

## New Brushlegged Caenid Mayflies from South Africa (Ephemeroptera: Caenidae)

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*Barnardara* McCafferty and Provonsha, gen. n. and *B. demoori* McCafferty and Provonsha, sp.n. are described from larvae taken in eastern Transvaal, South Africa. *Clypeocaenis* Soldán, *Amercaenis* Provonsha and McCafferty, and *Barnardara* represent the known genera of brushlegged Caeninae, all of which are presumed to be filter feeders. *Barnardara* is distinguished by a large truncate clypeus devoid of setae, broadly funnel shaped microtrichiae over much of the body, and randomly arranged long setae on the forelegs. *Clypeocaenis umgeni* Provonsha and McCafferty, sp.n. is described from larvae taken in Natal and is also known from the eastern Cape of South Africa. It represents the sixth known species of this genus and the first from southern Africa, with most others known from the Oriental region. Both *B. demoori* and *C. umgeni* are apparently deposit filter feeders.

Keywords: Ephemeroptera, Caenidae, *Barnardara*, *Clypeocaenis*, South Africa.

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### INTRODUCTION

Fourteen genera are currently recognized in the pannote mayfly family Caenidae (see Hubbard, 1990). Of the 11 genera that lack ocellar tubercles on the larval head – a group sometimes known as the subfamily Caeninae (e.g., Malzacher, 1987) – two are known to have larvae with arrangements of very long setae on the forelegs. These brushlegged caenines include the genus *Clypeocaenis*, described by Soldán (1978), the genus *Amercaenis*, described by Provonsha and McCafferty (1985), and the following species: *C. afrosetosa* Soldán from Upper Volta, *C. bisetosa* Soldán from Iran and India, *C. femorisetosa* Soldán and Landa from Sri Lanka, *C. multisetosa* Soldán from India, *C. oligoetosa* Soldán from Vietnam, and *A. ridens* (McDunnough) from North America.

In 1990, one of us (WPM) and Nadine McCafferty sampled streams and rivers extensively in South Africa and discovered a new genus and species of brushlegged Caeninae and a new species of *Clypeocaenis*. These were listed as unnamed and undescribed taxa of Caenidae in a table of South African Ephemeroptera species provided by McCafferty and deMoor (1994). Descriptions of these new taxa with brief remarks are provided here.

*Barnardara* McCafferty and Provonsha, gen. n.

*Larva.* Head (Figs. 1, 8) with genal ridge well developed; clypeus (Fig. 1) protruding, lacking long setae; frons and anterior vertex covered with minute, broadly funnel shaped, perforated microtrichiae (Figs. 8, 9). Mandibles (Fig. 2) with cluster of several long setae on outer margin. Maxillae (Fig. 3) with two-segmented palps; terminal segment densely covered with long filtering setae. Labium (Fig. 4) with three-segmented palps; apex of terminal segment of palps narrowing to nipplelike point.

Thorax with scattered minute, broadly funnel shaped, perforated microtrichiae (see Fig. 9). Dorsal face of forefemora (Fig. 5) with transverse row of spatulate setae in apical third. Foretibiae and foretarsi (Fig. 5) covered with long, randomly arranged setae.

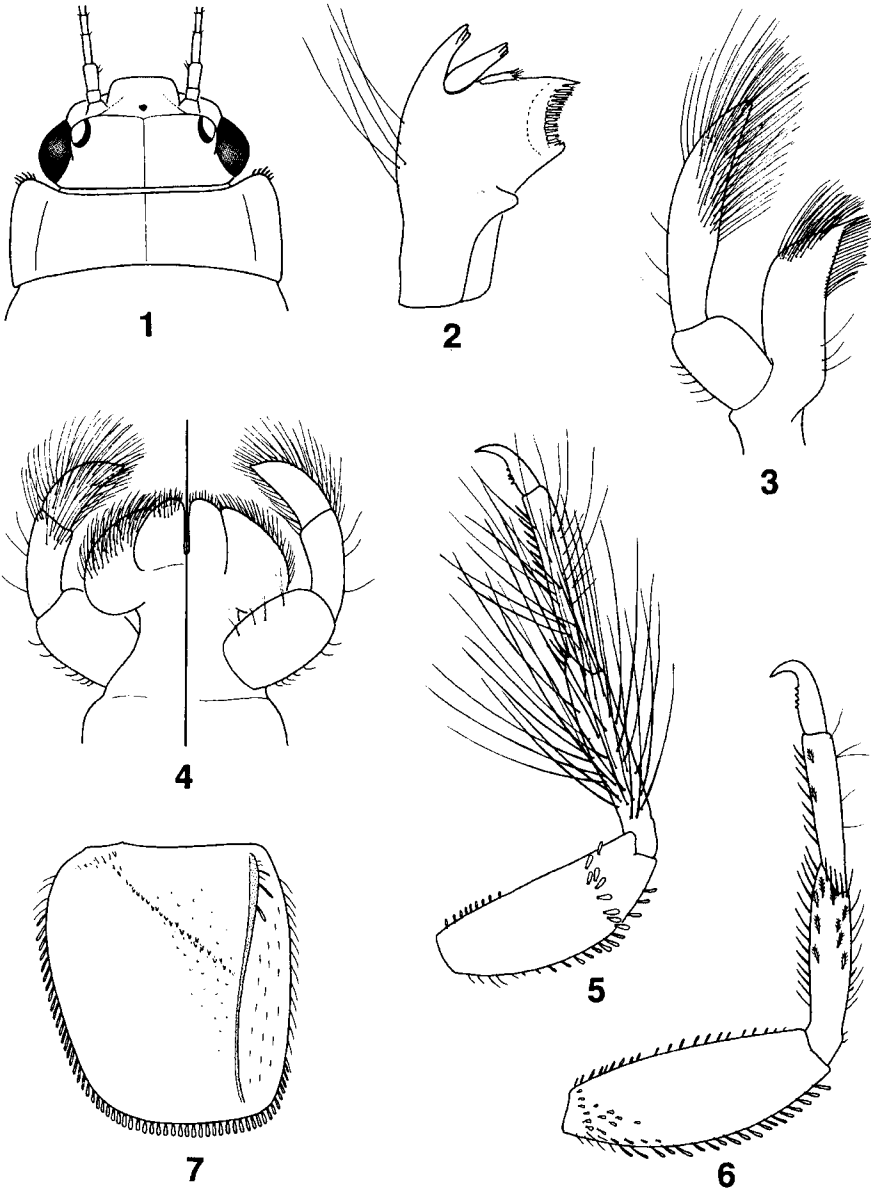
Abdomen (Fig. 10) with scattered minute, broadly funnel shaped, perforated microtrichiae; posterolateral projections poorly developed on all abdominal segments; posterior margins of terga 7 and 8 each with row of spatulate setae. Distal margin of terminal sternum bifurcate. Gill 1 short, subequal to width of hind coxa. Operculate gills (Figs. 7, 11) with scattered small, broadly funnel shaped, perforated microtrichiae dorsally; inner fork of dorsal Y-ridge slightly produced and forming a moderate keel.

*Adult.* Unknown.

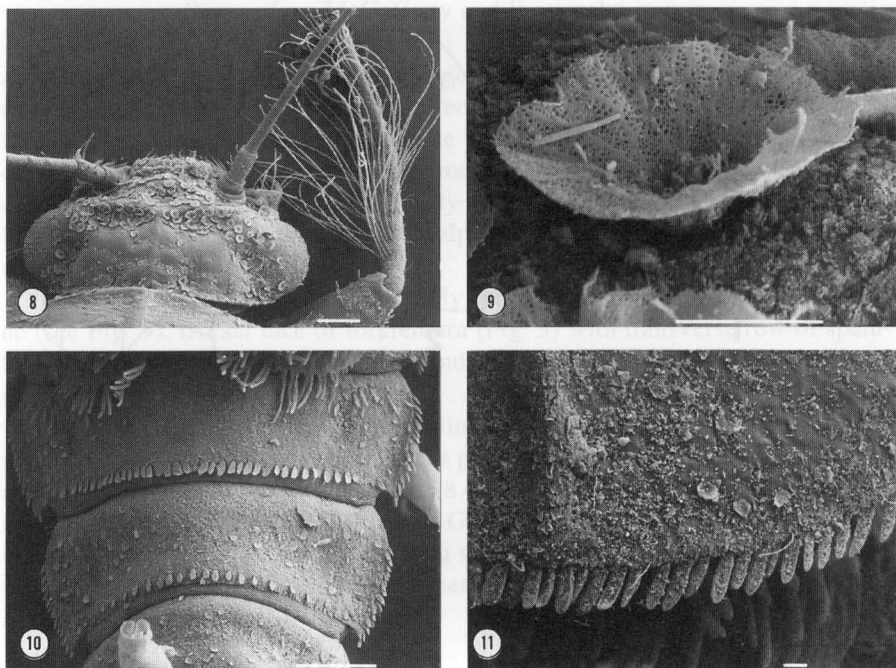
*Type species.* *Barnardara demoori* McCafferty and Provonsha.

*Etymology.* The genus group name is an arbitrary combination of letters incorporating the name Barnard and a Latinized feminine gender ending. The genus is named for K. H. Barnard, South African naturalist, who, in the first half of this century, collected and named some 27 valid species of South African Ephemeroptera.

*Diagnosis.* *Barnardara* larvae can be told from all other brushlegged Caeniinae by the absence of long setae in the clypeal region of the head, and by their foreleg brush, which is made up of randomly arranged long hairlike setae scattered over both the dorsal surface and inner margin of the tibiae and tarsi (Fig. 5). In *Clypeocaenis*, setae of the foreleg brush are arranged in distinct, uniform, diagonal rows (Fig. 16) and in *Amercaenis* these filtering setae are oriented along the tibial and tarsal inner margins only. *Barnardara* larvae also possess highly distinctive microtrichiae (Figs. 8, 9), describable as somewhat dish shaped or broadly funnel shaped with somewhat flaring and undulating sides and with perforations (reminiscent somewhat of certain corals). The special microtrichiae occur profusely on the vertex of the head and are scattered dorsally on the thorax and abdomen; they are only about 10  $\mu\text{m}$  in diameter and unpigmented, and thus may not always be discernible with a light microscope. Similar, but not exactly the same types of microtrichiae have been found in some larvae of some *Caenis* species (Malzacher, 1984, 1992; Kang and Yang, 1994). *Barnardara* larvae can be further separated from those of *Amercaenis* by the absence of spatulate setae



Figs. 1-7. *Barnardara demoori* sp. n., larva, 1 Head and pronotum. 2. Right mandible (ventral). 3. Maxilla. 4. Labium (left, ventral; right, dorsal) 5. Foreleg (dorsal). 6. Hindleg (dorsal). 7. Left operculate gill.



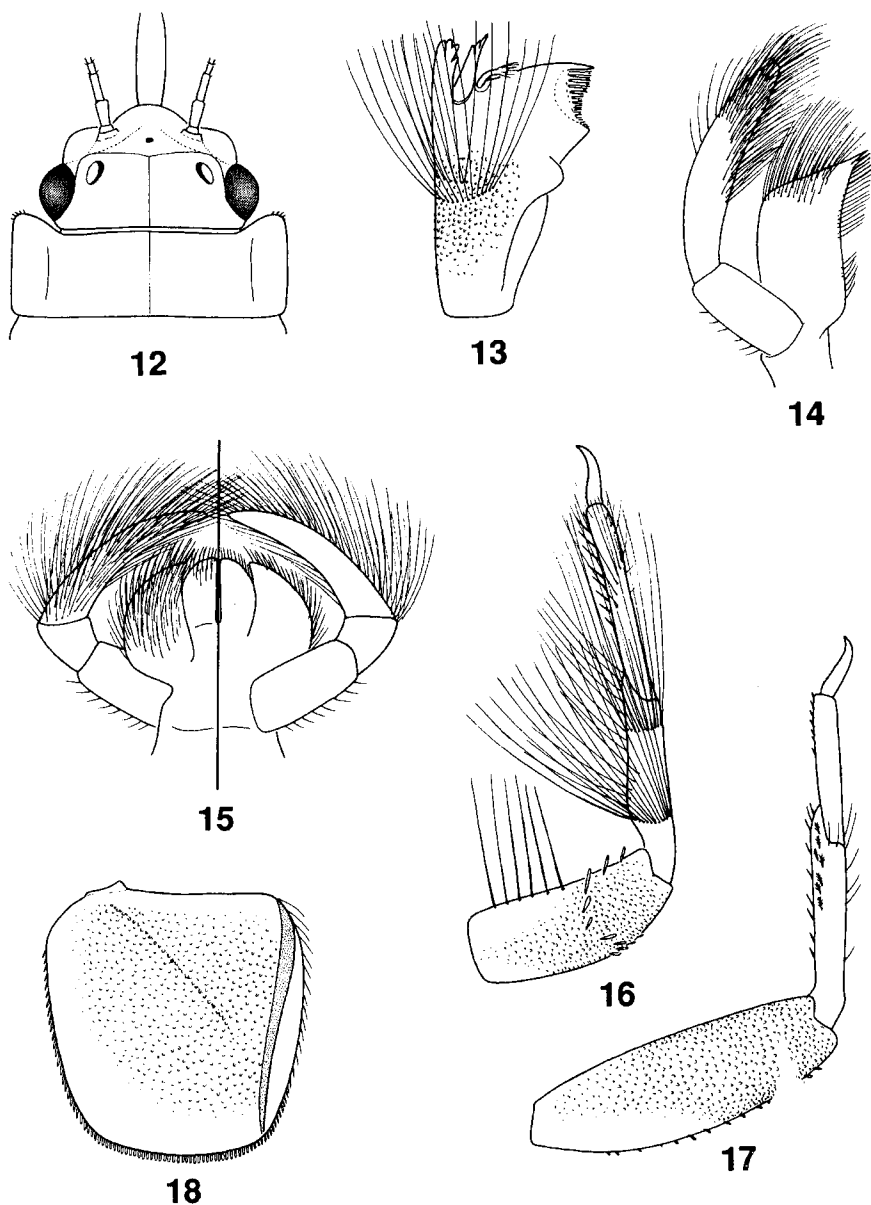
Figs. 8-11. *Barnardara demoori* sp. n., larva. 8. Head and foreleg. 9. Microtrichiae on head. 10. Abdominal segments 7, 8. 11. Posterior margin of operculate gill. (Length of white line: 8, 10 = 100  $\mu$ m; 9, 11 = 10  $\mu$ m).

on the surface of the operculate gills and by their two-segmented maxillary palps. *Amercaenis* larvae have three-segmented maxillary palps.

*Remarks.* Of the genera of brushlegged caenines, only *Barnardara* remains unknown in the adult stage. *Amercaenis* adults are remarkably similar to *Caenis* adults (Provonsha, 1990). *Clypeocaenis*, on the other hand, apparently possesses a number of characteristics that separate it from other known caenid adults, including a vestige of the well-developed larval clypeus (Soldán, 1983). We do not presently know the relationships of the three brushlegged caenine genera, and although they presumably form a natural grouping, they must be examined cladistically with respect to other caenids as well as other pannote mayflies in general prior to deducing their relationships.

***Barnardara demoori* McCafferty and Provonsha, sp.n.**

*Larva.* Body 2.5 - 3.0 mm in length. Caudal filaments 1.5 - 2.0 mm in length. Vertex of head (Figs. 1, 8) with anterolateral prominences bearing lateral ocelli;



Figs. 12-18. *Clypeocaenis umgeni* sp. n., larva. 12. Head and pronotum. 13. Right mandible (ventral). 14. Maxilla. 15. Labium (left, ventral; right, dorsal). 16. Foreleg (dorsal). 17. Hindleg (dorsal). 18. Left operculate gill.

frons medium brown, with narrow transverse brown stripe between lateral ocelli; clypeus broad and truncate, encompassing entire area between antennal bases. Mandibles (Fig. 2) with 4-7 long setae on outer margin. Basal segment of maxillary palps (Fig. 3) very stout, with width subequal to galealacinia length; crown of galealaciniae with brush of moderately long setae, inner margin with setal comb present only in apical half. All labial palp segments (Fig. 4) subequal in length; basal segment stout; segments 2 and 3 covered with moderately long setae; segment 3 with stout spines mixed with long setae near apex; glossae and paraglossae densely covered with short to moderately long setae.

Thorax generally light brown with darker stains dorsally and light tan ventrally; mesothorax with prominent black spots at anterolateral edge of wingpads; all legs pale and unmarked. Pronotum (Fig. 1) with lateral margins straight to slightly convex; anterolateral corners rounded, projecting slightly and edged with short spatulate setae. Forefemora (Fig. 5, 8) with entire outer margin and basal half of inner margin lined with spatulate setae; inner margin of foretarsi (Fig. 5) with row of 6-9 stout, spinelike setae. Mid- and hindlegs (Fig. 6) similar in setation: femora with inner and outer margins each with row of moderately long, spatulate setae, and dorsal face with cluster of short, spatulate setae near base; tibiae with numerous short, simple setae along outer margin and with fimbriate setae on dorsal face; tibiae and tarsi with row of spines on inner margin. All tarsal claws strongly hooked and with four or five prominent medial denticles.

Abdomen light brown, with abdominal terga 1-7, and operculate gills stained with dark brown, and all abdominal sterna with sublateral short longitudinal black dashes. Median projection of tergum 2 elongate and hook shaped in lateral view; lateral margins of abdominal segments (Fig. 10) with row of moderately long spatulate setae. Operculate gills (Figs. 7, 11) with several stout, spatulate setae near base; inner margin and basal half of outer margin with short, simple setae; apical half of lateral margin and posterior margin edged with broad, spatulate setae. Caudal filaments with long setae at lateral margins of each segment (setae slightly longer than respective segment).

*Adult.* Unknown.

*Material examined.* Holotype: larva, South Africa, eastern Transvaal, Krüger National Park, Olifants River, at bridge on dirt road near Olifants Camp, X-29-1990, W.P. and N. McCafferty. Paratypes: 42 Larvae, same data as holotype; 10 larvae, South Africa, eastern Transvaal, Krüger National Park, Olifants River, 15 km from blacktop road, "Fig Tree Site", X-29-1990, W.P. and N. McCafferty. The holotype and 40 paratypes are deposited in Purdue Entomological Research Collection (PERC), West Lafayette, Indiana; 12 paratypes are deposited in the Albany Museum, Grahamstown, South Africa.

*Etymology.* The species is named in honor of Dr. F.C. deMoor, curator of aquatic insects at the Albany Museum, who kindly facilitated field work in South Africa that led to the discovery of this species.

*Remarks.* This species is currently known only from a subtropical area of the eastern Transvaal, in the protected Krüger National Park. The Olifants River

where the species occurred was 30-50 m wide with generally shallow riffles and runs. Sampling was in October and thus prior to the onset of the dry season, when the river can deteriorate considerably. At the collection sites, current was moderate and substrates were mixed, ranging from sand and gravel to cobble and large boulders mixed with sand and gravel. At the type locality, there was considerable marginal vegetation present. *Barnardara demoori* was evidently present in the broad cross-section of substrate types present, including marginal vegetation.

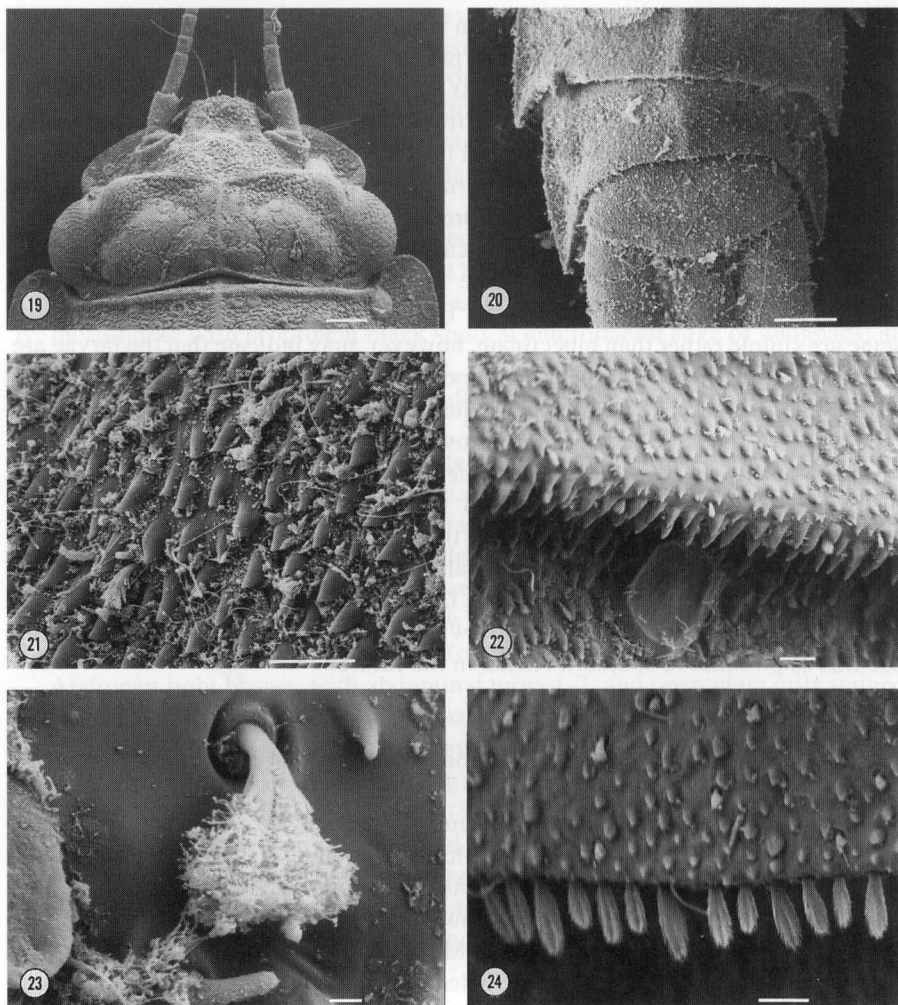
As is the case for other brushlegged caenines, this species is presumed to be a filter feeder. The long bipectinate setae found on the mouthparts are typical of such feeders (see e.g., McCafferty and Bae, 1992). The fact that foreleg brush setae are simple rather than bipectinate, however, may indicate that the larvae are active, deposit filterers, suspending deposited food particles from the substrate with the long setae of the forelegs, rather than passive seston filterers (see detailed remarks under *Clypeocaenis*, below).

There is a slight possibility that *B. demoori* represents the larvae of a previously named southern African caenid species that is known only as adults – possibly a *Caenis* if, like *Amercaenis*, the adults of *Barnardara* prove not to be as distinctive as the larvae. Presently, valid species of *Caenis* from South Africa that are known from adults only include *C. basuto* Demoulin from Basuto and *C. liebenauae* Malzacher from Natal. It will thus be important to rear as many caenids as possible in southern Africa in the future.

*Clypeocaenis umgeni* Provonsha and McCafferty, sp. n.

*Larva.* Body 3.5-4.5 mm in length. Caudal filaments 2.2 - 2.7 mm in length. Head (Figs. 12, 19) with lateral ocelli located on anterolateral prominences of vertex; genal ridge well developed; frons dark brown; clypeus protruding, convex apically, and bearing two long, stout setae anteriorly. Mandibles (Fig. 13) with two distinct rows of long setae. Maxillae (Fig. 14) with two-segmented palps; apical segment and crown of galealaciniae with long filtering setae. Labium (Fig. 15) with three-segmented palps, segment 3 approximately 3x length of segment 2; ventral surface of glossae, paraglossae, and segment 3 of palps densely covered with long filtering setae.

Thorax generally light brown; mesothorax with dark brown lateral maculations at base of wingpads, and with short, dark brown, longitudinal dashes in scutal area; sterna and all legs pale. Pronotum (Fig. 12) with lateral margins straight; anterolateral corners projecting anteriorly. Forefemora (Fig. 16) with transverse row of stout, spatulate setae in distal half of dorsal face; inner margin with 5-7 long setae in basal half. Foretibiae (Fig. 16) with long setae arranged in two distinct rows. Foretarsus (Fig. 16) with irregular, diagonal row of long setae; inner margin lined with stout, spine-like setae. Mid- and hindlegs (Fig. 17) similar in setation: outer margin of femora lined with short spatulate setae and lacking long hairlike setae; tibiae with few hairlike setae, but with dorsal surface



Figs. 19-24. *Clypeocaenis umgeni* sp. n., larva. 19. Head. 20. Posterior abdominal segments. 21. Body spination. 22. Posterior margin of abdominal segment 7. 23. Microtrichiae on operculate gill. 24. Posterior margin of operculate gill. (Length of white line: 19, 20 = 100  $\mu$ m; 21-23 = 10  $\mu$ m; 24 = 1  $\mu$ m).

with row of fimbriate setae; inner margin of tibiae and tarsi with spinelike setae. Tarsal claws of all legs similar: moderately long, slightly curved, and with 5-7 minute denticles in basal half.

Abdominal terga 2-7 stained with dark brown; sterna pale. Median projection of tergum 2 moderately well developed and hook shaped in lateral view. Posterolateral projections of abdominal segments weakly produced on segments 1-5,



becoming increasingly more pronounced on segments 6-9; terga 6-8 with low median ridge (Fig. 20); posterior margins of terga lacking setation but with strong tooth-like spines (Fig. 22); abdominal terga and operculate gills densely covered with small posteriorly directed spines (Figs. 21, 22, 24) (giving roughened appearance to entire surface) and with sparsely scattered, minute, plumelike microtrichiae (Fig. 23). Distal margin of terminal sternite slightly indented medially. Gill 1 short, subequal to width of hind coxa. Operculate gills (Figs. 18, 24) with inner fork of Y-ridge strongly developed into keel, lacking setation; dark brown laterad of keel; inner margin with row of short, simple setae; outer and posterior margins with stout, spatulate setae. Caudal filaments pale; posterior margin of all basal segments and every other apical segment with whirl of short setae (setae much shorter than distance between whirls).

*Adult.* Unknown

*Material examined.* Holotype: larva, South Africa, Natal, Umgeni River below Nagel Dam, 1100 m. IX-21-1990; W.P. and N. McCafferty. Paratypes: 2 larvae, same data as holotype; 13 larvae, South Africa, Natal, Umgeni River just above Nagel Dam impoundment, IX-21-1990; W.P. and N. McCafferty. The holotype and 10 paratypes are deposited in PERC. Five paratypes are deposited in the Albany Museum. Other material: one larva, South Africa, Natal, Umlaas River between Camperdown and Eston; X-3-1971, G.F. and C.H. Edmunds, PERC.

*Etymology.* The specific epithet is a noun in apposition in reference to the Umgeni, the river from which the type specimens were taken.

*Diagnosis.* *Clypeocaenis umgeni* larvae can be distinguished from those of (*C. afrosetosa*, the only other *Clypeocaenis* known from the Afrotropics, by the presence of 5-7 long setae on the inner margin of the forefemora. *Clypeocaenis afrosetosa* larvae lack setae on the inner margin of the forefemora. Larvae of the new species can be told from all other known *Clypeocaenis* larvae by the unique combination of having only two long setae on the clypeus, some long setae on the inner margin of the forefemora, and only short, spatulate setae on the outer margin of all femora.

*Remarks.* The larvae described above were taken in shallows (7.0-22.0 mm depth) of relatively slow to moderate current on coarse sandy substrate, both above and below the Nagel Dam impoundment in Natal. In ecological studies of the Buffalo River in the eastern Cape of South Africa, Palmer et al. (1993a, 1993b) provided data on the larvae of a mayfly they referred to as Caenidae sp. B. It is clear from examination of some of that material by WPM while in South Africa, and from SEM micrographs presented in Palmer et al. (1993b), that their Caenidae sp. B is *C. umgeni*. Palmer et al. (1993a) reported only riffle habitat for *C. umgeni*; however, the specific substrate was not indicated, and we cannot be sure if the riffle habitat was devoid of coarse sand, as would be expected, or if the species may have occurred in other habitats as well. By comparison, *C. afrosetosa* (referred to as Caenidae sp. I) from western tropical Africa was taken in very fast current and stony substrate by Petr (1970).

Although Palmer et al. (1993b) did not observe the feeding behavior of *C. umgeni*, they postulated that it was an active filterer [deposit filterer, sensu McShaffrey and McCafferty (1988)], not a passive filterer (seston filterer), based on the fact that mouthpart setae were of the bipectinate filtering type but the long foreleg setae were simple. In addition, gut-content data (Palmer et al., 1993a) showed that *C. umgeni* fed on mostly amorphous detritus and that its diet did not differ appreciably from that of *Caenis* sp. larvae that were also studied. These authors assumed the long foreleg setae would be used to stir up deposits of detritus that would then be filtered by the mouthpart setae. Although the absence of long, bipectinate, hairlike setae on the forelegs may preclude the ability to use these legs for passive filtering, the presence of long, bipectinate setae does not, on the other hand, assure that they are used for passive filtering as, for example, in *Isonychia* (Wallace and O'Hop, 1979). McCafferty and Bae (1992) found that the highly developed bipectinate foreleg setae of the potamanthid mayfly *Anthopotamus verticis* were used primarily for deposit filtering.

The newly discovered distribution of *Clypeocaenis* in southern Africa typifies a common pattern for mayflies and some other organisms – that is a strong biogeographic affinity between the southern Afrotropics, India, and southeast Asia. For example, a geographic pattern very similar to that of *Clypeocaenis* is found in the ephemerid genus *Afromera* (see McCafferty and Edmunds, 1973; McCafferty and Gillies, 1979).

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