

***Dasyhelea atrata* Wirth, 1952 (Diptera, Ceratopogonidae), a new species to the fauna of Finland and Norway, with notes about synonymy**

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A biting midge species of the genus *Dasyhelea* Kieffer, 1911 known previously from North America, Caucasus and East Siberia, is reported for the first time from northern Finland and Norway. In addition to an illustrated description of the male, a new junior synonym is proposed.

Key words: Diptera, Ceratopogonidae, *Dasyhelea atrata*, new record, new synonym, Holarctic fauna, Fennoscandia, Norway, Finland, arctic region, peat-bogs, DNA barcoding, COI.

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Introduction

Regardless of the fact that there are known 6276 extant species of biting midges (Ceratopogonidae) worldwide, which are distributed among 121 extant genera (Borkent & Dominiak 2020, Borkent *et al.* 2022), this large and diverse group of lower dipteran remains poorly studied. Especially the non-hematophagous members of the family Ceratopogonidae, like e.g., *Dasyhelea* Kieffer, 1911 midges, are being neglected. The latter, species rich genus is represented by nearly 630 extant species in the World fauna (Borkent & Dominiak 2020, Borkent *et al.* 2022). However, only around 65 species have been reported from Europe so far (Szadziewski *et al.* 2013, Salmela *et al.* 2015, Strandberg & Johanson 2015), of which 15 and 22 named species are known to occur in

Finland and Norway, respectively (Huldén & Huldén 2014, Salmela *et al.* 2015, Dominiak & Stur 2022). Biting midges of the genus *Dasyhelea* are widely distributed, inhabiting most often moist environments, and being reported from lowlands to high altitudes, reaching elevations up to 4000 m a.s.l. (Borkent & Spinelli 2007).

Males of many *Dasyhelea* species have asymmetrical genitalia which is a unique feature among all biting midges. Females have vestigial mandibles and deprived of tooth maxillae (Carter *et al.* 1921, Glukhova 1981), and similarly to males, they feed on sweet secretions of plants, nectar, and honeydew (Waugh & Wirth 1976, Szadziewski *et al.* 1997). At least in a case of some tropical species such feeding behaviour put *Dasyhelea* in a group of important pollinators of various plants, e.g., of cocoa tree *Theobroma*

cacao L. and rubber tree *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. (Lee *et al.* 1989). In temperate zones, imagines of both sexes have been observed on umbelliferous plants (Szadziewski *et al.* 1997) and on birthwort *Aristolochia clematitis* L. (Havelka 1978). Remarkably, in laboratory studies, females of *Dasyhelea* had fully developed eggs within 24 hours after emergence without taking any meal (Lee & Chan 1985).

Larvae and pupae of *Dasyhelea* occupy a wide variety of aquatic, semi-aquatic and terrestrial habitats. They can be found in various types of lotic and lentic ecosystems, fresh- and inland saline waters, intertidal zone of seas, moist soil (also saline soil), sap oozing from trees, wet bark, decomposing plants and fungi (Thienemann 1925, Mayer 1934a, Waugh & Wirth 1976, Wirth 1978, Szadziewski 1983, Graves & Graves 1985, Szadziewski *et al.* 1997, Dominiak 2012). Immatures of some species occur in extreme habitats such as small water reservoirs formed in tree hollows, damaged tree trunks, bamboo stems, fruit shells, leaf axils (Goetghebuer 1925; Johannsen 1932; Mayer 1934a, b; Zilahi-Sebess 1936; Disney & Wirth 1982; Szadziewski & Dominiak 2006), temporary rock pools and their artificial equivalents (Kieffer 1925, Zilahi-Sebess 1931, Johannsen 1932, Remmert 1953, Wirth 1987, Lee *et al.* 1989, Ashe *et al.* 2007), hot springs and pitchers of various species of monkey cups (Johannsen 1932, Mayer 1934b, Sheppe 1975, Wirth & Beaver 1979, Lee & Chan 1985). Just recently, a first instance of leaf-mining behaviour of Ceratopogonidae larvae was described, with a species of the genus *Dasyhelea* mining leaves of the floating fern *Salvinia minima* Baker (Dominiak & Borkent 2023, in press).

Material and methods

The examined male specimens from Finland and Norway were collected with Malaise traps, cleared in 10% KOH or phenol-ethanol mixture, dissected and subsequently slide mounted in Euparal or a mixture of Canada balsam and orange oil, respectively. The specimen from Finland (DIPT-JS-2016-0432) is deposited at

the Regional Museum of Lapland, Rovaniemi, Finland (LMM), while the specimen from Norway (TSZD-PD-300183) at the Arctic University Museum of Norway collection (TMU). The Norwegian specimen comes from a sample collected in a framework of a project financed by the Norwegian Biodiversity Information Centre (NBIC) (Artsprosjektet 2021).

Morphological terms used in the description and method of taking measurements follow Szadziewski (1986), Dominiak (2012) and Díaz *et al.* (2018). Photo of male genitalia of the specimen from Finland was taken with a Leica M205 C stereomicroscope equipped with the Leica Flexacam C1 digital camera and LAS X software (v.5.0.3.24880). The image was finally edited with Adobe Photoshop (v.22.5.1). Photographs of the Norwegian specimen were taken using a Zeiss Axioscope 7 microscope with an AxioCam 208 color camera. Images were stacked and edited using the Affinity Photo 2 and Topaz Sharpen AI softwares. Only the specimen from Norway was measured. All plates were created using Affinity Designer 2.

Photographs of male genitalia of type specimens of *D. atrata* and *D. serristernum* as well as female abdomen of allotype of *D. atrata*, not included in this paper but used as a supplementary data to the original descriptions of these two species, were obtained from the United States National Museum, USA (USNM) and the Natural History Museum, University of Tartu, Estonia (TUZ).

DNA barcoding was made in cooperation with the Norwegian Barcode of Life (NorBOL). A sample containing three legs for the barcoding of cytochrome oxidase 1 (COI) gene was sent to the Canadian Centre for DNA Barcoding, BIO (Ontario, Canada), where DNA was extracted and sequenced (bi-directionally Sanger sequencing). Only the specimen from Norway was barcoded and both the sequence and metadata are available in the Barcode of Life Data Systems (BOLD) (dataset “DS-CERTRO Ceratopogonidae Troms county”, dx.doi.org/10.5883/DS-CERTRO).

The record of *D. atrata* from Finland has previously been published in the Global Biodiversity Information Facility (GBIF) (<http://>

tun.fi/NVO.20170834; Finnish Biodiversity Information Facility 2023).

Data about lakes chemistry comes from the Norwegian Environment Agency website (<https://www.miljodirektoratet.no/>). Detailed maps were taken from Google Maps (maps.google.com; accessed 23 April, 2023) and Norgeskart (SSR ©Kartverket, kartverket.no; accessed 23 April, 2023), and modified using Affinity Photo 2.

Results

Dasyhelea atrata Wirth, 1952

atrata Wirth, 1952: 164 (*traverae* group, USA: California - locus typicus, Alaska); Wirth 1965: 126 (catalog, California, Alaska, Louisiana); Waugh & Wirth 1976: 236 (*leptobranchia* group); Borkent & Grogan 2009: 11 (catalog, California, Alaska, Northwest Territories, Louisiana).

erristernum Remm, 1967: 18 (Georgia - locus typicus, Russia). Remm 1988: 83 (catalog, Armenia, East Siberia, Georgia, Russia). **New synonymy.**

Material examined. FINLAND (Figure 1A). Tervola municipality, Ruuttulampi conservation area, wetland, N 66.20775, E 24.98982, around 70 m a.s.l., Malaise trap, 1.VI.2012–15.IX.2012, leg. J. Salmela, 1 male (DIPT-JS-2016-0432) (LMM). NORWAY (Figures 1B, 2). Salangen municipality, Masterbakkvatna, wetland, N 68.81344, E 18.06236, 545 m a.s.l., Malaise trap, 3–30.VIII.2022, leg. P. Dominiak, 1 male (TSZD-PD-300183) (TMU).

Description. Whole body dark, only tarsi paler. Head (Figure 3A). Proximal antennal segments similar in size and shape, distal ones elongated, with last segment lacking apical prolongation; length of segments 8–13 (in μm): 28, 32, 71, 80, 62, 55. Frontal sclerite elongate, leaf-shape, with lateral lobes. Clypeus entire with lateral lobes, nearly pentagonal, bearing only 5 setae. Palpomere 3 slender, length 0.074 mm, palpal ratio around 4.7; sensilla capitata sparse, present in bottom half of palpomere 3, on the inner margin of the segment. Legs as in Figure 3B. Tarsal ratio of foreleg 2.1, midleg 2.1, hind leg 1.8. Hind tibial comb with 5 spines. Wing with only one radial cell (Figure 3C), length 1.1 mm, costal ratio 0.38. Halter stem and knob dark. Genitalia as in Figures 4A–B. Apicolateral processes of tergite

9 cylindrical with single apical seta. Cerci well developed, with 4–5 setae. Gonocoxite widest in its basal half, circa 1.6 times longer than greatest width. Gonostylus long, gently curved, outer margin tapering towards apex from around 1/4 its distal length, with two strong setae on inner margin in midlength and few smaller ones in apical part. Gonocoxal apodemes and paramere form an asymmetrical structure. Paramere long and stout, tapering towards apex, slightly twisted and bent ventrally in apical portion. Aedeagus symmetrical, with low and rather wide arch and one pair of long spoon-shape posterolateral projections. Sternite 9 with posteromedian protuberance, most probably fused with aedeagus. Depending of position on slide and preparation method, posterior margin of sternite 9 with anvil-like extension (Figure 4B) or with two more obviously separated mediolateral finger-like protrusions (Figure 4A). Posterior margin of sternite 9 serrate, on whole length (anvil-like extension) or only on the tops of the mediolateral finger-like protrusions.

Discussion

Based on the original descriptions and illustrations, photographs of type specimens obtained from curating institutions, as well as on the currently examined specimens, we suggest that *D. atrata* and *D. serristernum* should be regarded synonyms. According to the original description of *D. serristernum* (Remm 1967) this species differs from *D. atrata* only in having sharp and bent top of paramere and serrate margin of sternite 9. Otherwise, both species share only similarities (size and coloration of the body and details of male genitalia, especially shape of gonostylus and aedeagus). Lack of the two differentiating features mentioned by Remm (op. cit.) in the American species is an observation artifact. On the photographs of *D. atrata* holotype received from USNM (USA), top of the paramere looks rounded, but the sharp and bent apical portion of paramere is not easy to detect on dark specimens cleared in phenol-ethanol mixture. The same concerns the presence of small teeth on the sternite 9. Although not shown on the drawing in

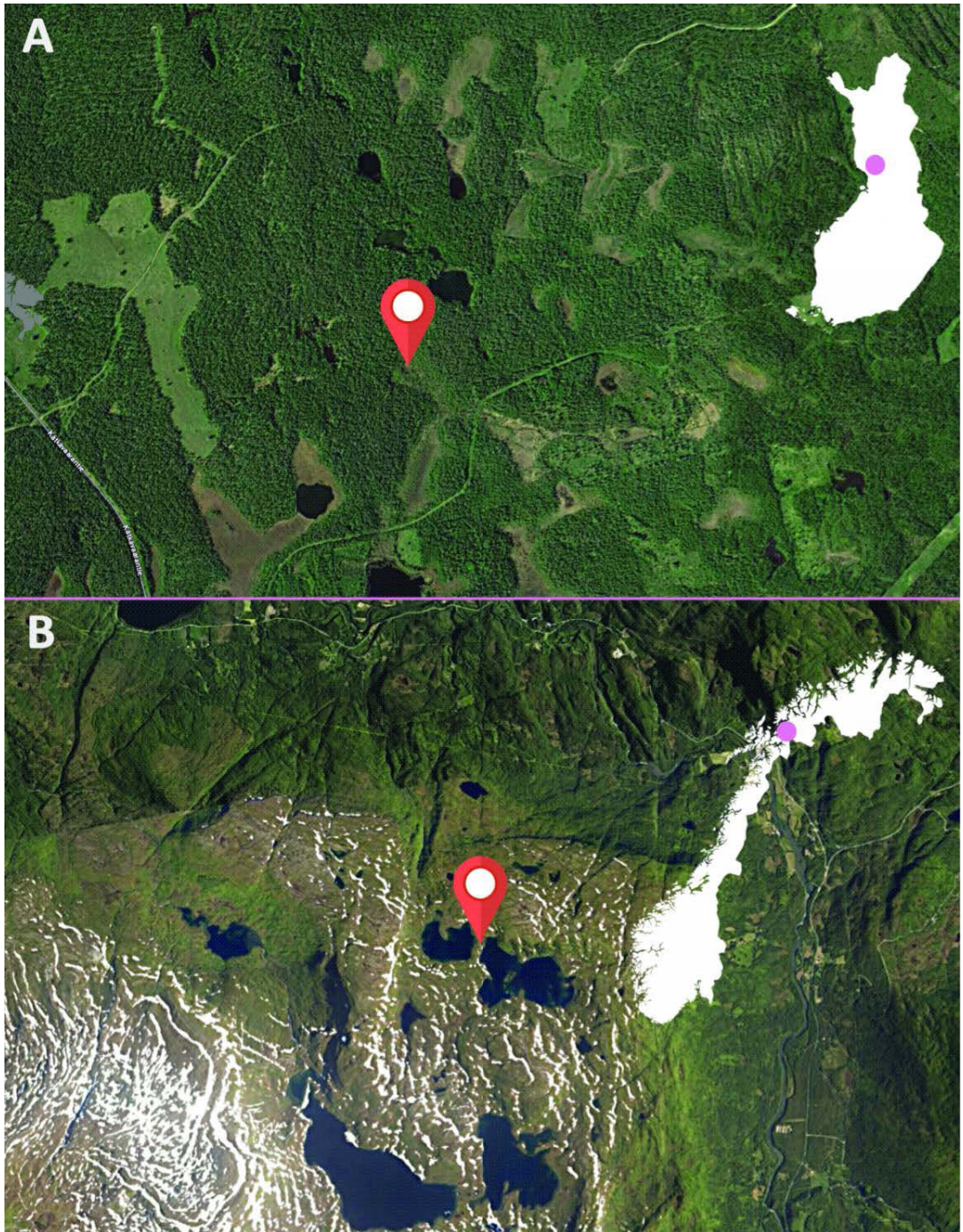


FIGURE 1. Satellite photos of sampling sites and distribution maps of *Dasyhelea atrata* Wirth, 1952 specimens in Fennoscandia. **A.** Finland, Tervola municipality. Photo source: Google Maps. **B.** Norway, Salangen municipality. Photo source: Norgeskart.



FIGURE 2. Malaise trap at Masterbakkvatna where the male of *Dasyhelea atrata* Wirth, 1952 was collected in Norway. Photo by P. Dominiak, 17 June 2022.

the original description (Wirth 1952), the apices of the mediolateral prongs in the holotype male of *D. atrata* have serrate margin. The specimen from Finland, with anvil-like extension, has well visible serrate margin of the sternite on its whole middle part. In the specimen from Norway, only the apices of the mediolateral prongs are covered with teeth, while area between them seems to be smooth. The appearance of the posterolateral projections of aedeagus in the specimen from Finland resembles those in the holotype male of *D. atrata*, while in the specimen from Norway they are perfectly spoon-shape, arranged in the same way as in *D. serristernum*.

Dasyhelea atrata was described from California, where male holotype was collected in the second half of August in the Black Lake Canyon and the paratypes at various locations within the state and in Alaska. Although the original description covers both sexes, the characteristic of female specimen is very brief, lacking details about sternite 9 (subgenital plate) shape. On photographs of the allotype female's

abdomen the latter feature as well as shape of seminal capsule are barely visible.

Dasyhelea serristernum was described from montane areas in Caucasus. Holotype (male) of *D. serristernum* was collected in the second half of May, in the Aragvi river valley in Pasanauri (Mtskheta-Mtianeti region), while single paratype male comes from Gizel, where it was collected in the Gizeldon river valley (North Ossetia–Alania). Photographs of male genitalia of the holotype and paratype received from TUZ (Estonia) are of rather poor quality, taken from the dorsal side, and therefore shape of sternite 9 and most details of aedeagus are not visible. These photographs are available on the eBiodiversity portal (<https://elurikkus.ee/en>).

The specimen from Finland was sampled on lowlands, 47 km southwest from Rovaniemi, from a boggy (rich spring fen), forested area near a stream flowing out of Ruuttulampi pond. The single male specimen from Norway was collected from a small area with mire situated between Nedre Masterbakkvatn and Øvre Masterbakkvatn on

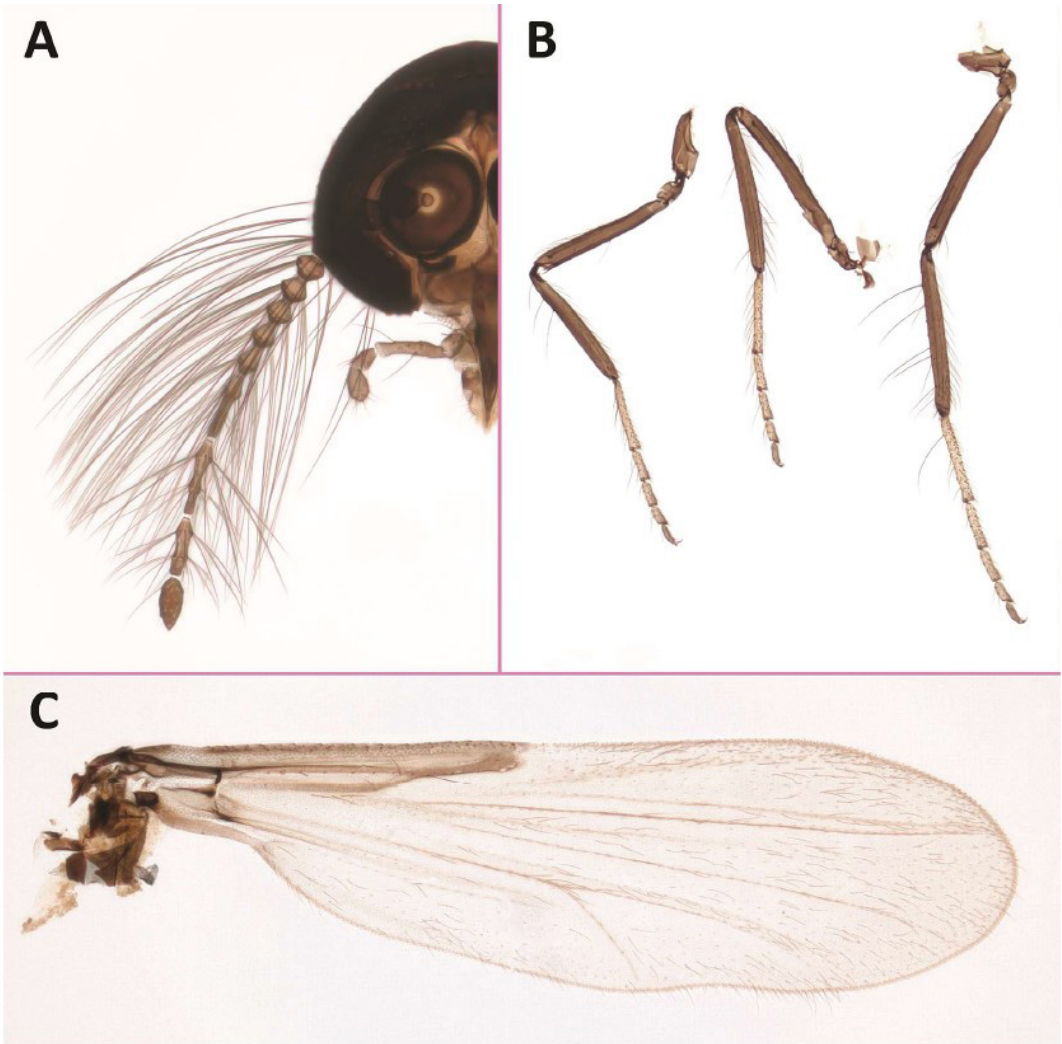


FIGURE 3. *Dasyhelea atrata* Wirth, 1952, male, specimen from Norway. **A.** Head, right side. **B.** Fore-, mid-, hind legs (from left to right). **C.** Wing.

elevation 545 m a.s.l. These moderately calcareous lakes are surrounded by nearly continuous circle of mountains, ranging in elevation from circa 600 to 800 m a.s.l. Unfortunately, little is known about habitats in which *D. atrata* was observed by W.W. Wirth and H. Remm. One of the paratype males, from Alaska, was collected with an emergence trap but even in this case exact locality data are missing. It is very probable though, that similarly to some other members of the genus *Dasyhelea*, immatures of this species live among wet plants on various types of wetlands and near water

margins or inhabit small water reservoirs.

Per day, the DNA barcoded specimen from Norway is the only member of a BIN number BOLD:AFA8657 (distance to the nearest neighbour equals 7,3%).

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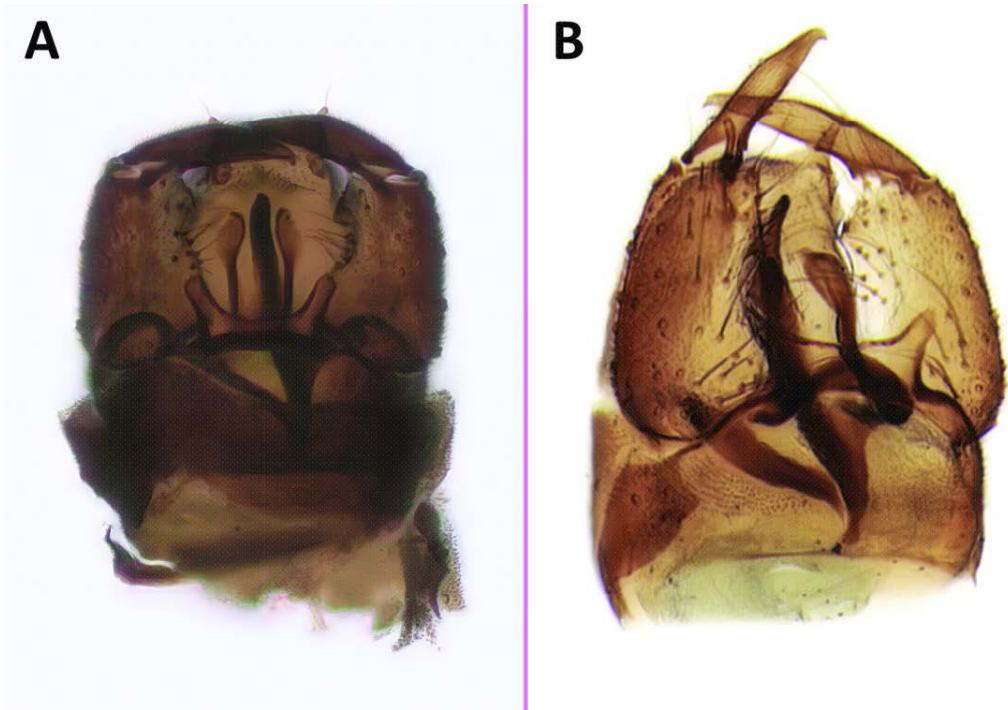


FIGURE 4. *Dasyhelea atrata* Wirth, 1952, male genitalia. **A.** Specimen from Norway, ventrolateral view. **B.** Specimen from Finland, ventral view.

of the type specimens of *D. atrata* and *D. serristernum*.

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