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***Acanthocyclops pennaki* n. sp. (Copepoda: Cyclopoida)  
from the Hyporheic Zone of the  
South Platte River, Colorado, U.S.A.<sup>1</sup>**

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*Abstract.* A new species of cyclopoid copepod, *Acanthocyclops pennaki*, is described from the hyporheic zone of the South Platte River, Colorado, U.S.A. The species differs from congeners by the combined characters of the antennule of 12 articles, lack of the antenna exopodite seta, spine formula 2,3,3,3, setal formula 4,4,4,4, caudal ramus without hairs on the medial surface, lateral terminal spine of the leg 4 endopodite article 3 slightly shorter than the medial terminal spine, and leg 4 endopodite article 3, 1.8–2.2 times longer than broad. *Acanthocyclops plattensis* is a junior synonym of *A. vernalis*.

In the course of a review of North American species of the genus *Acanthocyclops*, I examined the type specimens of *A. plattensis* Pennak & Ward, 1985 from the South Platte River, Colorado deposited at the National Museum of Natural History, Smithsonian Institution (USNM 216702). The material, deposited as cotypes, consists entirely of adult and juvenile cyclopoid copepods ascribable to the common *A. vernalis* (Fischer, 1853) s. l. Specimens identified as *A. plattensis* in a sample from the South Platte River supplied by R. W. Pennak included 43 individuals of *A. vernalis*, and one mature female of the genus *Acanthocyclops* that agreed in some, but not in all respects with the description of *A. plattensis*. Nine samples of copepods from the South Platte River lent by J. V. Ward and supposed to contain specimens of *A. plattensis* yielded numerous adults and copepodids of *A. vernalis*, plus one female, one male, and three copepodids of the same species as in the sample examined earlier. No representatives of species congruent in all respects to the description of *A. plattensis* were present in the samples. Since the designated type material

<sup>1</sup> I thank Drs. Robert W. Pennak and James V. Ward for their kindness in supplying samples of sediment and copepods from the South Platte River. Drs. Fenner A. Chace, Jr. and Frederick M. Bayer advised on nomenclatural questions. Comments by Dr. Eugene H. Schmitz and an anonymous reviewer resulted in improvements in the text. Publication costs, in part, are being met by a grant from the Spencer-Tolles Fund of the American Microscopical Society.

of *A. plattensis* contains only specimens of *A. vernalis*, the former species becomes a junior synonym of the latter. The other species represented in the samples is described herein as a new taxon.

For taxonomic examination, the specimens were treated according to the methods of Reid et al. (1991). Type material was deposited in the collections of the National Museum of Natural History, Smithsonian Institution.

#### TAXONOMIC ACCOUNT

Order Cyclopoida G. O. Sars, 1886  
Family Cyclopidae Burmeister, 1834  
*Acanthocyclops* Kiefer, 1927  
*Acanthocyclops pennaki* n. sp.  
(Figs. 1–4)

*Specimens examined.* Holotype female, dissected and mounted on slide, Macrobar, Sta. 1, 0–50 cm, Rep. 2, 30 Jun 1983, USNM 251603. Allotype male, right antennule removed and mounted on slide, rest of specimen ethanol-preserved, Macrobar, Station 3, 0–30 cm, 21 Sep 1983, USNM 251604. Paratypes: Female, dissected and mounted on slide, undated, USNM 251350; one copepodid, ethanol-preserved, Macrobar, Sta. 1, Rep. 2, 0–50 cm below water table, 21 Sep 1983, USNM 251605; and two copepodids, ethanol-preserved, Macrobar, Sta. 3, 0–30 cm, 21 Sep 1983, USNM 251606. All from South Fork of South Platte River, Colorado, collected by J. V. Ward.

*Type locality.* South Fork of South Platte River, Colorado, 39°05'26"N, 105°10'W. Site described by Pennak & Ward (1985, 1986).

*Description of female.* Length (excluding caudal setae) of holotype, 932  $\mu\text{m}$ ; of paratype, 960  $\mu\text{m}$ . Body widest at posterior margin of cephalosome (Fig. 1a). Lateral margins of pediger 4 smooth, rounded in dorsal view (Fig. 1b, c); pediger 5 rounded or only slightly keeled, extending to or slightly beyond lateral margin of genital segment in dorsal view. Hyaline fringes of urosomites crenulate. No cuticular pitting observed. Genital segment (Fig. 1a, c, d) about as broad as long, tapering posteriorly; seminal receptacle with irregularly expanded anterior part, posterior part only slightly expanded, pore-canal short and curved, lateral canals curved. Anal somite (Fig. 1a, e) ornamented with two diagonal rows of tiny spines distal to anal operculum, and tiny spines along posteroventral margin; anal operculum unsclerotized, weakly convex, not extending beyond posterior margin of anal somite. Caudal ramus of holotype (Fig. 1a, f)  $105 \times 25 \mu\text{m}$ , thus 4.2 times longer than broad; ramus of paratype  $111 \times 25 \mu\text{m}$ , thus 4.4 times longer than broad; ramus without surface ornament. Lateral caudal seta inserted at distal 70% of length of lateral margin of ramus. Most caudal setae finely and homonomously plumed, dorsal setae naked. Lengths of caudal setae of holotype in  $\mu\text{m}$ : dorsal 95, lateral 37, medial-most to lateral-most terminal, respectively 96, 532, 312, 56. Lengths of lateral and medial-most to lateral-most terminal caudal setae of paratype, respectively 49, 111, 528, 332, and 71  $\mu\text{m}$  (dorsal setae of paratype missing).

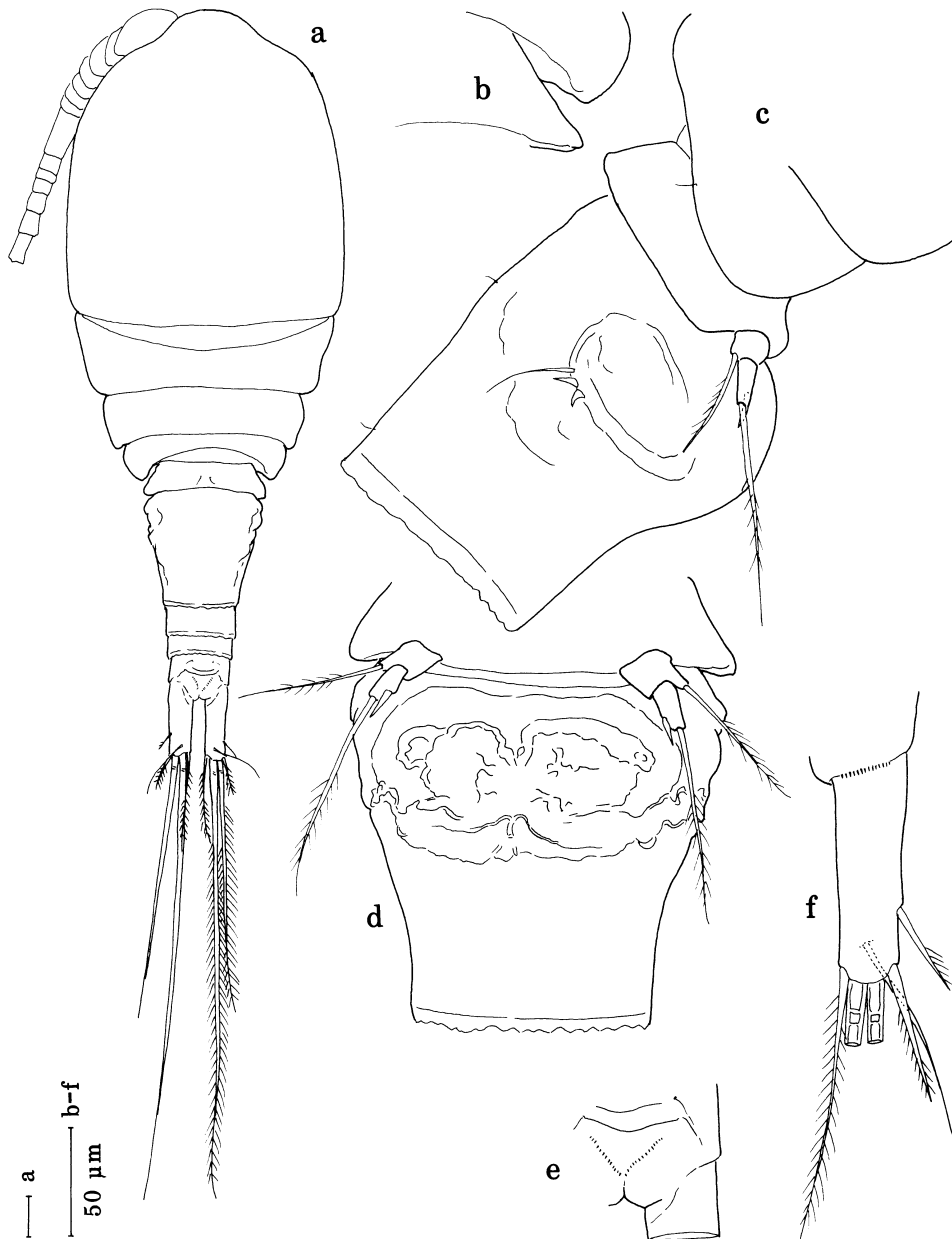


FIG. 1. *Acanthocyclops pennaki* n. sp. Holotype female, USNM 251603. a, Habitus, dorsal; b, Pedigers 4 and 5, right side, dorsal; c, Pedigers 4 and 5 and genital segment, right lateral; d, Pediger 5 and genital segment, ventral; e, Part of anal somite, dorsal; f, Left caudal ramus, ventral. Fig. 1a drawn at 400 $\times$ ; Fig. 1b-f drawn at 600 $\times$ . Both scale bars represent 50  $\mu$ m.

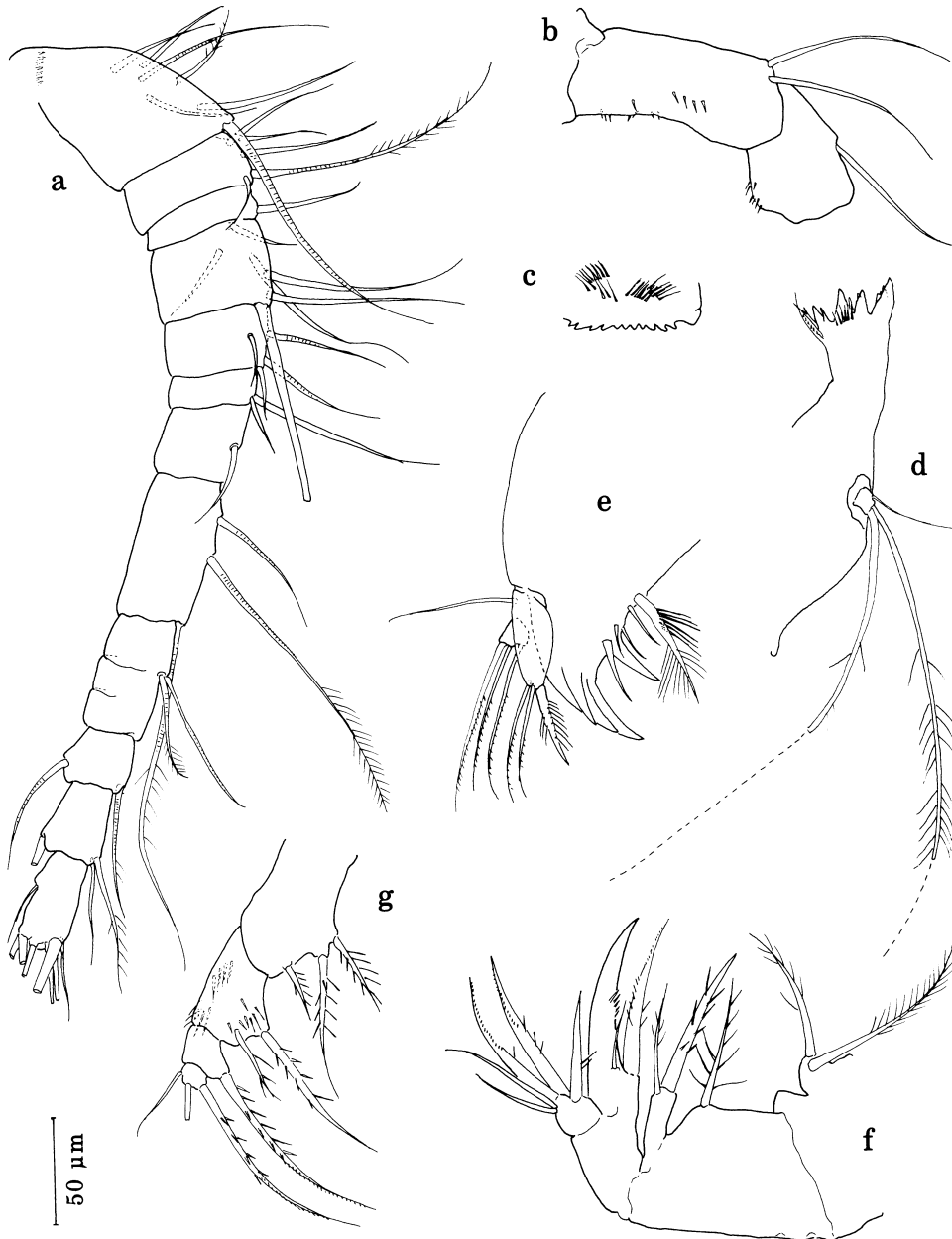


FIG. 2. *Acanthocyclops pennaki* n. sp. Holotype female, USNM 251603. a, Antennule; b, Antenna articles 1 and 2, caudal side; c, labrum (one corner broken); d, Mandible (length of setae of palp estimated from setae of paratype female, USNM 251350); e, Maxillule; f, Maxilla; g, Maxilliped. Fig. drawn at 600 $\times$ .

Antennule (Figs. 1a, 2a) shorter than cephalosome, composed of 12 articles, article 9 of holotype partly divided into thirds by dorsal sutures, thus appearing to be composed of 14 articles in dorsal view (Fig. 1a); article 9 of paratype lacking such sutures. Articles 5 and 6 each with slender spine inserted on ventrodistal margin; articles 9 and 11 each with long slender esthetasc reaching past succeeding article. Antenna (Fig. 2b) lacking exopodite seta, article 1 sparsely ornamented on caudal and posterior surfaces, frontal surface of article 1 lacking ornament, antenna otherwise similar in proportions of articles and number of setae of articles 3 and 4 to antenna of *Acanthocyclops montana* Reid & Reed (in Reid et al., 1991). Labrum (Fig. 2c) with 11 blunt teeth between rounded lateral protuberances and four irregular groups of long spines on ventral surface; labrum of adult paratype female (USNM 251350) with 12 teeth. Mandible (Fig. 2d) with transverse row of slender spines at base of teeth of pars incisiva. Setae of both mandibles of holotype broken in dissection; dotted lines in Fig. 2d indicate lengths of these setae as estimated from corresponding setae of adult paratype female. Maxillule (Fig. 2e), surface of palp lacking ornament. Maxilla (Fig. 2f) with five small teeth near midlength of claw. Maxilliped (Fig. 2g), article 3 with three irregular groups of spines.

Swimming legs 1–4 (Fig. 3a–e) triarticulate, spine formula 2,3,3,3, setal formula 4,4,4,4. Leg 3 (not figured) exactly as leg 2. Couplers of legs 1–3 lacking ornament; coupler of leg 4 with transverse row of tiny spines on posterior surface. Leg 4 endopodite article 3 of holotype, length 53  $\mu\text{m}$ , breadth 24  $\mu\text{m}$ , thus 2.2 times longer than broad; corresponding article of paratype, length 52  $\mu\text{m}$ , breadth 29  $\mu\text{m}$ , thus 1.8 times longer than broad. Leg 4 endopodite article 3 with two terminal spines, length of lateral terminal spine of holotype 37  $\mu\text{m}$ , length of medial terminal spine 44  $\mu\text{m}$ ; lengths of corresponding spines of paratype, 37 and 43  $\mu\text{m}$ .

Leg 5 (Fig. 1c, d) consisting of two free articles, article 1 with lateral seta, article 2 with subterminal medial spine, in length about one-half length of article, and long, sparsely plumed terminal seta. Leg 6 (Fig. 1c) with long slender dorsal seta and two stout spines. Neither specimen bearing egg sacs.

*Description of male.* Length of allotype 776  $\mu\text{m}$ . Habitus similar to that of female except for normal sexual dimorphism; caudal ramus  $79 \times 21 \mu\text{m}$ , thus 3.76 times longer than broad. Most caudal setae broken; length of single remaining dorsal seta 75  $\mu\text{m}$ , length of lateral seta 33  $\mu\text{m}$ . Antenna, mouthparts, and swimming legs similar to corresponding structures of female. Antennule (Fig. 4a) geniculate, of 17 articles, article 1 with two esthetascs and one socket probably of esthetasc, articles 4, 9, and 13 each with one esthetasc, all esthetascs long and broad, most esthetascs except that of article 13 constricted near midlength. Leg 4 endopodite 3, length 46  $\mu\text{m}$ , breadth 22  $\mu\text{m}$ , thus 2.1 times longer than broad; leg 4 endopodite 3, length of lateral terminal spine 33  $\mu\text{m}$ , of medial terminal spine 41  $\mu\text{m}$ .

Leg 5 (Fig. 4b) similar to that of female. Leg 6 consisting of small plate bearing on distal margin small stout spine and two setae, dorsal seta reaching posterior margin of succeeding somite.

*Etymology.* Named for Dr. Robert W. Pennak, in appreciation of his initial recognition of some of the distinguishing characters of this species and, in a broader sense, for his many contributions to taxonomic and ecological knowledge of North American freshwater meiofaunal organisms.

*Comparisons.* *Acanthocyclops pennaki* is distinct from congeners in the combined characters of the antennule of 12 articles, the spine formula 2,3,3,3, the setal formula 4,4,4,4, the caudal ramus without hairs on the medial surface, the lateral terminal spine of the leg 4 endopodite article 3 slightly shorter than the medial terminal spine, and the leg 4 endopodite article 3, 1.8–2.2 times longer than broad. An additional distinctive feature is the lack of an exopodite seta on the antenna. Reid et al. (1991) reviewed diagnostic characters of congeners from North America. Two species, *A. exilis* (Coker, 1934, redescribed by Yeatman, 1944) and *A. columbiensis* Reid, 1990 resemble *A. pennaki* in having the caudal ramus with naked medial surface, similar spine and setal formulae, and the leg 4 endopodite 3 terminal spines unequal in length. *Acanthocyclops exilis* usually has the antennule of 11, rarely with 12, and in one instance with 10 articles. In *A. exilis*, articles 3 and 4 of the antennule are fused. Additionally, in *A. exilis* the leg 4 endopodite 3 is short, 1.4 times longer than broad, and its terminal spines are decidedly unequal, the medial terminal spine being about twice the length of the lateral terminal spine (measured from Coker, 1934, fig. 6c). *Acanthocyclops columbiensis* is a much smaller species, adult females measuring 460–480  $\mu\text{m}$  and adult males 360–440  $\mu\text{m}$  in length. In *A. columbiensis*, the antennules of all individuals examined are composed of 14 articles, the caudal ramus is short, only 2.3 times longer than broad, the antenna bears an exopodite seta, and the leg 4 endopodite article 3 is only slightly longer than broad with two very short terminal spines (Reid, 1990). Reid et al. (1991) also listed differential diagnostic characters of all known species of the genus *Acanthocyclops*. Outside North America, there are two species combining the characters of a spine formula of 2,3,3,3, the caudal ramus lacking hairs on the medial surface, and the antennule always or sometimes composed of 12 articles. In *A. michaelseni* (Mrázek, 1901) from South America, the antennule usually has 11, but sometimes may have 12 articles, the dorsal caudal seta is shorter than the lateral-most terminal caudal seta, and the setae of the leg 4 endopodite article 3 do not reach past the ends of the terminal spines. In *A. morimotoi* Ito, 1952 from Japan, the leg 4 endopodite 3 has only one terminal spine. Of two species for which the females are undescribed, *A. skottsbergi* Lindberg, 1949 from South America has the medial surface of the caudal ramus haired, and *A. agamus* Kiefer, 1938 from Europe has either or both rami of legs 1–4 biarticulate.

*Acanthocyclops plattensis* as described by Pennak & Ward (1985) combines characters of both *A. pennaki* and *A. vernalis*. The antennule of 12 articles described for *A. plattensis* is similar to the antennule of *A. pennaki* but differs from the antennule of *A. vernalis* which is composed of 17 articles. The spine and setal formulae of 2,3,3,3 and 4,4,4,4, respectively, reported for *A. plattensis* could be attributed either to *A. vernalis* or *A. pennaki*, in that the spine formula of *A. vernalis* is variable. Pennak & Ward (1985) described and illustrated the

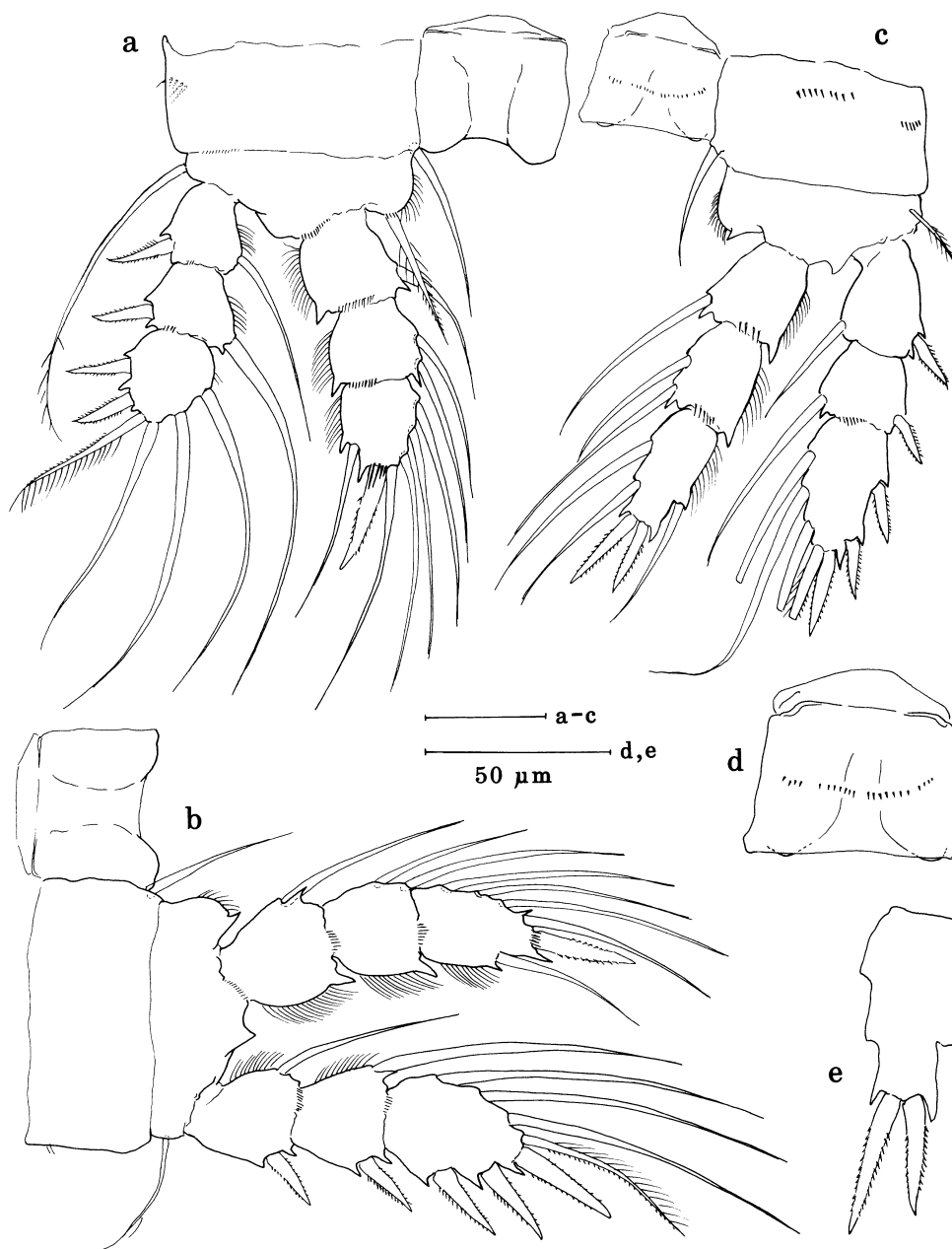


FIG. 3. *Acanthocyclops pennaki* n. sp. Holotype female, USNM 251603. a, Leg 1 and coupler, anterior (most plumage of setae of swimming legs omitted for clarity); b, Leg 2 and coupler, anterior; c, Leg 4 and coupler, posterior; d, Leg 4 coupler, posterior; e, Leg 4 endopodite article 3. Fig. drawn at 600 $\times$ ; details of Figs. 3c and d confirmed at 1,000 $\times$ . Both scale bars represent 50  $\mu$ m.



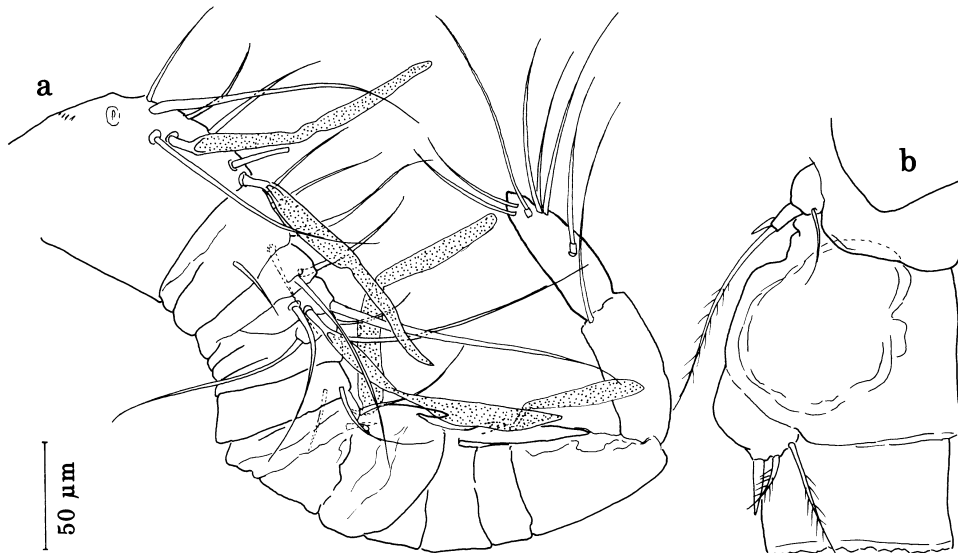


FIG. 4. *Acanthocyclops pennaki* n. sp. Allotype male, USNM 251604. a, Antennule; b, Anterior urosomites, left lateral. Figure drawn at 600 $\times$ ; details of Fig. 4a confirmed at 1,000 $\times$ .

caudal ramus of *A. plattensis* as being 5.6–5.8 times longer than broad, with short dorsal and medial-most and lateral-most terminal caudal setae. This description corresponds exactly to the caudal ramus of *A. vernalis*. The leg 4 endopodite article 3 of *A. plattensis*, described as having a long lateral terminal spine and a longer medial terminal seta, may have come from an aberrant individual inasmuch as the corresponding articles of both *A. vernalis* and *A. pennaki* have two terminal spines.

#### DISCUSSION

Adults and/or copepodids of *A. vernalis* were present in five of the 10 samples from the South Platte River that I examined. Several samples supposed to contain specimens of *A. plattensis* included neither that species as described nor specimens of *A. pennaki*, but did include many specimens of *A. vernalis*. This confusion appears to invalidate the estimates of absolute numbers and vertical distribution in the hyporheic zone of the South Platte as given for *A. plattensis* by Pennak & Ward (1985, 1986).

Pennak & Ward (1985, 1986) characterized *A. plattensis* as a hypogean species on the basis of the habitat where it was collected as well as its supposed frequency of occurrence in that habitat. In the samples supplied to me and supposed to contain many specimens of *A. plattensis* there were very few specimens of *A. pennaki*. Because *A. pennaki* is a large species relative to many hypogean congeners, and because on reexamination it was present in low numbers in the stream hyporheic samples, it may not be strictly hypogean. *Acanthocyclops pennaki* possesses some morphological features typical of hypogean species, namely the lack of the exopodite seta of the antenna in both sexes and the large esthetascs of the antennule of the male.

Reid (1990) and Reid et al. (1991) suggested that *A. plattensis* might be assigned to the genus *Diacyclops*. This suggestion was based on the figures of legs 4 and 5 by Pennak & Ward (1985, fig. 1A, B). The figure of leg 4 does not conform to the corresponding legs of the specimens of *A. pennaki* described herein. The leg 5 of *A. pennaki* has the medial spine one-half the length of the distal article of the leg, conforming to the generic diagnosis of *Acanthocyclops*.

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