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Article

Chaetocladius rottensis sp. n., a glacial alpine species from the upper basin of the Rhône River, Switzerland (Diptera, Chironomidae, Orthocladiinae)

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ABSTRACT

The male adult of *Chaetocladius rottensis* sp. n. is described based on material collected between 1998 and 2018 in glacial alpine springs and streams delimited by the upper basin of the Rhône River (Mutt stream, Swiss Alps, alt. 1800-2100 m). The nearest known alpine species are: *C. aedeagolobatus* Rossaro, Magoga & Montagna, 2017 and *C. lodscrozetae* Moubayed-Breil, 2018. Despite the high resemblance between these three species, *C. rottensis* sp. n. can be separated on a combination of characters as detailed in Table I. In particular, *C. rottensis* sp. n. and *C. lodscrozetae* are considered to be sister species based on close morphological similarity. They both belong to relict alpine elements and are considered here as local biogeographic indicators. Currently, there are 16 recorded *Chaetocladius* species from Switzerland including 13 recently reported by MOUBAYED-BREIL & LODS-CROZET (2018) and 3 additional new records: *C. aedeagolobatus* Rossaro, Magoga & Montagna, 2017; *C. dentiforceps* (Edwards, 1929), *C. subalpinus* Rossaro, Magoga & Montagna, 2017. Consequently, the description of *C. rottensis* sp. n. increases the total number in the genus to 17 for this country. Remarks, morphological affinities and comments on the ecology of the new species are highlighted.

Keywords: Taxonomy, new species, Swiss Alps, conservation measures.

Chaetocladius rottensis sp. n., une espèce alpine glaciaire connue du haut bassin du Rhône suisse (Diptera, Chironomidae, Orthocladiinae)

RESUMÉ

L'adulte mâle de *Chaetocladius rottensis* sp. n. est décrit à partir d'un matériel collecté entre 1998 et 2018 dans des sources et ruisseaux glaciaires alpins délimités par le bassin supérieur de la rivière Rhône et le ruisseau de Muttbach (Alpes Suisses, alt. 1800-2100 m). Les espèces alpines les plus proches sont: *C. aedeagolobatus* Rossaro, Magoga & Montagna, 2017 and *C. lodscrozetae* Moubayed-Breil, 2018. Malgré une grande ressemblance entre les 3 espèces précitées, *C. rottensis* sp. n. peut être séparée

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par une combinaison des caractères détaillés dans le tableau I. En particulier, *C. rottensis* sp. n. et *C. lodscrozetae* sont considérées ici comme 2 espèces sœurs sur la base d'une grande similarité morphologique. Elles correspondent à des éléments alpins reliques, considérés comme des indicateurs biogéographiques à l'échelle locale. À ce jour, le genre *Chaetocladius* était représenté en Suisse par 16 espèces dont 13 récemment citées par MOUBAYED-BREIL & LODS-CROZET (2018) auxquelles s'ajoutent 3 nouvelles citations : *C. aedeagolobatus* Rossaro, Magoga & Montagna, 2017 ; *C. dentiforceps* (Edwards, 1929); *C. subalpinus* Rossaro, Magoga & Montagna, 2017. La description de *C. rottensis* sp. n. porte donc à 17 le total d'espèces connues de ce pays. La position taxonomique, des affinités morphologiques et des commentaires sur son écologie sont mis en évidence.

Mots-clés : taxonomie, nouvelle espèce, Alpes Suisses, mesures de conservation.

Photo 1. Type locality of C. rottensis *sp. n. on the Mutt stream (1800 m). Surrounding habitats where the type-material was collected. In the background, the River Rhône. B. Lods-Crozet, 15.IX.2018.*

Photo 1. Localité-type de C. rottensis *sp. n. au bord du Muttbach (1800 m). Habitats de bordure où le matériel-type a été collecté. En arrière-plan, la rivière Rhône. B. Lods-Crozet, 15.IX.2018.*

1. Introduction

Knowledge provided on the taxonomy, geographical distribution and ecology of the known Chaetocladius species (BRUNDIN 1947, 1956, SÆTHER 1990, CASPERS 1987, CRANSTON et al. 1989, BHATTACHARWAY et al. 1993, MOUBAYED 1989, MAKARCHENKO & MAKARCHENKO 2001, 2004, 2007, 2011a-b, LANGTON & PINDER 2007, ZELENTSOV 2007, STUR & SPIES 2011, ASHE & O'CONNOR 2012, KOBAYASHI 2012, WANG et al. 2012, SÆTHER & SPIES 2013, LANGTON & ARMITAGE 2015, MAKARCHENKO et al. 2017, MOUBAYED-BREIL 2017, MOUBAYED-BREIL & ASHE 2016, MOUBAYED-BREIL & DIA 2017, ROSSARO et al. 2017, MOUBAYED & LANGTON 2019, MOUBAYED-BREIL & BITUSIK 2019), show that the genus *Chaetocladius* currently comprises worldwide up to 95 described species.

2. Material and methods

The studied male adults were collected by the first author in the Swiss Alps (upper Rhône, Photos 1-2) using a sweeping net and Malaise traps. More detailed data on the typology of the sampled habitats are provided in LODS-CROZET (1998, 2012), LODS-CROZET et al. (2001) and MOUBAYED-BREIL & LODS-CROZET (2018). The examined adults were preserved in 80-85% ethanol for taxonomic observation and description. Figures of tergite IX and anal point in dorsal and lateral view were made before the final dorsal mounting. Information on the methodology of mounting and conservation of the type material is provided in MOUBAYED-BREIL & ASHE (2016). Morphological terminology and measurements follow those of SÆTHER (1980) and LANGTON & PINDER 2007.

3. Description

Chaetocladius rottensis sp. n.

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Material examined

Holotype. **Switzerland**: upper basin of the River Rhône, Mutt stream (Photos 1-2), alt. 1800 m, 17.IX.2018, 46°34'12"N, 8°22'52"E; 1 male adult, leg. B. Lods-Crozet. Environmental data of Mutt stream water are: crystalline water, conductivity 3.3-138.0 μS/cm; temperature 4.2-10.7 °C during late spring to late summer (June-September).

Paratypes (all leg. B. Lods-Crozet). **Switzerland.** 2 male adults, one from the same locality as for holotype (site M5); 2 male adults from Mutt stream (site M4), alt. 2100 m, 08.IX.1998, 46°34'06"N, 8°24'16"E.

Holotype (mounted on one slide; GBIF-CH00617918) is deposited in the collections of the 'Muséum cantonal des sciences naturelles, département de zoologie, 6 place de la Riponne, CH-1014 Lausanne, Switzerland.' Remaining paratypes are deposited in the collections of the senior author.

Etymology. The name '*rottensis*' of the new species refers to the River Rhône (Rotten in German), which runs in the upper valley where is located the well-known glacier of the river.

Diagnosis

C. lodscrozetae and *C. aedeagolobatus* are the closest to *C. rottensis* sp. n., from which the new species can be separated on the basis of the tabulated distinctive morphological features as provided in Table I and the following main combination of characters. Head. Eyes bare; terminal flagellomere 705 μm long, distinctly clubbed, AR 1.55-1.60; clypeus top-like; palpomere 3 with 4 pointed sensilla coeloconica. Thorax. Lobes of antepronotum not gaping, dorsocentrals not decumbent; scutellum with 6 setae; squama with 11 setae. Hypopygium. Tergite IX broadly rectangular, with 15-16 setae located on posterior part; anal point broadly triangular, apex pointed; dorsal hump massive, orally projecting, composed of 2 separate margins, inner one undulated with 10 lateral setae, outer one bare. Virga octopus-shaped, composed of 3 pairs of spines. Lateral expansion of sternapodeme well developed;

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR	BV	SV	BR
PI	915	1110	615	350	245	140	100	0,55	3,16	3,29	3.70
PII	845	860	410	250	185	120	100	0,48	3,23	4,16	3.10
PIII	1025	1045	620	315	255	145	110	0,59	3,26	3,34	3.00

Table 1. "LR = Length of tarsomere ta_1 divided by length of tibia (ti); BV = Combined length of femur (fe), tibia and ta_1 divided by combined length of tarsomeres ta_2-ta_5; SV = Ratio of femur plus tibia to tarsomere ta_1; BR = Ratio of longest seta of ta_1 divided by minimum width of ta_1, measured one third from apex."

phallapodeme strongly sinuous. Inferior volsella bilobed, proximal lobe triangular, ending into a downwardly bent beak-like apex, distal part pouch-like. Gonostylus half bulb-shaped, anterior side linear, with orally directed setae, posterior margin rounded; crista dorsalis low, present pre-apically.

Male imago

(n = 5 male adults; Figs 1A-0)

Large: total length 3.95 mm. Wing length 2.40-2.45 mm. General colouration contrasting brown to dark brown. Head dark brown, antennae pale brown, thorax brown to dark brown, mesonotal stripes dark brown; wing pale; legs contrasting brown to dark brown; anal segment contrasting brown to dark brown. Head (Fig. 1A). Eyes bare, inner margin bare. Temporals 13 including 9 biserial inner and 4 outer verticals. Antenna 915-920 μm long, 13-segmented; ultimate flagellomere 700-705 μm long, distinctly clubbed, with dense sensilla chaetica; antennal groove beginning on segments 3; AR 1.58. Clypeus (Fig. 1B) top-like, bearing 12 setae in 3 rows. Palp 5-segmented, segments 1-2 fused; palpomere 3 (Fig. 1C) with 4 sensilla coeloconica, not needle-like; length (μm) of segments: 25, 35, 145, 145, 180; segments 3 and 4 subequal. Thorax. Antepronotum well developed, with fused lobes (Fig. 1E), lateral antepronotals 5; acrostichals 12-13, short, in 1-2 rows; dorsocentrals 9, not decumbent, uniserial; prealars 3; humeral pit without contrasting spots. Scutellum with 6 setae in 1 row (3 on each side of the midline). Wing. Brachiolum with 1 seta; membrane with dense coarse punctuation; distribution of setae on veins: R, 11; R1, 1; remaining veins bare; squama with 11 uniserial setae. Legs. Tibial spurs of PII and PIII (length in μm): PI, 75; PII, 60, 35; PIII, subequal, 40. Sensilla chaetica: present on tarsomeres ta1-ta5 of PI-PII; absent on tibiae. Length (in μm) and proportions of prothoracic (PI), mesothoracic (PII) and metathoracic (PIII) legs (n = 1, paratype) as the Table 1. Hypopygium in dorsal, ventral and lateral view as in Figs 1G-I (1G, dorsal; 1H, ventral; 1I, lateral); ventral view (Fig. 1H) only with apodemes, tergite IX and anal point omitted. Tergite IX 110 μm long, 175 μm maximum width, broadly rectangular, posterior margin semicircular, with 15 dorsal setae placed on the posterior part (7-8 setae on each side of the base of anal point); posterodorsal part with a massive orally directed rounded hump located at base of anal point, clearly visible laterally (Fig. 1I) and dorsally (Fig. 1K), outer margin of hump bare, inner margin with distinct undulation bearing 8 dorsolateral setae (4 on each side). Anal point (Figs 1G, I, K) about 55 μm long, maximum width 5-6 μm at base, triangular, sharply pointed apically. Laterosternite IX with 10 setae (5 on each side). Apodemes (Fig. 1H), transverse sternapodeme arched, lateral expansion typically well developed; phallapodeme 105 μm long, strongly sinuous basally and medially, basal part reaching junction of gonocoxite. Virga (Figs 1G-H, J) octopus shaped, composed of 6 curved spines. Gonocoxite 250 μm long, markedly broad basally, maximum width 80-85 μm, inner ventral margin with 9-10 strong setae. Inferior volsella (Figs 1G, L) 60 μm long, maximum width 40 μm, extending from middle part of gonocoxite to its distal part; proximal part triangular, sparsely covered with setae, apical part nose- to beak-

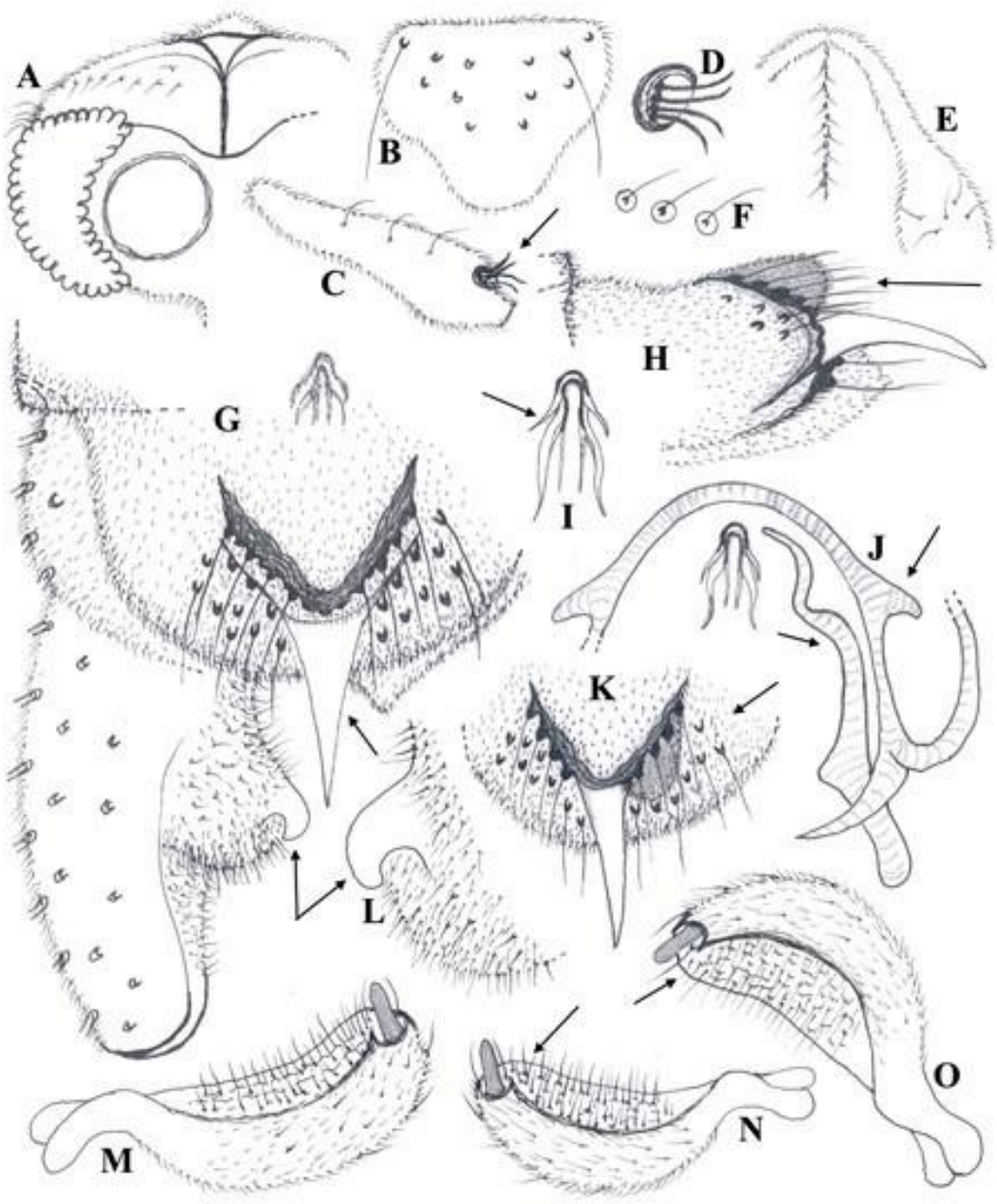

Figure 1. Male imago of Chaetocladius rottensis *sp. n. Head (left side, dorsal), frontal area, vertex and temporal setae (A); clypeus (B); palpomeres 3 (C); sensilla coeloconica (D); lobes of antepronotum with acrostichals (E); dorsocentral setae (F); hypopygium, dorsal (G); apodemes and virga, ventral (H); tergite IX and anal point, lateral (I); virga (J); anal point, distal part of tergite IX and dorsal hump, dorsal view (K); inferior volsella, right side (L); gonostylus in acute angle (M), right angle (N) and lateral view (O). The arrows indicate some distinctive characters.*

Figure 1. Imago mâle de Chaetocladius rottensis *sp. n. Tête (côté gauche, vue dorsale), aire frontale, vertex, et soies temporales (A) ; clypéus (B) palpomères 3 (C) ; sensilla coeloconica (D) ; lobes de l'antepronotum et soies acrosticales (E) ; soies dorso-centrales (F) ; hypopyge, vue dorsale (G) ; apodèmes et virga, vue ventrale (H) ; pointe anale, partie distale du tergite IX et bosse dorsale, vue dorsale (K) ; volselle inférieure, côté droit (L) ; gonostyle, angle aigu (M), angle droit (N), en vue latérale (O). Les flèches indiquent quelques caractères distinctifs.*

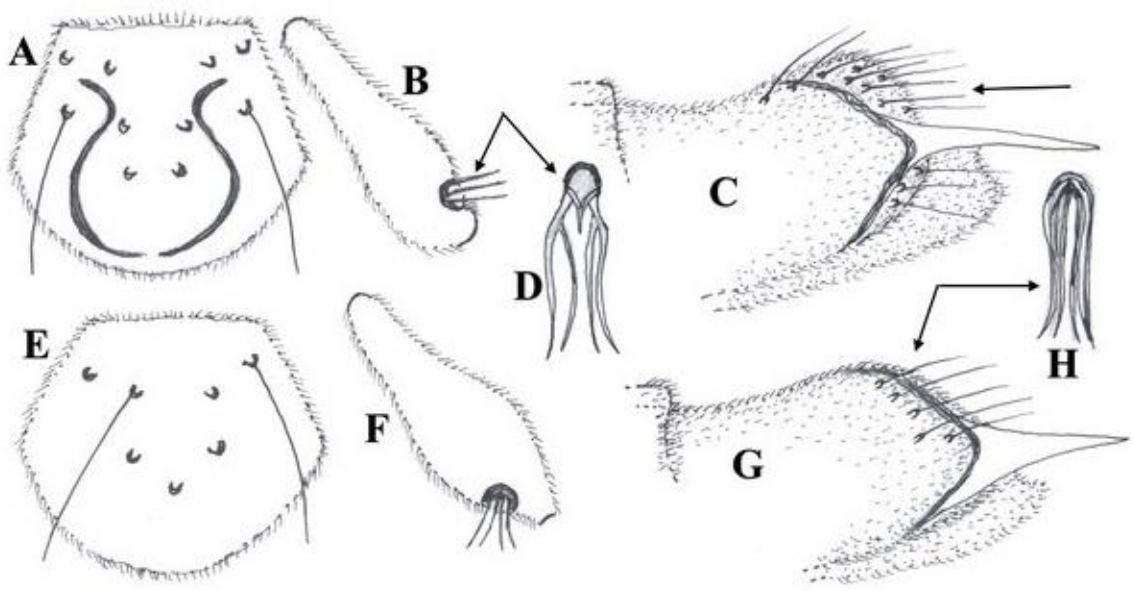

Figure 2. Male imago of Chaetocladius aedeagolobatus (*Figs A-D*) *and* C. subalpinus (*Figs E-G*). *Clypeus* (*A, E*)*; palpomere 3* (*B, F*)*; tergite IX and anal point, lateral* (*C, G*)*; virga* (*D, H*). *The arrows indicate some distinctive characters.*

Figure 2. Imago mâle de Chaetocladius aedeagolobatus (*Figs A-D*) *et* C. subalpinus (*Figs E-G*). *Clypéus* (*A, E*)*; palpomère 3* (*B, F*)*; tergite IX et pointe anale, vue latérale* (*C, G*)*; virga* (*D, H*). *Les flèches indiquent quelques caractères distinctifs.*

shaped, hyaline, bare and abruptly bent downwards; distal part pouched, covered with setae. Gonostylus (Figs 1M-O) 105 μm long, 45-50 μm maximum width, posterior margin semicircular; anterior margin smooth, anterior side concave medially, bearing numerous orally directed small setae; crista dorsalis low, located preapically; megaseta well developed. HR = 2.38; HV = 3.76.

Female adult: known but not described.

Pupal exuviae and larva: unknown.

4. Remarks & discussions

The genus *Chaetocladius* Kieffer, 1911 is represented by about 40 species in Europe, of which 13 are reported from Switzerland (Lods-Crozet, 1998, Merz et al. 2001, Bächli et al. 2014, Moubayed-Breil & Lods-Crozet 2018) including: *C. castellai*, Moubayed-Breil, 2018; *C. coppai* Moubayed-Breil, 2017; *C. dissipatus* (Edwards, 1929); *C. laminatus* Brundin, 1947; *C. lencioniae*, Moubayed-Breil, 2018; *C. lodscrozetae*, Moubayed-Breil; *C. longivirgatus* Stur & Spies, 2011; *C. macunensis*, Moubayed-Breil, 2018; *C. melaleucus* (Meigen, 1818); *C. muttensis*, Moubayed-Breil, 2018; *C. perennis* (Meigen, 1830); *C. piger* (Goetghebuer, 1913); C. *suecicus* (Kieffer, 1916). In this paper 3 additional new records are reported: *C. aedeagolobatus* Rossaro, Magoga & Montagna, 2017 (Figs 2A-D), *C. dentiforceps* (Edwards, 1929) and *C. subalpinus* Rossaro, Magoga & Montagna, 2017 (Figs 2E-H). Consequently, the description of *C. rottensis* sp. n. increases the total number of known species to 17 from this country.

The following taxonomic notes include remarks on some known related species from the Swiss Alps (upper basin of the Rhône River, Mutt stream) and other neighbouring Alpine areas. The new species is close to *C. aedeagolobatus* and *C. lodscrozetae* based on morphological similar-

Characters	*lodscrozetae*	cf. *aedeagolobatus*	*rottensis* sp. n.
Total length, main size	3.85	3.00	3.95
Wing length, main size	2.00	2.35	2.45
Eyes	bare	heavely pubescent	bare
Antenna, Ts, μm	470	525	705
AR	1.02	1.28	1.58
Tmp	12	11	14
Clypeus, setae	top-like, 6 setae	trapezoidal, 6 setae	top-like, 12 setae
Antepronotum	lobes not gaping	lobes gaping	lobes not gaping
Acr	10-11	17	12-13
Dc	9 not decumbent	10, decumbent	8, not decumbent
Tergite IV, Dh	present, proeminent	P, week	P, proememinent
Tergite IV, Dh	with dorsal setae	with dorsal setae	bare
Wing, squama	5-10	6-9	11
AnPt	P, long, parallel-sided	P, long, parallel-sided	P, long, triangular
AnPt, Dp	Well-developed	low	Well-developed
Setae on Dp	located on dorsal margin	absent on dorsal margin	absent on dorsal margin
AnPt: Apex	not pointed	not pointed	sharply pointed
Stp, lateral expansion	weak	weak	Well-developed
Phl, shape	short, weakly sinuous	long, strongly sinuous	long, strongly sinuous
SupVo	A	A	A
InfVo	thumb shaped, apex rounded	large nose-like apex rounded	beck-like, apex pointed
Gs	Preapical part linear	Preapical part projecting	low lobe-like
Gs, Cd	A	P	A
Virga	inversed-U shaped	cluster of long spines	Jellyfish shaped

Table I. Male adult of Chaetocladius *cf.* aedeagolobatus, C. lodscrozetae, C. rottensis *sp. n.: main distinguishing characters. Abbreviations: Ts, terminal segment of antenna; AR, antennal ratio; Temp, temporals; Acr, acrostichals; Dc, dorsocentrals; AnPt, anal point; Dl, dorsal lamellae; Stp, Sternapodeme; Gc, gonocoxite; Gs, gonostylus; Cd, cirsta dorsalis; P, present; A, absent; SupVo, superior volsella; InfVo, inferior volsella.*

Tableau I. Adulte mâle de Chaetocladius *cf.* aedeagolobatus, C. lodscrozetae, C. rottensis *sp. n.: principaux caractères distinctifs. Abbreviations: Ts, segment terminal de l'antenne; AR, rapport antennaire; Temp, soies temporales; Acr, soies acrostichales; Dc, soies dorso-centrales; AnPt, pointe anale; Dl, lamelle dorsale; Stp, Sternapodeme; Gc, Gonocoxite; Gs, Gonostyle; Cd, crista dorsalis; P, présent; A, absent; SupVo, volselle supérieure; InfVo, volselle inférieure.*

ity. *C. rottensis* sp. n. and *C. lodscrozetae* are considered here to be sister species. Nevertheless, all three of the previously cited species appear to belong to one group: the *lodscrozetae*-gr. Morphological affinity between the new species and similarly related congeners (namely: *C. aedeagolobatus* and *C. lodscrozetae*) are highlighted on a combination of distinctive characters detailed in Table I.

Photo 2. Type locality of C. rottensis *sp. n. on the Mutt stream (2100 m). Surrounding habitats where the type-material was collected. B. Lods-Crozet, 15.IX.2018.*

Photo 2. Localité-type de C. rottensis *sp. n. au bord du Muttbach (2100 m). Habitats de bordure où le matériel-type a été collecté. B. Lods-Crozet, 15.IX.2018.*

5. Ecology and geographical distribution

The new species is known only from cold rheocrenes and lotic habitats delimited by glacial springs and streams enriched with bryophytes.e type material was collected close to the glacial upper Rhône catchment (Mutt stream, central part of the Swiss Alps, alt. 1800-2100 m). Cold stenothermic springs, small waterfalls and riffles covered with hygropetric microhabitats appear to be the favoured habitat for larval populations. Thus, *C. rottensis* sp. n. belongs to the crenophilous community of species as documented by Lindegaard (1995). Emergence period: from late summer to early autumn. The high flood plain of "Gletsch" has been part of the inventory of alluvial zones in Switzerland since 1992 and is subject to restrictions on use (protection of the natural Alpine habitats, flora and fauna, etc.). One of the major challenges is local climate change, which is affecting the rainfall regime and contributing to both a non-stop retreat and rapid disappearance of small glaciers (in particular: the glacier of Mutt). Such pristine habitats, considered as hotspot of diversity and microrefugia for biogeographic representative and endemic species, deserve greater consideration and increased conservation measures.

Associated species encountered with *C. rottensis* sp. n. include boreoalpine and some endemic species for the Alps: *Boreoheptagyia alpicola* Serra-Tosio, 1989; *B. legeri* (Goetghebuer, 1933); *D. bertrami* Edwards, 1935; *D. bohemani* Goetghebuer, 1932; *D. nowickiana* Kownacki & Kownacka, 1975; *D. steinboecki* Goetghebuer,

1933; *D. zernyi* Edwards, 1933; *Syndiamesa edwardsi* (Pagast, 1947); *Pseudodiamesa branickii* (Nowicki, 1873), *Pseudokiefferiella parva* Edwards, 1932; *Bryophaenocladius flexidens* Brundin, 1947; *B. helveticus* Moubayed & Lods-Crozet, 2022; *B. subvernalis* (Edwards, 1929); *Chaetocladius* cf. *aedeagolobatus*, *C. coppai, C. laminatus, C. lodscrozetae*, *C. longivirgatus*, *C. suecicus*; *Eukiefferiella fittkaui* Lehman, 1972; *E. minor* (Edwards, 1929); *Heleniella helvetica* Moubayed-Breil & Lods-Crozet, 2016; *Limnophyes knispelae* Moubayed-Breil & Lods-Crozet, 2023; *Orthocladius fuscimanus* (Kieffer, 1908) and *Tokunagaia rectangularis* (Goetghebuer, 1933).

To date, the geographical distribution of *C. rottensis* sp. n. is restricted to the Alpine glacial catchments of the upper Rhône, Mutt stream (Photos 1-2). The presence of new species in some high mountain Alpine ranges of Switzerland highlights the importance of cold glacial enclaves, considered to be hotspots of endemism, in the preservation and persistence of autochthonous alpine relic species. Such species are considered to be biogeographically representative and their loss would be biologically indicative of global warming and local climate change.

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