



Chironomus gelhausi, a new species of surface-mating *Chironomus* Meigen, 1803 (Diptera: Chironomidae) from Mongolia

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Abstract

The adult male and female of *Chironomus gelhausi* n. sp. are described from a small lake in western Mongolia. Based on field observations and morphological characters, *C. gelhausi* is a surface-mating species which has retained the ability to fly. Morphological characteristics associated with surface-mating in this species include apically truncated wings, reduced antennal plume in the male, reduced palps, reduced mid and hind leg length, and enlarged hypopygium. Behavioral observations and morphology of *C. gelhausi* indicate that this species is a species of *Chironomus* which has independently evolved morphological characteristics consistent with surface-mating behavior similar to that of *Fleuria* and other species within *Chironomus sensu lato*. We can assume that this behavior and the associated morphological characteristics are related to survival in a harsh environment where high winds could displace aerial mating swarms from the larval habitat.

Key words: non-biting midges, Chironominae, *Chironomus sensu lato*, skating, Great Lakes region of Mongolia

Introduction

Most Chironomidae form aerial-mating swarms although a small fraction of species mate on substrates or on the water's surface (Fedorova & Zhantiev 2009). Surface mating and skating is common in marine dipteran species (Neumann 1976, Qi *et al.* 2018) although this behavior is also observed in some winter-emerging species and species occurring at high elevations and latitudes (Ferrington & Sæther 1987, Bouchard & Gelhaus 2020). Based on the distribution of surface-mating species, it is hypothesized that this behavior is associated with survival in environments with harsh conditions (e.g., low air temperatures) or to avoid displacement from the larval habitat due to high winds (Danks 1981). In Chironomidae, this behavior occurs on all continents and is found in many different lineages including distantly related taxa such as *Bryophaenocladus* Thienemann (Epler 2012); *Corynocera* Zetterstedt (Cranston *et al.* 1989), *Diamesa* Meigen (Serra-Tosio 1974, Hansen & Cook 1976), *Dicrotendipes* Kieffer (Qi *et al.* 2018), *Fleuria* Kieffer (Song *et al.* 2017), *Oliveridia* Sæther (Ferrington & Sæther 1987), *Orthocladus* v. d. Wulp (Soponis 1983), *Telmatogeton* Schiner (Cranston 1989), and *Zealandochlus* Brundin (Brundin 1966). This behavior is often accompanied by morphological characteristics including reductions in the wings, antennae, palps, and legs and an enlargement of the hypopygium. The reductions or loss of structures are hypothesized to be a means to conserve energy due to a loss of their function in cold or harsh environments (Byers 1969, Danks 1981). For example, wings are not needed if air temperatures are below the threshold for flight (Byers 1969) or plumose antennae are not needed if there is no aerial swarming behavior where the males use their antennae to identify conspecific females (Fedorova & Zhantiev 2009). However, some structures may also be modified to improve their function such as the legs and wings for propulsion on the water's surface or enlargement of the hypopygium due to differences in mating position or mating behavior compared to aerial-mating species. We describe the male and female of an unusual species in the genus *Chironomus* Meigen with several morphological characteristics consistent with surface mating.

This publication also provides information on what is known of the ecology and distribution of this new species and describes possible strategies for this species in a harsh environment.

Methods, material, and terminology

Specimens were preserved in 75% ethanol and slide mounted in Euparal following the procedure described by Pinder (1989). Morphological nomenclature followed that of Sæther (1980). The following abbreviations and morphological measures were used: AR (antennal ratio) = length of 11th flagellomere/length of flagellomeres 1–10; VR (venarum ratio) = length of cubitus (Cu)/length of media (M); BV = length of (femur + tibia + ta₁)/length of (ta₂ + ta₃ + ta₄ + ta₅); LR = leg ratio, length of ta₁/length of tibia; SV = length of (femur + tibia)/length of ta₁; HR = hypopygium ratio, length of gonocoxite/length of gonostylus; HV = hypopygium value, total length (TL)/length of gonostylus times ten; P₁ = fore leg; P₂ = mid leg; P₃ = hind leg; fe = femur; ti = tibia; ta₁...ta_n = 1st tarsus... nth tarsus; R = radius; R₁: Radius 1 vein; R₄₊₅ = radius 4+5 vein; UMSP = University of Minnesota Insect Collection, Saint Paul, Minnesota, USA; ANSP = Academy of Natural Sciences, Philadelphia, Pennsylvania, USA. Total length (TL) was measured as the length of the abdomen (measured from the concave anteriomedian margin of segment I to the apex of the gonostylus) plus the length of the thorax (measured from the posterior margin of the postnotum to the anterior apex of the scutum in lateral view). Wing length (WL) was measured as the length from arculus to apex of wing.

Description of new species

Chironomus gelhausi Bouchard sp. nov.

Type material. *Holotype*: MONGOLIA, Hovsgol Aimag, Moron Soum, Tunamal Nuur, 5.5 km west of Arbulag, N 49.89920, E 99.39433, 1871 m, 7.vii.2006, leg. J.K. Gelhaus, 1 male (UMSP).

Allotype: MONGOLIA, Hovsgol Aimag, Moron Soum, Tunamal Nuur, 5.5 km west of Arbulag, N 49.89920, E 99.39433, 1871 m, 7.vii.2006, leg. J.K. Gelhaus, 1 female (UMSP).

Paratypes: MONGOLIA, Hovsgol Aimag, Moron Soum, Tunamal Nuur, 5.5 km west of Arbulag, N 49.89920, E 99.39433, 1871 m, 7.vii.2006, leg. J.K. Gelhaus, 14 males, 2 females (UMSP [10 males, 1 female], ANSP [4 males, 1 female]).

Etymology. Named for Jon K. Gelhaus, the collector of the material used for this study and a friend and colleague of the authors. Jon Gelhaus was also influential in setting the first author (RWB) on the path of studying insects and Diptera in particular.

Diagnostic characters. Males can be separated from other Chironomini by the combination of the following: fused anteprenotal lobes; pulvilli present; antenna with 11 flagellomeres; well-developed inferior and superior volsellae; setae on the base of the superior volsella; inferior volsella distally and dorsoventrally broadened, but not greatly expanded as in most *Kiefferulus*; and lack of median setae on anal tergite. More specifically, males can be separated from other species of *Chironomus s. lat.* (see treatment of taxonomy in “Remarks” section) by the combination of the following: large, conical frontal tubercles; antennae lacking typical plume; an apical truncation of the wing; AR 1.27–1.70; shortened palps; mid and hind tarsi reduced; long inferior volsellae extending well beyond gonostylus; parallel-sided anal point which rapidly constricts distally into a small point; setae present on ventral side of extension of superior volsellae; and lack of median setae on anal tergite. Females can be separated from other Chironomini by the following: squama with setae; antenna with 5 flagellomeres; palps with 5 segments; pulvilli present; front tibia with low, rounded scale; mid and hind tibia with 2 spurs; gonocoxapodeme rounded and not joined mesally; lack of setae on gonocoxite IX; gonapophyses VIII divided into dorsomesal lobe and well-developed ventrolateral lobe; cerci large; and segment X expanded forming a collar around basal half of cerci although not as well developed as in *Fleuria*. More specifically, females can be separated from other species of *Chironomus s. lat.* by the combination of the following: large, conical, frontal tubercles; reduced palps; an apical truncation of the wing; mid and hind tarsi reduced; gonocoxite IX without seta; apodeme lobe weak, without microtrichia; and segment X with more than 20 setae.

Description

Male imago (n=15, unless otherwise stated). Total length 8.40–13.47, 9.80 mm (n=14). Wing length 3.79–4.32, 4.15 mm. Total length/wing length 1.98–3.21, 2.36 (n=14). Wing length/length of profemur 3.99–6.09, 4.48 (n=14). Coloration brown to pale brown (alcohol preserved specimens), wings hyaline and without markings.

Antenna (n=6) (Fig. 1A). Antennae missing from most specimens. Antenna with 11 segments and antennal plume reduced; AR 1.27–1.70, 1.54. Ultimate flagellomere 629–815, 737 μm long. Longest antennal seta 183–363, 275 μm long (n=4), most setae missing in some specimens.

Head (Fig. 1B). Temporal setae 17–35, 28 μm ; including 3–8, 5 inner verticals, 6–14, 10 outer verticals, and 7–16, 13 postorbitals. Clypeus with 5–22, 16 setae. Frontal tubercle 88–153, 114 μm high, 105–170, 139 μm wide, well developed and conical shaped with apical end constricted (Fi. 1B). Frons covered in dense microtrichia with microtrichia longest on frontal tubercles. Tentorium, stipes and cibarial pump as in Figure 1C. Tentorium 230–325, 281 μm long; 55–84, 68 μm wide at sieve plate and 40–70, 55 μm wide at tentorial pit. Stipes 175–294, 267 μm long; 10–17, 14 μm wide. Palp segment lengths (n=12): 75–124, 92; 60–90, 75; 198–278, 235; 51–270, 141; 116–153, 131. Third palpomere (Fig. 1D; n=14) with 11–19, 15 sensilla, longest 10–24, 16 μm long.

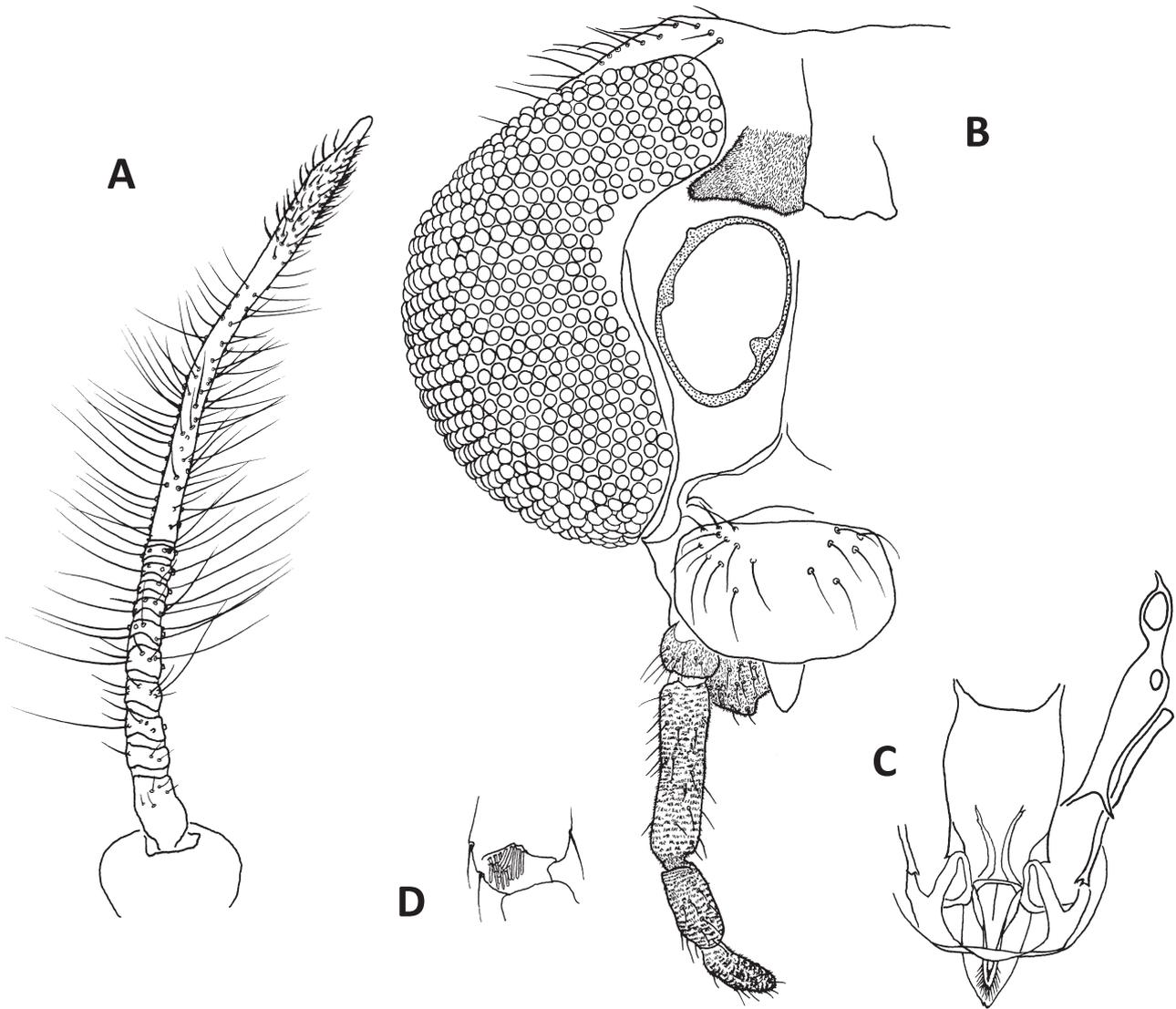


FIGURE 1. *Chironomus gelhausi* n. sp. male. A—antenna; B—head; C—cibarial pump; D—distal end of third palpomere.

Thorax. Tubercle well developed. Anteprepronotum with no setae. Dorsocentrals 10–19, 15, all short and decumbent; acrostichals 6 (n=1), all short and decumbent, starting midway between anteprepronotum and tubercle, typically not visible when laterally mounted although two setal scars were apparent on tubercle on one specimen; prealars 7–11, 9. Scutellum with 6–15, 10 setae.

Wing (Fig. 2A). Apical tip of wing truncated; VR 1.02–1.11, 1.07. Brachiolum with 3–5, 4 setae; R 18–27, 24; R₁ with 0 setae; R₄₊₅ with 2–8, 4 setae; other veins and cells bare. Squama with 13–26, 18 setae.

Legs (Figs. 2B, C). Mid and hind legs reduced in length (Fig 2B). Scale of fore tibia 24–60, 43 µm long (Fig 2C); spur of mid tibia 29–53, 41 µm long; spur of hind tibia 30–59, 43 µm long (Fig 2C) although hind tibia spur reduced or missing on some specimens. Comb on mid tibia 18–31, 24 µm long, with width of combs on mid tibia similar; comb on hind tibia 18–38, 25 µm long, one comb on hind tibia much wider than the other (Fig 2C). Width at apex of fore tibia 145–175, 161 µm; width at apex of mid tibia 120–189, 170 µm; width at apex of hind tibia 160–213, 193 µm. Lengths and proportions of legs as in Table 1.

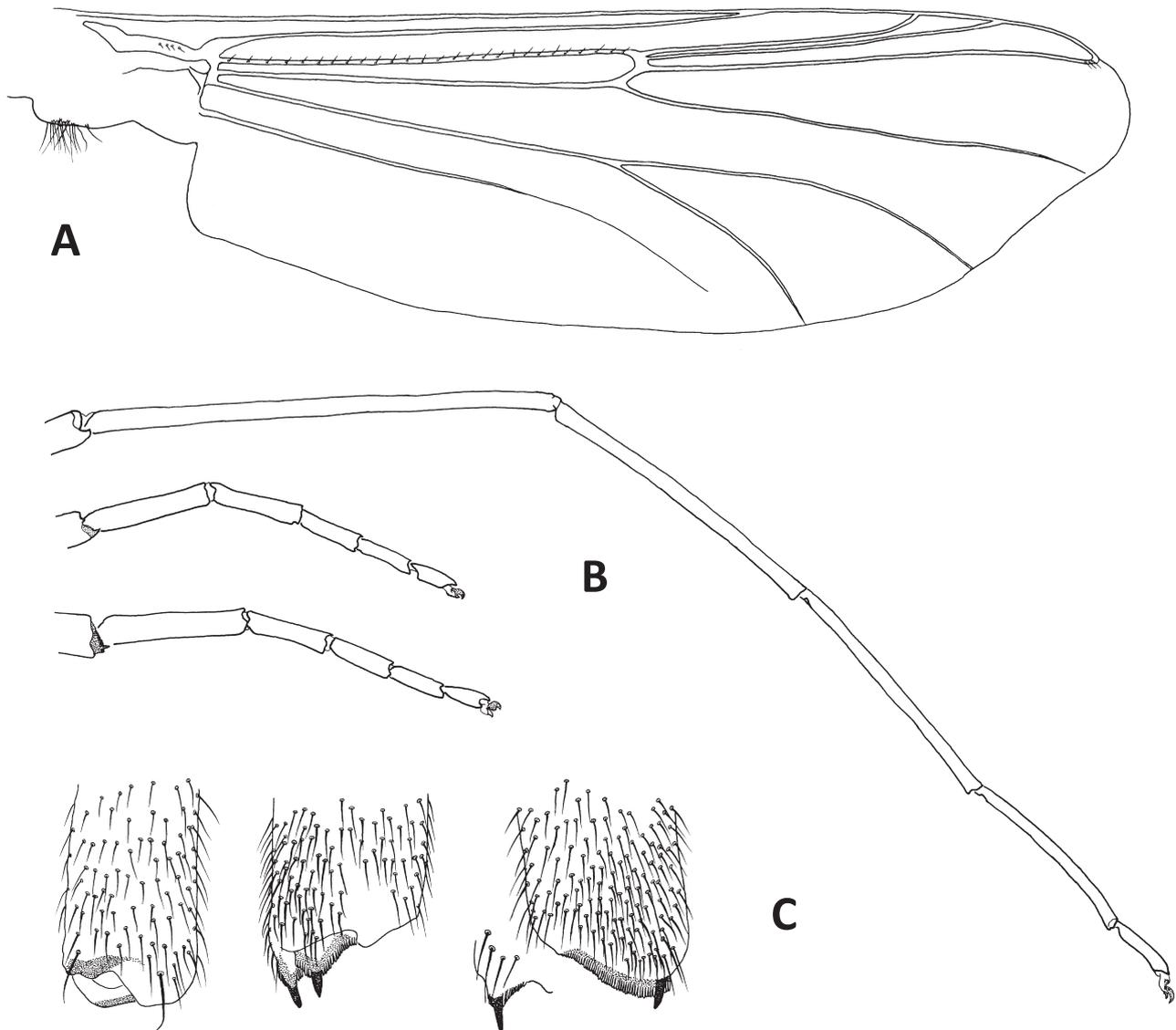


FIGURE 2. *Chironomus gelhausi* n. sp. male. A—wing; B—fore, mid, and hind tarsi; C—apex of fore, mid, and hind tibiae.

Hypopygium (Fig. 3). Rotated up to 180° in all specimens examined. Tergite IX covered with microtrichia, with no median setae anterior of the anal point and 39–61, 50 setae on each side of base of anal point (Fig. 3E); anal tergite bands forming a shallow “U” and not reaching the base of anal point (Fig. 3A). Laterosternite IX with 0 setae. Anal point broad, parallel-sided and rapidly constricting to a small point, 92–115, 104 µm long, 40–78, 65 µm wide at base, 59–78, 69 µm wide medially, 5–15, 11 µm wide near apex; T-shaped in cross section. Transverse sternapodeme 390–525, 468 µm long, nearly straight (Fig. 3B). Phallapodeme 445–636, 556 µm long. Superior volsella and 280–380, 340 µm long, 76–125, 101 µm wide at base, 24–54, 40 µm wide at apex, with 27–38, 31 setae on the ventral side and extending to approximately the midpoint of the medially directed extension; dorsal side of the superior volsella with microtrichia only present on base and ventral side with microtrichia extending approximately 2/3 of the superior volsellae (Fig. 3C). Median volsella absent. Inferior volsella extending beyond apex of gonosty-

lus 662–1118, 902 μm long, 48–145, 70 μm wide at base, 66–194, 115 μm wide at apex, dorsoventrally expanded distally, and covered with numerous simple, stout setae (Fig. 3D). Gonocoxite 403–732, 558 μm long. Gonostylus 414–690, 538 μm long, robust, dorsoventrally expanded, and with numerous stout setae, especially on the inner margin (Fig. 3D). HR 0.79–1.22, 1.04. HV (n=14) 1.42–2.65, 1.87.

TABLE 1. Lengths (in μm) and proportions of legs of *Chironomus gelhausi* n. sp. male (n = 15).

	fe	ti	ta ₁	ta ₂
p ₁	1982–2405, 2188	1896–2276, 2095	1998–2426, 2227	1290–1711, 1452
p ₂	1790–2986, 2052	1825–2195, 2036	611–734, 663	361–466, 421
P ₃	1954–2393, 2160	1848–2320, 2099	649–854, 738	404–473, 429
	ta ₃	ta ₄	ta ₅	
p ₁	1055–1425, 1186	817–1173, 929	361–490, 400	
p ₂	320–386, 348	250–310, 272	226–264, 244	
P ₃	310–379, 345	250–303, 271	225–264, 241	
	LR	BV	SV	BR
p ₁	1.02–1.13, 1.06	1.42–1.76, 1.65	1.82–2.02, 1.93	0.52–0.90, 0.62
p ₂	0.30–0.36, 0.33	3.51–4.49, 3.70	5.49–7.67, 6.17	0.37–0.54, 0.48
P ₃	0.30–0.38, 0.35	3.72–4.20, 3.89	5.49–6.41, 5.78	0.34–0.60, 0.48

Female imago (n=3, unless otherwise stated). Total length 8.53–9.24, 8.79 mm. Wing length 5.02–5.24, 5.11 mm. Total length/wing length 1.64–1.84, 1.72. Wing length/length of profemur 4.32–5.07, 4.63. Coloration as in male.

Antenna (Fig. X). AR 0.51–0.67, 0.57. Flagellomere lengths (in μm): 234–264, 245; 123–130, 127; 114–121, 117; 128–143, 133; 303–400, 353. Longest antennal seta 129–170, 150 μm long.

Head (Fig. X). Well-developed conical frontal tubercles, frontal tubercle 59–86, 76 μm high, 91–100, 96 μm wide, with conspicuous microtrichia. Frons as in male. Temporal setae 22–25, 24; including 3–4, 3 inner verticals, 9–11, 10 outer verticals, and 8–13, 10 postorbitals. Scapus setae 0–8, 5. Clypeus with 22–33, 28 setae. Tentorium 275–311, 292 μm long; 49–85, 64 μm wide at sieve plate and 31–50, 40 μm wide at tentorial pit. Stipes 270–296, 283 μm long; 10–16, 13 μm wide. Palp segment lengths (n=2; in μm): 79–104, 92; 55–80, 68; 226–275, 251; 128–130, 129; 136–173, 155. Third palpomere (n=2) with 19–26, 23 sensilla, longest 11–15, 13 μm long.

Thorax. Tubercle well developed. Anteprepronotum with no setae. Dorsocentrals 13–19, 15, all short and decumbent; apparently 0 acrostichals, although they may not be visible in laterally mounted specimens as in the male; prealars 7–9, 8. Scutellum with 7–16, 11 setae, uniserial.

Wing. Apical tip of wing truncated as in male; VR 1.08–1.13, 1.10. Brachiolum with 3–4, 4 setae; R with 29–35, 32 setae; R₁ with 1–11, 5 setae; R₄₊₅ with 13–24, 18 setae; other veins and cells bare. Squama with 14–17, 16 setae.

Legs. Mid and hind legs reduced in length. Scale of fore tibia 33–45, 37 μm long; spur of mid tibia 40–44, 41 μm long; spur of hind tibia 31–34, 33 μm long (n=2). Comb on mid tibia 20–25, 23 μm long, with width of combs on mid tibia similar; comb on hind tibia 22–23, 23 μm long (n=2), one comb on hind tibia much wider than the other. Width at apex of fore tibia 125–135, 130 μm ; of mid tibia 154–165, 158 μm ; of hind tibia 179–187, 182 μm . Lengths and proportions of legs as in Table 2.

Abdomen. Tergite VIII with 32–37, 34 setae. Sternite VIII with 122–179, 149 setae and no lateral setae.

Genitalia (Fig. 4). Gonocoxite IX without setae. Tergite IX with 51–56, 53 setae. Gonocoxapodeme rounded and not joined mesally. Segment X expanded forming a collar around basal half of cerci with 64–78, 71 setae. Cercus large, expanded anteriorly and irregularly shaped, 355–424, 393 μm long. Seminal capsule 273–346, 320 μm long and 194–241, 217 μm wide. Notum 367–383, 376 μm long. Gonapophyses VIII divided into a dorsomesal lobe and well-developed ventrolateral lobe; apodeme lobe weak, without microtrichia.

Pupa: unknown

Larvae: unknown

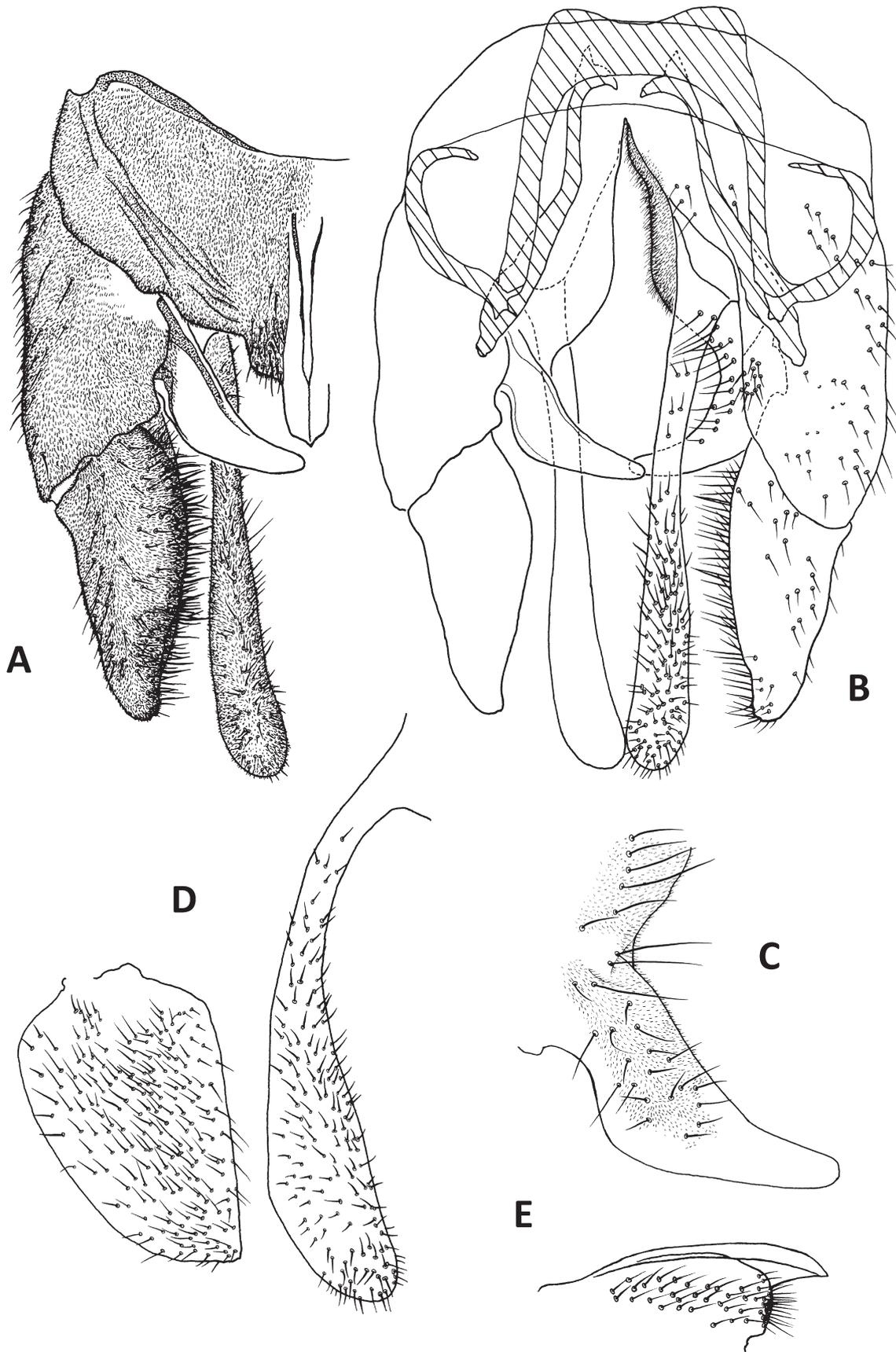


FIGURE 3. *Chironomus gelhausi* n. sp. male. A—hypopygium, dorsal view; B—hypopygium with anal point and tergite IX removed, dorsal aspect to the left and ventral aspect to the right; C—ventral view of superior volsella; D—lateral view of gonostylus (left) and inferior volsella (right); E—anal point, lateral view.

TABLE 2. Lengths (in μm) and proportions of legs of *Chironomus gelhausi* n. sp. female (n = 3, unless otherwise noted).

	fe	ti	ta ₁	ta ₂
p ₁	1821–1821, 1989	1817–1817, 1962	1839–1766, 1906	973–973, 1176
p ₂	1958–1958, 2158	2017–2017, 2309	768–738, 803	479–479, 551
P ₃	2165–2165, 2411	2288–2260, 2480	1276–1276, 1445 (n=2)	853–853, 973 (n=2)
	ta ₃	ta ₄	ta ₅	
p ₁	771–728, 821	648–609, 684	336–322, 358	
p ₂	405–404, 454	313–313, 338 (n=2)	230–230, 249 (n=2)	
P ₃	671–671, 755 (n=2)	471–471, 530 (n=2)	266–266, 304 (n=2)	
	LR	BV	SV	BR
p ₁	1.01–0.97, 1.01	2.01–1.93, 2.01	1.98–1.98, 2.10	0.81–0.81, 0.99
p ₂	0.38–0.35, 0.38	3.32–3.31, 3.32 (n=2)	5.18–5.18, 5.61	0.99–0.61, 0.99
P ₃	0.56–0.56, 0.58 (n=2)	2.53–2.47, 2.53 (n=2)	3.49–3.38, 3.49 (n=2)	0.75–0.75, 0.76 (n=2)

Remarks. Currently, we lack consensus regarding the placement and status of *Chironomus* subgenera and closely related genera (Cranston *et al.* 1989, Martin *et al.* 2007, Epler *et al.* 2013) which complicates placement of *C. gelhausi*. Cranston *et al.* (1989) recognized several subgenera (i.e., *Camptochironomus*, *Lobochironomus*, *Chaetolabis*, and *Chironomus s. str.*). *Fleuria* and *Baeotendipes* are included as separate genera in Cranston *et al.* (1989), but this publication also noted that these two genera are probably subordinate within *Chironomus*. Epler *et al.* (2013) treats *Baeotendipes* and *Fleuria* as part of *Chironomus s. lat.* although it is also noted that inclusion of *Fleuria* with *Chironomus* does not imply synonymy. In addition, Epler *et al.* (2013) indicated that *Camptochironomus* should be synonymized with *Chironomus s. str.* which is supported by molecular studies of phylogenetic relationships within the genus (Guryev *et al.* 2001, Martin *et al.* 2007). Although a fuller description of the status of *Chironomus* and closely related genera is beyond the scope of this paper, it is relevant to the generic placement of *C. gelhausi*. Here we follow the classification of Martin *et al.* (2007) and Epler *et al.* (2013) where *Chironomus s. lat.* consists of the subgenera *Chironomus s. str.*, *Chaetolabis*, and *Lobochironomus* (including *Einfeldia* Group C). The genus *Chironomus s. lat.* also includes “*Baeotendipes*” which may be part of *Chironomus s. str.* or a separate subgenus. The taxa *Fleuria* and *Benthalia* (*Einfeldia* species group B) are considered to likely be distinct genera closely related to *Chironomus*.

In addition to our lack of consensus regarding the placement and status of *Chironomus* subgenera and closely related genera, the placement of *C. gelhausi* is complicated by several morphological characteristics which are apparently unusual due to its surface-mating habit. It has been demonstrated that in other surface mating Chironomidae taxa with highly specialized morphology, placement into a genus using only morphology can be problematic (e.g., Andersen *et al.* 2016, Qi *et al.* 2018). However, the morphology in *C. gelhausi* is not so specialized for surface mating to make generic placement ambiguous, particularly within the broader concept of *Chironomus s. lat.* (*sensu* Epler *et al.* 2013). As such, *C. gelhausi* fits reasonably well within the diagnosis for the genus *Chironomus*. The following characters for *C. gelhausi* are consistent with the adult male diagnosis for *Chironomus s. lat.* in Cranston *et al.* (1989): 11 flagellomeres; fused anteprenotal lobes; pulvilli present; well-developed inferior and superior volsellae; and setae on the base of the superior volsellae. This species differs from the *Chironomus s. str.* diagnosis in Cranston *et al.* (1989) in that setae are present on the ventral side of the extension of the superior volsella which is bare in other *Chironomus s. str.* species. Although superior volsellae differ in shape between *C. gelhausi* and *Chironomus* (*Chaetolabis*), both taxa possess setae on the ventral side of the superior volsellae indicating that this character occurs within *Chironomus s. lat.* In addition, median anal tergite setae are absent in *C. gelhausi* which is unusual in *Chironomus s. lat.*; however, these setae are also absent in some surface-mating *Chironomus s. str.* species (e.g., *Chironomus pallidivittatus* Malloch and *Chironomus tepperi* Skuse) (Cranston *et al.* 1989, Martin 2022). The mean antennal ratio for males of *C. gelhausi* was only 1.54 which differed from the diagnostic antennal ratios for *Chironomus s. lat.* (greater than 2.0; Cranston *et al.* 1989) and “*Baeotendipes*” (approximately 2.0; Cranston *et al.* 1989). However, the lower antennal ratio is also observed in other surfacing mating taxa (e.g., *Fleuria* antennal ratio = 0.64; Song *et al.* 2017). Thus, there is no discrepancy placing *C. gelhausi* in *Chironomus s. lat.* if the lower antennal ratio in *C. gelhausi* can be attributed to its surface-mating habit. Similarly, *C. gelhausi* differs from the diagnoses for most other *Chironomus* species (Cranston *et al.* 1989) by possessing reduced palps, reduced mid and

hind legs, and a robust gonostylus densely covered with setae on the inner margin. However, some or all of these characters are also observed in some *Chironomus s. str.* and “*Baeotendipes*” species and can presumably be attributed to surface mating.

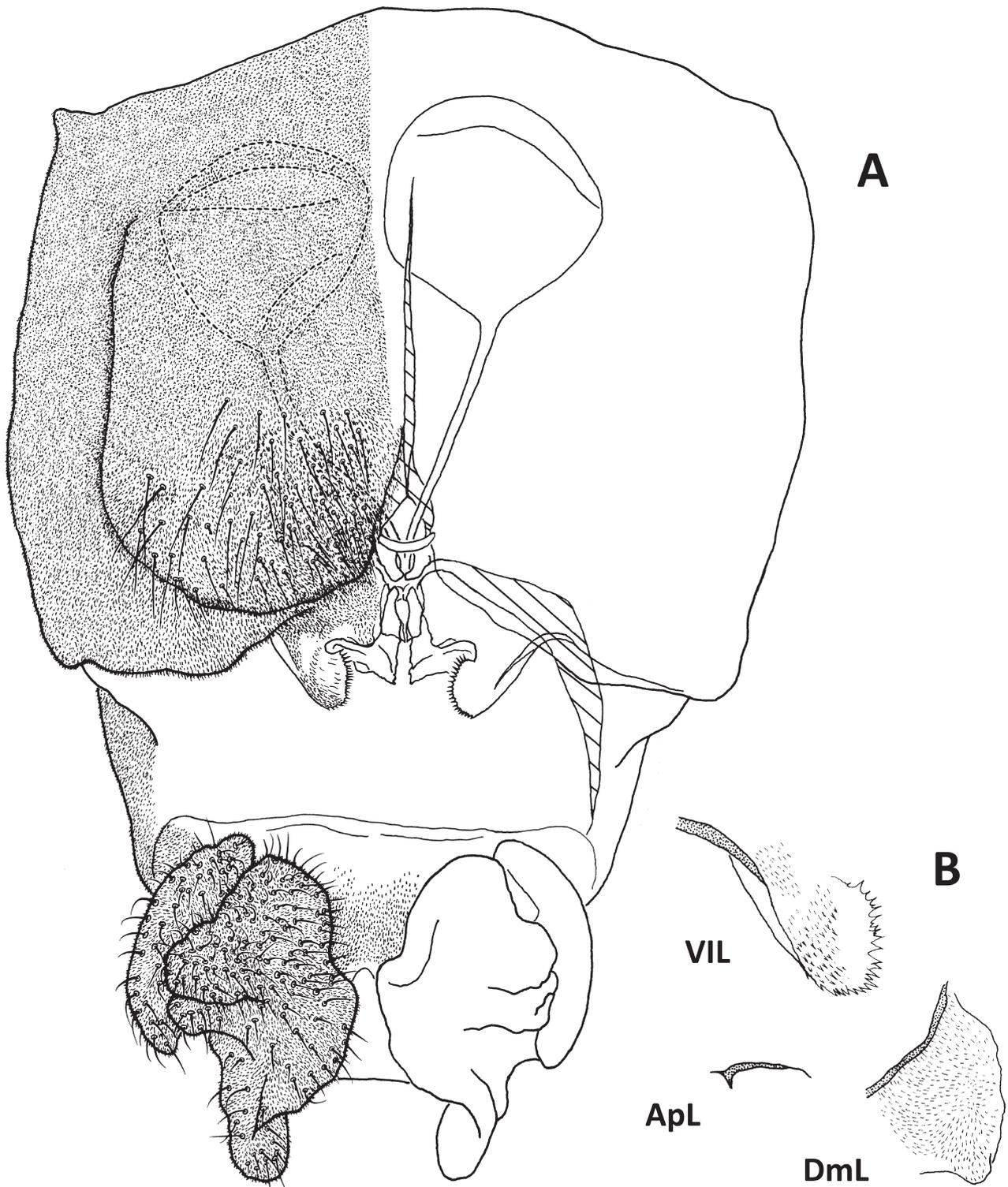


FIGURE 4. *Chironomus gelhausi* n. sp. female genitalia, A—ventral view; B—lobes of gonapophyses VIII (VIL = ventrolateral lobe; ApL = apodeme lobe; DmL=dorsomesal lobe).

The species *C. gelhausi* shares several morphological characteristics with *Fleuria* including truncated wings, large and conical frontal tubercles, reduced palps and mid and hind legs, lack of median anal tergite setae, and robust gonostylus densely covered with setae on the inner margin. However, these characters are likely to be homoplastic

and related to the shared surface-mating habit of these taxa. In addition, the hypopygia of these two taxa are very different with *Fleuria* possessing a globular hypopygium with short, wide superior and inferior volsellae and a short, kidney-shaped gonostylus (Cranston *et al.* 1989). However, the distinctive hypopygial characters in *Fleuria* may represent strongly modified morphology associated with surface-mating and therefore is possibly autapomorphic within the species. Another species which may represent a second species of *Fleuria* with a more typical hypopygium, *Chironomus natchitochae* Sublette (Cranston *et al.* 1989), also does not have hypopygial characters which would indicate affiliation with *C. gelhausi*. Placement of *C. natchitochae* within *Benthalia* (*Einfeldia* Group B) has also been suggested (J. Martin pers. com., Epler 2019) based on the presence of a longitudinal row of median setae on the anal tergite. However, *C. gelhausi* lacks median anal tergite setae which indicates that it does not belong within *Benthalia*. The species *C. gelhausi* shares some characters with *Kiefferulus* including the presence of setae on the ventral side of the extension of the superior volsella and the lack of median setae on the anal tergite in some species. However, in males of *C. gelhausi*, the inferior volsella is not as strongly expanded distally and in the female there are no apically pointed scales on the dorsomesal lobe (Cranston *et al.* 1990). Overall, morphological characters do not indicate that *C. gelhausi* should be placed in *Fleuria*, *Benthalia*, or *Kiefferulus*.

The female of *C. gelhausi* also fits within *Chironomus s. lat.* although some characters are not consistent with the diagnosis in Sæther (1977). For example, the apodeme lobe in *C. gelhausi* does not appear to bear microtrichia although this may be consistent with some *Chironomus*. For example, microtrichia are not shown on the illustration of the apodeme lobe *Chironomus aprilinus* Meigen (as *Chironomus halophilus* Kieffer) in Sæther (1977). Segment X also has large extensions which bear more than 20 setae on each side in *C. gelhausi*. However, in *C. gelhausi* the apodeme lobe is not fused with the dorsomesal lobe and the extensions on segment X are not expanded to the extent observed in *Fleuria*. The expanded segment X and the lack of setae on gonocoxite IX could be associated with surface mating although we are not aware of previous discussions regarding how these genitalic characters may be advantageous for surface-mating species. In general, additional comparative analyses of the females between *Chironomus* and related genera is needed.

Although *C. gelhausi* fits reasonably well into the genus *Chironomus*, it may not key out correctly in existing keys for adult males and females (e.g., Cranston *et al.* 1989, Sæther 1977) due to the apically truncated wing, reduced palps, reduced mid and hind tarsi, and other characters associated with surface mating. In both Cranston *et al.* (1989) and Sæther (1977), *C. gelhausi* will likely key out as *Fleuria*, although for both the male and female, these couplets do not match all of the characters used in the couplets for *Fleuria*. As a solution, we suggest, the following amendment to the dichotomous key in Cranston *et al.* (1989):

- 2. Wing apically with angled truncation and antenna with fewer than 10 flagellomeres (Fig. 10.22) *Fleuria* (p. 379)
- Wing apically rounded. Antenna with 11–13 flagellomeres (*Acalcarella* exceptionally has 9 flagellomeres). If wing apically with angled truncation then antenna with 11 flagellomeres. 3

For the female, the dichotomous key in Sæther (1977) would need to be amended in several locations and we do not suggest those here. An update to the key in Sæther (1977) including the addition of taxa and to reflect changes in taxonomy would be an opportunity to incorporate amended characters in *Chironomus*.

Despite some characters which differ from the diagnosis, *C. gelhausi* fits best within *Chironomus s. lat.* and atypical characteristics can be attributed to its surface-mating habit as in some other *Chironomus s. str.* species (Hein & Schmulbach 1971) and possibly “*Baeotendipes*”. Due to uncertainty regarding the relationship and status of *Chironomus* subgenera and closely related taxa, we opt not to propose subgeneric placement for *C. gelhausi*. In general, additional study, including examination of the larva and pupa as well as cytological and molecular evidence will be needed to determine relationships between this species and other species of *Chironomus s. lat.*

Distribution and ecology. The habitat from which *C. gelhausi* was collected is used here to describe its ecological requirements and possible distribution for this species. *Chironomus gelhausi* is known from a single lake in Mongolia, Tunamal Nuur (nuur = lake; Fig. 5A). Interestingly, another surface-mating species was collected at this locality, a skating trichopteran, *Agrypnia hayfordae* Morse & Chuluunbat (Morse & Chuluunbat 2007). This lake is small, approximately 8 hectares, with a muddy and rocky shoreline, and is surrounded by steppe (Fig. 5). At the time of sampling, this lake lacked emergent vegetation and floating algae (Fig. 6) and had black, anoxic sediments indicating high levels of nutrient enrichment. Many species of *Chironomus* occur in and are in fact characteristic of eutrophic and hypereutrophic lakes. Based on physical descriptions of this lake, *C. gelhausi* occupies a habitat which is characteristic of many species in this genus. Some species of *Chironomus* are also tolerant of elevated sa-

linity (Cranston *et al.* 1989) and many lakes in western Mongolia are considered subsaline, hyposaline, mesohaline, and hypersaline (Bouchard *et al.* in press). However, salinity measurements for Tunamal Nuur were not available and we cannot determine at this time if this species is halophilic. Although this species is known from a single lake, it is possible that this species occurs in other lakes in the region given that lakes are relatively common within the Great Lakes region of Mongolia. Unfortunately, it is possible that habitat for this species is shrinking because lakes in this region face threats from overgrazing and climate change which is decreasing lake sizes and degrading water quality (Laurie *et al.* 2010, Hilker *et al.* 2014, Tao *et al.* 2015).



FIGURE 5. Wide view of the type locality (Tunamal Nuur) of *Chironomus gelhausi* n. sp. (photo credit: C. Riley Nelson).



FIGURE 6. Shoreline habitat of the type locality (Tunamal Nuur) of *Chironomus gelhausi* n. sp. (photo credit: C. Riley Nelson).

We use observations of the behavior of *C. gelhausi* in the field and morphological characteristics to describe possible strategies used by this species to exploit the harsh environment in which they occur. During collection of this species, individuals were observed aggregating on exposed rocks near the shore in groups largely consisting

of males. Some individuals were observed skating using their wings for propulsion on the water's surface. Active adults were observed skating out toward the middle of the lake, but no aggregations on the water's surface were observed. Although copulation was not observed in the field, the hypopygium was inverted up to 180° in all preserved male specimens examined for this study. This indicates that these individuals had mated and that the hypopygium remained in the inverted position following mating. This attribute can be used to provide insight into the mating behavior of *C. gelhausi*. Torsion of the male abdomen (i.e., hypopygium inversum) has been observed in several surface-mating dipterans including chironomids (e.g., *Chironomus tepperi* Skuse, *Fleuria* Kieffer, *Oliveridia hugginsi* Ferrington & Sæther, *Dicrotendipes sinicus* Qi & Lin) and tipulids (*Phantolabis lacustris* (Alexander)) (Martin & Porter 1977, Cranston et al 1989, Ferrington & Sæther 1987, Qi et al 2018, Bouchard & Gelhaus 2020). In these taxa, torsion of the abdomen occurs when the mating pair changes to an end-to-end position while coupled (Neumann 1976). In this position, either the male or female may transport the opposite sex away from competitors or to the oviposition site. The torsion of the male abdomen suggests that in *C. gelhausi* coupling begins with a face-to-back position with dorsal flexion of the male's abdomen (see Neumann 1976). Once coupled, the position likely changes to an end-to-end position with 180° torsion of the male's abdomen. However, it is not known if this species mates on substrates or on the water's surface.

Observations of the behavior and morphology of *C. gelhausi* indicated that morphological features associated with surface mating are not as extreme in this species as in some other surface-mating species of Chironomidae (e.g., *Clunio* Haliday, *Pontomyia* Edwards, *Zealandochlus* Brundin). Field notes also indicated that this species could both skate on the water's surface as well as fly short distances. This species was also observed flying to light traps. This intermediate degree of adaption to surface-mating where adults can skate as well as fly has been documented in other chironomids which have or are presumed to have lost the behavior of aerial swarming including *Fleuria* Kieffer and *Goeldichironomus amazonicus* (Fittkau) (Fittkau 1968, Wirth 1979, Fedorova & Zhantiev 2009). Such a strategy would presumably be beneficial in ensuring that adults are not displaced from the mating site while also maintaining the ability to rapidly disperse to new habitats. We can hypothesize that such a strategy is advantageous on the Mongolian steppe where there is limited tall vegetation to provide shelter for aerial swarms and suitable habitats can be sparsely distributed in the landscape. We conclude that *C. gelhausi* is a *Chironomus* species which has independently evolved surface-mating behavior and concomitant morphological characteristics that impart advantages in a harsh environment.

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