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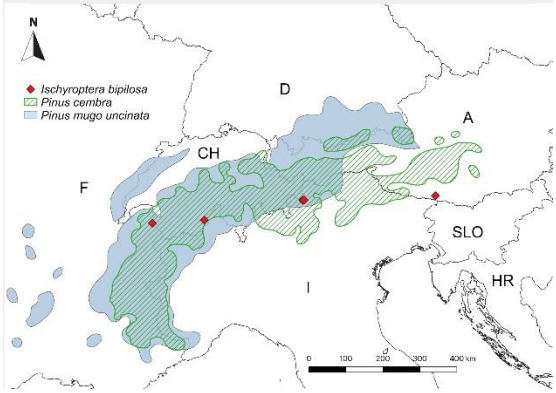

ISSN 2949-6748 Volume 4 No. 1 2025

Journaal van Syrphidae

An international journal on Syrphidae, “Journaal van Syrphidae” (http://zoobank.org/References/632F826B-7A33-4CA7-80D6-9B96135409C1), founded in 2022 by the Syrphidae Foundation. ***JvS*** publishes original work in the form of articles, comments and symposium papers on all topics concerning Syrphidae (Insecta, Diptera) from all biogeographical regions.

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Funding
JvS is financed through the Syrphidae Foundation, and can only survive by donations of readers and other organisations or private persons gifts.

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Journaal van Syrphidae 4 (1): 1–19 ISSN 2949-6748
https://www.syrphidaeintrees.com/jvs/

Article

https://doi.org/10.55710/1/XORB2334
https://zoobank.org/References/0AFB7271-CD59-4C90-A60D-AC25593D08EC

A review of *Ischyroptera bipilosa* Pokorny, 1887 (Diptera, Syrphidae), a possibly extinct Alpine endemic species

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Received: 14-11-2024 Accepted: 01-01-2025 Available online: 23-01-2025
Handling Editor: Gerard Pennards

Abstract. The information from published research and personal observations of *Ischyroptera bipilosa* Pokorny, 1887 is reviewed and discussed. All known existing specimens in various entomological collections have been traced and their associated data provided. The species is redescribed and includes several newly recognised characters separating it from allied genera. Based on the literature review and the phylogenetic position of *Ischyroptera bipilosa* there is also a discussion concerning its habitat and ecology. This information might aid in finding existing populations of this species, leading to a better understanding of this enigmatic fly.

Key words: endemic species, extinction, alpine habitat, Pelecocerinae, monotypic genus, false truffle.

Citation: van Steenis J., Koch B. & van Steenis W. 2025. A review of *Ischyroptera bipilosa* Pokorny, 1887 (Diptera, Syrphidae), a possibly extinct Alpine endemic species. Journaal van Syrphidae 4(1): 1–19. https://doi.org/10.55710/1/XORB2334

Introduction

The family Syrphidae is species rich, with over 6.000 known species worldwide, occurring in all biogeographical regions except Antarctica (Rotheray & Gilbert 2011). The adults are important pollinators receiving increasing attention from researchers and policymakers (Potts *et al*. 2016; Doyle *et al*. 2020; Vujić *et al*. 2022; Li *et al*. 2023). Pollinators are under heavy pressure due to the human influence on land use and ongoing global warming, and declines in both number of specimens and species have been observed in several European countries

(Carvalheiro *et al*. 2013; Gatter *et al*. 2020; Hallmann *et al*. 2021; Barendregt *et al*. 2022; Zeegers *et al*. 2024). The IUCN European Red List of Hoverflies states that more than 37% of the species are threatened, out of which 33 are assessed as Critically Endangered (Vujić *et al*. 2022). One of these Critically Endangered species is *Ischyroptera bipilosa* Pokorny, 1887, a species known only from 8 specimens and 4 localities along the southern and western range of the Alps with the last specimens recorded in 2008 (van der Ent *et al*. 2021).

Ischyroptera bipilosa was described by Pokorny in 1887, who immediately realised the uniqueness of this species and established *Ischyroptera* as a new genus. Lindner (1941) described *Ischyroptera annulipes*, which later was placed as a synonym of *Pelecocera tricincta* Meigen, 1822 (Peck 1988). The classification of this genus has been discussed by several authors (e.g. Sack 1932; Hull 1949; Thompson 1972; Séguy 1961; Vujić *et al*. 2019) and it is regarded to belong to the subfamily Eristalinae, tribe Rhingiini and the subtribe Pelecocerina. It resembles species of *Cheilosia* Meigen, 1822 subgenus *Taeniochilosia* Oldenberg, 1916 and some authors speculate it might be an aberrant species within this subgenus (pers. comm. Ante Vujić).

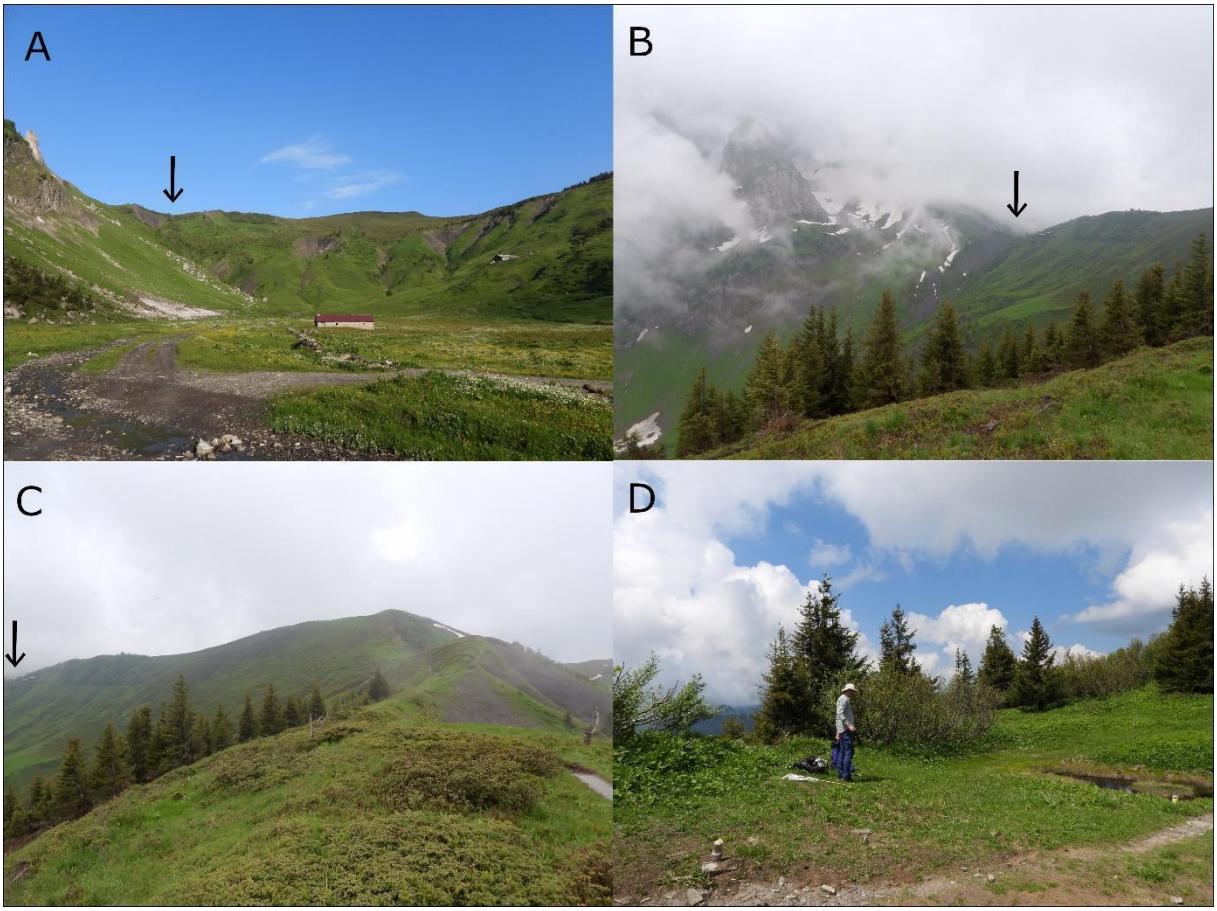

Figure 1. Col de Bretolet, Switzerland, 14 June 2023. **A**. View to the west, from Vallee de Barme. **B**. View to the South-West, from Arête de Beroi. **C**. View to the West from Arête de Beroi. **D**. At the Col de Bretolet. Arrows in **A**–**C** indicating the Col de Bretolet.

In order to get a better picture of where to find this species, the literature was studied, the existing material in entomological collections was traced and studied, and the known collecting sites in Switzerland were visited in 2023. By reviewing the existing literature and including personal observational notes, a better picture of the possible habitat and habits of

Ischyroptera bipilosa has been compiled. The search for this information began with the original publication of Pokorny and included all known references dealing with this species (Pokorny 1887, 1889; Lindner 1941; Séguy 1961; Goeldlin de Tiefenau 1974; Aubert *et al*. 1976; Maibach *et al*. 1992; Speight 2020; van der Ent *et al*. 2021).

In this paper the phylogenetic position is presented based on a literature review and a description of the species, with the latter based on two studied specimens (SMNS, see below). This is accompanied by figures of the adult and the male genitalia. The possible larval habitat is discussed based on the supposed relationship with the genera *Pelecocera* Hoffmansegg *in* Meigen, 1822 (see van Steenis 2023) and *Cheilosia*, and in light of the recent discovery of the larval habitat of *Pelecocera* (Okada *et al*. 2021; Orengo-Green *et al*. 2024; Ståhls 2024). Some inconsistencies within the literature records are discussed.

Material and methods

The literature was critically reviewed and a summary is given under distribution and biology in the results section. Two of the known collecting localities (Figs 1, 2) were visited by the authors in May and June 2023. The habitat information of these localities is presented in the results section. Collection managers of the museums where *Ischyroptera bipilosa* specimens were supposedly kept were asked for information about the number of specimens, the gender and their label information. The label information (Fig. 7) of the specimens studied is given in quotation marks with a double backslash indicating a new line on the label. In the case where neither the specimens nor the labels have been studied, the presumed collecting information is given without quotation marks or backslash. Additional collecting information found in the publication in which the specimen(s) are mentioned is given within square brackets.

The terminology follows that of van Steenis *et al*. (2023) and plant names are from the world flora online (WFO 2024).

The pictures of the supposed habitat were taken by the first author with a Nikon Coolpix P1000, except Fig. 2D which was taken by the third author. The photos, all made by the first author, for the figures of the adult specimens were taken with a Canon EOS D6 equipped with a Canon MP-E 1–5 x macro zoom lens and a Yongnuo YN14EX macro ring flash. The final figures were assembled using Zerene stacker. The illustrations of the genitalia from the male in the MZL (see below) were made by Claus Claussen. Only photos of this specimen were studied here. Both the photos and the line drawings of the genitalia were further edited with GNU Image Manipulation Program 2.8.14. The mapping program QGIS3.10 was used to illustrate the distribution of *I. bipilosa* as well as *Pinus cembra* L. and *Pinus mugo* ssp. *uncinata* Ramond ex DC. Data on the tree species were obtained from the European Atlas of Forest Tree Species (Caudullo *et al.* 2017).

The type specimen and the other specimen collected by Pokorny could be in one of the Austrian or Czech Republic natural history collections as Pokorny was a commercial school director working in Vienna and also the former chairman of the Natural Science Association in Troppau, “Austria”, currently Opava in the Czech Republic (Anonymous 1900; Ziegler 2008). Lindner (1941) states that Sack (1932) made his description of *Ischyroptera bipilosa* based on the type of Pokorny in the Natural History Museum of Vienna. The description given by Sack (1932) seems to be a copy of that given by Pokorny (1887) and it is unclear if Sack really studied any specimen of *I. bipilosa*. Földvari & Papp (2007) write that the Pokorny collection was in Budapest but had been destroyed in 1956. However, one female specimen, with labels (Fig. 7A) indicating it is the type specimen collected by Pokorny, was found in the National Institute of Agro-environmental Sciences, Tsukuba, Japan (pers. comm. Martin Hauser). The other female specimen could not be located. The collections are given below, with their acronyms in parentheses:

Private collection of Guy Van de Weyer, Reet, Belgium (GWR).
Naturéum - Muséum cantonal des sciences naturelles, Lausanne, Switzerland (MZL).
National Institute of Agro-environmental Sciences, Tsukuba, Japan (NIAES).
Staatliches Museum für Naturkunde, Stuttgart, Germany (SMNS).

Results

Phylogenetic position

Pokorny (1887) described *Ischyroptera* based on one female specimen which was also the holotype of the new species *bipilosa* in the same paper. However, he did not discuss any placement within Syrphidae. One of the first authors to place *Ischyroptera* close to *Pelecocera* was Sack (1932), who also gave an extensive description of the species. Subsequent authors (Hull 1949; Séguy 1961; Thompson 1972; Shatalkin 1975) placed the genus as sister of *Cheilosia* and *Pelecocera* either as genus, (sub)tribe or subfamily. In a recent paper by Vujić *et al*. (2019) on the phylogenetic placement based on molecular markers, *Ischyroptera* was retained as a genus within the tribe Rhingiini, based on the available morphological information, as no DNA was available for this species.

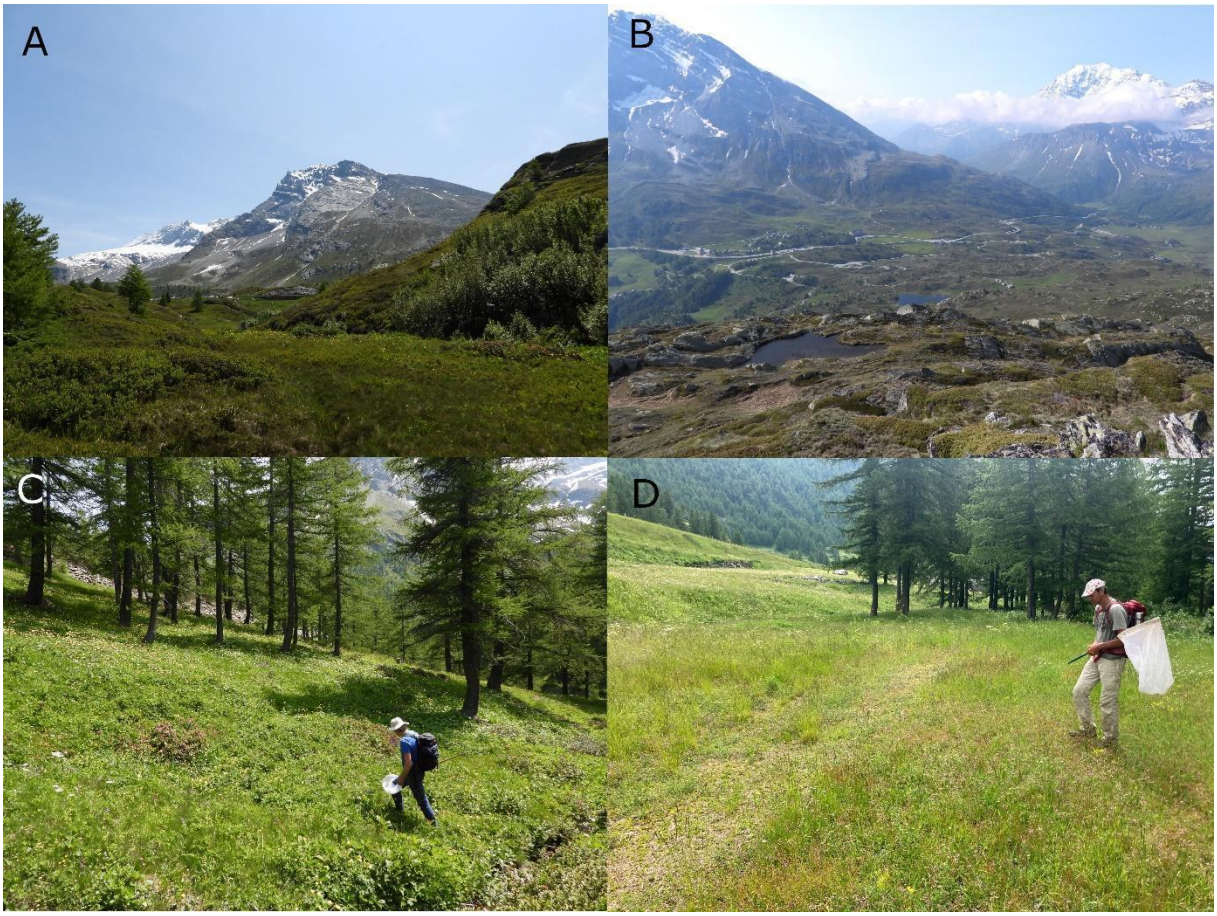

Figure 2. Simplon Pass, Switzerland, 17 to 21 June 2023. **A**. Overview to the North-East with a view at the Hübschhorn. **B**. Overview to the South-East from the Staldhorn. **C**. Simplon area, Gampisch. **D**. Simplon area, Diveria river.

Based on the following characteristics, *Ischyroptera* is a member of the tribe Rhingiini: face with clear facial tubercle in both sexes, wide and bulging parafacia; face with a clypeal and malar tubercle; antenna rather short, about as long as width of head; postpronotum pilose; anepimeron and posterior anepisternum pilose; scutellum with a ventral

pile fringe; legs simple, without enlargements or modifications; wing with cross-vein r-m before (most genera) or at the middle (in *Ferdinandea* Rondani, 1844 and *Ischyroptera*) of cell dm; two segmented aedeagus (i.e. Thompson 1972; Vujić *et al*. 2019).

In Vujić *et al*. (2019) a table is provided with characteristics differentiating the genus *Ischyroptera* from the other members of the tribe Rhingiini. In the following section the characteristics differentiating *Ischyroptera* from *Cheilosia* (*Taeniochilosia*) are given, with the terms used by Vujić *et al*. (2019) in square brackets. After this list, newly scored characteristics are given, indicating that *Ischyroptera* is a well-defined genus within the Rhingiini, in bold face are the characters found in *Ischyroptera* and not in *Cheilosia*: **aristal insertion on apico-dorsal corner of postpedicel** [beyond basal 1/3] (Figs 6A, B) versus before or at basal 1/3 (Fig. 6C); **crossvein r-m at middle of cell dm** [discal cell] (Figs 3E, 5A) versus before the middle of cell dm; hypandrium elongate (Figs 4A, F) versus squarish shaped [normal]; **distiphallus dentate** (Fig. 4G) versus non-dentate; lateral sclerites of distiphallus fused (Fig. 4G) versus partly fused. The character of the ending of the costal vein and the shape of the subepandrial sclerite [minis] was not found to be as stated by Vujić *et al*. (2019): in both *Ischyroptera* and *Cheilosia* (*Taeniochilosia*) vein C ends near (only slightly before or after or at) the apex of the wing, while the subepandrial sclerite is only narrowly separated apically versus broadly separated [more divided] apically; basiphallus broadly lunulate shaped versus shortly T-shaped, however *Cheilosia aratica* Barkalov, 1978 has a slightly lunulate basiphallus (see Barkalov & Ståhls 1997).

Newly scored characteristics differentiating *Ischyroptera* from *Cheilosia*: paravertica in female not present (Fig. 5E) versus weakly to clearly developed; parafacia very broad and bulging (Figs 6D) versus narrow (Fig. 6F) to slightly widened (Fig. 6E), not bulging; **first aristomere entirely visible** (Figs 6A, B) probably like in *Katara connexa* Vujić & Radenković, 2018 versus partly to entirely hidden within the postpedicel (Fig. 6C); arista incrassate and covered by short black setae (Figs 6A, B) versus arista thin and threadlike bare to densely covered in long pile (Fig. 6C), with the exception of *Cheilosia* (*Taeniochilosia*) *atriseta* (Oldenberg, 1916), in which the arista is of similar structure as in *Ischyroptera*; **triangular excavation on proepisternum absent** versus excavation present; **proepisternum bare** versus pilose; **pile fringe of ventral calypter in male unbranched to bifurcate** versus multifurcate and **in female unbranched** versus bifurcate.

***Ischyroptera bipilosa* Pokorny, 1887**

Ischyroptera bipilosa Pokorny, 1887: 399
Figs 3–6, see also https://syrphidae.myspecies.info/taxonomy/term/461 (Speight & de Courcy Williams 2020); https://syrphidae.fr/Ischyroptera_bipilosa/I_bipilosa_coll.html (Dussaix 2024).

Description

Male (Figs 3A, E). Measured length of body: 5.9 mm; length of wing: 5.5 mm. The length of the body of the male in coll. GWR is estimated to be 6 mm (Dussaix 2024).
Head. Head in frontal view (Fig. 3D) triangular shaped, black coloured and non-pruinose and shiny; a weakly pruinose, sub-shiny fascia along the eye margin and parafacia; a narrow fascia of dense silvery-white pruinosity on occiput along the posterior eye-margin; face with wide and triangular shaped frons and short frontal prominence; face in lateral view (Fig. 3B) concave ventrally from the antenna, with large and anteriorly protruding facial tubercle, clypeal knob and malar tubercle; gena and ventral part of parafacia bulging; parafacia very wide; head in dorsal view (Fig. 3C) with small ocellar triangle; occiput, especially the ventral part very wide; frons with deep medial sulcus; lunule with wide and blunt ending medial arm

and sharp triangular shaped lateral arms; acetabula separated by the facial sclerotization; antenna black, except baso-ventral part of postpedicel orange to brownish coloured; scape rounded to cup shaped; pedicel oval; postpedicel (Fig. 6A) small, elongate drop-shaped; arista inserted on apico-dorsal corner of the postpedicel, with three clearly visible aristomeres, incrassate and densely covered with short black setae; parafacia with long, white scattered pile; frons long and densely black pilose; ocellar triangle and dorsal occiput long black pilose; medial part of occiput short white pilose; ventral part of occiput and gena long white pilose; eyes bare, holoptic.

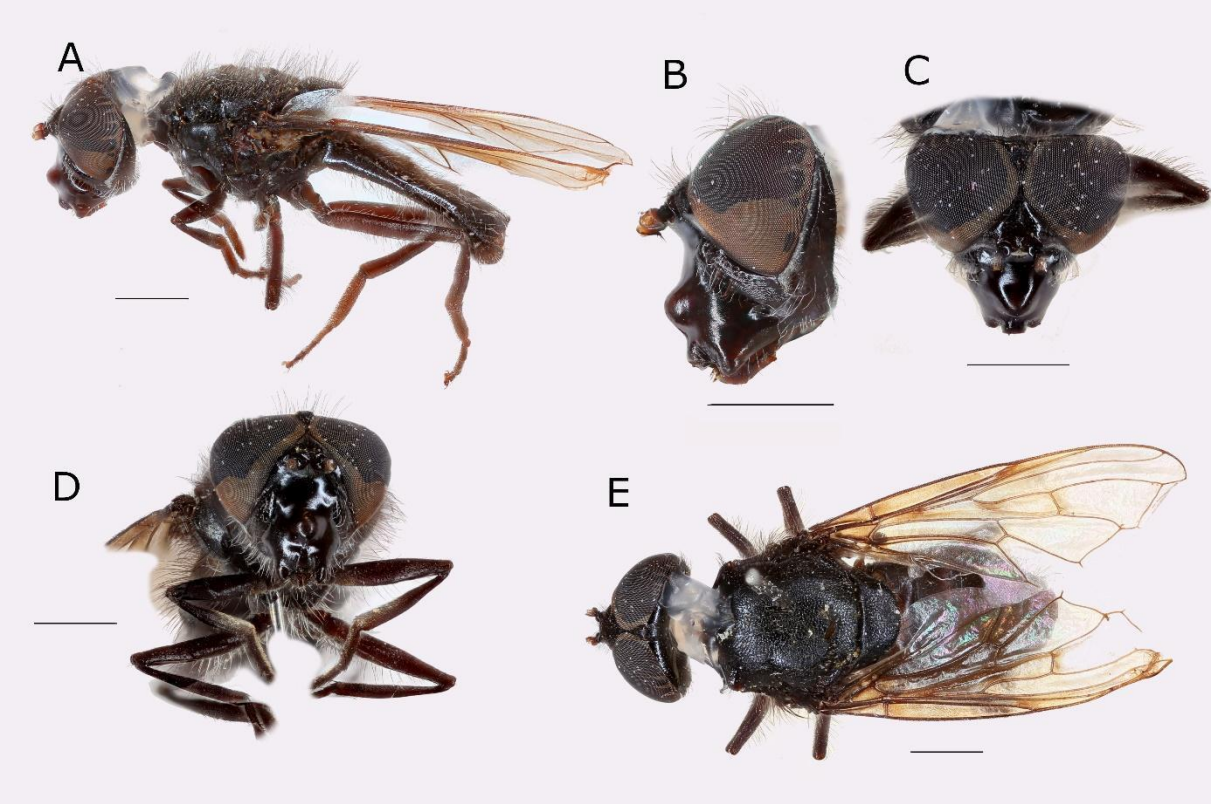

Figure 3. Adult *Ischyroptera bipilosa*, male, Villacher Alp. **A**. Adult, lateral view. **B**. Head, lateral view. **C**. Head, dorsal view. **D**. Head, frontal view. **E**. Adult, dorsal view. Scale 1.0 mm. Note: postpedicel is missing.

Thorax (Figs 3A, E). Black coloured, densely punctate, non-pruinose and rather dull, puncta on postalar callus less dense; scutum with transverse sulcus, without notopleural sulcus and narrow notal wing lamina; scutellum semi-circular; postpronutum with long mixed black to light-brown pile; scutum with short posteriorly recumbent white pile and mixed with long erect black pile; scutellum long white pilose with long white coloured subscutellar pile fringe; basisternum trapezoid shaped and with only a few short pili; antepronotum, proepimeron, posterior anepisternum, anepimeron pilose; katepisternum with separated dorsal and ventral pile patch; metasternum rather narrow, bare; subalare with long antero-dorsal part and very long plumule reaching posteriorly beyond calypter; haltere brownish-black; calypter brownish-black with yellow pile fringe; pile fringe on ventral calypter unbranched to bifurcate.
Wing (Figs 3A, E). Veins dark-brown on basal half up to crossvein r-m, apically light brown coloured; membrane antero-basally dark-brown otherwise hyaline; membrane entirely microtrichose; pterostigma weakly differentiated from the rest of the membrane; vena spuria only differentiated from the rest of the membrane by a line of darker microtrichia; alula well developed, about 2 times longer than wide; vein Rs with 4 to 5 black seta; crossvein r-m

medially placed on cell dm; cell r_1 open; vein R_{4+5} straight; vein M_2 beyond vein M_1 and vein M_4 beyond crossvein dm-m; angle of vein M_1 with vein R_{4+5} about 45°.
Legs (Figs 3A, D). Black coloured and slender, without modifications; coxa rather long white pilose, procoxa ventrally and mesocoxa laterally with rather long setae-like pile; trochanter short white pilose; tibia and tarsus with short and predominantly black setae-like pile, on ventral surface of protibia and protarsus and on medial surface of metatarsus with silvery coloured setae-like pile; femora with short black setae-like pile on most of its surface and with long mixed black and white pile on postero-ventral surface; pro- and mesofemur anterobasal with patch of dense very short brownish setae.
Abdomen (Figs 3A, E). Oval, black coloured, rather strongly punctate, sub-shiny without pattern of more dull or more shiny parts; terga almost entirely black pilose, except some white pile intermixed along the lateral margin; pile on terga short and semiadpressed along the margin long and erect; sterna with long erect white pile.

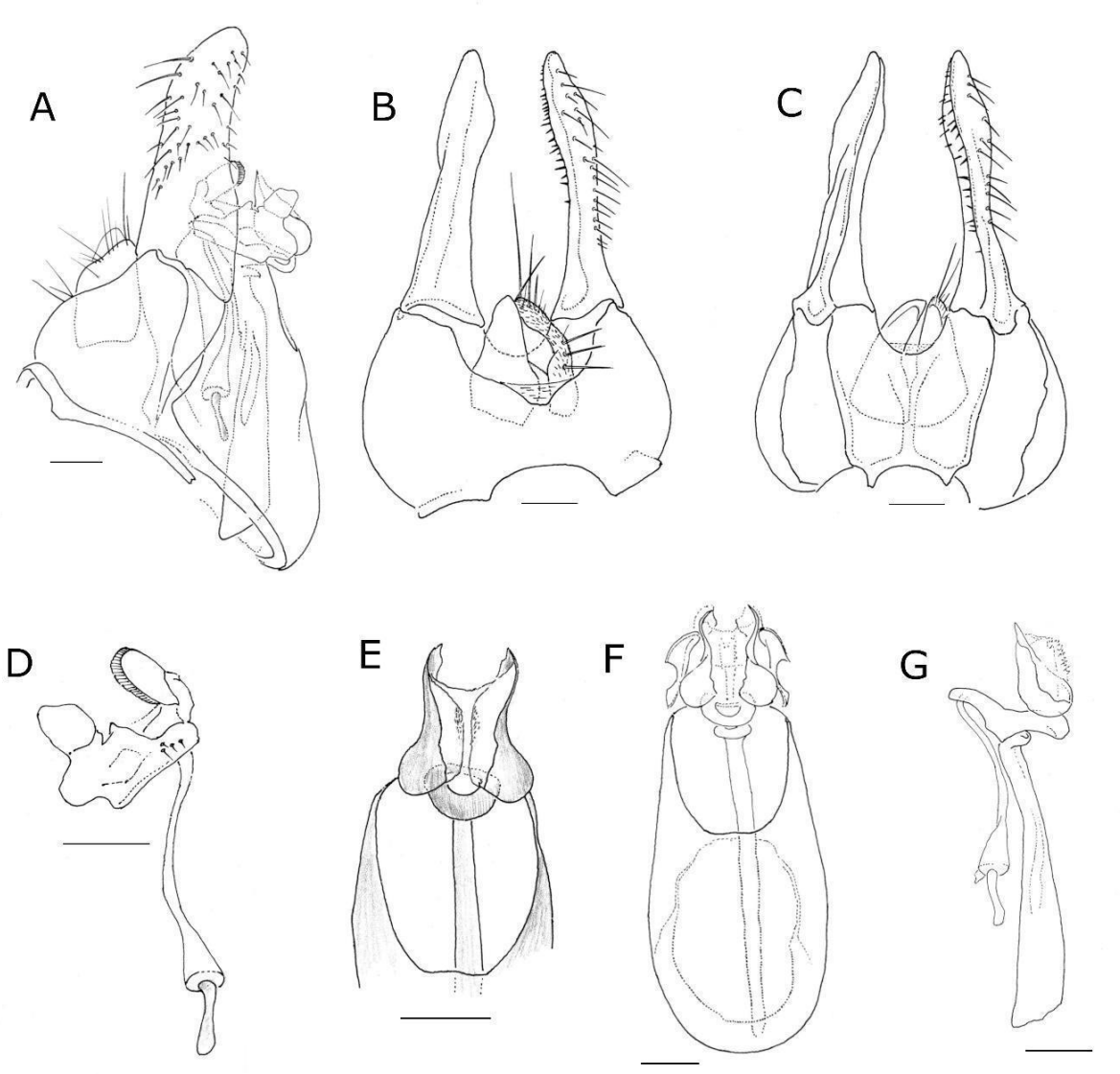

Figure 4. *Ischyroptera bipilosa*, male, Col de Bretolet, genitalia. **A**. Lateral view. **B**. Epandrium, dorsal view. **C**. Epandrium, ventral view. **D**. Postgonite with ejaculatory structures, lateral view. **E**, **F**. Hypandrium, dorsal view. **G**. Phallus, lateral view. Scale 0.1 mm. Drawings after Claus Claussen unpubl.

Genitalia (Fig. 4). Epandrium broadly triangular shaped; cerci squarish and long white pilose; surstylus elongate, rectangular shaped, without lateral carina, with long black setae apically and laterally, along medial margin with short black setulae; subepandrial sclerite rectangular shaped with lateral arms only narrowly separated apically; hypandrium elongate, rectangular shaped; postgonite sinuous with three lateral rounded lobes, the dorsal lobe with ctenidium, ventrally two rounded lobes; distiphallus dentate, angulate shaped; lateral sclerites of distiphallus fused; basiphallus broadly lunulate shaped.

Female (Figs 3A, B). Measured length of body: 8.1 mm; length of wing: 6.6 mm. The length of the body of the female is estimated to be 6–9 mm (Pokorny 1887; Dussaix 2024) and the length of wing 5–7 mm (Pokorny 1887).
Similar to the male, except for the normal sexual dimorphism and the following characteristics:
Head (Figs 5A–C, 6D). Eyes dichoptic (Fig. 5E), separated by 3–4 times the width of the ocellar triangle; vertex punctate, dulled; median sulcus and along eye-margin non-punctate, shiny; frons shiny; frons long black pilose; lateral area of vertex with slightly shorter and adpressed white pile; scape and pedicel short and cup shaped; postpedicel (Figs 5C, 6B) very large triangular shaped, covered with dense silvery pruinosity and on median surface with punctiform sacculi on both medial and lateral areas.
Thorax (Figs 5A, B). Pile fringe on ventral calypter simple, unbranched.
Abdomen (Figs 5A, B). Shape more rounded and less densely black pilose.

Known material (label info see Fig. 7): **Austria**: “Villach. Alp // Kärnt. 10.VII.[19]41 // Lindner coll.”, “SMNS_Dip_ // 007788”, 1♀ (SMNS), specimen here studied; “Villach.-Alp // 11.VII 1941 // Lindner coll. “, “QR-code // USNM ENT 00035388”, “SMNS_Dip_ // 007789”, “EOL PICTURED // SPECIMEN” [green label], 1♂ (SMNS), specimen here studied; **Italy**: “Tyrolis // Stilfser Joch”, “*Ischyroptera* // *bipilosa* Pok.”, “Type”, 1♀ (NIAS), photo studied[possibly this is the type specimen, uncertain who labelled this as type]; [Stilfser Joch, Franzenshöhe, Mid July to mid-August 1888], 1♀ [depository unknown] not studied; **Switzerland**: “Suisse-Bretolet // 16 VII 63 // 13.00-14.00”, “GBIFCH // 00677505 // QR-code”, 1♀ (MZL), photo studied; “Bretolet // 5.V.76”, “GBIFCH // 0677532 // QR-code”, 1♂ (MZL), photo and genitalia drawings studied; “Switzerl 23.05.2008 // Wallis 1607 M // Simplon Dorf // Leg. G. Van de Weyer”, 1♂ 1♀ (GWR), photos studied.

Distribution.
This species is known from 4 localities in the southern and western parts of the Alps. As far as literature with exact collecting data is concerned, the species is known from Austria, Italy and Switzerland. Séguy (1961) mentions this species based on Pokorny (1887) and Calloni (1889: p 123 and p 248) but does not list it as occurring in France. Calloni (1889) deals with the fauna of the Italian alps citing Pokorny (1887). We did not find any confirmation for the occurrence in France (as given by Speight 2020), although it might have been that the specimen from the Col de Bretolet from 1963 originated from France, it is included in the Swiss list (Maibach *et al*. 1992) and as such there is no voucher specimen from France.

A more precise description of the localities is given here: In Italy the type was found at the Stilfser Joch pass [Stilfser Joch, mid July 1886, 2500 m a.s.l.] and another female at the Stilfser Joch just below the Franzenshöhe, mid July to mid August at an altitude of possibly 2200 to 2500 m a.s.l. [46,52° N 10,45° E] (Pokorny 1887, 1889); in Austria at the Villacher Alp it was collected on the descent from the Ludwig Walter haus [Dobratsch Gipfelhaus] at 2143 m a.s.l. [46,62° N 13,67° E] (Lindner 1941); in Switzerland it was found at the Col de Bretolet at 1900–2000 m a.s.l. [46,14° N 6,79° E] (Goeldlin de Tiefenau 1974; Aubert *et al*.

1976) and in the Simplon area close to Simplon Dorf at just over 1600 m a.s.l. [Chapel Eggen, 46,20675° N 8,041222° E] (pers. comm. Guy van de Weyer).

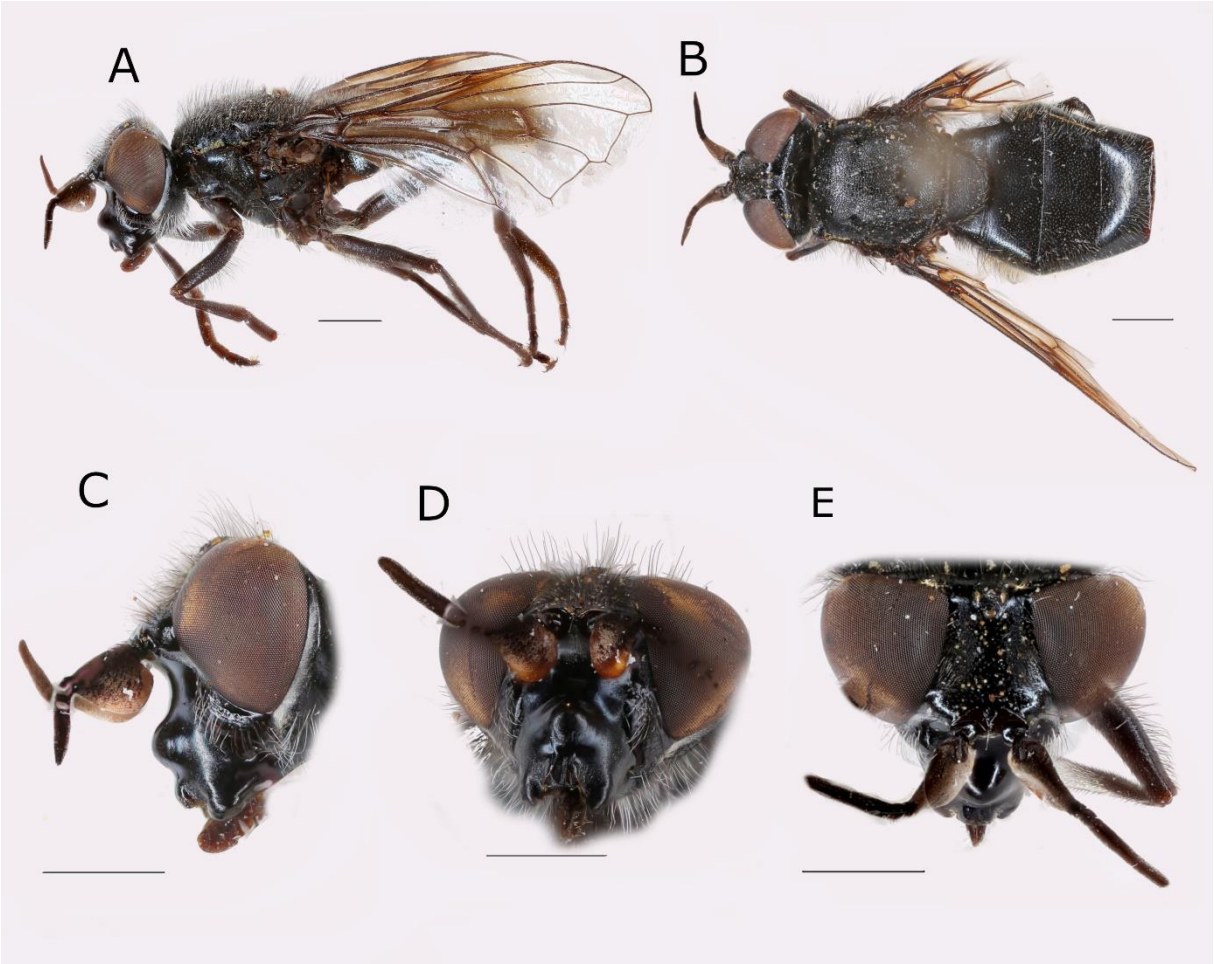

Figure 5. *Ischyroptera bipilosa*, female, Villacher Alp. **A**. Adult, lateral view. **B**. Adult, dorsal view. **C**. Head, lateral view. **D**. Head, frontal view. **E**. Head, dorsal view. Scale 1.0 mm.

Biology.
The biology of this species is enigmatic with collecting dates ranging from early May to mid-August at an altitudinal range from 1600–2500 m a.s.l. It was found flying along bushes close to the ground; along a footpath at the time of snowmelt (Pokorny 1887, 1889); sitting on the ground on the footpath (Lindner 1941); or while visiting flowering *Potentilla* spp. (pers. comm. Guy Van de Weyer). It was also collected in a flight interception trap between 13.00 and 14.00 hours (label data). Male(s) are reported to hover 2–3 metres above ground level and settle on bare rocks (pers. comm. Pierre Goeldlin de Tiefenau *in* Speight 2020). It could not be verified if this report concerns the only collected male on the 5th of May 1976 or that it truly concerns multiple males. In flight it resembles sawflies (Pokorny 1887). Based on the above given biology Speight (2020) concluded that the preferred environment is bare ground on calcareous, rocky moraine and talus slopes with very sparse ground vegetation, although it has also been collected in montane / subalpine, unimproved, calcareous grassland.

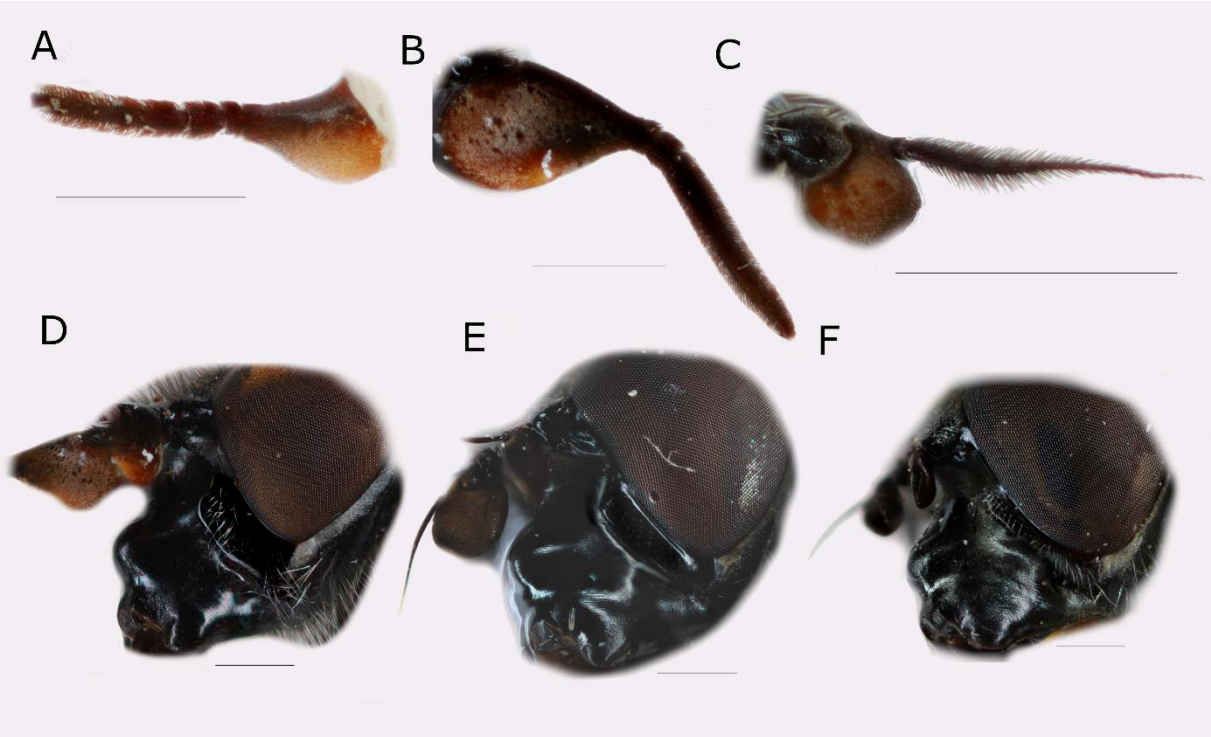

Figure 6. **A**–**C**. Postpedicel + arista, lateral view. **D**–**F**. Parafascia, female, antero-lateral view. **A**. *Ischyroptera bipilosa*, male, Villacher Alp. **B, D**. *Ischyroptera bipilosa*, female, Villacher Alp. **C**. *Cheilosia* (*Taeniochilosia*) *aristata* Barkalov & Ståhls, 1997, male, Simplon area, Switzerland. **E**. *Cheilosia* (*Taeniochilosia*) *laeviseta* Claussen, 1987, Ailefroide, France. **F**. *Cheilosia* (*Taeniochilosia*) *loewi* Becker, 1894, Zinal, Switzerland. Scale 0,5 mm.

The habitats on the Col de Bretolet (Fig. 1) and at the Simplon Pass (Fig. 2) in the Swiss Alps are characterised by alpine grassland with shrubland and rocks. Green alder (*Alnus alnobetula* ssp. *alnobetula* (Ehrh.) K.Koch (syn *A. viridis* (Chaix) DC.)) is the main shrub species dominating at the Col de Bretolet, whereas the area around Simplon Dorf (Fig. 2D) is additionally covered by pine (*Pinus cembra* L. and *P. mugo* ssp. *uncinata* Ramond ex DC.) and larch (*Larix decidua* (L.) Mill.) forests. At an altitude of around 2000 m a.s.l. (2006 m Simplon Pass, 1923 m Col de Bretolet), the trees are only sparse and the vegetation season mainly extends between May and September, the surfaces being under a cover of snow during winter. The closed forest further down is mainly composed of spruce (*Picea abies* (L.) H. Karst.) and larch. The rocks at the Simplon Dorf and Pass are mainly composed of moraine and gneiss, to a small extent also limestone, whereas the cliffs above the Col de Bretolet are mainly calcareous, from which also the debris found further down the Col derives. The area around the Simplon Pass and Dorf belongs to the Continental Alps. Instead, the Col de Bretolet is part of the Northern Pre-Alps forming the North-Western limit of the High Alps, thus being exposed to different climatic effects. This last locality is a major insect migration route, millions a day, including a multitude of hoverflies (Aubert *et al.* 1976), while its tree cover has increased tremendously during the last decades (pers. comm. Pierre Pury).

The Stilfser Joch is a high mountain pass in the Eastern Alps situated at an elevation of 2757 m a.s.l. Located in Northern Italy near the Swiss border, this region features a complex geology dominated by sedimentary rocks, primarily limestone and dolomite, along with significant amounts of metamorphic rocks. The diverse landscape of Stilfser Joch includes various zones ranging from submontane to nival, leading to an increase of boreo-montane and arcto-alpine faunal elements with higher altitude (Ziegler 2008). At lower elevations, the montane zone features dense forests primarily composed of coniferous trees such as spruce and larch. As the elevation increases, the montane forests give way to a zone

characterised by mixed forests of spruce, larch, and Swiss pine (*Pinus cembra*; see the factsheet of this species in Caudullo & de Rigo 2016). The understory in this zone includes shrubs such as green alder and a variety of herbaceous plants. Higher up, the area is dominated by alpine meadows and grasslands, interspersed with rocky outcrops and scree slopes with mountain pine (*Pinus mugo* Turra; see the factsheet of this species in Ballian *et al*. 2016). The climate of Stilfser Joch is continental, mainly influenced by its central Alpine position.

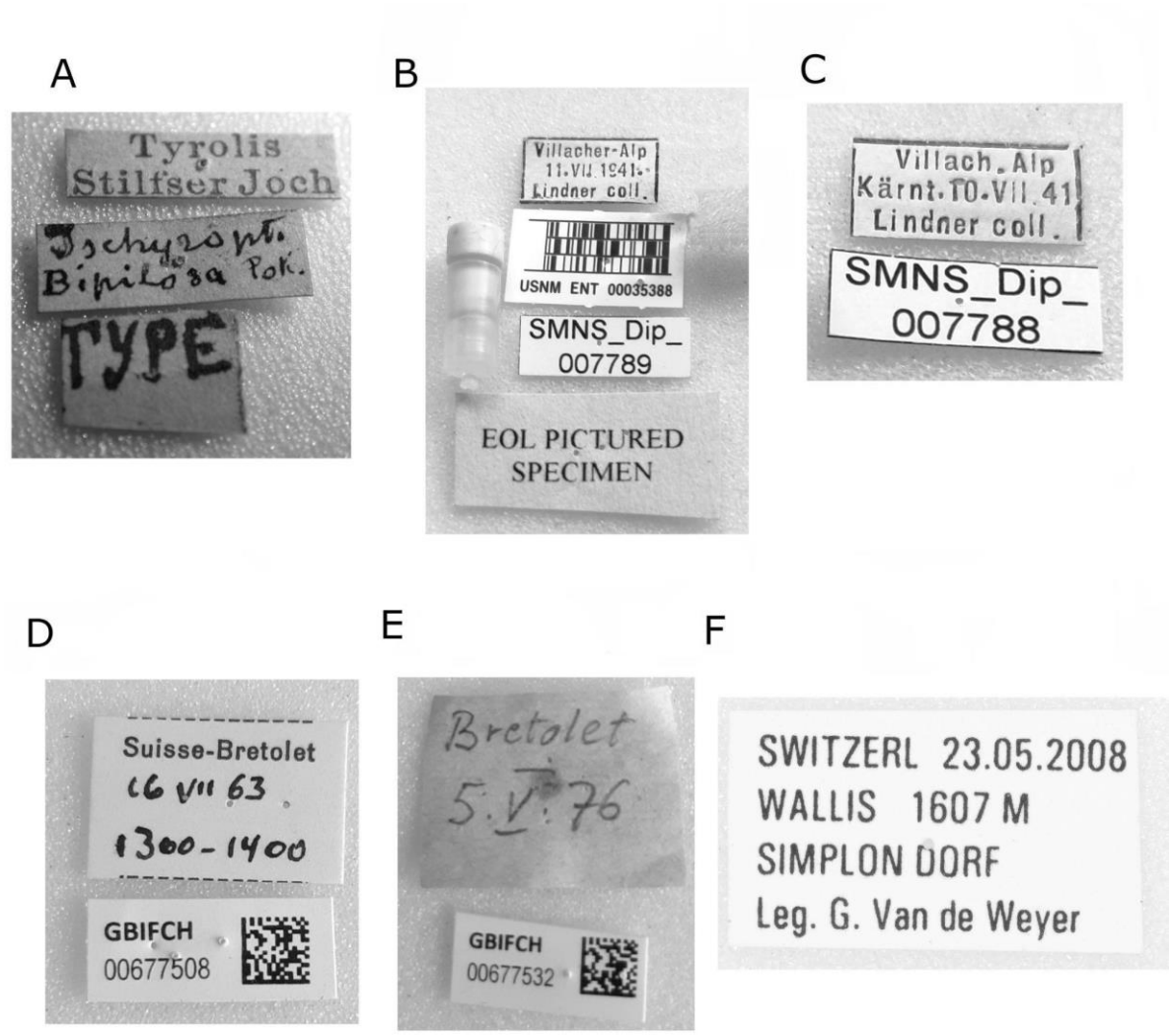

Figure 7. Collecting labels of *Ischyroptera bipilosa*. **A**. presumed Holotype specimen, Stilfser Joch, Italy (NIAES). **B**, **C**. Villacher Alp, Austria (SMNS). **B**. male **C**. female. **D**, **E**. Col de Bretolet, Switzerland (MZL). **D**. female. **E**. male. **F**. Simplon pass, Switzerland (GWR), male and female. Figs A, D–F from Martin Hauser, Anne Freitag, Marion Podolak and Snezana Radenković.

The Dobratsch, also known as Villacher Alp, is a prominent limestone massif with a peak reaching 2166 m a.s.l. This massif is notable for its extensive network of caves and shafts formed by the dissolution of limestone rock, creating a large cave system where ice is preserved throughout the year. On the southern slope of the Dobratsch, particularly in the Schütt area, the landscape is often covered by landslide material and slope debris extending to the foot of the wall. Solid rock surfaces are typically only visible in areas affected by gullies and debris flows. The natural vegetation of the Dobratsch includes a variety of forest types and scrublands (Jungmeier 2013). The originally dominant conifer forest, particularly the

mountain pine forest, has been transformed to grassland for grazing on the eastern side. Elsewhere, the area is characterised by bizarre rock formations, boulder slopes, mountain pine scrub, and red (*Pinus sylvestris* L.) and black pine (*Pinus nigra* J.F. Arnold) forests, with deciduous forests appearing at lower altitudes. Above the steep cliffs of the Dobratsch's south face, between 1600 to 1800 m a.s.l, the spruce-larch mountain forest represents the highest forest form. In these areas, spruce and larch dominate, thriving in the thin soil layer over rocky ground where few other trees can grow. Black pine competes with larch in certain areas, while red pine takes over landslide areas with low water retention, supplanting spruces. In the steep walls and rocky landscapes, only black pines or spruces manage to establish themselves due to the challenging growing conditions. The Dobratsch region experiences a subarctic climate that borders on a tundra climate.

The presumed exact collecting sites are in close vicinity of pine forests although the specimens were collected on sparse rocky moraine and grasslands. In summary, the species flies at greatly varying altitudes, has a long flight period across a wide variety of alpine habitats and occurs in very low densities.

Discussion

In some of the references incomplete and sometimes even doubtful information was found, i.e. Aubert *et al*. (1976) mention the collection of "the second female specimen ever collected", while Pokorny (1887, 1889) mentioned 2♀♀ and Lindner (1941) collected 1♂ and 1♀ indicating that already 4 specimens from two different localities were published. In Séguy (1961) the species is mentioned to be recorded in July at an altitude of 2500-2800 m a.s.l. and Maibach *et al*. (1992) indicate it as "Rare" in Switzerland indicating it has been recorded from 5–9 localities, although only two records from one locality, namely the Col de Bretolet were known. In another example, Speight (2020) records the species as occurring in France without indicating where this information came from, since no published data seems to exist for France. The record in Aubert *et al*. (1976) was from "Col de Bretolet, a pass at the border between Switzerland and France" and it is therefore possible that this specimen originated from France, although it is listed as occurring in Switzerland (Maibach *et al*. 1992). In the following sections an overview is given about what was found in the literature and what we think is the correct information.

Country occurrence

The presence of *Ischyroptera bipilosa* in France might be based on a personal communication of Goeldlin de Tiefenau, as the Col de Bretolet is situated on the border between France and Switzerland. It might be that the specimen of 1976 was collected in France although this record is stated to be a Swiss record in Maibach *et al*. (1992). Furthermore, the map in van der Ent *et al*. (2021) is not correct in the placement of the occurrence point in France. This point concerns the Col de Bretolet and should be positioned more to the east in Switzerland at the border with France. As only two records are known from Col de Bretolet and both are mentioned to be from Switzerland, the occurrence in France needs to be deleted.

The Col de Bretolet area has been visited repeatedly by multiple collectors in the 21st century without finding *Ischyroptera*. This locality is one of the main sites for studying bird migration in Switzerland and systematic captures of hoverflies were made for more than ten years between 1962 and 1973 with only one female of *Ischyroptera bipilosa* found out of a total of more than 2 million hoverflies captured (Aubert 1963, 1964; Aubert *et al*. 1976). Although most were clearly migrating species, it demonstrates the extreme rarity of the species. Despite its rarity and the possibility that it is overlooked, the continued presence of the species in Austria and Italy seems doubtful since both the Stilfser Joch and the Villacher

Alp areas have been visited by several of the best German entomologists over many years at the end of the 20th century without seeing any *Ischyroptera* (Martin Hauser pers. comm.; Romig 2008, 2016; Ziegler 2016). In addition, the Villacher Alp suffers from intensive pressure by tourists and this might have caused a deterioration of the habitat.

The historically known occurrences of *Ischyroptera* therefore include Austria (extinct), Italy (extinct) and Switzerland (probably extinct on Col de Bretolet, possibly extinct in the Simplon area).

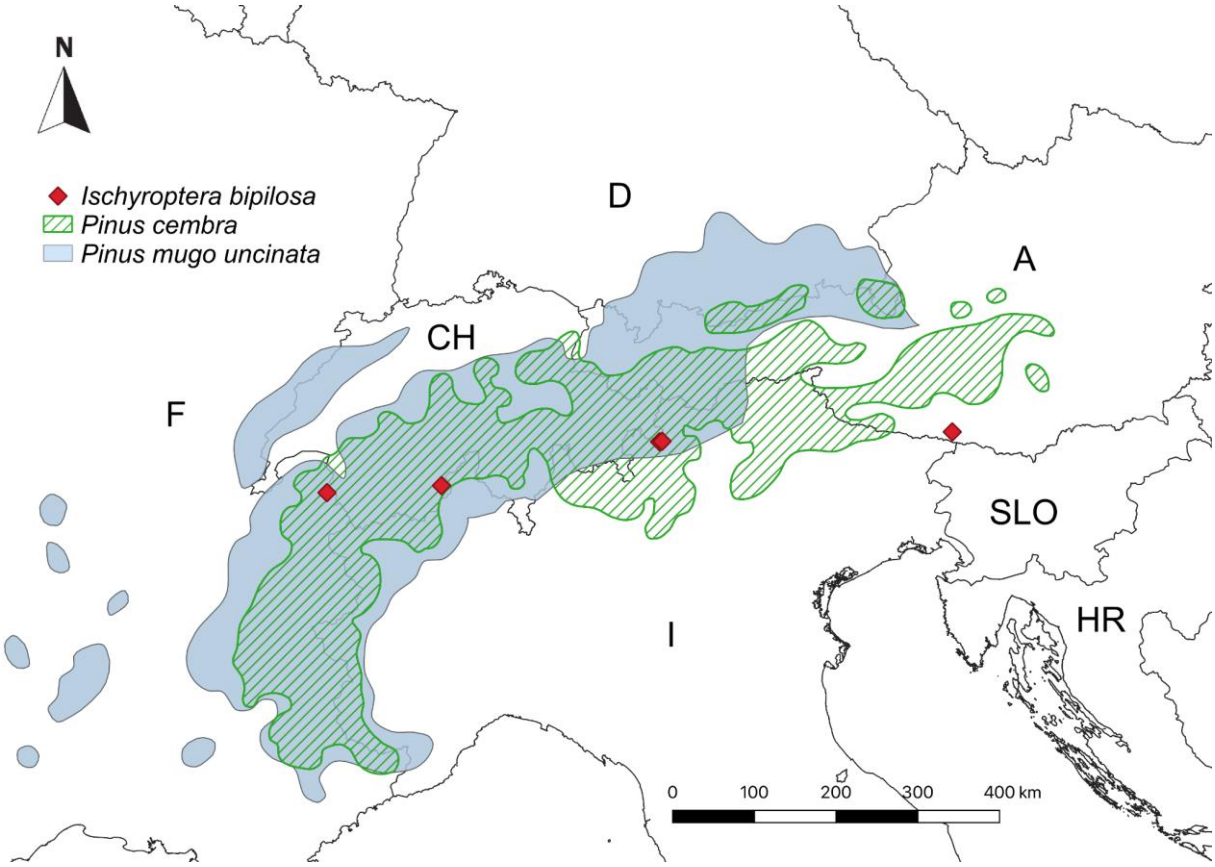

Figure 8. Alpine distribution of *Ischyroptera bipilosa* and the *Rhizopogon* associated pine trees *Pinus cembra* and *Pinus mugo* ssp. *uncinata*. Data on the tree species were obtained from the European Atlas of Forest Tree Species (Caudullo *et al.* 2017).

Possible habitat and behaviour

Based on the description of the habitat of the Col de Bretolet and the Simplon Pass and the known biology of *Ischyroptera bipilosa*, a generalised idea is formed concerning the habitat preference and its habits.

Based on the phylogenetic relationship and the peculiar basoflagellomere with many sacculi, *Ischyroptera* is hypothesised to have a similar larval habitat as *Cheilosia* subgenus *Eucartosyrphus* Barkalov, 2002 (Hackman & Meinander 1979; Rotheray 1990; Stuke 2000) and *Pelecocera* (Okada *et al*. 2021; Orengo-Green *et al*. 2024; Ståhls 2024), which might be mushrooms of the genera *Rhizopogon* Fr. or *Suillus* Gray as these genera form a sister group within the Boletales (Breitenbach & Kränzlin 1991; Grubisha *et al*. 2002). It might also be that *Ischyroptera* is dependent on *Pinus cembra* or *P. mugo* ssp. *uncinata* forests as these are subalpine to alpine tree species with an altitudinal range from 1100 to 2700 m a.s.l (Ballian *et al*. 2016; Caudullo & de Rigo 2016; InfoFlora 2024). The co-occurrence of *Ischyroptera bipilosa* with both *Pinus cembra* and *P. mugo* ssp. *uncinata* is remarkable (Fig. 8), although at

the Villacher Alp both tree species are seemingly missing. The post-glacial occurrence and dispersal of *Pinus cembra* is well studied and its range, most likely, once encompassed the Villacher Alp too (Hartl & Zeitlinger 1977; see blue dots in Fig. 7 in Casalegno *et al*. 2010; Gugerli *et al*. 2022), while at present there are no populations left in this area (Turnowsky 1955; Heinze & Holzer 2013). A reason why *Ischyroptera* was collected at the Villacher Alp might be a connection with the Habitats Directive Annex I code 9420 (Alpine *Larix decidua* Mill. and/or *Pinus cembra*) forests occurring at this site (EU 2024; Natura 2000 2024). Both *Pinus cembra* and *P. mugo* ssp. *uncinata* are considered a glacial relict of high conservation value with a high degree of mycorrhization harbouring 20 species of the mushroom genera *Rhizopogon* and *Suillus* (Mandolini *et al*. 2022), of which several are on the Swiss Red List of mushrooms (Senn-Irlet *et al*. 2007). *Rhizopogon* species are mostly associated with *Pinus* spp. (Miyamoto *et al*. 2019) and in Europe it is known from *Pinus cembra*, *P. mugo* s.l. and *P. nigra* J.F. Arnold (Moser *et al*. 1999; Moser & Peintner 2000; Mandolini *et al*. 2022).

Contact with Austrian mycologists confirmed the presence of Coleoptera in hypogeous fungi like *Rhizopogon*, but unfortunately nothing is known concerning the presence of Syrphidae in these fungi nor about any possible co-occurrence of *Ischyroptera bipilosa*, *Pinus cembra* or *P. mugo* s.l. and *Rhizopogon* species. However, several species of *Rhizopogon* have been found in connection with *Pinus cembra* and *P. mugo* s.l., e.g. *R. melanogastroides* Lange, *R. pannosum* Zeller & Dodge, *R. pumilionus* (Ade) Bataille and *R. roseolus* (Corda) Th.M.Fries (pers. comm. U. Peintner; Fogel & Peck 1973; Moser *et al*. 1999; Moser & Peintner 2000; Mleczko *et al*. 2021).

Consequently, the search for *Ischyroptera bipilosa* might be more successfully achieved by looking for the rare *Rhizopogon* species connected to either *Pinus cembra* or *P. mugo* ssp. *uncinata* in order to find the larvae rather than searching for the adults as has been done by many Dipterists in the past. This approach of searching for larvae rather than the adult flies has been successful for some other rare hoverfly species in Scotland like *Blera fallax* (Linnaeus, 1758) and *Callicera rufa* Schummel, 1842 (Rotheray & MacGowen 2000).

Acknowledgements

For loan of material the following curators are thanked: Anne Freitag and Marion Podolak (Lausanne, Switzerland), Daniel Whitmore (Stuttgart, Germany). Many people helped with a diverse array of information: Martin Speight (Wicklow, Ireland) for seeing the male and female in the MZL, forwarding information from Guy Van de Weyer and Pierre Goeldlin de Tiefenau, and providing us with some personal consideration. Snezana Radenković (Novi Sad, Serbia) for providing photos and drawings of *Ischyroptera* specimens in MZL and GWD; Claus Claussen (Flensburg, Germany) for the drawings of the male genitalia; Anne Freitag and Marion Podolak (Lausanne, Switzerland) helped with information and photos of the male and female in the MZL; Guy Van de Weyer (Reet, Belgium) provided exact locality information from the specimens of *Ischyroptera* collected by him. Martin Hauser (Sacramento, USA) provided information about field visits in Villacher Alp and Stilfser Joch, the *Ischyroptera* specimens collected by Lindner and the presumed type specimen found in the NIAES; Pierre Pury (Switzerland) gave information on the habitat at Col de Bretolet; Torsten Dikow (Washington, USA) had information about the USNM label on one of the specimens actually belonging in the SMNS; Esther Ockermüller from Zobodat (Austria) for information about Emanuel Pokorny; Jindřich Roháček (Silesian Museum, Opava, Czech Republic) for information that this museum does not have any specimen collected by Pokorny; Ursula Peintner (Innsbruck, Austria) provided information on Alpine *Rhizopogon* species and additional literature. Finally, Chris Palmer (Portsmouth, U.K.) read and corrected the English.

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