Hydrobaenus saetheri Cranston, new species, an aestivating, winter-emerging chironomid (Diptera: Chironomidae) from California

PETER S. CRANSTON¹, GINA M. BENIGNO² AND MARIANNE C. DOMINGUEZ¹

¹Entomology Department, University of California Davis, Davis, CA 95616, USA
E-mail: pscranston@ucdavis.edu
²California Department of Water Resources, 3251 S Street, Sacramento CA 95816 USA

Abstract. A new orthocladiine midge, Hydrobaenus saetheri Cranston, new species, is described from larvae, pupae and adults, evidently belonging to the genus Hydrobaenus Fries. Larvae aestivate over summer, and commence development as soon as wetted when winter-rains induce flow in seasonal waterways. Larvae of this species dominate in the early flow, and adult numbers can reach nuisance levels in mid-winter.

Key words: Chironomidae, Orthocladiinae, Hydrobaenus, new species, California

Introduction

The chironomid genus Hydrobaenus Fries is restricted to the northern hemisphere and includes several species that emerge as adults in mid-winter having developed from aestivating larval cocoons (Saether 1976; Grodhaus 1980; Kondo & Okuda 1990). Some species attain nuisance numbers such as Hydrobaenus kondoi (Sæther) in Japan, described by Kondo (1996) as “enormous swarms of midges have brought serious nuisances: inhalation of dust from dead adults, disturbance to drivers, and invasions of factories and residences in the area”. Other species have been alluded to as emerging in large numbers elsewhere (e.g., for Germany, Steinhart 2000). Amongst reports of aestivating Chironomidae, Grodhaus (1980) mentioned a species of Hydrobaenus from California whose identity has remained unknown. Recently, in a study of fish and their diets in the Yolo Bypass, a winter floodway of the waterways due west of Sacramento (California), a dominant species of chironomid was revealed to emerge abundantly in winter. Indeed, the adult midges are abundant enough to cause nuisance to the vehicle drivers on “the river of cars” (Gary Snyder, unpublished) on the busy Interstate 80. Rehydration of previously summer-dry sediments has revealed early larval instars emerge post-inundation and develop quite rapidly to mid-winter emergent adults. Life history details are provided here from experimental and field observations. All stages are identifiable readily as belonging to Hydrobaenus, but no life history stage matches any previously described taxon. Here the species is described as Hydrobaenus saetheri new species, taking authorship of the senior author alone. The epithet acknowledges Professor Ole A. Sæther’s important resolution of the generic boundaries in this area of previous confusion, and in recognition of his many contributions to systematics of Chironomidae, on the occasion of his 70th birthday.

Material and methods

All specimens came from sites within the Yolo Bypass waterway (Fig. 1), the primary floodplain for the Sacramento River and associated waterways (Sommer et al. 2001). This seasonally inundated flood-control system extends some 61 kms from north to south, is up to 16 km wide and covers some 24,000 hectares. The floodplain is typically inundated at least once annually from the Sacramento River or smaller tributaries during winter or spring in all but the driest of years. All collections were made between November 2004 and late January 2005 by G. M. Benigno. In November 2004 pre-inundation sediment samples 45 x 30 x 10 cm were collected
from summer-dried areas of the Yolo Bypass. Samples were placed in clear plastic bins covered with a 1 mm mesh and flooded to a minimum depth of 10 cm on November 5, 2004. Flooded sediments were exposed to ambient photoperiod and water temperature, which ranged in the bins from 9–14°C. For three weeks after inundation, samples were collected twice weekly using a 100 μm mesh hand net and preserved in 70% ethanol.

Initial inundation of the floodplain occurred in late December, 2004. During the first month of inundation, weekly drift net collections were made from the perennial floodplain channel. Adult midges, often with associated exuviae still attached, and pharate adults especially were intercepted by such drift nets. Samples were fixed in 10% buffered formalin containing Rose Bengal dye and transferred to 70% ethanol for preservation within one month of collection.

Slides were made by clearing in KOH, neutralization in Glacial Acetic Acid, dehydration in Isopropanol and mounting in Euparal. Adults, especially females, predominantly were teneral with incompletely expanded wings, and were collected into formalin which fails to clear and make poor slides. Some larval mounts were made in Hoyers Mountant and ringed with clear nail varnish.


**Institutional abbreviations**

BMNH – British Museum (Natural History), Cromwell Rd, London SW7 5BD, UK.


ZMB – The Natural History Collections, Bergen Museum, Bergen, Norway.

ZSM – Zoologische Staatssammlung, Munchen, Germany.

**Hydrobaenus saetheri** Cranston, new species

**Type material.** Holotype male, slide mounted in Euparal. USA: California, Yolo Co., Causeway, wildlife area, North of I80 freeway, 38°31’27”N 121°35’21”W, 9.xi.2004, G. M. Benigno (USNM). Paratypes: same locality as holotype; 24 L (10 slides, 8 Hoyers), 6 Pe/male, 1 Pe/female, 9 males, 6 females (BMNH, USNM, ZMB, ZSM).

One paratype comprises the voucher for the species (and hence the genus) in an ongoing molecular phylogeny project (Morse & Cranston in prep).

**Male (n = 10)**

Body length 3.8–5.4 mm, wing length 2.6–3.2 mm. Thorax, legs and abdomen brown-black.

Thorax. Antepronotal lobes broadly connected medially, with weak notch. Thoracic setation: 4–6 lateral antepronotals, 2–3 minute acrostichals, 4–9 dorsocentrals, 4–5 prealars, 0 supraalars, 7–9 uniserial scutellars.


Legs. Midleg with pseudospurs on ta₁, LR₁ 0.73–0.96, LR₂ 0.54–0.59, LR₃ 0.50–0.53.

Hypopygium, as in Figure 2A. Gonocoxite 240–260 μm long. Gonostylus 110–118 μm long, with 3–7 apical / subapical megasetae (Fig. 2B)

Female (n = 4)

Body length 3.0–3.8 mm, wing length 2.2–2.5 mm.

Head. Terminal (5th) antennal segment darkened, 120–145 μm long. AR 0.61–0.74. Head with 2–3 frontals, 2–3 strong postorbitals, 9–13 clypeals.

Fig. 2. Hydrobaenus saetheri Cranston, new species, adult. A. – Male hypopygium. B. – Apex of gonostylus. C. – Female genitalia, lateral view. D. – Female genitalia, ventral view, left side.
Thorax. Setation: 4–6 lateral antepronotals, many small hooked acrostichals, 5–8 dorsocentrals, 3–4 prealars, 0 supraalars, 9–10 uniserial scutellars.

Wing. Squama with 18–24 setae, R with 8–10, R₁ with 4–6, and R₄₊₅ with 1–2 setae. V.R. 1.01–1.05.

Legs. LR₁ 0.69–0.72, LR₂ 0.50–0.51, LR₃ 0.50–0.53.

Genitalia (Figs. 2C, 2D). Gonocoxite IX protruding, microtrichiose, with 12–19 setae. Tergite X with 15–21 long setae on each of 2 protrusions. Seminal capsules bicolored (dark in oral 2/3), 135–155 μm long, 62–75 μm wide, elongate-ovoid, without distinct neck; seminal duct with 10–15 μm long microtrichia orally, with strong loop.

Pupa (n = 7)
Length 4.4–5.1 mm.

Cephalothorax 1.06–1.22 mm long. Frons with paired warts, frontal setae c. 120 μm long. Thoracic horn (Fig. 3D) spinose throughout, 350–400 μm

long, maximum width (subapical) 54–68 μm. Antepronotals: 2 dorsal, 90–120 μm long; 1 lateral, 45–55 μm long; 3 pc, 1 thicker and longer, 120–140 μm long; 2 short and thin, 35–45 μm long; dorsocentrals evenly spaced on mid-thorax, dc 10–20 μm long, dc1σ, 50–55 μm long.

**Abdomen.** Tergites as in Figure 3E. L-setae of T IV and V non-taeniate, VI with 3 taeniate L-setae, VIII with 4 (rarely 3) taeniate L-setae; L4 located very posteriorly on III–VII. Anal lobe fringe with 24–30 setae; 3 macrosetae of maximum length 325–400 μm. Genital sacs extending slightly but distinctly beyond anal lobe.

**Larva (n = 14)**

Body length 5.9–8.5 mm, color uncertain (preserved stained pink).

**Head capsule.** Length 400–550 μm, yellow-brown with occipital margin dark, mental, mandibular and premandibular teeth brown-black. Mentum (Fig. 3A) 133–188 μm wide, ventromental plate maximum 15–20 μm wide. Antenna (Fig. 3B) segment lengths (in μm): 60–77.5, 12.5–18.75, 5–8, 5, 3.75–5. AR 1.85–2.95. Blade 25–35 μm long. Lauterborn organs subequal to segment 3 in length. Labrum with SI seta c. 50 μm long, with 6–8 coarsely plumose branches; S II stout, 75 μm long, S III minute, S IV short. Premandible with 2 dark apical teeth, 172–205 μm long. Mandible (Fig. 3C) 140–175 μm long.


**Systematics**

Adult males broadly conform to generic diagnoses (Sæther 1976; Cranston et al. 1989) with additional species (Sæther 1989), except for the virtual absence of acrostichals (a pale elongate oval area in the mid-third of the thorax may enclose few very short, perhaps curved, setae), the virga is indistinct, and the gonostylus, uniquely in the genus, bears several megasetae (Fig. 2B). The female adult conforms to Sæther’s (1976) description. The pupa and larvae both key to Hydrobaenus and match completely the diagnoses of Sæther (1976), Coffman et al. (1986, pupa) and Cranston et al. (1983, larva).

Six species groups are recognized for adults (Sæther 1976; Cranston et al. 1989), with fewer and less clearly delimited groups for the immature stages. Based on the normal palp and antenna, non-triangular gonostylus without crista dorsalis, weak anal point, and measures / counts (based on essentially overlapping numbers) the adult male keys to the pilipes group. Based on distribution and length of L-setae, smooth genitalic sheath without terminal papilla and mensural features the pupa keys to the rufus / lugubris group, conforming to the latter except for the longest anal lobe fringe seta being longer and posterior-most amongst the macrosetae. Keys to larval species groups are inadequate, but the coarsely plumose SI seta may be indicative of the pilipes group. That *H. saetheri* does not fit comfortably into any one species group in all life history stages may be unsurprising given the inability to recover these groups in numerical cladistic analyses (Cranston & Humphries 1988).

**Ecology**

*Hydrobaenus saetheri* appears to be a dominant species in the seasonally-inundated floodplains of the Sacramento River. In Yolo Bypass, sampling during 1998–2005 revealed that *Hydrobaenus* dominates the chironomid fauna during flood. Larval *H. saetheri* appear rapidly after inundation and are maintained at relatively high levels throughout flood events (Sommer et al. 2004). Abundance trends correlate closely with flow, probably as a result of increased seasonal inundation of terrestrial habitats at higher flows. *H. saetheri* larvae emerged from 18 of 24 (75%) rehydrated floodplain sediment samples from throughout the Yolo Bypass. Co-occurring Chironomidae, one species each of *Limnophyes*, *Goeldichironomus* and *Paratanytarsus*, were uncommon. Mandible length measurements indicate that larval *H. saetheri* collected four days after experimental rehydration were second and third instar larvae and fourteen days after rehydration all larvae collected were in fourth instar. This suggests emergence from a desiccation-resistant resting stage (likely a cocoon) upon rehydration is followed by rapid maturation.

Emergence of *H. saetheri* larva from floodplain sediments was observed also in the field. In shallow, slow-flowing floodplain waters, drift net samples two and three weeks after initial inundation of the floodplain collected 183 and 320 larvae per m³, respectively. In the faster flowing main drainage channel of the floodplain, very high densities (up to 550 per m³) of incompletely-emerged adults were collected from drift nets. Drifting larvae are a major prey item for native fishes, which rely on Yolo Bypass as nursery habitat (Moyle et al. 1986; Cranston et al. 1986).
et al. 2004; Sommer et al. 2001). As a consequence of the exceptional production of Hydrobaenus in the Yolo Bypass, feeding success of young fish is superior to that of adjacent perennial rivers. Hatching of pupae from the drift creates dense swarms of adults, providing additional prey for aquatic and terrestrial food webs. During the drier summer and autumn months, the species evidently is sustained by aestivating larval cocoons in floodplain soils.

Several other species of Hydrobaenus can take advantage of temporary aquatic conditions by producing desiccation-resistant cocoons as 2nd or 3rd instar larvae (Sæther 1976; Grodhaus 1980; Kondo & Okuda 1990). An unidentified Hydrobaenus species was reported from cocoons in dried sediments from Northern California vernal pools (Grodhaus 1980). Larvae removed from cocoons were 2nd instar, and laboratory-reared larvae built cocoons when they reached second instar regardless of moisture conditions, suggesting an obligatory diapause period regardless of hydrologic conditions (Grodhaus 1980). This material appears lost, since it is not in the modest Grodhaus collection housed in the Essig Museum, Berkeley. Two visits to a vernal pool Grodhaus studied (CA: Siskiyou Co., Murphy Well, 41°40’N 125°07’W) in mid-summer 2005 revealed no cocoons in apparently suitable (winter-wet vernal) soil, no larvae developed on inundation, and neither were Hydrobaenus present in the farm pond created at the site (apparently since Grodhaus’ visits). Thus, we cannot equate the new taxon described here with that studied by Grodhaus.

Acknowledgements

We thank Ted Sommer (California Department of Water Resources) for drawing our attention to this phenomenon, for funding Gina Benigno’s ecological studies and for permission to include otherwise unpublished data on the Yolo Causeway ecosystem. Marianne Dominguez’s examination of specimens and excellent drawings were funded from the Evert Schlinger endowment for systematic entomology to the senior author. Finally, it gives us pleasure to dedicate this contribution to Professor O.A. Sæther for collaboration, intellectual debate on phylogenetics, and above all for providing the scientific community with a phylogenetic and taxonomic framework within which to make so many observations on Chironomidae.

References

Sæther, O.A. (1976) Revision of Hydrobaenus, Trissocladus, Zalutschia, Paratrisocladus, and


Accepted: 8 February 2006.