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NEW RECORDS OF HARPACTICOID COPEPODS FROM EVERGLADES NATIONAL PARK (FLORIDA, U.S.A.): DESCRIPTION OF *NITOKRA EVERGLADENSIS*, NEW SPECIES (AMEIRIDAE), SUPPLEMENTARY DESCRIPTION OF *ATTHEYELLA AMERICANA*, AND REDESCRIPTION OF *BRYOCAMPTUS NEWYORKENSIS* (CANTHOCAMPTIDAE)

M. Cristina Bruno, Janet W. Reid, and Sue A. Perry

(MCB, SAP) South Florida Natural Resources Center, Everglades National Park, 40001 State Road 9336, Homestead, Florida 33034, U.S.A. (corresponding author e-mail: Cristina_Bruno@contractor.nps.gov); (JWR) Virginia Museum of Natural History, 1001 Douglas Avenue, Martinsville, Virginia 24112, U.S.A.

A B S T R A C T

Three species of harpacticoid copepods are newly reported from long- and short-hydroperiod groundwater and surface freshwater habitats in Everglades National Park, Florida, U.S.A. One is new to science and described herein; *Nitokra evergladensis*, new species, differs from congeners mainly in details of setation and spination of the endopodites of the swimming legs, the ornamentation of the anal operculum, and the shape and setae of the caudal ramus. Records of members of the genus *Nitokra* in fresh waters in the U.S.A. are reviewed, and a key to their identification is presented. We present a supplementary description of *Attheyella americana*, a widespread species previously unrecorded in southern Florida, based on material from the Everglades. Collections of the rare species *Bryocamptus newyorkensis* in the Everglades have extended its distribution considerably southward. We redescribe both sexes on the basis of specimens collected from Everglades National Park and also from Great Smoky Mountains National Park, Tennessee, and discuss the geographical distribution and habitats of the species. The Everglades "freshwater" harpacticoid fauna is depauperate, having a large proportion of species adapted to marine habitats.

Research on free-living copepods in Everglades National Park, initiated relatively recently, has yielded several new species and new records (Reid, 1989, 1992; Bruno *et al*., 2000; Loftus and Reid, 2000). We report additional new records of harpacticoid copepods from two distinct Everglades habitats, the perennial wetland Taylor Slough, and ephemeral waterbodies in the higher-elevation Rocky Glades (Fig. 1).

The ameirid *Nitokra evergladensis*, new species, is described from two specimens collected from surface waters in Taylor Slough during the dry season. Only a few species of this genus have been collected from freshwater habitats in the U.S.A. We review records and provide a key for their identification.

The canthocamptid *Attheyella americana* (Herrick, 1884) was collected in different areas of the Rocky Glades; several specimens came from solution holes during the dry season, and one specimen came from surface-water samples during the wet season in 1999. This species was described by Herrick (1884) as *Canthocamptus northumbricus* var. *americanus*, redescribed by Coker (1934) as *Attheyella northumbrica americana*, and given species rank as *Attheyella* (*Mrazekiella*) *americana* by Wilson (1958). The most detailed description was by Coker (1934), which we supplement based on the Everglades material. This species was previously reported from Polk and Leon counties in northern Florida (Marsh, 1926; Wilson, 1958); this is the first record from southern Florida and from Everglades National Park.

We also redescribe the rare canthocamptid *Bryocamptus newyorkensis*, amplifying Chappuis' (1926) original, rather cursory description. We collected a few specimens of *B. newyorkensis* in Taylor Slough, from surface waters during the wet season and from rehydration experiments with soil patches collected there during the dry season; and from a shallow well in the Rocky Glades. Additional specimens recently collected from damp moss in the Great Smoky Mountains National Park, Tennessee, were also studied to provide a complete

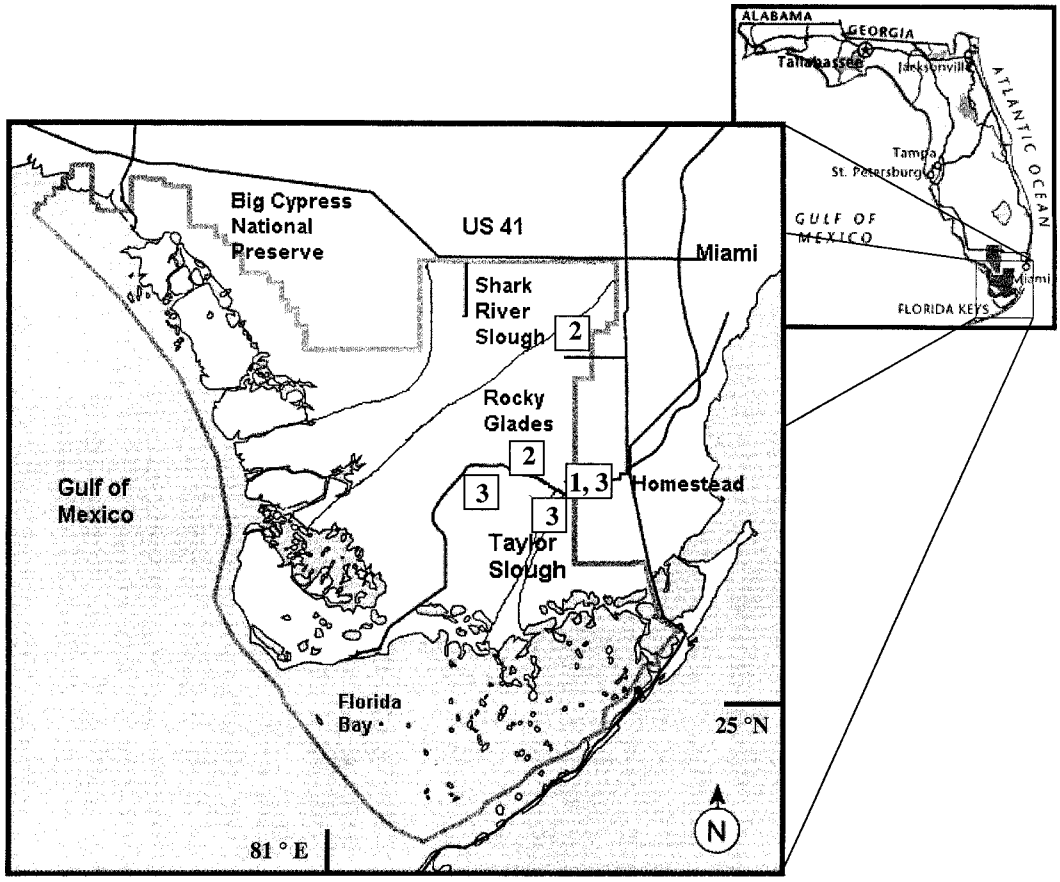


Fig. 1. The locations of the collection sites in Everglades National Park, Florida, U.S.A. 1, *Nitokra evergladensis*, new species; 2, *Attheyella americana*; 3, *Bryocamptus newyorkensis*.

redescription of this species. These are new records for Florida, Tennessee, and both of the national parks. Of the few previously published records of *B. newyorkensis*, we were able to confirm only that of Hudson *et al.* (1998) from Lake Huron.

Finally, we briefly discuss the composition of the Everglades harpacticoid community.

Materials and Methods

In Everglades National Park, specimens were collected with different methods, appropriate to each habitat. For ground water, we used a Wayner one-half horsepower portable pump connected to a Coleman 1750® portable generator. For surface water, we used a Par Jabasco hand pump for solution holes, and Brakke's (1976) inverted funnel traps as modified by Witheside-Williams (1975) for flooded areas. Samples were filtered using an 80 μm-mesh plankton net and were fixed in 5% buffered Formalin. The allotype of *Nitokra evergladensis* sp. nov. was collected while sampling for chironomid pupal exuviae at the water surface with a dipping pot and a 125 μm sieve (Jacobsen and Perry, 2001). The methodology of the rehydration experiments was described by Bruno *et al.* (2001). All specimens were mounted on permanent slides in Fauré's medium.

Copepods from the Great Smoky Mountains National Park were sorted live from the accompanying substrate and fixed and stored in 70% denatured ethanol; for illustration, they were transferred to glycerin and then to lactic acid and were drawn in temporary mounts in the latter medium. Most drawings were made at 400× and at 1,000×, the latter with an oil-immersion lens, by using a drawing tube mounted on a Leica DMLS® microscope equipped for phase contrast; some were made at 600× or 1,000× by using a Wild M20® microscope.

The descriptive terminology follows Huys and Boxshall (1991). The following abbreviations are used: enp-1–3, endopodite segments 1–3; exp-1–3, exopodite segments 1–3; P1–5, legs 1–5.

Specimens have been deposited in the collections of the Virginia Museum of Natural History, Crustacean Catalogue, Martinsville, Virginia (VMNH), and the Museum of the Great Smoky Mountains National Park, Gatlinburg, Tennessee (GRSM). Specimens that will be deposited at the Everglades Original Collection Center, Everglades National Park, Homestead, Florida (EVER), are temporarily in M. C. Bruno's collection.

The description and redescriptions are the responsibility of M. C. Bruno and J. W. Reid only.

As regards the spelling of *Nitocra*/*Nitokra*, we follow the opinion of Bowman (1988), who noted that the correct original spelling of the genus name is *Nitokra*. Bowman argued that the version *Nitocra*, being an incorrect subsequent spelling, is unavailable; therefore, *Nitokra* cannot be suppressed as an unused senior synonym and be replaced by *Nitocra*.

Descriptions

Ameiridae Monard, 1927; Lang, 1948

Nitokra Boeck, 1864

Nitokra evergladensis, new species
Figs. 2a–4g

Material Examined.—Holotype: female, dissected, and mounted on slide labeled: "*Nitokra evergladensis* holotype" (VMNH 356), M. C. Bruno leg., 17 February 2000, collected with inverted funnel trap in North Taylor Slough (25°26′11.9″N, 080°35′35.3″W). Allotype: male dissected and mounted on slide labeled: "*Nitokra evergladensis* allotype"(VMNH 357), R. E. Jacobsen leg., 11 February 1999, collected in North Taylor Slough (25°25′12.80″N, 80°35′22.98″W). Both from Everglades National Park, Dade County, Florida, U.S.A.

Holotype Female.—Body slender, cephalosome smooth, with no dorsal hyaline window present, hyaline frills of all abdominal somites smooth. Genital double-somite subdivided dorsally and laterally by chitinous band, anterior part with 1 lateral row of spinules and 4 dorsal hairs (microtrichae) just anterior to chitinous band, and 1 anterolateral pore on each side. Posterior part with 1 ventral and 2 lateral rows of spinules anterior to hyaline frill, continued dorsally with 1 line of punctuations, and 4 hairs. Fourth urosomite posteriorly ornamented as posterior part of preceding somite, with additional anterolateral row of spinules on each side. Fifth urosomite ornamented as preceding somite, except smooth dorsally (Fig. 2a). Anal somite (Fig. 2a) with 2 short rows of spinules along ventrodistal margin, 1 transverse row of strong spines on outer side of each caudal ramus, and row of spinules around insertion of each ramus on ventral side; 1 pore on medial side of insertion of each ramus. Anal operculum (Fig. 2a) with 7 strong marginal spines. Caudal rami subconical, short; ratio of length to width 1.02, with 1 distoventral pore. Posterolateral seta longer than terminal accessory seta, anterolateral seta short and thin, dorsal seta 1.5 as long as caudal ramus, inserted near distomedial corner. Two spines near posterolateral seta, 2 spines near terminal accessory seta; 2 spines near dorsal seta. Medial terminal seta twice as long as lateral terminal seta, both terminal setae with breaking planes.

Rostrum (Fig. 2b) narrow, reaching end of first segment of antennule.

Antennule (Fig. 2b) 8-segmented, with aesthetasc on segment 4 passing end of segment 8. Number of appendages beginning at proximal segment: 1, 5, 7, 3 + aesthetasc, 1, 3, 3, 6 + aesthetasc.

Antenna (Fig. 2c) with basis; exopodite 1-segmented, with 3 distal setae, outer seta longest.

Mandible (Fig. 2d): pars molaris of precoxa with several teeth; palp 2-segmented, with 1 lateral and 4 apical setae. Exopodite absent, basipodite with only 1 seta.

Maxillule (Fig. 2e): arthrite of precoxa with 5 setae and spines and 1 slender seta on inner margin. Coxa with 3 setae, 1 geniculate; basis with 4 setae. Exopodite 1-segmented, with 2 slender setae.

Maxilla (Fig. 2f): syncoxa with 1 plumose seta, and 1 endite with 2 apical setae and 1 long strong tooth. Basipodite with claw. Endopodite 1-segmented, with 2 apical setae.

Maxilliped (Fig. 2g): basipodite with row of spinules. Endopodite with strong claw.

P1 (Fig. 2h) with 3-segmented rami. Endopodite longer than exopodite, enp-1 as long as exp-1 and exp-2 together; enp-2 and enp-3 subequal; enp-3 with 1 pennate, 1 long geniculate, and 1 slender apical setae. Exp-3 with 2 lateral pennate spines, longer spine on lateral corner, and 2 geniculate apical spines.

P2–4 with 3-segmented rami (Figs. 2i, j, k, 3a). Major armament of P1–P4 as follows:

P1	basipodite 1–1	exp 0–1; 1–1; 0,2,3
		enp 1–0; 1–0; 1,2,0
P2	basipodite 0–1	exp 0–1; 1–1; 2,2,3
		enp 0–0; 1–0; 1,2,1
P3	basipodite 0–1	exp 0–1; 1–1; 2,3,2
		enp 0–0; 1–0; 1,4,0
P4	basipodite 0–1	exp 0–1; 1–1; 2,3,2
		enp 0–0; 1–0; 2,3,0

Distal spines on exp-1 and exp-2 of P2 and P3 large and posteriorly curved. P1 (Fig. 2h) and P4 couplers (intercoxal sclerites) bare, P2 (Fig. 2i) and P3 (Fig. 2k) couplers with distal row of long spines on each lobe.

P5 (Fig. 3b): baseoendopodite long, almost reaching end of exopodite, with seta on distolateral corner, medial lobe with 5 pennate setae of which next outermost is longest, lengths of remaining 3 setae similar. Three spinules on lateral corner, and 1 median pore. Exopodite oval, with total of 6 setae; setae and accessory

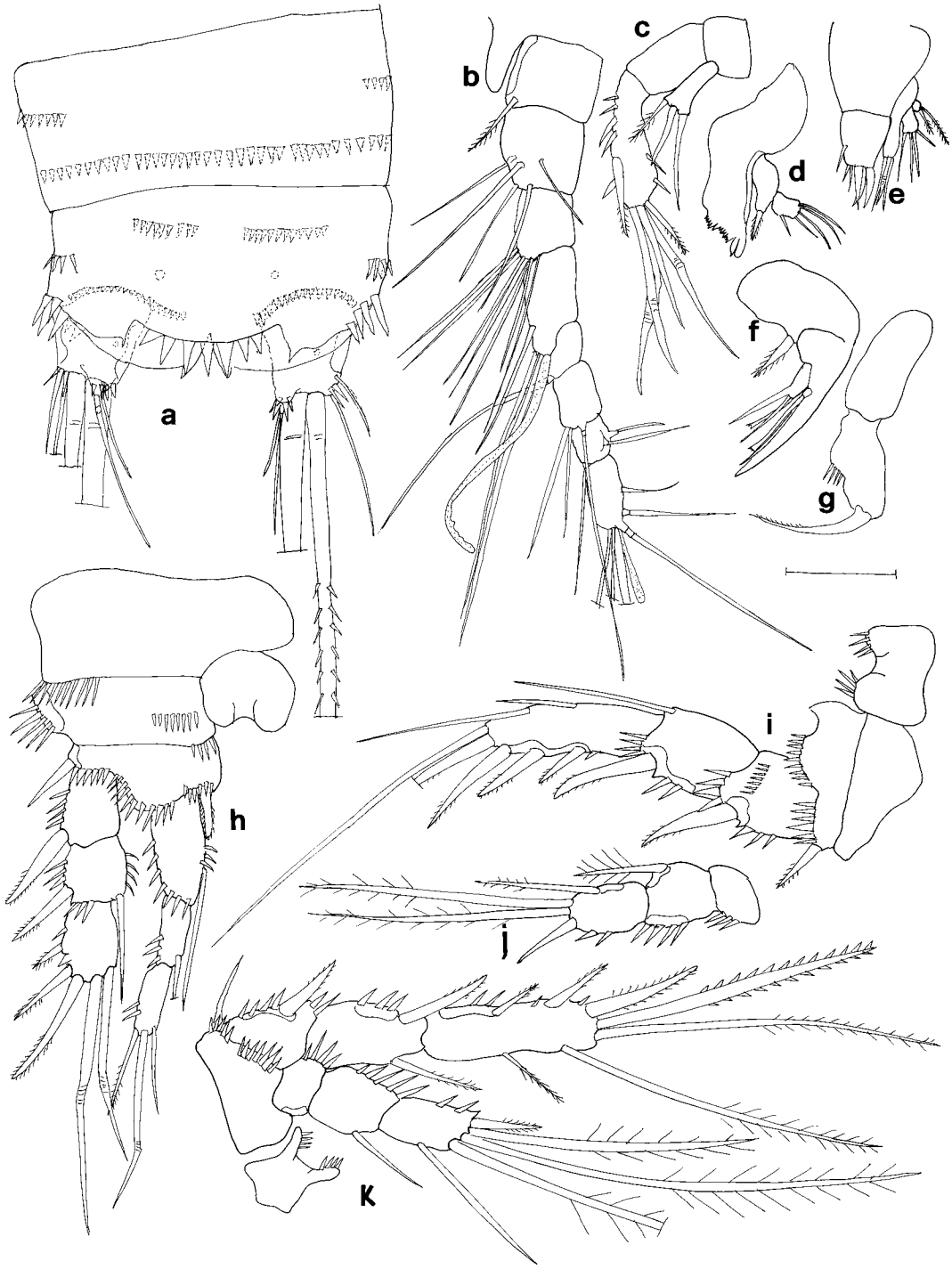


Fig. 2. *Nitokra evergladensis*, new species. Holotype female. a, last two urosomites, anal operculum and caudal rami, dorsal view; b, rostrum and antennule; c, antenna; d, mandible; e, maxillule; f, maxilla; g, maxilliped; h, P1; i, P2 basipodite, exopodite and coupler; j, P2 endopodite; k, P3. Scale = 25 μm.

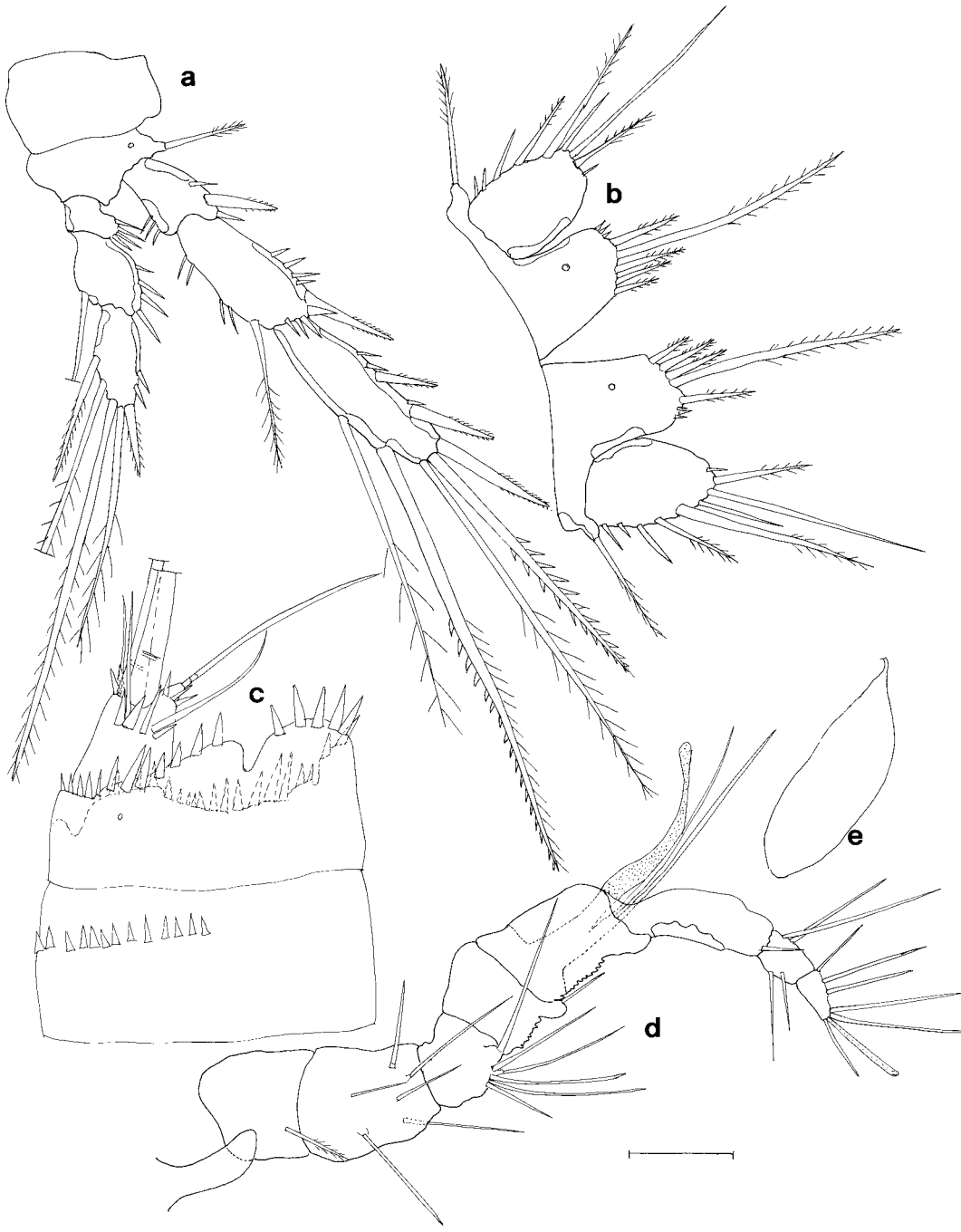


Fig. 3. *Nitokra evergladensis*, new species. a, b, holotype female; c–e, allotype male. a, P4; b, P5; c, last two urosomites, anal operculum, and caudal ramus, ventrolateral view; d, rostrum and antennule; e, spermatophore. Scale = 25 μm.

spinules arranged as follows: 2 apical setae, medial seta short and pennate, lateral seta long and slender; and 1 spinule on medial corner; lateral corner with seta; on outer margin, proximal to distal: 2 spines of different lengths, 1 short normal seta, 1 short pennate seta, 1 pennate seta, almost as long as lateral apical seta.

Allotype Male.—Body slender, cephalosome smooth, with no dorsal hyaline window present,

Fig. 4. *Nitokra evergladensis*, new species. Allotype male. a, P1; b, P2 exopodite; c, P2 endopodite; d, P3; e, P4; f, P5; g, P6. Scales = 25 μm.

hyaline frills of all abdominal somites smooth, body surface variolated. Each urosomite with 1 row of ventral spines extending laterally. Anal somite (Fig. 3c) with row of ventral spines around caudal ramus. Anal operculum as in female (Fig. 3c). Caudal ramus (Fig. 3c) similar to that of female, but without spines near insertion of posterolateral seta. Dorsal seta and

anterolateral seta longer than in female, anterolateral seta inserted more proximally than in female, with 2 spines near insertion. Mouthparts as in female.

Rostrum (Fig. 3d) longer than in female.

Antennule (Fig. 3d) 8-segmented, aesthetasc segment 4 reaching almost to end of antennule. Number of appendages beginning at proximal segment: 1, 6, 6, 3 + aesthetasc, 0, 1, 4, 6 + aesthetasc.

Antenna similar to that of female.

Spermatophore as in Fig. 3e.

P1 (Fig. 4a): basipodite with strong outer spine and geniculate spine on inner corner. Exopodite 3-segmented, segments 1–3 with respectively 1, 1, and 2 strong spiniform setae, curved posteriorly. Last segment with 2 apical geniculate setae. Endopodite 3-segmented, with long thin seta on inner corner of first and second segments. Two normal and 1 geniculate apical setae.

P2 (Fig. 4b): exopodite similar to that of female, but medial setae on segments 1 and 2 shorter, and lateral spines on last segment longer and stronger than in female. Endopodite (Fig. 4c) segment 1 with medial seta; segments 2 and 3 more elongate than in female, with same ornamentation.

P3 (Fig. 4d): exopodite similar to that of female, but with longer and stronger medial spines. Endopodite segments 1 and 2 each with medial seta; segment 3 with 1 lateral seta, 2 apical setae, and 1 apical spine.

P4 (Fig. 4e): exopodite similar to that of female. Endopodite first segment with 1 medial seta; segments 2 and 3 more elongate than in female, with same ornamentation.

P1, P3, and P4 couplers as in female; P2 coupler bare.

P5 (Fig. 4f): baseoendopodite less developed than in female, with only 4 short setae on medial lobe, outermost seta pennate, and several spinules on outer margin. Exopodite rounded, with 1 normal and 2 pennate apical setae of which middle seta is longest; spine on medial corner, 2 short slender setae and 1 spine on lateral margin.

P6 (Fig. 4g) with 2 setae; medial seta long, lateral seta very short.

Derivatio Nominis.—The specific name refers to Everglades National Park, *locus typicus* of the species. The specific epithet is a noun in the genitive singular.

Discussion.—The apparent sexual dimorphism in the setation of swimming legs 2–4 in *N. evergladensis*, new species, is unprecedented in the genus, although intraspecies variability does exist. The male has an inner seta on the first segment of the legs 2–4 endopodites, which is absent in the female; the last segment of leg 3 endopodite in the male has two apical setae, whereas the female has three. Leg 2 coupler also differs. Nonetheless, the similarities in the ornamentation of the exopodites and of the last segment of endopodites of legs 1, 2, and 4, in the mouthparts, in the caudal rami and anal operculum, and in the body ornamentation led us to allocate the two specimens to the same taxon. The collection sites for the two individuals are only about 200 meters apart, although the specimens were collected in different years. Because only a single individual of each sex was found, it is impossible to evaluate whether some or all of the observed differences are sexual dimorphisms, or are, alternatively, variations. There is the additional fact that only one other congener, the quite different *Nitokra bisetosa* Mielke, 1993, has been collected in freshwater habitats in the Everglades (see below).

Nitokra evergladensis most resembles *N. galapagoensis* Mielke, 1997, collected in interstitial marine habitats in several islands of the Galápagos Archipelago (Mielke, 1997). Females of the two species share several similarities: P1 endopodite with a very short basal segment, and the general pattern of the armament of the legs 2–3 with the first segment of the legs 2–4 endopodites without an inner seta. They differ in the antenna, which has an allobasis in *N. galapagoensis* and a basis in *N. evergladensis*; in the ornamentation of the leg 5 exopodite; and in the presence of an inner seta on leg 4 enp-2 of *N. evergladensis*. The male of *N. evergladensis* differs from that of *N. galapagoensis* in the armament of P2–P4, the structure and ornamentation of P5, and the ornamentation of the last segment of the P3 endopodite.

Mielke (1997) discussed features that distinguish *N. galapagoensis* from the other members of this extensive genus, which include the antenna with an allobasis, the leg 1 endopodite with a very short basal segment, the major armaments of legs 2–4, the leg 5 exopodite with only 5 setae, and the leg 5 baseoendopodite of the male with only 1 seta. As discussed above, some of these features are present in *N. evergladensis* and allow us to distinguish and characterize the new species as well.

Nitokra evergladensis also resembles *Nitokra bdellurae* (Liddell, 1912), found in the empty egg-cases of a trematode parasitic on the gill lamellae of a specimen of *Limulus* collected in ''America'' (Liddell, 1912) and redescribed by Gurney (1930) from the original specimens. Females of these two species and *N. galapagoensis* share the following features: segment 3 of legs 2–4 exopodites each with 7 setae, legs 2–4 endopodite segment 1 without a medial seta, and leg 5 with 5 setae on the baseoendopodite. *Nitokra evergladensis* and *N. bdellurae* also share a leg 5 with 6 setae on the exopodite. They differ in the ornamentation of the anal operculum, the length of segment 1 of the leg 1 endopodite, the length of the caudal rami, and the structure and ornamentation of leg 5 in the males.

The only other ameirid species collected in Everglades National Park, *Nitokra bisetosa* Mielke, 1997 (Bruno *et al*., in review), differs from *N. evergladensis* in the following conspicuous features: basal and middle segments of endopodites P2–P4 without a seta, distal segment of endopodite P3 in the male slightly modified, and baseoendopodite of female P5 with only 2 setae.

Records of members of the genus *Nitokra* in fresh waters of North America are scarce (Williamson and Reid, 2001). *Nitokra hibernica* (Brady, 1880) was probably introduced into Lake Ontario and has now colonized most of the Great Lakes (Hudson *et al*., 1998). *Nitokra spinipes* Boeck, 1865, has also been recorded from the Great Lakes (Czaika, 1978; Hudson *et al*., 1998). *Nitokra lacustris* (Shmankevich, 1875) s. str., a species that sometimes enters fresh water, has been recorded from salt marshes in Massachusetts, Louisiana, and South Carolina (Coull *et al*., 1979; Fleeger *et al*., 1983; Fleeger, 1985; Fiers and Rutledge, 1990; Ruber *et al*., 1994). Recently, *Nitokra bisetosa*, a typical marine species previously known from the Caribbean and Pacific coasts of Costa Rica (Mielke, 1993, 1994), was collected (Bruno *et al*., in review) in freshwater habitats in Everglades National Park. Records of the genus for Central America and the Antilles are more numerous (see geographical listing by Reid, 1990). *Nitokra lacustris* has been reported from Mexico, Cuba, and Aruba, although certain records require confirmation (Dussart and Defaye, 1990; Suárez-Morales and Reid, 1998). *Nitokra lacustris sinoi* Marcus and Por, 1961; *N. pusilla* G. O. Sars, 1911; *N. spinipes*; and *N. typica* Boeck, 1865, have been reported from the Yucatán Peninsula, although several of these records also require confirmation (Suárez-Morales and Reid, 1998).

The collection of *Nitokra evergladensis* in the Everglades modestly extends the recorded distribution of the genus along the eastern part of the United States to South Florida. Nonetheless, the morphological affinities and possible close relationship of the new species with two marine ones, *N. galapagoensis* and *N. bdellurae*, suggest a possible origin of this species from coastal marine forms distributed along the Central American and North American coasts.

In Table 1, we present a key for identification of the few species of *Nitokra* presently recorded from continental and brackish waters of the United States.

Canthocamptidae G. O. Sars, 1906

Attheyella (*Mrazekiella*) *americana* (Herrick, 1884)
Figs. 5a–8g

Material Examined.—6 females, each mounted on different slides labeled ''*Attheyella americana* female no. 1, 2, 3, 4, 5, 6'' (VMNH 358, 359, 360, EVER), 13 May 1999, collected from a solution hole on Long Pine Key, 25°25′11.77″N, 080°39′7.33″W). One female, dissected and mounted on slide labeled ''*Attheyella americana* female no. 7'' (EVER), 9 March 1999, same location. One female, mounted on slide labeled ''*Attheyella americana* female no. 8'' (VMNH 361), collected with inverted funnel traps, 10 November 1999, near Chekika ranger station, 25°38′9.97″N, 080°34′9.27″W). One male, dissected and mounted on slide labeled ''*Attheyella americana* male no. 1'' (VMNH 362), same date and location as for females 1–6. Thirteen males, each mounted on different slides labeled ''*Attheyella americana* male no. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14'' (VMNH 363, 364, 365, 366, EVER), same date and location as for females 1–6. All from Everglades National Park, Dade County, Florida, U.S.A., leg. M. C. Bruno.

Female.—Surfaces of thoracic and abdominal somites ornate, with many rows of tiny spinules. Cephalosome variolated, margin smooth, with small rounded dorsal hyaline window (Fig. 5a). Dorsal, elliptical hyaline window (Fig. 5b) present on pediger 2. Genital somite with dorsolateral tube-pore near distal margin. Urosomites 2–3 each with dorsolateral tube-pore near distal margin. Anal somite (Fig. 5c, d) with row of spinules on posteroventral margin near each caudal ramus, extending laterally.

Anal operculum (Fig. 5c, d) with 12–16 spines.

Caudal rami (Fig. 5c, d) length/width ratio 1.1, dorsal keel extending about two-thirds

Table 1. Key for identification of the few species of *Nitokra* presently recorded from continental and brackish waters of the United States. The key employs the tabular format and, in part, characters developed by Wells (1976) for his world key to marine harpacticoids. Characters: 1, Legs 2–4 endopodite segment 3, total number of setae of female/and of male (if different); 2, Legs 2–4, endopodite segment 1, number of setae on inner margin of female/and of male (if different); 3, Leg 5 female, number of setae on baseoendopodite: exopodite; 4, Leg 5 male, number of setae on baseoendopodite: exopodite.

Characters				
1. P2–4 enp-3 setae ♀/♂	2. P2–4 enp-1 setae ♀/♂	3. P5 ♀ setae	4. P5 ♂ setae	Species
4:5:5	1:1:1	5:5–6	3–5:6	*spinipes*
4:5:5	0:0:0	5:6	3:5–6	*bdellurae*
4:5:5/4:4:5	0:0:0/1:1:1	5:6	3:3	*evergladensis*
4:4:4	1:1:1	5:6	3–4:6	*typica*
3:5:5	0:0:0	5:5–6	2:6–7	*lacustris* s. str.
3:4:4	0:0:0	2:5	2:6	*bisetosa*
2:3:3	0:0:0	5:6	5:6	*hibernica*

length of ramus, ending with dorsal seta. One spinule and 2 spinules near insertion of anterolateral seta and posterolateral seta respectively. Dorsal seta composite, terminal accessory seta very thin. Inner terminal seta stout, with breaking plane, barbed, about four-fifths as long as body. Outer terminal seta with breaking plane, barbed, about one-fifth as long as body.

Rostrum (Fig. 5e) fused to cephalosome, tip rounded, with 2 small sensilla, not passing first segment of A1.

Antennule (Fig. 5e) 8-segmented, number of appendages beginning at proximalmost segment: 1, 9, 5, 2 + aesthetasc, 1, 2, 2, 6+ aesthetasc. Length of aesthetasc on segment 4 about midlength of last segment.

Antenna (Fig. 5f) with allobasis, with plumose spines on inner margin. Endopodite 1-segmented, medial margin with 2 strong spines and several spinules, apically with 3 geniculate setae and 1 tiny seta plus 2 spines. Lateral margin with few spinules. Single segment of exopodite with 1 lateral and 2 apical setae.

Mandible (Fig. 5g) palp 1-segmented, with 1 lateral and 3 apical setae.

Maxillule (Fig. 5h) arthrite of precoxa with 6 apical spines. Coxal endite with 2 spines. Basal endite with 8 setae.

Maxilla (Fig. 5i) syncoxa with 2 endites, proximal endite with 1 spine and 1 seta, distal endite with 2 apical setae. Basis ending in spiniform tip. Endopodite reduced to tubercle with 2 setae.

Maxilliped (Fig. 5j) prehensile.

P1–P4 (Fig. 6a, b, c, d, 7a, b), formula for major ornamentation as follows:

P1	basipodite 1–1	exp 0–1; 1–1; 0,3,1 enp 1–0; 1–0; 0,3,0
P2	basipodite 0–1	exp 0–1; 1–1; 1,3,2 enp 1–0; 3,3,0
P3	basipodite 0–1	exp 0–1; 1–1; 2,3,2, enp 1–0; 3,3,0
P4	basipodite 0–1	exp 0–1; 1–1; 2,3,2 enp 1–0; 3,2,1

Outer setae present on P1 and P2 basipodite. Outer setae on exopodites of legs 1–4 spiniform. P1 coupler (Fig. 7c) with row of tiny hairs. P2 coupler with 3 distal spines on each side (Fig. 6a). P3 (Fig. 7d) and P4 couplers bare.

P5 (Fig. 7e) medial expansion of baseoendopodite small, bearing 6 pennate setae, of which 2 lateral setae thin, and spinules on lateral expansion, near lateral seta. Exopodite about 2.5 times longer than broad, with rows of spinules along lateral margins and 1 transverse proximal row, 3 subapical lateral spiniform setae, and 2 pennate apical setae, medialmost seta very long.

Male.—Body ornamentation similar to that of female, except first abdominal somite with lateral row of spines near posterior margin. Dorsal hyaline windows of cephalosome and of pediger 2 (Fig. 7f) as in female. Anal somite and anal operculum as in female (Fig. 7g). Caudal ramus (Fig. 7g) similar to that of female, with 3 spinules near posterolateral seta.

Antennule (Fig. 7h) 7-segmented, geniculate, number of appendages beginning with proximal segment: 1, 8, 9 + aesthetasc, 3, 2, 0, 7 + aesthetasc.

Antenna and mouthparts as in female.

P1 (Fig. 8a) exopodite, outer spines longer and stronger than in female.

P2 (Fig. 8b) exopodite, outer spines longer and stronger than in female. Endopodite segment 1 longer than in female.

Fig. 5. *Attheyella* (*Mrazekiella*) *americana*. Female. a, cephalosome and dorsal hyaline window, lateral view; b, pediger 2 and hyaline window, lateral view; c, anal somite, anal operculum, and caudal rami, dorsal view; d, last two urosomites, anal operculum, and caudal ramus, lateral view; e, rostrum and antennule; f, antenna; g, mandible; h, maxillule; i, maxilla; j, maxilliped. Scale = 25 μm; the scale marked with an asterisk refers to Fig. 5a and b.

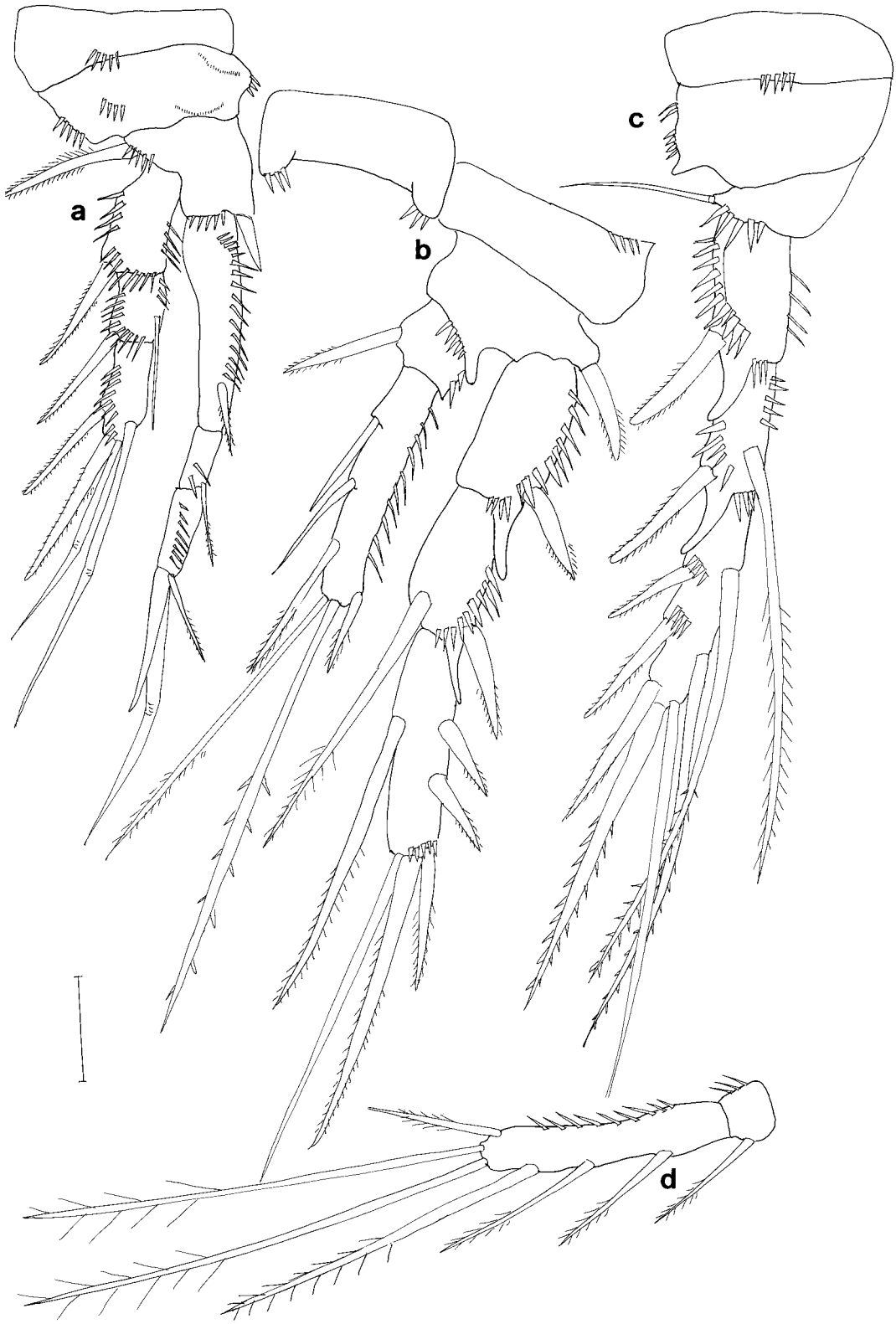


Fig. 6. *Attheyella* (*Mrazekiella*) *americana*. Female. a, P1; b, P2 and coupler; c, P3 exopodite and basipodite; d, P3 endopodite. Scale = 25 μm.

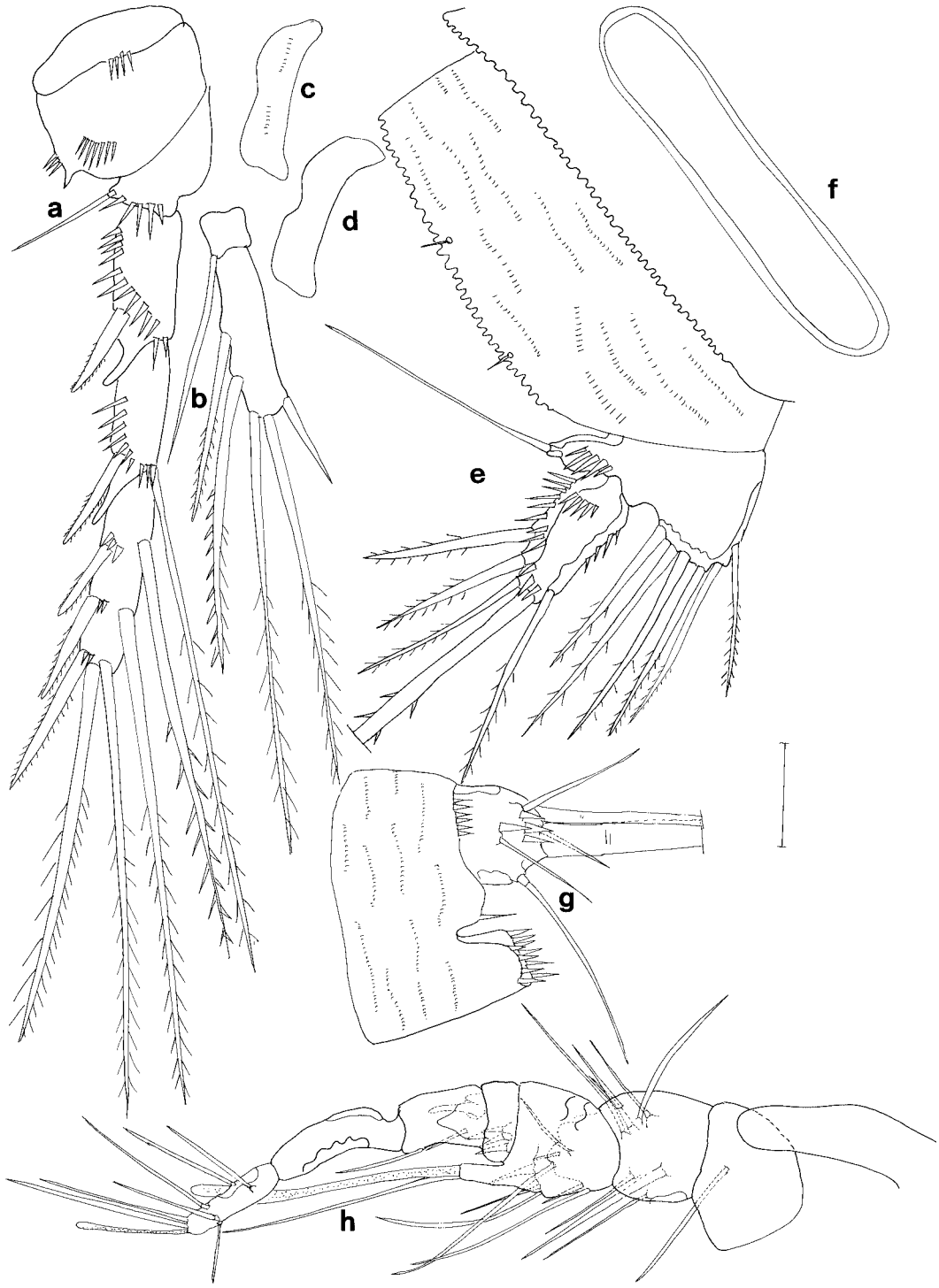


Fig. 7. *Attheyella* (*Mrazekiella*) *americana*. a–e, female; f–h, male. a, P4 exopodite and basipodite; b, P4 endopodite; c, P1 coupler; d, P3 coupler; e, P5 and first urosomite; f, dorsal hyaline window of cephalosome, dorsal view; g, anal somite, anal operculum, and caudal ramus, lateral view; h, rostrum and antennule. Scale = 25 μm.

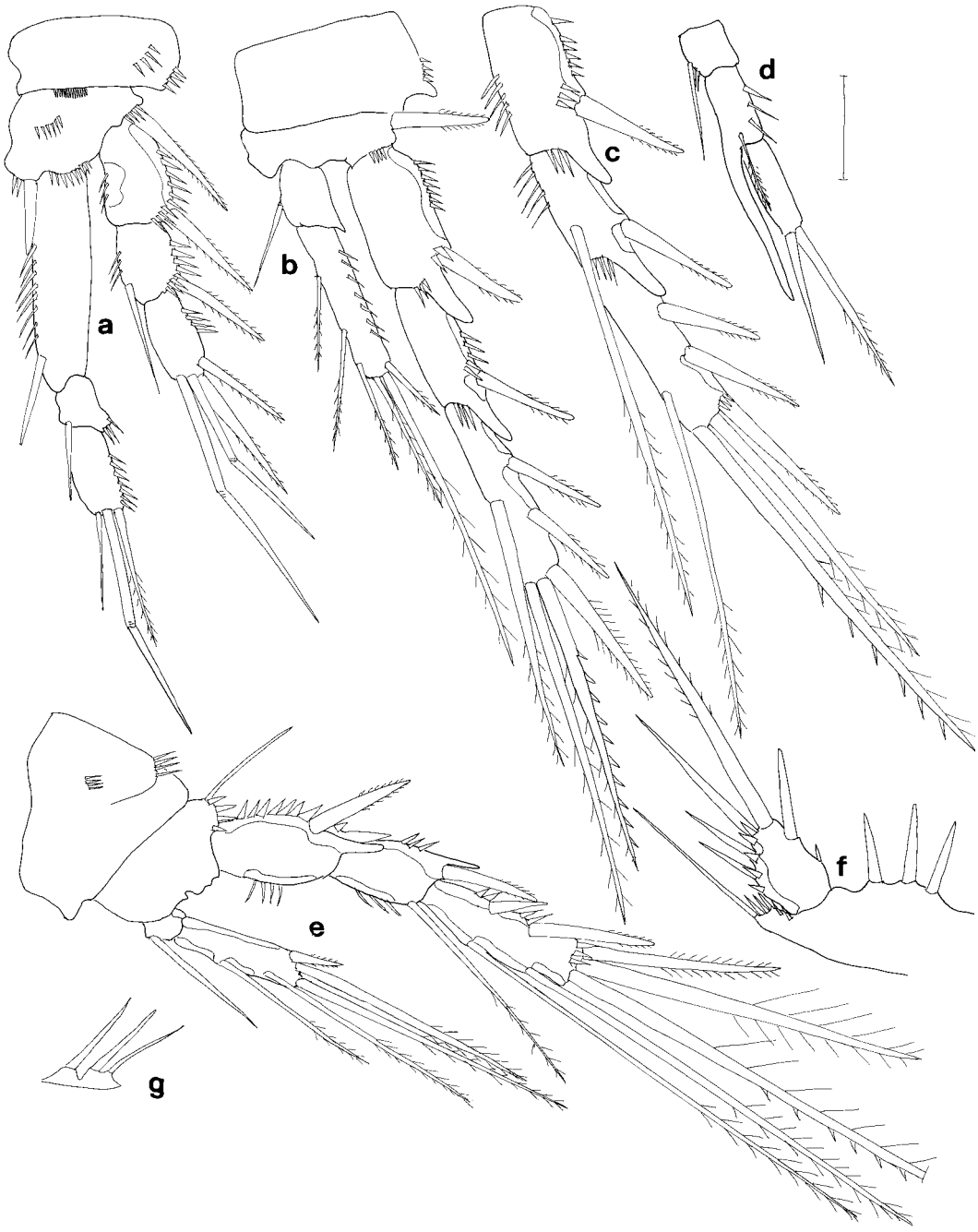


Fig. 8. *Attheyella* (*Mrazekiella*) *americana*. Male. a, P1; b, P2; c, P3 exopodite; d, P3 endopodite; e, P4; f, P5; g, P6. Scale = 25 μm.

P3 exopodite (Fig. 8c) lateral spines longer and stronger than in female. Endopodite (Fig. 8d) 3-segmented, modified; segment 1 with medial seta, spiniform process on second segment reaching past end of third segment; third segment with 2 apical setae of different lengths.

P4 (Fig. 8e) exopodite, outer spines longer

and stronger than in female. Endopodite segment 2 longer than in female, with same ornamentation.

Couplers as in female.

P5 (Fig. 8f) baseoendopodites fused, medial portion of each baseoendopodite little expanded, with 3 spines all subequal in length. Exopodite elongated, with 2 apical setae, medial apical seta long and pennate. Medial spine on lateral corner bare, stout, with 2 long spines along lateral margin.

P6 (Fig. 8g) consisting of narrow, fused transverse plate bearing on each side 3 setae, subequal in length.

Canthocamptidae G. O. Sars, 1906
Bryocamptus Chappuis, 1928
Bryocamptus (*Bryocamptus*) *newyorkensis* (Chappuis, 1926)
Figs. 9a–10m

Major Synonyms.—*Canthocamptus newyorkensis* Chappuis, 1927: 307, fig. 6–11

Bryocamptus (*Bryocamptus*) *newyorkensis*: Chappuis, 1929a: 44; 1929b: 478; Borutsky, 1952: 177, 178, fig. 61–79.

Material Examined.—One female, mounted on slide labeled "*Bryocamptus newyorkensis* female no. 1" (VMNH 368), 15 January 1999, emerging from a rehydrated soil sample taken from South Taylor Slough (25°18′7.3″N, 080°37′8.6″W). One male, dissected and mounted on slide labeled "*Bryocamptus newyorkensis* male no. 1" (VMNH 369), 19 January 2000, inverted funnel trap, in North Taylor Slough (25°26′10.3″N, 080°35′21.2″W). One male, mounted on slide labeled "*Bryocamptus newyorkensis* male no. 2" (EVER), 28 April 1999, emerging from a rehydrated soil patch, same location as female. One male, dissected and mounted on slide labeled "*Bryocamptus newyorkensis* male no. 3" (EVER), 11 June 2001, collected from a well near Pine Glades Lake (25°26′05.8″N, 80°43′14.91″W), 3-m depth. All from Everglades National Park, Dade County, Florida, U.S.A., leg. M. C. Bruno. One female in ethanol (GRSM); one female, dissected and mounted on slide labeled "*Bryocamptus newyorkensis* female no. 2" (GRSM), 2 June 1999, Tennessee, Blount County, Cades Cove, moss from logs beside isolated water-filled ditch, a side channel of Abrams Creek (35°35′38″N, 083°50′39″W), sample no. GS-99-82. Two females, dissected and mounted on separate slides labeled "*Bryocamptus newyorkensis* female no. 3, 4" (EVER), same date and location as female no. 2. One male, dissected and mounted on slide labeled "*Bryocamptus newyorkensis* male no. 4" (GRSM), same date and location as female no. 2. One male, dissected and mounted on slide labeled "*Bryocamptus newyorkensis* male no. 5" (EVER), same date and location as female no. 2. All from Great Smoky Mountains National Park, leg. J. W. Reid and W. A. Reid.

Female.—Length of female no. 1, measured from rostrum to anal operculum, 0.57 mm. Habitus (Fig. 9a) typically canthocamptid. Body surface covered with tiny hairs and scattered long sensilla. Cephalosome with smooth margin and large oval, medially constricted, dorsal hyaline window (Fig. 9b). Dorsal, elliptical hyaline window on pediger 2. Margins of thoracic and abdominal somites smooth. Genital double-somite with small row of spinules on each side of and slightly anterior to genital field, and more posterior paired row of lateral spinules. Urosomite 4 also with paired posterior rows of spinules. Urosomite 5 with spinules extending ventrally. Anal somite (Fig. 9c) with row of spinules on posteroventral margin and row near each caudal ramus, extending laterally. Anal operculum (Fig. 9c) convex, with smooth margin.

Caudal ramus (Fig. 9c) subconical, elongated, length/width ratio 1.36. Small dorsal keel extending to about midlength and ending with dorsal seta. Two spinules near insertion of anterolateral seta and posterolateral seta; posterolateral seta inserted near end of ramus. Dorsal seta composite, terminal accessory seta thin, with 3 spinules near its insertion. Inner terminal seta with breaking plane, barbed, about one-third length of body (Fig. 9n). Outer terminal seta with breaking plane, barbed, about one-fifth length of body.

Rostrum fused to cephalosome, large, with rounded tip bearing 2 small sensilla; reaching distal end of segment 1 of A1 (Fig. 9a).

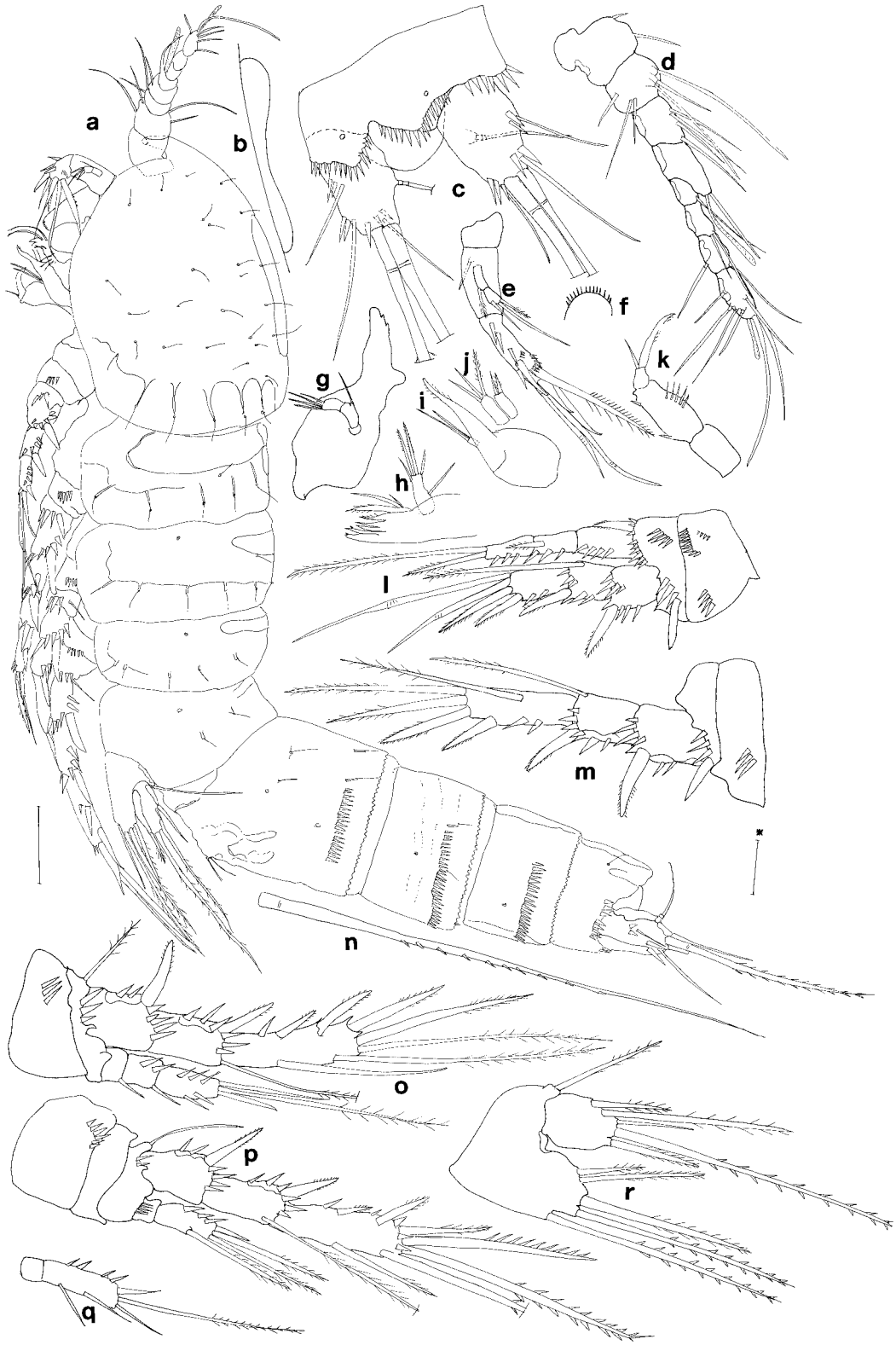
Antennule (Fig. 9d) 8-segmented, number of appendages beginning at proximalmost segment: 2, 6, 4, 1 + aesthetasc, 1, 2, 2, 7 + aesthetasc.

Antenna (Fig. 9e) with allobasis, endopodite 2-segmented, medial margin with spinules, apically 2 geniculate setae, 1 pennate seta, 1 strong spine. One subapical medial spine; 2 hyaline frills on lateral margin. Exopodite 2-segmented, first segment with 1 seta, second segment with 1 short subapical seta and 2 apical setae, 1 long and 1 short and pennate.

Labrum as in Fig. 9f.

Mandible (Fig. 9g) coxa with knob on outer surface, palp 2-segmented, segment 1 with 1 seta, segment 2 with 4 apical setae.

Maxillule (Fig. 9h) arthrite of precoxa with 5 apical spines. Basis with 1 endite with 3 apical spines. Exopodite with 1 lateral and 4 apical setae.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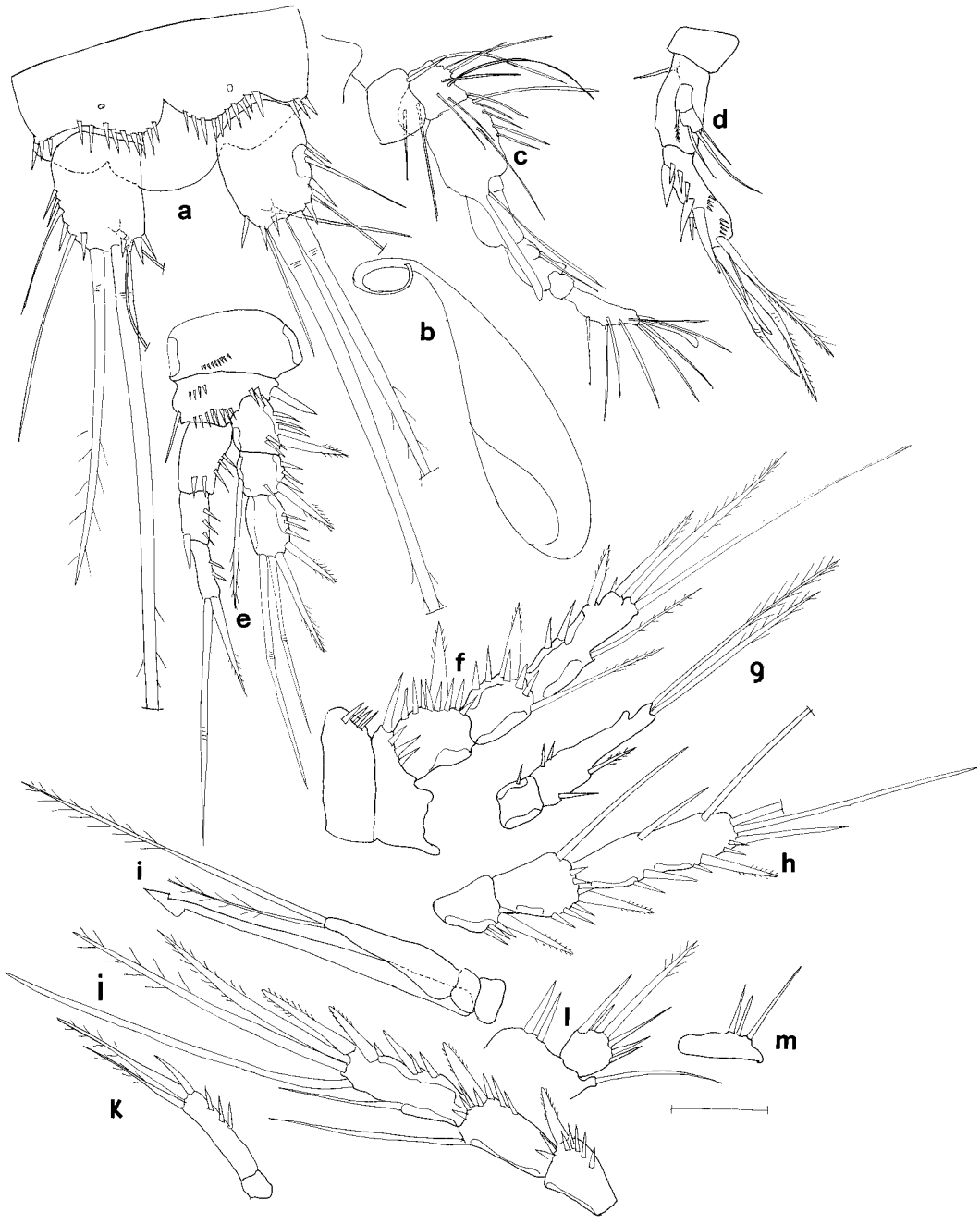

Fig. 10. *Bryocamptus* (*Bryocamptus*) *newyorkensis*. Male. a, anal somite, anal operculum, and caudal rami, ventral view; b, spermatophore; c, rostrum and antennule; d, antenna; e, P1; f, P2 exopodite; g, P2 endopodite; h, P3 exopodite; i, P3 endopodite; j, P4 exopodite; k, P4 endopodite; l, P5; m, P6. Scale = 25 μm.

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Fig. 9. *Bryocamptus* (*Bryocamptus*) *newyorkensis*. Female. a, habitus, lateral view (specimen from Great Smoky Mountains); b, dorsal hyaline window of cephalosome, lateral view; c, anal somite, anal operculum, and caudal rami, ventral view; d, antennule; e, antenna: f, labrum; g, mandible; h, maxillule; i, maxilla, syncoxa and endopodite; j, maxillar endites; k, maxilliped; l, P1; m, P2 basipodite and exopodite; n, caudal ramus inner terminal seta (specimen from Great Smoky Mountains); o, P3; p, P4; q, P2 endopodite; r, P5. Scales = 25 μm; the scale marked with an asterisk refers to Fig. 9a and n.

Maxilla syncoxa (Fig. 9i) with 2 endites (Fig. 9j), proximal endite with 2 short spines, distal endite with 3 apical setae. Basis ending in spiniform tip, with 1 seta; endopodite represented by tubercle bearing 2 setae (Fig. 9i).

Maxilliped (Fig. 9k) prehensile.

P1–P4 with 3-segmented exopodites (Fig. 9l, m, o, p). P1 and P3 with 3-segmented endopodites (Fig. 9l, o), P2 and P4 with 2-segmented endopodites (Fig. 9q, p). Formula for major ornamentation as follows:

P1	basipodite 1–1	exp 0–1; 1–1; 0,3,1
		enp 0–0; 1–0; 0,2,0
P2	basipodite 0–1	exp 0–1; 1–1; 1,2,2
		enp 0–0; 2,3,0
P3	basipodite 0–1	exp 0–1; 1–1; 2,3,2
		enp 1–0; 1–0; 0,3,0
P4	basipodite 0–1	exp 0–1; 1–1; 2,3,2
		enp 0–0; 1,3,0

Setae present on basipodites of P1 and P2, and lateral setae on exopodites of legs P1–P4 spiniform. P1–P4 couplers bare.

P5 (Fig. 9r) medial expansion of baseoendopodite almost as long as exopodite, bearing from lateral to medial margin: 1 long subapical serrate seta, 1 serrate and 1 apical pennate setae, and 2 short pennate subapical setae. Exopodite about 1.5 times longer than broad, with 1 subapical outer spiniform seta, 1 subapical outer pennate seta, 1 short normal seta, and 1 long serrate apical seta, and 1 spiniform seta on medial margin.

Male.—Length of male no. 2, measured from rostrum to anal operculum, 0.412 mm. Habitus as in female. Urosomites each with posterior ventral row of spinules, extending laterally. Hyaline windows as in female. Anal somite and anal operculum as in female (Fig. 10a). Caudal ramus similar to that of female in shape, but dorsal seta inserted near end of caudal ramus, and 2 spines near anterolateral seta. Mouthparts as in female.

Spermatophore (Fig. 10b) concave.

Rostrum (Fig. 10c) small, not reaching past segment 1 of antennule.

Antennule (Fig. 10c) 8-segmented, geniculate, number of appendages beginning with proximalmost segment: 1, 10, 7 + aesthetasc, 0, 0, 1, 0, 8 + aesthetasc.

Antenna (Fig. 10d) similar to that of female.

P1 (Fig. 10e) similar to that of female.

P2 exopodite (Fig. 10f) similar to that of female. Endopodite (Fig. 10g) 2-segmented, first segment with spinule on medial margin; second segment with 2 medial spinules, 2 lateral spines, 2 apical pennate setae, and knob-like apophysis on medial distal corner.

P3 exopodite (Fig. 10h) similar to that of female, except lateral spines longer and stronger. Endopodite (Fig. 10i) 3-segmented, modified; spiniform process on segment 2 reaching past end of corresponding exopodite, ending in barbed tip. Third segment with 2 apical setae of different lengths.

P4 exopodite (Fig. 10j) similar to that of female, except lateral spines longer and stronger. Endopodite (Fig. 10k) 2-segmented; segment 1 bare, segment 2 elongate, with 1 spiniform seta and 2 setae of different lengths on apex.

P1–P4 couplers as in female.

P5 (Fig. 10l) baseoendopodites fused, medial portion of each baseoendopodite little expanded, with 2 spines subequal in length. Exopodite small, bearing from lateral to medial corner: 1 seta, 1 strong pennate apical seta, 1 short slender seta, and 1 long spine. Two short slender setae along lateral margin.

P6 (Fig. 10m) consisting of narrow transverse fused plate bearing 3 setae of different lengths on each side.

Variations.—Dorsal hyaline windows on pedigers 2, 3, and 4 not visible on mounted female specimens from Everglades National Park. Females from Great Smoky Mountains National Park have the urosomite 4 with two rows of paired spinules, instead of a continuous row, and lack the small row of spinules on each side of the genital double-somite (Fig. 9a).

Discussion.—*Bryocamptus newyorkensis sensu* Chappuis is a rare species. Chappuis (1926) originally recorded it from the Park of Pelham Bay in the state of New York. Borutsky (1952) reported one female specimen from Siberia, which was probably a misidentification. The few later published reports, all from U.S.A., were from Louisiana by Wilson (1956), a stream in Minnesota by Shiozawa (1978, 1991), and Lake Huron by Hudson *et al*. (1998).

However, examination of the sparse material deposited as this species at the U.S. National Museum of Natural History, Smithsonian Institution, as well as several samples recently collected from the Great Smoky Mountains National Park, revealed the existence of a previously unsuspected species-complex. This complex consists of at least six morphs that all broadly conform to the original description of

B. newyorkensis, i.e., have the leg 1 endopodite three-segmented, the leg 1 exopodite segment 2 with a medial seta, the anal operculum smooth, the leg 5 baseoendopodite with five setae in the female, and the leg 5 exopodite with six setae in the male. Five of these morphs differed among themselves and from *B. newyorkensis* in such details as the segmentation of endopodites of legs 2 and 3, the number of setae on the leg 3 endopodite, and the relatively short medial terminal seta of the leg 3 endopodite. Only the specimens from Lake Huron, Cades Cove in the Great Smoky Mountains (Tennessee), and the Everglades conform exactly to Chappuis' description in these respects. We therefore consider these specimens, and no others, as representing Chappuis' species, which we have redescribed here. The remaining morphs will be treated in a separate contribution.

The records from the Everglades and Great Smoky Mountains national parks extend the verified distribution of *B. newyorkensis* from the northern to the southeastern United States, although with very few individuals. This species seems to be adapted to temporary habitats, exhibiting diapause and colonizing groundwaters; in Everglades National Park, we collected it from areas of Taylor Slough that dry seasonally, both from surface waters and emerging from rehydrated soil (Bruno *et al.*, in press), and from a shallow well in the Rocky Glades at the end of the year 2001 dry season, which was a record dry year. In Great Smoky Mountains National Park, *B. newyorkensis* was collected only from damp moss near, but not in, the nearby water-filled ditch.

Discussion

The Florida Everglades is an extensive subtropical wetland formed during the past 5,000 years by peat and marl deposition within depressions in the limestone substratum during seasonal inundations. The freshwater marshes in Everglades National Park range from deeper sloughs and ponds, flooded most of the year, to higher elevation marl prairies that now dry for eight to ten months each year owing to inadequate inflows and over-draining. The ephemeral wetlands in the eastern part of the park between Shark and Taylor sloughs (Fig. 1) are called the Rocky Glades. They lie at a slightly higher elevation than the sloughs, and the typical soil is marl over a limestone bedrock, which, with time, has undergone extensive dissolution, producing a typical karstic landscape with thousands of solution holes. During the wet season (May–October), rainfall and groundwater recharge fill the solution holes and reflood the wetland surface. In the dry season (November–April), surface water disappears because of evaporation, percolation, evapotranspiration, and very altered hydrology through overdrainage, leaving only the deepest holes with water. Some holes are deep enough to connect with the groundwater, even during severe droughts (Loftus *et al.*, 1992).

The Everglades harbor a relatively depauperate continental copepod fauna, possibly because of these extreme hydrological conditions, allied to semitropical temperatures and the geological youth of the lower Florida peninsula (discussed by Loftus and Reid, 2000). In particular, only 10 (Bruno *et al.*, in review) species of harpacticoids have been collected to date in spite of intensive collecting spanning 13 years (Reid, 1989, 1992; Bruno *et al.*, 2000, in press; Loftus and Reid, 2000). This is in contrast to the total of about 30 harpacticoid species (mainly canthocamptids) usually occurring in well-collected regions of comparable extent (cf. Reid, 1994). Fewer species of harpacticoids have been reported from the rest of Florida than from Everglades National Park. These include the two species previously reported from Florida and part of the continental North American fauna (*A. americana* and *Phyllognathopus viguieri* (Maupas, 1892)), three species also occurring elsewhere in North America (*B. newyorkensis*; *Cletocamptus deitersi* (Richard, 1897); and *Onychocamptus mohammed* (Blanchard and Richard, 1891)); three apparently endemic species (*N. everg ladensis*; *Elaphoidella fluviusherbae* Bruno and Reid, 2000; and *E. marjoryae* Bruno and Reid, 2000); and two species of marine origin (*N. bisetosa* and *Paramphiascella* sp., Bruno *et al.*, in review). The higher number of taxa recorded from Everglades National Park than from the rest of Florida is probably due to the lack of research in appropriate benthic and subterranean habitats in other parts of the state.

Moreover, in Everglades National Park, harpacticoids have been collected only in low numbers. This may indicate a community under extreme stress, caused by the shortened periods of inundation and lowered water levels because of human water management during the past century. Water management operations also

produce drawdowns in the Rocky Glades during the wet season. These disturbances have affected the aquatic fish and macroinvertebrate communities (Loftus *et al*., 1990, 1992; Acosta and Perry, 2001) and might prevent generalist species of harpacticoids from colonizing surface waters and groundwaters in the Everglades National Park.

The Everglades National Park harpacticoid list includes only five species (the canthocamptids *A. americana*, *B. newyorkensis*, *E. fluviusherbae*, *E. marjoryae*, and the phyllognathopodid *P. viguieri*), which might be considered typical members of a ''continental'' fauna. The other five (the canthocamptid *C. deitersi*, the laophontid *O. mohammed*, the ameirids *N. evergladensis* and *N. bisetosa*, and the diosaccid *Paramphiascella* sp.) belong to groups that include predominantly marine species, some of whose members are able to establish populations in continental saline and sometimes fresh waters. The ''continental'' faunal component, besides the cosmopolitan, euryoecious *P. viguieri*, is composed of species that seem to be adapted to survive in short-hydroperiod habitats, either entering diapause (Bruno *et al*., in press) or using groundwaters as a refugium from the drought. For example, *N. evergladensis* was collected in Taylor Slough in two consecutive years, each time in the middle of the dry season when the surface water levels were very low. Twenty-one of the total 22 specimens of *A. americana* were collected in solution holes in the short-hydroperiod habitats at the end of the dry season. *Bryocamptus newyorkensis* was collected from diverse habitats, as follows: two specimens from rehydrated soil samples collected in the long-hydroperiod habitats during the dry season, one specimen from surface water in a long-hydroperiod habitat during the wet season, and one specimen in groundwater in the short-hydroperiod habitats at the end of a record dry year. Also, the other two species of endemic harpacticoids, *Elaphoidella fluviusherbae* and *E. marjoryae*, were collected exclusively in the short-hydroperiod habitats of the Rocky Glades, mostly during the dry season (Bruno *et al*., 2000). Whereas only five specimens of the former species were collected from a single well, the latter specieswas collected from wells and a solution hole and when emerging from a rehydrated soil patch. The short-hydroperiod habitats of the Rocky Glades seem to sustain more diverse harpacticoid communities than the sloughs because of the high heterogeneity of their habitats and their extremely well-developed karstic system having the consequent exchange between surface and ground-waters. This exchange enhances the possibility of passive dispersal of marine species via saltwater intrusion (Price and Swart, 2001) into the aquifer.

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