PROC. ENTOMOL. SOC. WASH.
106(2), 2004, pp. 312–318

A NEW SPECIES OF *BRACHYCERCUS* CURTIS (EPHEMEROPTERA: CAENIDAE) FROM CHINA

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Abstract.—***Brachycercus capnicus,* new species**, is described from larvae and reared male adults recently collected from the southern provinces of China. The new species represents the first true record of the genus *Brachycercus* Curtis and subfamliy Brachycercinae from China, and the eighth such from the Eastern Hemisphere. *Brachycercus capnicus* is morphologically similar to *B. gilliesi* Soldán and Landa from southern Asia and *B. japonicus* Gose from eastern Asia; however, the larvae of *B. capnicus* are distinguished by color pattern, antennal setae, and shape of the ocellar tubercles. The adults of *B. capnicus* are distinguished from other known Asian congeners by body size, pedicel length compared to that of the scape, color pattern, and development of vestigial abdominal processes. Larval habitat of the new species is typical of the genus.

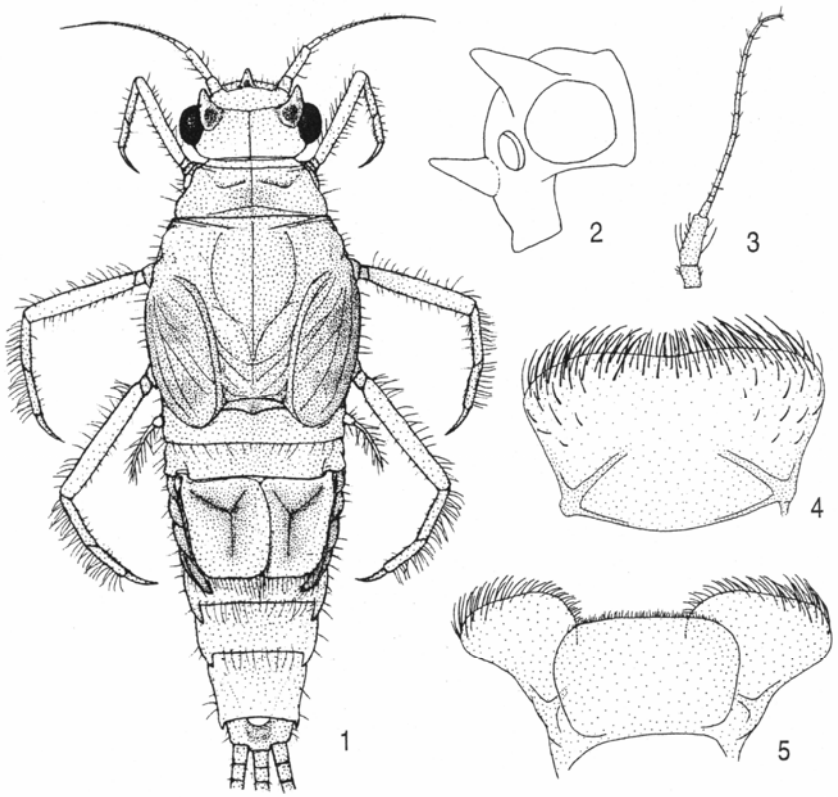
Key Words: mayflies, China, *Brachycercus,* new species

The genus *Brachycercus* Curtis of the subfamily Brachycercinae (McCafferty and Wang 2000) of the cosmopolitan mayfly family Caenidae is distributed in the Holarctic and Oriental regions. Larvae of the genus are typified by their possession of ocellar tubercles and two-segmented labial palpi. Seven species have been known previously from the Eastern Hemisphere (Tshernova 1952, Soldán 1986, Kluge 1991, Soldán and Landa 1991, Tojo 2001), but only one *Brachycercus* species has been recorded from China. It was taken from the northeastern region of that country and informally referred to as B. YUa by Quan et al. (2002). In the vicinity of China, *B. harrisella* Curtis has been recorded from Mongolia and the Amur River Basin, and *B. tubulatus* Tshernova has been recorded from Korea and the Amur River Basin (Tshernova 1952, Soldan 1986, Kluge 1991, Hwang and Bae 1999). These records suggest that the two latter species eventually will be found in China. The Chinese species originally described as *Brachycercus parviforcipis* Zhou, Gui, and Su (2000) is actually a member of the genus *Caenis* Stephens (subfamily Caeninae) and was recombined as such by Zhou and Zheng (in press). The description of a new Chinese species of *Brachycercus* is presented below.

Brachycercus capnicus Zhou, Sun, and McCafferty, new species

(Figs. 1–18)

Mature larva.—Body (Fig. 1) length 3.4–5.0 mm. Caudual filaments length 1.8–2.3 mm. General coloration pale yellow brown. *Head*: Coloration pale yellow; occiput and frons stained with brown centrally, without dark brown patches or black stripes posterior to lateral ocellar tubercles. Head capsule with anterolateral transverse row of long setae on either side between base of

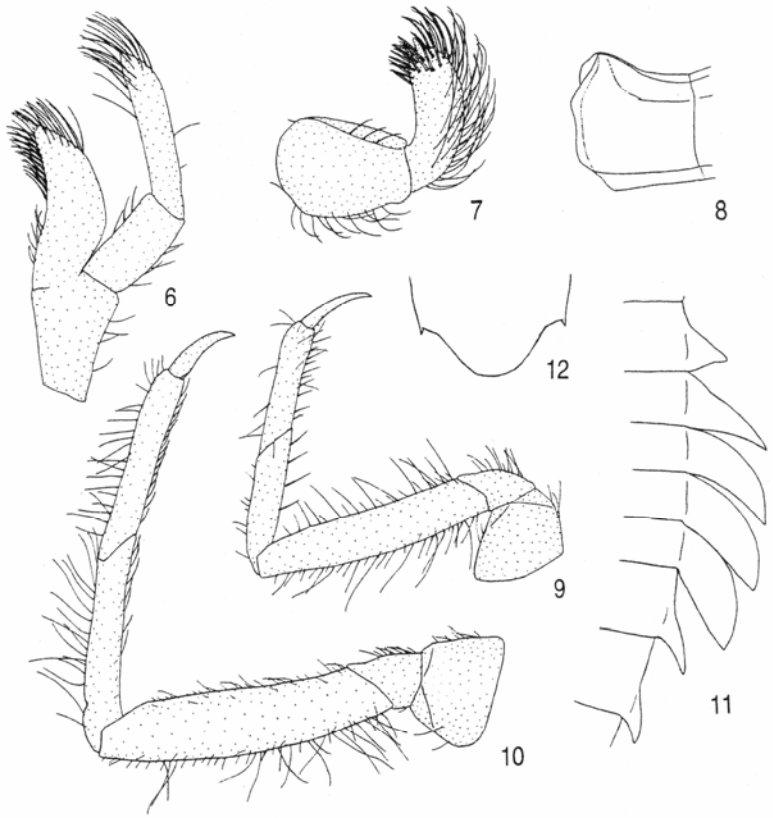


Figs. 1–5. *Brachycercus capnicus*, larva. 1, Habitus. 2, Ocellar tubercles (lateral). 3, Antenna. 4, Labrum. 5, Hypopharynx.

antenna and base of mandible. Lateral ocellar tubercles triangulate in lateral view (Fig. 2), with length slightly greater than width at base, and subequal to width of eye, with anterior margin slightly concave and with apex round and lacking long setae. Middle ocellar tubercle triangulate in dorsal view (Fig. 1) and straight in lateral view, with length ca. two-thirds that of lateral ocellar tubercles and ca. 1.5× basal width; apex round to bluntly pointed. Eyes not elevated above level of vertex (Fig. 2). Antenna (Fig. 3) pale, with pedicel 2.0× scape length; scape and pedicel without maculae; pedicel with ca. 10 setae subequal to, or longer than, one-half length of pedicel. Clypeus with transverse row of relatively long setae anteriorly. Labrum (Fig. 4) nearly trapezoidal, with lateral margins slightly protruding, with medioapical margin slightly concave, and with relatively dense, stout setae along anterior margin. Lingua of hypopharynx (Fig. 5) with distal margin straight; superlinguae with lateral margins moderately and roundly produced. Maxilla (Fig. 6) with galealacinia length 2.9× basal width; palp segment 2 length 1.8× that of segment 1; segment 1 width 1.6× that of segment 2; palp segment 2 with few long, stout setae at apex extending somewhat basally along inner margin, and with only sparse, fine setae near base. Labial palp

(Fig. 7) with dense, long setae in lateral aspect of segment 2. *Thorax*: Notal coloration yellow brown, without distinct black maculae; sternal coloration pale yellow with diffuse black stain. Pronotum (Fig. 8) trapezoidal, darker medially, with lateral margin slightly produced. Prothoracic pleura and lateral mesonotum with sparse marginal setae. Prosternum with median transverse ridge roundly curving, but not produced ventrally. Mesosternum with anterior margin straight, without long, fine setae. Mesosternum and metasternum without protrusions. Legs pale throughout. Ratios of length of body : foreleg : midleg : hindleg, 3.1:1.0:1.5:1.5. Ratios of length of forefemur : tibia : tarsus : claw, 3.3:1.6:1.7:1.0. Ratios of length of hindfemur : tibia : tarsus: claw, 3.9:2.5:2.7:1.0. Ratio of hindfemur length to width, 4.3:1.0. Forefemur (Fig. 9) with row of very short setae in addition to relatively long setae along dorsal margin, and with row of stout setae in addition to some short setae along ventral margin; foretibia with row of four or five short setae along ventral margin; foretarsus with row of ca. 10 short setae along ventral margin; foretibia and tarsus also with scattered, sparse, short, fine setae on both anterior and posterior surfaces. Hindfemur (Fig. 10) with row of short setae interspersed with long setae along dorsal margin and short setae along ventral margin; hindtibia and tarsus with row of sparse, long setae along dorsal margins and row of short, stout setae along ventral margin; hindclaw (Fig. 10) adenticulate and moderatly curved, with length 4.0× basal width. *Abdomen*: Terga pale yellow, without distinct maculae; terga 1, 2, 7–9 with medial area somewhat darker; tergum 10 darkened anteriomedially. Tergum 1 with fine setae along posterior margin; tergum 7 with row of relatively dense, long setae along posterior margin; tergum 8 with much fewer setae along posterior margin. Segment 2 without short fingerlike process near base of operculate gill. Lateral processes on segments 2–8 (Fig. 11); process 2 triangulate and blunt; processes 3–6 strongly curved dorsally, with apices bluntly pointed; processes 5 and 6 subequal in length; processes 7 and 8 short; process 9 small, triangulate, with apex acutely pointed. Tergum 9 with posterior margin straight. Sterna flat, pale yellow, with pale diffuse black stain in some individuals, without noticable setae; sternum 9 (Fig. 12) with posterior margin convex. Operculate gill (Fig. 13) subquadrate, with length 1.3× width, without protruding edge at outer-posterior corner; dorsal surface yellow brown except pale along outer and posterior margins, with few long setae in outer region; Y-ridge somewhat darker than adjacent areas, with outer branch stained with black, branching in anterior third of gill, and with few long setae; ventral surface lacking dense, short setae; inner margin with row of relatively sparse, short setae; inner-posterior corner with row of relatively dense, long setae; outer-posterior corner with row of long setae (shorter than those of inner-posterior corner), intermixed with several very short setae; outer margin with row of long setae shorter than those of posterior margin. Caudal filaments pale yellow, with segments in apical third with long setae.

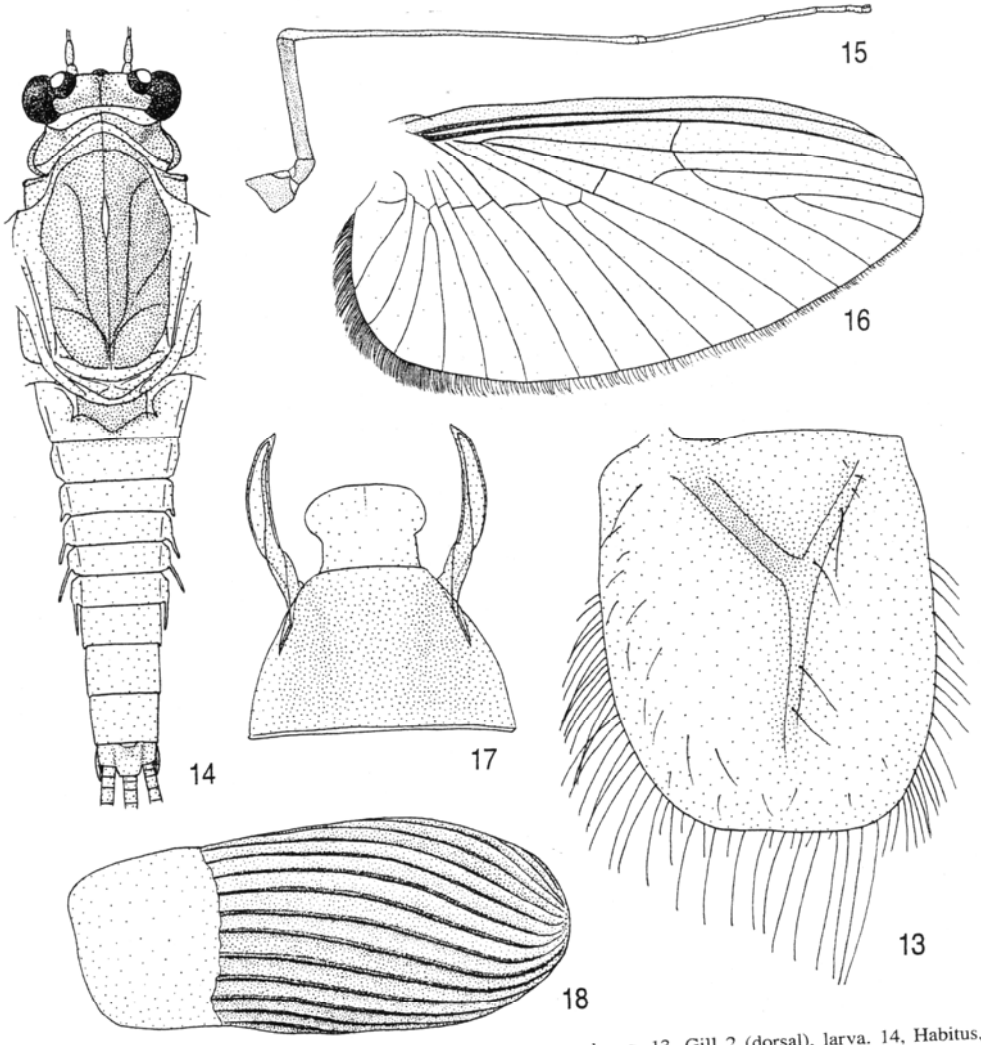
Male adult (in alcohol).—Body (Fig. 14) length 3.5–3.7 mm. Caudal filaments length 11.0–12.0 mm. Wing length 3.5 mm. *Head*: Occiput pale yellow, stained with diffuse pale brown. Stem of epicranial suture bordered with diffuse pale brown stain. Frons diffuse brown centrally above middle ocellus. Scape diffuse pale brown; pedicel pale brown, 2.3× length of scape; flagellum pale. *Thorax*: Pronotum pale yellow, with extensive black shading. Mesonotum and metanotum yellow brown. Metanotum with posteromedial protrusion broadly triangulate, with apex bluntly pointed. Thoracic sterna yellow, with diffuse black stain. Prosternum with blackened median transverse ridge straight, not prominent ventrally; mesosternum with sternacostal suture not blackened; mesosternum and metasternum without vestige of central protrusions.



Figs. 6–12. *Brachycercus capnicus*, larva. 6, Maxilla. 7, Labial palp. 8, Pronotum (left half, dorsolateral view). 9, Foreleg (anterior). 10, Hindleg (anterior). 11, Left lateral abdominal processes 2–8 (ventrolateral view). 12, Posterior margin of sternum 9.

Legs with coxae and trochanters brown; femora without a black dorsodistal macula; foreleg (Fig. 15) with femur pale brown, with brown stripes, and with tibia and tarsus pale; midleg and hindleg pale. Ratios of length of body : foreleg : midleg : hindleg, 2.5:2.3:1.0:1.1. Ratios of length of forefemur : tibia : tarsus, 1.0:2.9:1.9. Ratios of length of foretarsus segment I:II:III:IV:V, 1.0:12.7:5.3:3.0:2.0. Forewing (Fig. 16) with ratio of length to width at widest portion 1.9, with Sc, R1 and adjacent area pale brown; other veins pale. *Abdomen*: Coloration generally pale, without maculae, with terga 3–6 somewhat palest. Segments 3–6 with distinct vestiges of larval lateral processes. Genitalia (Fig. 17) with penes lobes moderately convex laterally, and with forceps slightly bowed, with apex pointed. Caudal filaments pale.

Female adult (in alcohol).—Body length 4.0 mm. Caudual filaments length 1.2 mm. Forewing length 4.5 mm, with ratio of length to width at widest portion 2.0. Ratio



Figs. 13–18. *Brachycercus capnicus*, larva, male imago, and egg. 13, Gill 2 (dorsal), larva. 14, Habitus, male imago. 15, Foreleg (dorsal), male imago. 16, Wing (dorsal), male imago. 17, Sternum 9 and genitalia (ventral), male imago. 18, Egg (lateral).

of length of body : foreleg : midleg : hindleg, 2.2:1.0:1.3:1.4. Coloration similar to male.

Egg (dissected from mature larva).—Length approximately 160 m. Shape (Fig. 18) narrow ovate, with single polar cap ca. one-third length of entire egg. Chorion (Fig. 18) with 10–15 broad costae in lateral view.

Material examined.—Holotype: ♂ adult, Wei-Yuan River (23.30 N, 100.41 E), Feng-Shan Village, Jing-Gu County, Yunnan Province, China, IV-8-2001, Chang-Fa Zhou (deposited in Nanjing Normal University, Nanjing, China). Paratypes: 17 ♂ adults, one ♀ adult, 15 ♂ subimagos, 3 ♀ subimagos (reared from larvae), 18 larvae, data and deposition same as holotype; 3 ♂ adults; two larvae, data same as holotype (deposited in the Purdue Entomological Re-

search Collection, West Lafayette, Indiana, U.S.A.). Other Material: two larvae, Sang-Lang, Wang-Mu County (25.10 N, 106.06 E) Gui-Zhou Province, China, IX-15-2000, Chuan-Ren Li and Chang-Fa Zhou (deposited in Nanjing Normal University, Nanjing, China).

Etymology.—The specific epithet is an adjective of masculine gender latinized from the Greek word "kapnikos," which means smoky. It is an allusion to the diffuse black stain on the thoracic sterna in the larvae and adults of the new species.

Discussion.—Among Asian species, larvae of *Brachycercus capnicus* and those of *B. tubulatus, B. corniger* Kluge, *B. japonicus* Gose, and *B. gilliesi* Soldán and Landa are relatively similar. Larvae of these species share the absence of thoracic sternal protrusions and a posterolateral protruding edge on the operculate gill (Fig. 13), and as such are distinguished from *B. harrisella.* Also, they all do not have dense, long setae along the anterior margin of mesosternum, which is a distinctive characteristic of *B. petersorum* Soldán and *B. minutus* Tshernova. Additional diagnostic features in larval *B. capnicus* are as follows. The lateral margin of abdominal segment 2 (Figs. 1, 11) is slightly produced and does not form a proccess subequal to that of segment 3, as is the case in *B. corniger.* The lateral ocellar tubercle (Figs. 1–2) is triangulate in lateral view, slightly shorter than the combination of scape and pedicel; the middle ocellar tubercle length is ca. 1.5× its basal width, and less than that of the lateral ones by ca. one-third; whereas in *B. japonicus* the lateral ocellar tubercle is fingerlike in lateral view and longer than the combination of scape and pedicel; the middle ocellar tubercle length is ca. 2.5× its basal width, and subequal to that of the lateral ones; and in *B. tubulatus* the middle ocellar tubercle is distinctively longer than the lateral ones. The pedicel (Fig. 3) has ca. 10 setae subequal to, or longer than one-half the length of the pedicel, and the abdominal terga (Fig. 1) lack maculae; whereas in *B. gilliesi* the pedicel has over 20 long setae, and the abdominal terga 1, 2, and 7–9 have a pair of brownish bands (Soldán and Landa 1991).

Four species of Asian *Brachycercus* had previously been known in the adult stage (Soldán 1986, Kluge 1991, Tojo 2001). The adults of *Brachycercus capnicus* can be distinguished from them as follows. Male and female *B. capnicus* are no more than 4.0 mm in length; whereas the male of *B. harrisella* is more than 4.5 mm, and the female is more than 5.0 mm. The ratio of pedicel to scape length is greater than 2.0 in *B. capnicus* (Fig. 14); whereas this ratio is ca. 1.5 in *B. minutus.* Abdominal segment 2 lacks vestiges of larval lateral processes in *B. capnicus* (Fig. 14); whereas these vestiges are distinct in *B. coniger.* Thoracic sterna of *B. capnicus* are extensively stained with pale black; whereas *B. japonicus* lacks such shading.

Brachycercus capnicus larvae were collected from a relatively clean-water river during the dry season when the river was 5–10 m in width. The larvae were found in association with a substrate composed of sand and silt, strewn with driftwood and leaf packs; a water depth of ca. 40 cm; and a current velocity less than 0.5 m/s. Other genera of mayflies collected in the same habitat included *Ephemera* Linnaeus, *Potamanthellus* Lestage, and *Caenis.*

Subimagos and adults of *B. capnicus* were attracted to a collecting light in predawn hours. The subimagos molted to adults while perched on stones near the attracting light. Many subimagos and adults of *Caenis* and *Clypeocaenis* Soldán were also collected at the same time by the same method. Similar observations for collecting alate stages of caenid mayflies were made by WPM in South Africa.

ACKNOWLEDGMENTS

We thank Dr. Chuan-Ren Li (Hubei Agricultural College, China) for helping collect specimens. Scanning Electron Micros-

copy was conducted at the Life Science Microscopy Facility, Purdue University.

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