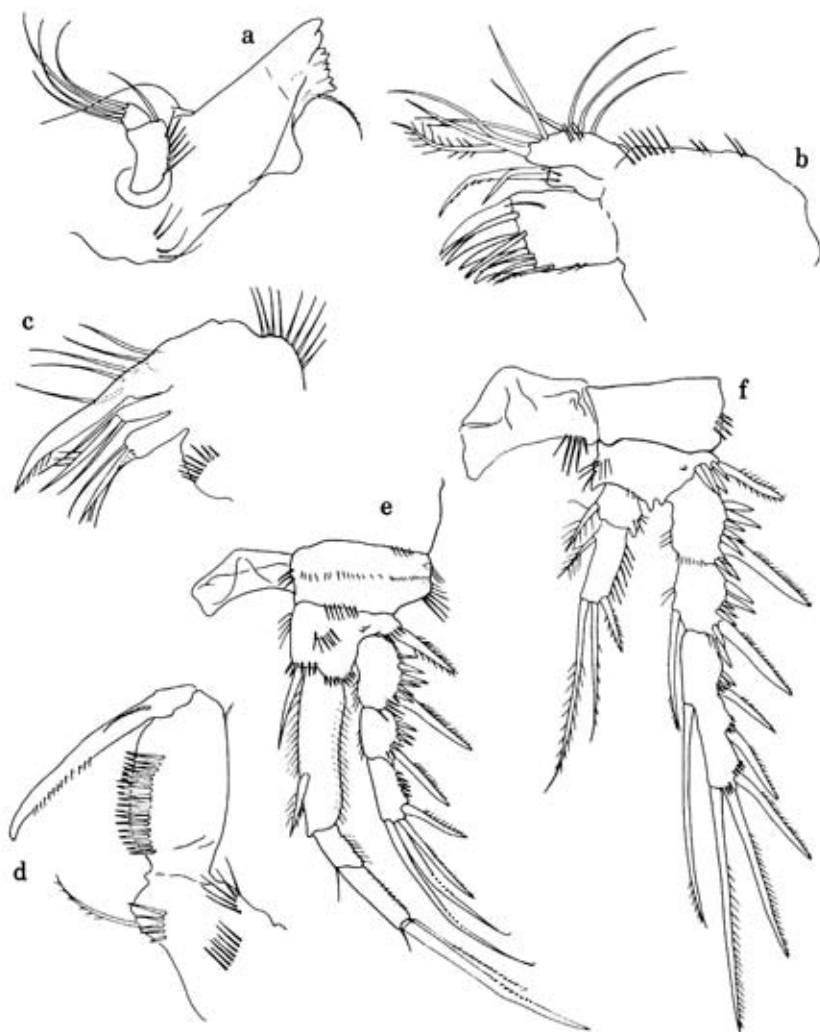


Fig. 8. *Attheyella (Delachauxiella) yemanjæ*, new species, female paratype USNM 250296: a, Mandible; b, Maxillule; c, Maxilla; d, Maxilliped; e, Left leg 1 and coupler, anterior; f, Left leg 1 and coupler, anterior.

Leg 1 (Fig. 8e) with exopodite and endopodite each of 3 articles, exopodite article 3 reaching end of endopodite article 1. Legs 2-4 (Figs. 8f, 9a-d) each with exopodite of 3 articles and endopodite of 2 articles. Leg 4 endopodites of dissected paratype (Fig. 9b,c), one ramus with article 1 naked

and 5 setae on article 2, other ramus with 1 seta on article 1 and 4 setae on article 2. Leg 4 endopodites of remaining females (Fig. 9d), all having article 1 with 1 seta and article 2 with 5 setae. Couplers of legs 1 and 4 naked, of legs 2 and 3 each with 2 groups of spines. Formula for major armament of legs 1-4 as follows:

Leg 1	basipodite 1-1	exopodite 0-1; 0-1; 0,2,2 endopodite 1-0; 1-0; 1,2,0
Leg 2	basipodite 0-1	exopodite 0-1; 1-1; 1,2,3 endopodite 1-0; 1,2,1
Leg 3	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 1-0; 3,2,1
Leg 4	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 0-0 or 1-0; 2,1,1 or 2,2,1

Leg 5 (Fig. 9e-h), basoendopodite and exopodite distinct; exopodite extending approximately to distal margin of medial expansion of basoendopodite. Left basoendopodite of dissected paratype (USNM 250296) with 6 setae on medial expansion and 1 row of slender spines on posterior surface between insertions of medialmost and next medialmost setae, medial margin of basoendopodite naked (Fig. 9f,g). Right basoendopodite of same specimen with 5 setae on medial expansion and 2 rows of slender spines, plus additional row of 3 setae on medial margin proximal to insertion of medialmost seta (Fig. 9e,h). Remaining specimens with 6 setae on each side and single row of setules. Exopodite with 4 setae. Setae of all specimens short, spiniform.

Description of Male.--Length of allotype 0.32 mm, lengths of paratypes 0.30 - 0.36 mm (median = 0.32 mm, n = 14). Habitus and shape of dorsal nuchal organ of cephalosome exactly as female. Urosomites (Fig. 10a) with all spine rows continuous ventrally; dorsal margins of hyaline frills of urosomites coarsely and irregularly serrate, ventral margins smooth. Ornament of anal somite and shape of anal operculum (Fig. 10a,b) as female. Caudal ramus (Fig. 10a,b) about as long as broad, shape and armament as female except lacking transverse dorsal row of spines posterior to dorsal crest present in some females.

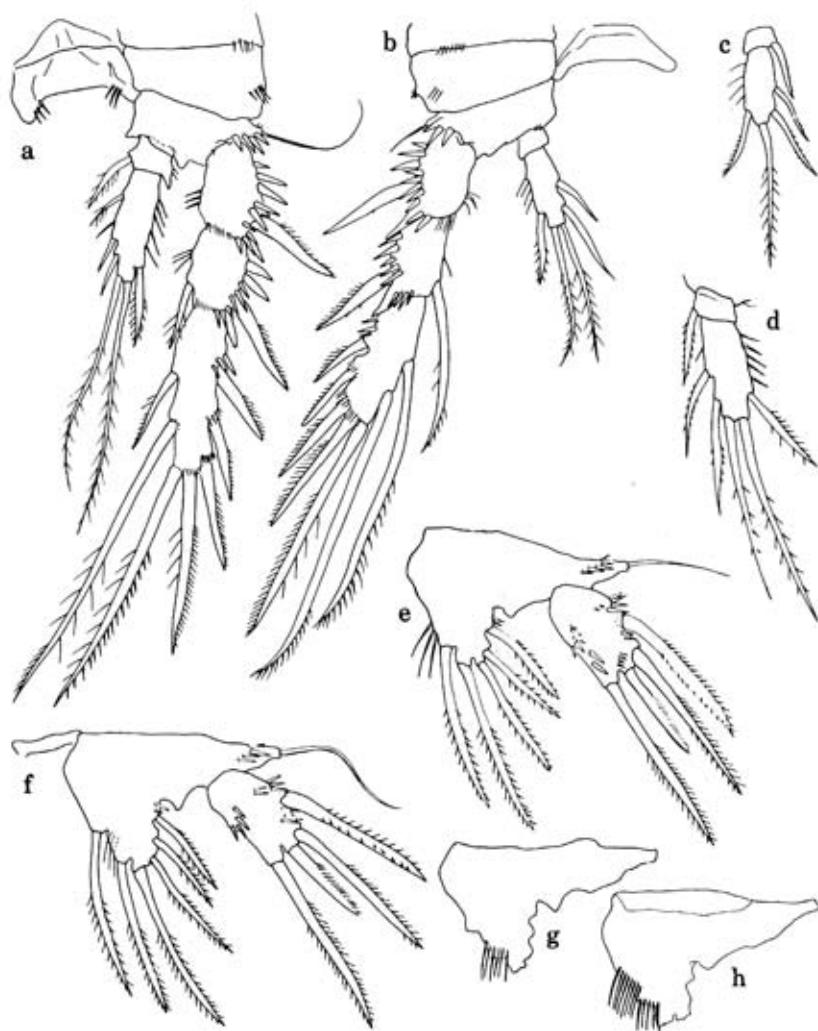


Fig. 9. *Attheyella (Delachauxiella) yemanjæ*, new species, female paratype USNM 250296: a, Left leg 3 and coupler, anterior; b, Right leg 4 and coupler, anterior; c, Left leg 4 endopodite, posterior; e, Right leg 5, anterior (drawn through transparent mount); f, Left leg 5, anterior; g, Left leg 5 omitting setae, posterior (drawn through transparent mount); h, Right leg 5 omitting setae, posterior. Female holotype MZUSP 10488: d, Left leg 4 endopodite, anterior.

Antennule (Fig. 10c) of 8 articles, geniculate with articles 1-4 expanded and articles 5 and 6 sculptured, articles 4 and 8 each with slender esthetasc, esthetasc of article 4 long. Rostrum, mouthparts, leg 1, and couplers of legs 1-4 as female.

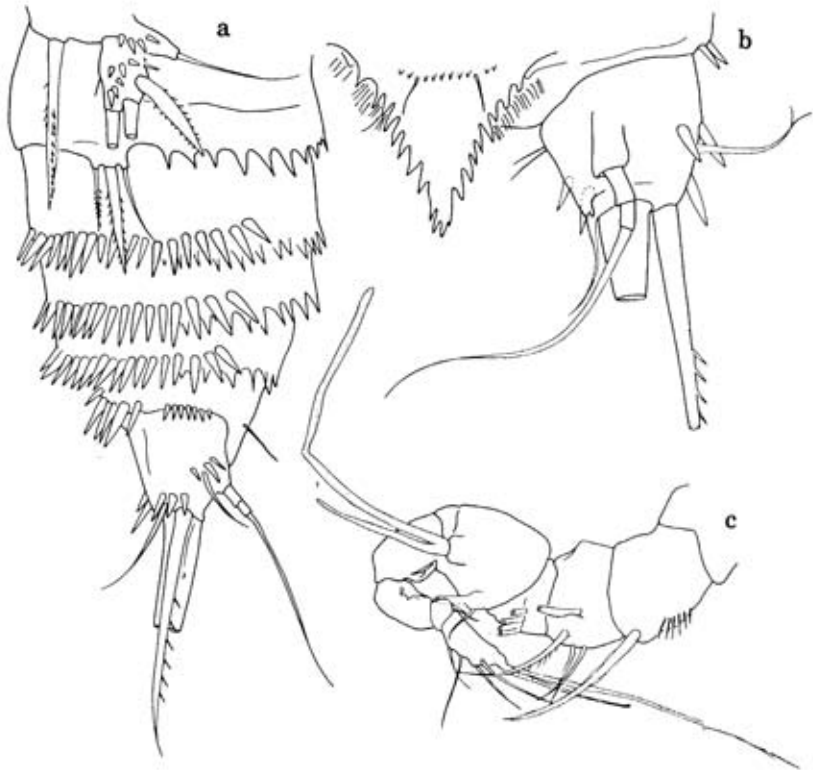


Fig. 10. *Attheyella* (*Delachauxiella*) *yemanjae*, new species, male paratype USNM 250296: a, Urosome, left lateral; b, Detail of anal somite and right caudal ramus, dorsal; c, Antennule (some setae omitted).

Leg 2 (Fig. 11a), exopodite as female; endopodite article 2 with 1 small seta on medial margin and 2 terminal setae, lateral margin notched at midlength and subdistally. Leg 3 (Fig. 11b) with lateral spines of exopodite articles 1 and 2 as female; endopodite with article 1 naked, article 2 with long slender double-barbed apophysis, and article 3 with 1 long terminal and 1 short stout subterminal plumed setae. Leg 4 (Fig. 11c) as female except endopodite article

1 naked and article 2 with 1 terminal and 2 subterminal setae. Formula for major armament of legs 2-4:

Leg 2	basipodite 0-1	exopodite 0-1; 1-1; 1,2,3 endopodite 1-0; 1,2,0
Leg 3	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 0-0; 1-0; 1,1,0
Leg 4	basipodite 0-1	exopodite 0-1; 1-1; 2,2,3 endopodite 0-0; 1,1,1

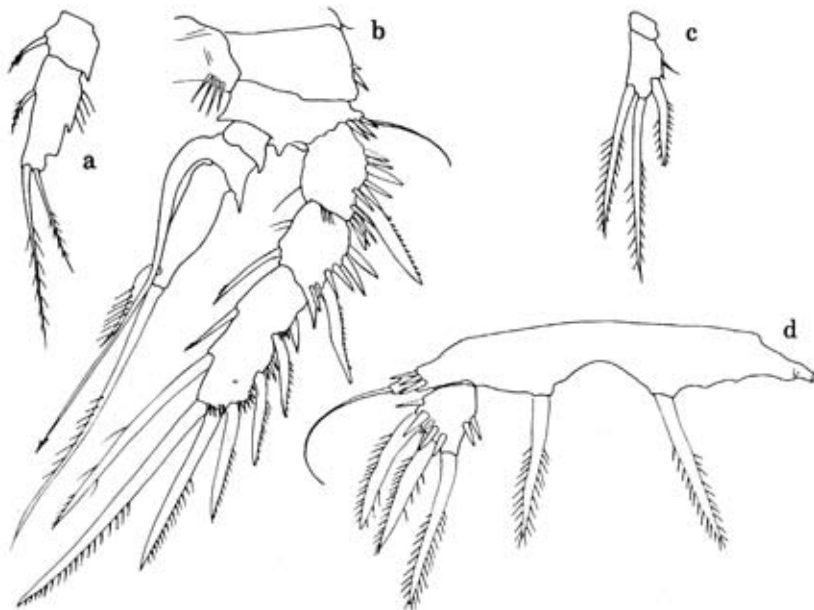


Fig. 11. *Attheyella* (*Delachauxiella*) *yemanjiae*, new species, male paratype USNM 250296: a, Left leg 2 endopodite, anterior; b, Left leg 3 and part of coupler, anterior; c, Left leg 4 endopodite, anterior; d, Leg 5 basoendopodites and right exopodite, anterior.

Leg 5 (Figs. 10a, 11d) with basoendopodites medially fused, little produced, each bearing 1 long spiniform seta on medial expansion. Exopodite distinct, little longer than broad, bearing 3 stout spiniform setae. Leg 6 (Fig. 10a) indistinctly separated from somite, bearing stout median spine and slender ventral and dorsal setae.

**Etymology.**--Named for Yemanjá, in the Candomblé pantheon the beneficent and terrible goddess of the sea and the patroness of those who work on the waters.

**Discussion and Comparisons.**--*Attheyella* (*D.*) *yemanjæ* falls in the same closely related species-group as *A. (D.) broiensis*. The female of *A. (D.) hanna* differs in having the anal operculum with a smooth margin and in lacking medial hairlike setae on the caudal ramus. *Attheyella (D.) insignis* is distinguished chiefly by the shape of the caudal ramus. The same characters of the caudal ramus, anal operculum and leg 1 setation distinguish both *A. (D.) yemanjæ* and *A. (D.) broiensis* from *A. (D.) dadayi*. *Attheyella (D.) lanata* is distinguished by the relatively less produced, straight-sided anal operculum, and the appendages of legs 1-5, especially leg 5 setiform, that is long and slender rather than short and spiniform. The dorsal nuchal organ of the female from Chile (Kiefer, 1959: fig. 6) is ovoid and slightly constricted posteriorly. *Attheyella (D.) horvathi* is distinct in the setation of leg 1 and in several minor characters. *Attheyella (D.) broiensis* has the anal operculum with straight sides, fine teeth, and a rounded apex, ventral marginal spines on urosomite 2, the caudal ramus with a dorsomedial process, the lateralmost terminal caudal seta and the leg 5 setae long and slender rather than short and spiniform, and the mandibular palp article 1 naked.

The known males of most members of the *Delachauxiella*-group have the basoendopodite with 2 spiniform setae on each side. The male of only *A. (D.) lanata* has but 1 seta at this location, similar to the male of *A. (D.) yemanjæ*. Rouch (1962) showed the smaller seta of the leg 3 article 3 of this species as slender and terminal rather than stout and distinctly subterminal as in *A. (D.) yemanjæ*. The male of *A. (D.) broiensis* and leg 5 of the male of *A. (D.) horvathi* are undescribed.

*Attheyella (D.) broiensis* and *A. (D.) yemanjæ* are the first and second members of the *Delachauxiella*-species group to be collected in the non-Andean neotropics. The most morphologically similar species are known from Paraguay, Andean Peru, and southern Argentina and Chile as previously discussed. The *Delachauxiella*-group as a whole has a Gondwanaland distribution in Australia and New Zealand as well as in South America.

## DISCUSSION

These surprising discoveries provide a new perspective on the wet campo habitat. Reid (1984) first pointed out the high species richness of the

copepod fauna of wet campos. Campo Úmido da Onça, the best-investigated of these, harbors a total of 29 species of harpacticoid and cyclopoid copepods (Reid, 1984, 1994a,b). This is the highest number of species of copepods yet collected from a single relatively homogeneous freshwater wetland. A comparable number of species may live in the diverse habitats offered by some lakes, the highest known species richness in a lacustrine habitat being the 36 cyclopoid and harpacticoid species recorded from Lake Pääjärvi, Finland (Sarvala, 1986). Reid (1984) attributed the high species richness of the wet campo copepod community to the physical stability of the habitat. This physical stability may also account for the ability of some species with temperate affinities to survive in the tropical region. The presence of these species lends a special interest to the wet campo species assemblage, which is otherwise composed of an exceptional proportion of endemics. Apparently these wetlands play an important and previously unsuspected ecological role as refugia for species with temperate zone affinities, as well as for many species that are found in no other type of habitat.

The fauna and flora of wet campos in most of the extensive cerrado region of central Brazil remain little studied. These habitats consist of small pockets of highly organic hydromorphic soils developed along watercourses where groundwater remains at or near the surface during most of the year. The wet campos occupy a small total area, but probably provide critical refugia and migration corridors for endemic plants and aquatic invertebrates. Because the soils of the wet campos are highly arable once ditched and drained, many wet campos located outside present biological preserves are now used for vegetable farming. The preservation of a significant proportion of these habitats should receive priority in development of conservation strategies for the cerrado region.

### ACKNOWLEDGMENTS

I am most grateful to Dr. Laszlo Forró for an extended loan of specimens from the Collectio Dadayana in the Hungarian Natural History Museum, and to Ms. Marilyn Schotte for drawing the final plates. The resources of the C. B. Wilson Copepod Library, National Museum of Natural History greatly aided this project.

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