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New species of *Cheumatopsyche* (Trichoptera: Hydropsychidae) from North Sulawesi, Indonesia

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Abstract. Sulawesi Island has a high density of endemic animal species, including insects in the order Trichoptera. We describe the males of four new species of *Cheumatopsyche* (Trichoptera: Hydropsychidae) from North Sulawesi (Provinsi Sulawesi Utara), and provide a checklist of the *Cheumatopsyche* species from the Indonesian archipelago. Describing the aquatic insect fauna is an important step toward establishing biomonitoring protocols in Indonesia, which is experiencing rapid development and water pollution problems.

Key Words. Borneo, caddisfly, Celebes, hydropsychid, Indonesia, Sulawesi Utara, Wallacea.

Introduction

Sulawesi (historically known as Celebes) is located in the center of a collection of islands bounded by Wallace's line to the west and Weber's line to the east. Proposed by Dickerson (1928), "Wallacea" appears to be a transition zone between the Oriental and Australasian biogeographical regions. Sulawesi's high density of endemic animal species has been attributed to the fact that, unlike other Indonesian islands that were connected at one time to the Asian or Australian continents, Sulawesi has remained isolated since its original fragments became land positive (Neboiss 1987). Studies of terrestrial animal groups have revealed that areas of endemism also exist within the island (Evans et al. 2003). Due to the limited geographical range of collection data and the relatively small number of described species, the distribution patterns of the Trichoptera groups on Sulawesi are not well understood. Of the 89 described species, only 7% are known outside of Sulawesi (Morse 2001). Furthermore, although approximately 18% of the endemic caddisfly species have been collected from more than one province in Sulawesi, *Lepidostoma* (Lepidostomatidae) is the only genus reported from the four major provinces. Among the non-endemic species, four are known from other areas in the Oriental biogeographical region (Morse 2001) while only two are also found in Australasia (Wells 1990). Until more of the Trichoptera fauna is discovered and described it cannot be known whether these patterns are real or artifacts of sampling effort, thus limiting the contribution of this ecologically important group to future biogeographical studies of "Wallacea."

The genus *Cheumatopsyche* Wallengren 1891 is diverse and cosmopolitan, but our knowledge of its species richness and diversity in Indonesia still is poor compared to other areas in mainland Southeast Asia and Australia. The Indonesian archipelago has 16 described species of *Cheumatopsyche* (Table 1), which constitutes just over 20 percent of the total described Indonesian Hydropsychidae (Morse 2001). Only two species of *Cheumatopsyche* have been described previously from Sulawesi (Malicky 1997). Both species are endemic, but only one has been found in more than one province. Because water pollution is a rapidly intensifying problem in Indonesia

Table 1. Checklist of Indonesian *Cheumatopsyche* (species from Brunei and Malaysian Sarawak are included because these countries are adjacent to Indonesian Kalimantan and collectively constitute the island of Borneo).

Java
C. angusta (Ulmer 1930:445–446, figure 101–103), *Hydropsychodes*
C. brevis (Ulmer 1930:450–451, figure 112–113), *Hydropsychodes*
C. cognita (Ulmer 1951:265–266, figure 374–375), *Hydropsychodes*
C. contexta (Ulmer 1951:270–272, figure 380–381), *Hydropsychodes*
C. globosa (Ulmer 1910:56–58, figure 8–9), *Hydropsyche*
C. kebumena Malicky 1997:1029, plate 5
C. kraepelini (Ulmer 1905:98–99, figure 17–19), *Hydropsychodes*
C. lucida (Ulmer 1907:29–30, figure 43–44), *Hydropsychodes*
Sumatra
C. camena Malicky 1997:1032–1033, plate 7
C. camilla Malicky 1997:1023, plate 1, 3
C. concava (Ulmer 1930:446–447, figure 104–106), *Hydropsychodes*
C. diehli Malicky 1997:1033, plate 7
C. musiana (Ulmer 1951:268–270, figure 359, 378–379), *Hydropsychodes*
C. pulchripennis (Banks 1939:491–492, figure 17), *Hydropsychodes*
C. telensis Malicky 1997:1026, plate 4
Borneo Island
C. chimaira Malicky 1997:1023, plate 3 (Brunei)
C. ernstheissi Malicky 1997:1034, plate 1, 6 (Brunei)
C. maculipennis (Ulmer 1930:449–450, figure 110–111), *Hydropsychodes*
C. stigma Kimmins 1955:390–391, figure 60–62 (Malaysia: Sarawak)
C. *temburonga* Malicky 1997:1027, plate 4 (Brunei)
C. tinjar (Kimmins 1955:391, figure 63–65), *Hydropsychodes* (Malaysia: Sarawak)
C. varia (Kimmins 1955:391–392, figure 66–68), *Hydropsychodes* (Malaysia: Sarawak)
Seram
C. piljanae Mey 1999:144, figure 11–13
C. ceramensis Mey 1999:144, figure 14–16
Sulawesi
C. caprotina Malicky 1997:1023–1024, plate 3 (Central Sulawesi)
C. *charybdis* Malicky 1997:1024–1025, plate 3 (North Sulawesi, Central Sulawesi)
C. praepilata Geraci 2005, n. sp. (North Sulawesi)
C. emas Geraci 2005, n. sp. (North Sulawesi)
C. kali Geraci 2005, n. sp. (North Sulawesi)
C. tenga Geraci 2005, n. sp. (North Sulawesi)

(Marshall 2005) and because hydropsychid caddisflies are important components of biomonitoring programs to detect water pollution in many developed countries (Merritt & Cummins 1996), improving our knowledge of the diversity and distributional patterns of Indonesian *Cheumatopsyche* is timely. We describe four new species of *Cheumatopsyche* from three localities in North Sulawesi (Provinsi Sulawesi Utara). We also provide a checklist of the *Cheumatopsyche* species known from other Indonesian islands, as well as Malaysian Sarawak and Brunei.

Materials and Methods

Adult *Cheumatopsyche* were collected into 80–95% ethanol in December 2004 and July 2005, using alcohol pan traps with ultraviolet light bulbs. Male genitalia were cleared with lactic acid, mounted in glycerin on depression slides and illustrated

using a Wild dissecting microscope with an optical grid (scale bars are indicated on figures). Original pencil drawings were inked digitally using Adobe® Illustrator® CS2 software and a Wacom© Grapphire digital tablet. Type specimens have been deposited in the U.S. National Museum of Natural History, Washington, D.C., U.S.A. (NMNH) and the Clemson University Arthropod Collection, Clemson, South Carolina, U.S.A. (CUAC), as indicated below.

Results

Two new species of *Cheumatopsyche* (*C. emas* Geraci n. sp., and *C. tenga* Geraci n. sp.) were collected only at low elevation localities on the Tenga River, while *C. kali* Geraci n. sp. was found only in small, higher elevation tributaries of the Tondono River basin. *Cheumatopsyche praepilata* Geraci n. sp. appears to be the most widespread species, and was collected at both low elevation sites on the Tondono and Tenga Rivers and at a higher elevation tributary of the Tondono River.

Cheumatopsyche Wallengren, 1891

Cheumatopsyche praepilata Geraci, n. sp.

Diagnosis. This species is similar to *Cheumatopsyche kali* n. sp. in size and in forewing color pattern, but can be diagnosed by the dorsal knob-like projection on the median lobe of the posterior margin of tergum X and by the raised sclerotic ridge on the anterior half of tergum X.

Description (In Alcohol). Head and thorax brown. Forewings brown with white mottling on both costal and anal margins. Coxae and femora brown, tibiae and tarsi light brown. Abdominal terga light brown; abdominal sterna and pleura pale cream.

Wings. Shape and venation characteristic of genus. Male forewing length 5 mm.

Male Genitalia. Segment IX, in lateral view, broad with anterior and posterior margins nearly parallel (Fig. 1a), dorsal margin subtriangular. Tergum X with posterior margin trilobed in dorsal view (Fig. 1b): two, blunt lateral lobes directed slightly mesad and extending beyond median lobe; median lobe wider than either lateral lobe and with raised ovoid knob, blunt posteriorly in lateral view; anterior half of tergum X raised as sinuous, vertical, sclerotized, darkened ridge with broadly curved anterolateral excavation. Inferior appendages each with basal segment long, distal 1/3 bowed mesad and widened slightly in ventral view (Fig. 1c); apical segment short (approximately 1/5 length of basal segment), apex curved mesad. Phallus broad and subquadrate basally in lateral view (Fig. 1a); distal 2/3 straight in lateral view; phallotremal sclerites, in ventral view, each with diamond-shaped convex mesal margin.

Types. Holotype, male: INDONESIA: Sulawesi Utara Province, Minahasa District, Kuwil Village, Tondono River at Kuwil Village bridge (01.44245° N, 124.93018° E), elevation 70 m, 3.xii.2004, coll. C.J. Geraci, M. Meray, M.F. Dien; deposited in NMNH. Paratypes: INDONESIA: same data as holotype, 7 males (NMNH); Sulawesi Utara Province, Minahasa District, Kali Village, Tondono River basin, tributary of Kali Stream across from entrance to Kali waterfall trail (01.39565° N, 124.84271° E), elevation 375 m, 8.xii.2004, coll. C.J. Geraci, M.F. Dien: 1 male (NMNH); Sulawesi Utara Province, Minahasa Selatan District, Tenga Village, Tenga River at Tenga Village bridge (01.06394° N, 124.44313° E), elevation 75 m, 11.xii.2004, coll. C.J. Geraci, M.F. Dien, C. Rante: 2 males (CUAC).

Etymology. Latin "praepilata (-a, -um)," meaning "tipped with a button," which refers to the ovoid knob on the posterior margin of tergum X.

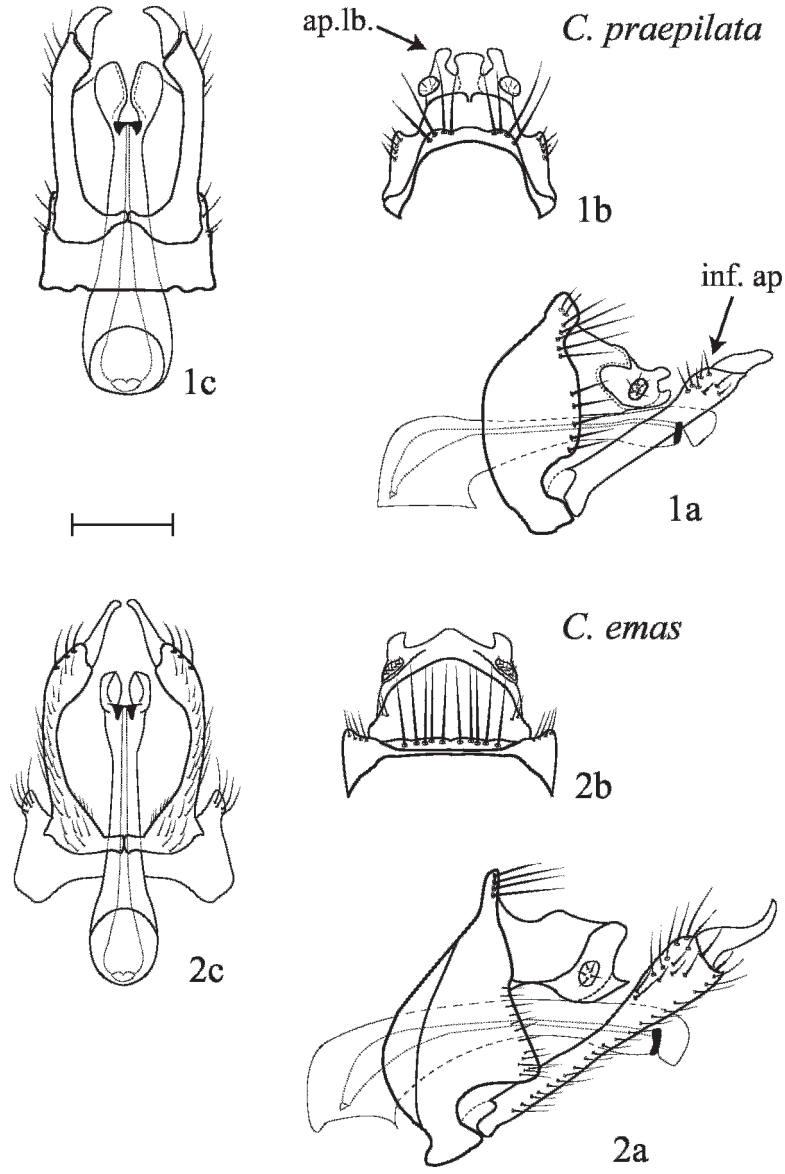

Figure 1. *Cheumatopsyche praepilata*, n. sp., (a) lateral aspect of segments IX and X and phallus of male holotype, (b) dorsal aspect of segments IX and X of male holotype, (c) ventral aspect of segment IX, inferior appendages, and phallus of male holotype, scale bar = 0.2 mm, inf. ap. = inferior appendage, ap. lb. = apicolateral lobe.

Figure 2. *Cheumatopsyche emas*, n. sp., (a) lateral aspect of segments IX and X and phallus of male holotype, (b) dorsal aspect of segments IX and X of male holotype, (c) ventral aspect of segment IX, inferior appendages, and phallus of male holotype scale bar = 0.2 mm.

Cheumatopsyche emas Geraci, n. sp.

Diagnosis. This species is similar to *Cheumatopsyche charybdis* Malicky, but has a longer forewing and differs in the shape of dorsum X and the inferior appendages.

Description (In Alcohol). Head, thorax, and legs golden. Forewings pale yellow with golden hairs, faint white mottling; hind wings pale yellow. Abdomen pale cream.

Wings. Shape and venation characteristic of genus. Male forewing length 11.0–11.5 mm.

Male Genitalia. Segment IX, in lateral view, with large submesal lobe directed caudoventrad, and extending beyond articulation of inferior appendages with basal plate; anterior margin rounded subventrally (Fig. 2a); dorsal portion longitudinally short, forming narrow transverse bridge (Fig. 2b). Tergum X, in lateral view, with shallow concave dorsal and ventral margins near base; posterior margin with apicolateral lobes widely separated from apicomedian lobe and acute apically; anterior 2/3 of segment raised dorsally and delimited posteriorly by vertical sinuate ridge; setal warts, in dorsal view, triangular and diagonally elongate, converging posteromesally; posterior margin with two truncate lateral lobes (Fig. 2b). Inferior appendages evenly bowed mesad; basal segment of each appendage broadened and rounded apically; apical segment hooklike, about 1/3 length of basal segment, distal end directed dorsad in lateral view and directed slightly mesad in ventral view (Fig. 2c).

Types. Holotype, male: INDONESIA: Sulawesi Utara, Minahasa Selatan District, Tenga Village, Tenga River at Tenga Village bridge (01.06394° N, 124.44313° E), elevation 75 m, 11.xii.2004, coll. C.J. Geraci, M.F. Dien, C. Rante; deposited in NMNH. Paratypes: INDONESIA: same data as holotype, 35 males (33 NMNH, 2 CUAC).

Etymology. Bahasa Indonesian "emas," meaning "gold."

Cheumatopsyche kali Geraci, n. sp.

Diagnosis. This species is similar to *C. praepilata* n. sp. in size and wing color pattern, but can be distinguished by the wide median cleft in the posterior margin of tergum X and the lack of a raised dorsal knob.

Description (*In Alcohol*). Head and thorax brown; legs golden brown; abdomen cream. Wings brown; forewing with white mottling and white spots on anterodistal edge.

Wings. Shape and venation characteristic of genus. Male forewing length 6.5 mm.

Male Genitalia. Segment IX anterior margin broadly and evenly rounded, posterior margin produced into submesal lobe, dorsal margin forming short, narrow, transverse bridge dorsally. Tergum X roughly quadrate and globose in lateral view (Fig. 3a), posterior margin with two lateral lobes separated by cleft nearly as wide as either lobe (Fig. 3b). Inferior appendages bowed in ventral view, distal 1/3 of each basal segment directed mesad, apical segments each with mesal margin concave in ventral view (Fig. 3c), tip projected dorsad in lateral view (Fig. 3a).

Types. Holotype, male: INDONESIA: Sulawesi Utara Province, Minahasa District, Kali Village, Tondono River basin, tributary of Kali Stream across from entrance to Kali waterfall trail (01.39565° N, 124.84271° E), elevation 375 m, 8.xii.2004, coll. C.J. Geraci, M.F. Dien; deposited in NMNH. Paratypes: INDONESIA: same data as holotype, 6 males (4 NMNH, 2 CUAC); Minahasa District, Marawas Tributary of Tondono River across from hydroelectric plant, N01.32944, E124.92554, elev 682 m, 7.xii.2004, coll. C.J. Geraci, M. Meray, M.F. Dien: 8 males (NMNH).

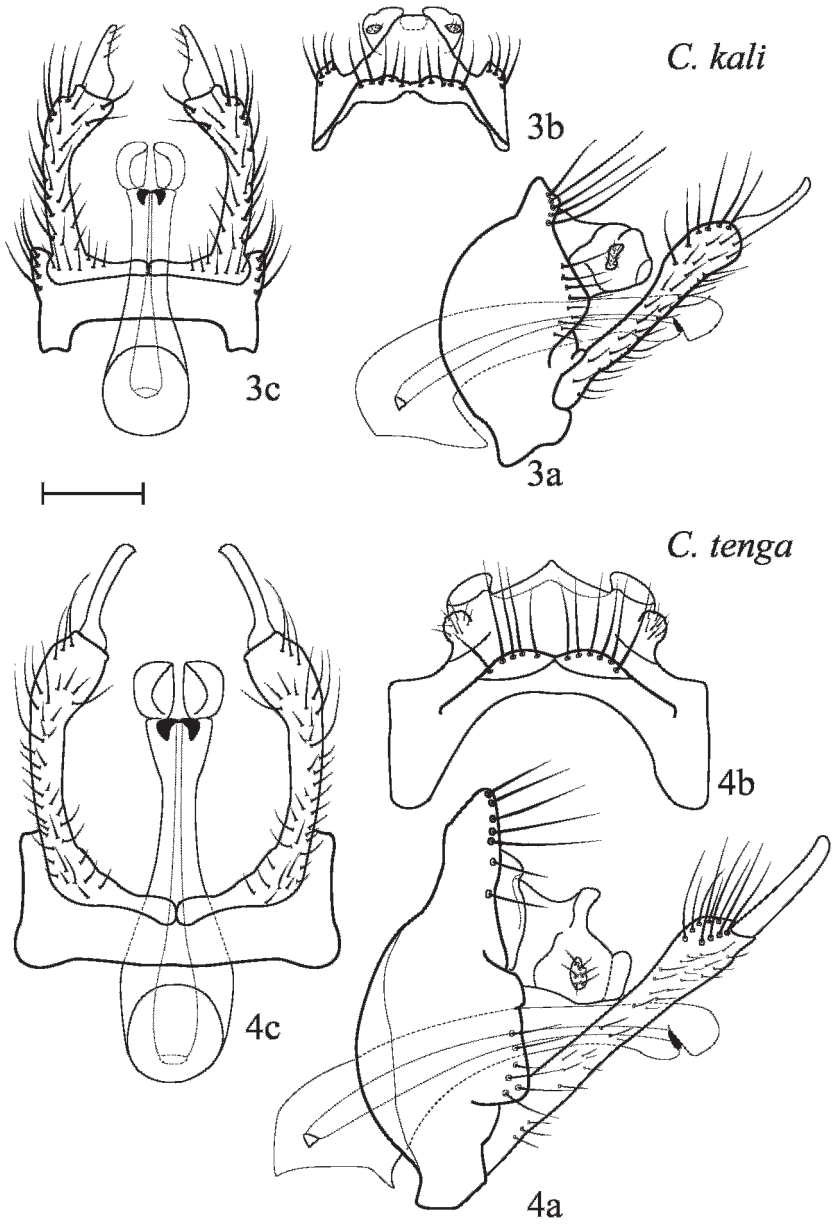

Figure 3. *Cheumatopsyche kali*, n. sp., (a) lateral aspect of segments IX and X and phallus of male holotype, (b) dorsal aspect of segments IX and X of male holotype, (c) ventral aspect of segment IX, inferior appendages, and phallus of male holotype, scale bar = 0.2 mm.

Figure 4. *Cheumatopsyche tenga*, n. sp., (a) lateral aspect of segments IX and X and phallus of male holotype, (b) dorsal aspect of segments IX and X of male holotype, (c) ventral aspect of segment IX, inferior appendages, and phallus of male holotype scale bar = 0.2 mm.

Etymology. Bahasa Indonesian ''kali,'' meaning ''small stream,'' referring to the type locality.

Cheumatopsyche tenga Geraci, n. sp.

Diagnosis. The male genitalia of this species are similar to those of *C. ceramensis* Mey, described from the island of Seram to the east of Sulawesi (Mey 1999). Both species have the posteromesal margin of tergum X lifted dorsally, but *Cheumatopsyche tenga* has a longer forewing and the distal end of its phallotheca is produced ventrally. Illustrations of *C. ceramensis* also do not show the junction of segment IX and tergum X as being weakly sclerotized or membranous, and show the lobe on the posterior margin of segment IX as more rounded than that of *C. tenga*.

Description (In Alcohol). Head, thorax, and legs golden; abdomen cream. Wings golden, forewing with faint mottling.

Wings. Venation characteristic of genus. Forewing length 7.5–7.8 mm.

Male Genitalia. Segment IX, in lateral view, with anterior margins evenly rounded below mesal line, narrowed above mesal line, dorsal portion sloped dorsad posteriorly; posterior margins produced into setose lobe ventrad of mesal line and overlapping or articulating with bases of inferior appendages (Fig. 4a). Tergum X appearing weakly sclerotized or membranous basally beyond junction of terga IX & X; posteromesal margin lifted dorsally and appearing as posteriorly directed horn in lateral view (Fig. 4a); posterior margin, in dorsal view (Fig. 4b), with apicolateral lobes truncate, each with distal portion darkened; apicomesal portion produced, broadly triangular. Inferior appendages each with distal portion of basal segment widened slightly with thick dorsal setae, distal segment 0.4× as long as basal segment (Fig. 4c), slightly curved mesad and tipped with two stout setae. Phallus curved evenly in lateral view, distal end produced ventrad.

Types. Holotype, male: INDONESIA: Sulawesi Utara Province, Minahasa Selatan District, Tenga Village, Tenga River at Tenga Village bridge (01.06394° N, 124.44313° E), elevation 75 m, 11.xii.2004, coll. C.J. Geraci, M.F. Dien, C. Rante, deposited in NMNH. Paratypes: INDONESIA: same data as holotype, 4 males (2 NMNH, 2 CUAC).

Etymology. Named after type locality.

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