New records and first DNA barcodes of the family Canthyloscelidae (Diptera) in Fennoscandia

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Prior to this study, members of Canthyloscelidae, a small, relict family of nematocerous Diptera, have very occasionally been found in Fennoscandia. This led to the widely accepted opinion of canthyloscelids being rare elements of the regional fauna. New data presented here on the occurrence of the three European species suggest that this picture needs a more differentiated view. We report two localities with abundant catches of *Hyperoscelis eximia* (Boheman, 1858) by use of Malaise traps, and one locality with abundant catches of *Synneuron annulipes* Lundström, 1910 by use of light traps. Other records of these two species concern mostly single specimens and are scattered across Fennoscandia. *Hyperoscelis veternosa* Mamaev & Krivosheina, 1969, represented in our material by only a single female, is the first record in Sweden and the second documented finding in Fennoscandia. All three canthyloscelid species were successfully barcoded with large barcode gaps on The Barcode of Life Data System (BOLD), and aligned with public barcodes of the North American *Synneuron decipiens* Hutson, 1977 in an ID-tree. Decaying logs of Norway spruce, *Picea abies*, presumably infested with brown rots caused by the bracket fungus *Fomitopsis pinicola*, were present in the near vicinity of most collecting sites, although the northernmost localities lie far from natural populations of this conifer. It is argued that the current conservation status of Canthyloscelidae in Fennoscandia should be maintained until a better understanding of adult and larval biology allows a more appropriate assessment. We also use the opportunity to emphasize, in our digital age, the crucially important role of depositing voucher specimens in public collections in order to validate records grey published online through photos or DNA barcodes.

Key words: Diptera, Canthyloscelidae, *Hyperoscelis*, *Synneuron*, Norway, Sweden, new records, Red List, biology.

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Introduction

Members of the Canthyloscelidae are small to medium sized, stout nematocerous flies believed to be relicts of an ancient fauna now restricted to primeval forests where their xylosaprophagous larvae develop in wet, rotting wood of tree trunks and stumps (Roháček & Ševčík 2009). The sinking of family Synneuridae into Canthyloscelidae as proposed by Amorim (2000) was further confirmed in a multilocus phylogeny by Ševčík *et al.* (2016). Even this enlarged family concept consists of only four genera and 12 described, extant species worldwide (Hutson 1977). These are distributed in the Holarctic Region (6 species), the southern Neotropical Region (2 species), and in New Zealand (4 species). Three of the Holarctic species are known to occur in Europe: *Hyperoscelis* *eximia* (Boheman, 1858), *Hyperoscelis veternosa* Mamaev & Krivosheina, 1969, and *Synneuron annulipes* Lundström, 1910.

Even though the type species of the genera *Hyperoscelis* Hardy & Nagatomy, 1960 and *Synneuron* Lundström, 1910 were described from Sweden and Finland, respectively, their presence in Fennoscandia has remained elusive due to the small number of published records. In recent years, some fresh findings including images have been entered into online faunistic databases like Sweden's Artportalen (ArtDatabanken 2019), and the Finnish Entomological Database (Kaitila 2017). As a result, all three species are currently red listed in the Fennoscandian countries, even though in very different categories from "regionally extinct" (RE) to "of least concern" (LC) (see e.g. Tingstad *et al.* 2017).

Here, we communicate new data on the occurrence of canthyloscelids in Norway and Sweden, including the first DNA barcodes of the three European species. Furthermore, we use this data for discussing aspects of habitat requirements and conservation status in Fennoscandia. Finally, we comment on issues of online data quality within the context of taxonomy and faunistics.

Materials and methods

Most examined specimens were dried from ethanol samples by use of HMDS baths (see Brown 1993), then pinned and deposited in the entomological collections at Tromsø University Museum, UiT – The Arctic University of Norway. A few specimens of both sexes of *Hyperoscelis eximia* are kept in freezers in 95% ethanol as a source for further genetic study. The *Synneuron* specimen from Västerbotten, Sweden (see below), is kept in 80% ethanol at Station Linné, Öland's Skogsby.

One leg each from fresh specimens of all three species were sent to the Canadian Centre for DNA barcoding, BIO (Guelph, Ontario, Canada), for DNA extraction and bi-directional Sanger sequencing as a part of the Norwegian Barcode of Life (NorBOL) initiative (see Kjærandsen 2017), itself a branch of the International Barcode of Life project (iBOL).

A Nikon Digital Sight DS-M5 microscope camera mounted on a Nikon SMZ1500 stereomicroscope was used to capture images of specimens in ethanol.

Acronyms used for biological provinces in Fennoscandia follow those used in the *Fauna Entomologica Scandinavica* book series, e.g. Bächli *et al.* (2004), except that capital letters are used throughout.

Identification of adults

Once arrived at the family, Canthyloscelidae, using the key by, for example Oesterbrook (2006), adults of *Hyperoscelis* (Figures 1 & 2) can be recognized by their stout gestalt, black body colour and, above all, distinctly club-shaped hind femora. Their wing venation, which is also characteristic of the genus, includes crossvein r-m being replaced by a long fusion of M_{1+2} and R. Roháček & Barták (2007) explain how both sexes of *H. eximia* and *H. veternosa* can be identified using characters of the wing (Figures 1D & 2D) and the terminalia (male, Figure 1C; female, Figure 2C). As regards wing characters, which are easier to observe than genitalic characters, in *H. eximia* the dark part of the basal section (Ms) of vein M is shorter relative to the pale part, and somewhat divergent from the basal part of R. In *H. veternosa*, in contrast, the dark part is longer relative to the pale part, running parallel to the basal part of R, and then abruptly bends into the pale part. Additionally, cell br is almost bare in *H. eximia* while having numerous (>40) macrotrichia in *H. veternosa*.

In comparison with both species of *Hyperoscelis*, *Synneuron annulipes* (Figure 3) is much smaller, has the hind femora less club-shaped and subequal in length to the mid femora, and has quite different wing venation: both R_{2+3} and r-m are replaced by fusions, with the latter forming an unmistakably characteristic x-shape near the anterior edge of the wing (Figure 3B).

The larvae of all three European species were described and keyed by Mamaev & Krivosheina (1969).

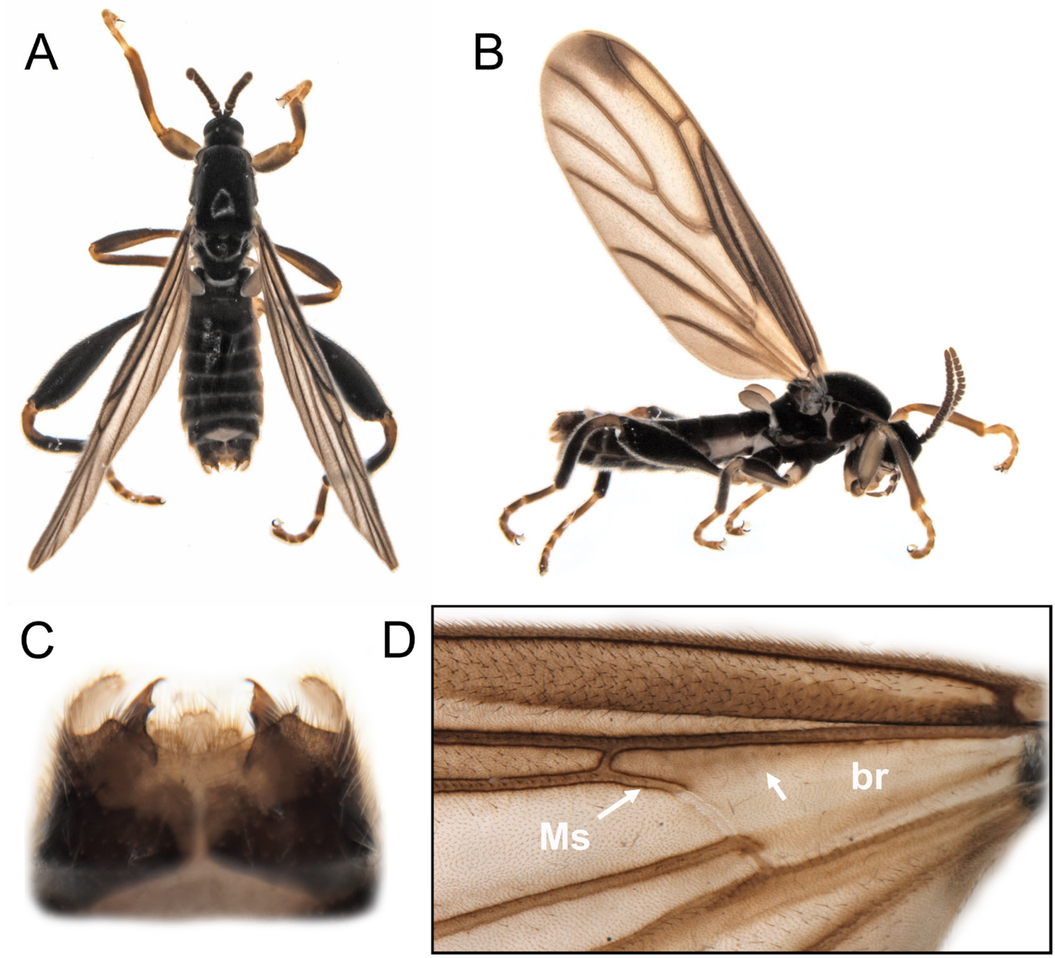

FIGURE 1. *Hyperoscelis eximia* (Boheman, 1858), specimen TSZD-JKJ-107694. **A**. Male in dorsal view; **B**. Male in lateral view; **C**. Male terminalia in dorsal view; **D**. Base of wing enlarged, showing the diagnostic characters of the species, i.e. the basal section (Ms) of the vein M being not longer than the pale part, and somewhat divergent form the basal part of R, and cell br nearly devoid of macrotrichia. Photos: Jostein Kjærandsen.

Hyperoscelis eximia **(Boheman, 1858)**

New records: **NORWAY**: **NSI**, Grane: Auster-Vefsna Nature Reserve, Stilleelva W, 65°32'02"N, 013°43'40"E, Malaise trap no. 1, 28 May-30 July 2018, leg. J. Kjærandsen, J. P. Lindemann & P. Dominiak, 23 males (TSZD-JKJ-104788, TSZD-JKJ-104789, TSZD-JKJ-104791, TSZD-JKJ-104792, TSZD-JKJ-104900, TSZD-JKJ-104901, TSZD-JKJ-104902, TSZD-JKJ- 104903, TSZD-JKJ-104904, TSZD-JKJ-104905, TSZD-JKJ-104906, TSZD-JKJ- 104907, TSZD-JKJ-104908, TSZD-JKJ- 104909, TSZD-JKJ-104910, TSZD-JKJ-104911, TSZD-JKJ-104912, TSZD-JKJ-104913, TSZD-JKJ-104914, TSZD-JKJ-104915, TSZD-JKJ-104916, TSZD-JKJ-105188, TSZD-JKJ-105277), 5 females (TSZD-JKJ-104917, TSZD-JKJ-104918, TSZD-JKJ-104919, TSZD-JKJ-104920, TSZD-JKJ-104921); Auster-Vefsna Nature Reserve, Stilleelva W, 65°31'55"N, 013°43'29"E, Malaise trap no. 2, 28 May-30 July 2018, leg. J. Kjærandsen, J. P. Lindemann & P. Dominiak, 2 males (TSZD-JKJ-106090 & TSZD-JKJ-106091), 2 females (TSZD-JKJ-104780 & TSZD-JKJ-106092);

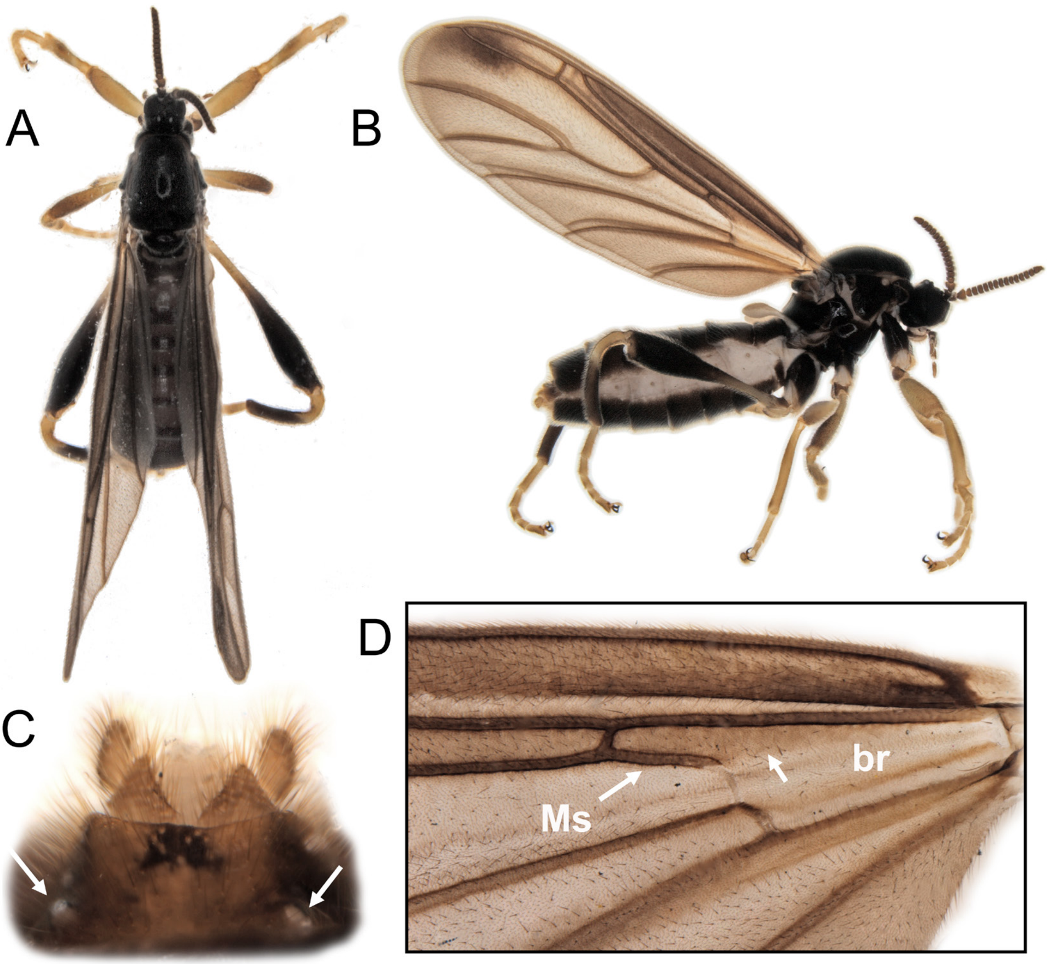

FIGURE 2. *Hyperoscelis veternosa* Mamaev & Krivosheina, 1969, specimen TSZD-JKJ-104899. **A**. Female in dorsal view; **B**. Female in lateral view; **C**. Female terminalia in dorsal view; **D**. Base of wing enlarged, showing the diagnostic characters of the species, i.e. the basal section (Ms) of the vein M being distinctly longer than the pale part, lies parallel to the basal part of R and then abruptly bends into the pale part, and cell br with numerous macrotrichia. Photos: Jostein Kjærandsen.

NSI, Saltdal: Vik, Tørråga, Malaise trap no 1, 29 May-22 July 2019, leg. J. Kjærandsen, J. P. Lindemann & P. Dominiak, 1 males (TSZD-JKJ-107603); **TRI**, Målselv: Rostadalen, Innset, 68°57'43"N, 019°45'11"E, Malaise trap, 14 June-10 August 2009, leg. T. E. Barstad, 2 males (TSZD-JKJ-107336 & TSZD-JKJ-107383), 3 females (TSZD-JKJ-100454, TSZD-JKJ-107337, TSZD-JKJ-107384). **SWEDEN**: **ÖG**, Ödeshög, Omberg, Storpissan Nature Reserve, 58°20´N, 14°39´E, 7 June2010, sweepnet, leg. C. Jaschhof, det. M. Jaschhof. 1 male (TSZD-JKJ-107694).

Barcodes: Eight of the examined males were successfully DNA-barcoded (500–658 BP, 0n) on BOLD and assigned to the Barcode Index Number **BOLD:ADS5898**. Currently this BIN has no additional members. Its nearest neighbour is *H. veternosa* in **BOLD:ADJ6424** at 12% distance (Figure 4).

Remarks: This species was described on the basis of two males and one female from near Tärna, Storuman, in Lycksele Lappmark, Sweden

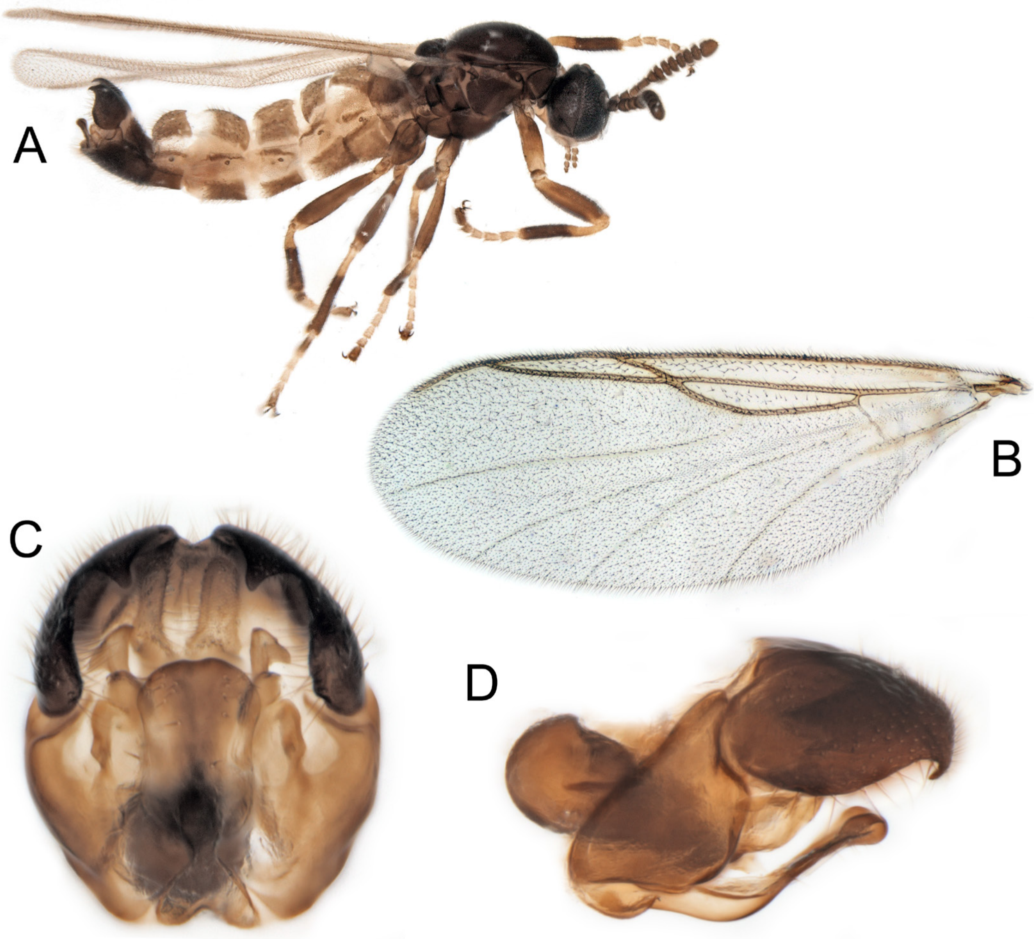

FIGURE 3. *Synneuron annulipes* Lundström, 1910, specimen TSZD-JKJ-107319. **A**. Male in lateral view; **B**. Wing of male, displaying the un-mistakenly characteristic wing venation; **C**. Male terminalia in ventral view; **D**. Male terminalia in lateral view. Photos: Jostein Kjærandsen.

by Carl Henrik Boheman in July 1856 (Hutson 1977, Andersson 1982). This remained the only Swedish record of the *reliktmygga*, so the Swedish name for *H. eximia*, for more than 150 years. Then, beginning with the year 2011, several new findings were reported on Artportalen, of which the only photo-document, a female from Ångermanland, is apparently based on misidentification (see under *H. veternosa*). The other reports of *H. eximia* on Artportalen, all from Västerbotten in 2013-2015, should be verified based on the reference specimens, considering how subtle the morphological distinctions between *H. eximia* and *H. veternosa* are. A single male of *H. eximia* was found by us in 2010 in Storpissan Nature Reserve in Odeshögs kommun, Östergötland, which proves the species' occurrence even in southern Sweden. Storpissan (Figure 5A) is a famous and prized locality for entomologists from Sweden and abroad, especially for those with an interest in saproxylic insects. The nature reserve of 10 ha, set aside as a forest reserve in 1935, preserves an old-growth stand of Norway spruce (*Picea abies*), where great amounts of dead wood have accumulated as a result of undisturbed, natural forest succession. Our specimen was taken by

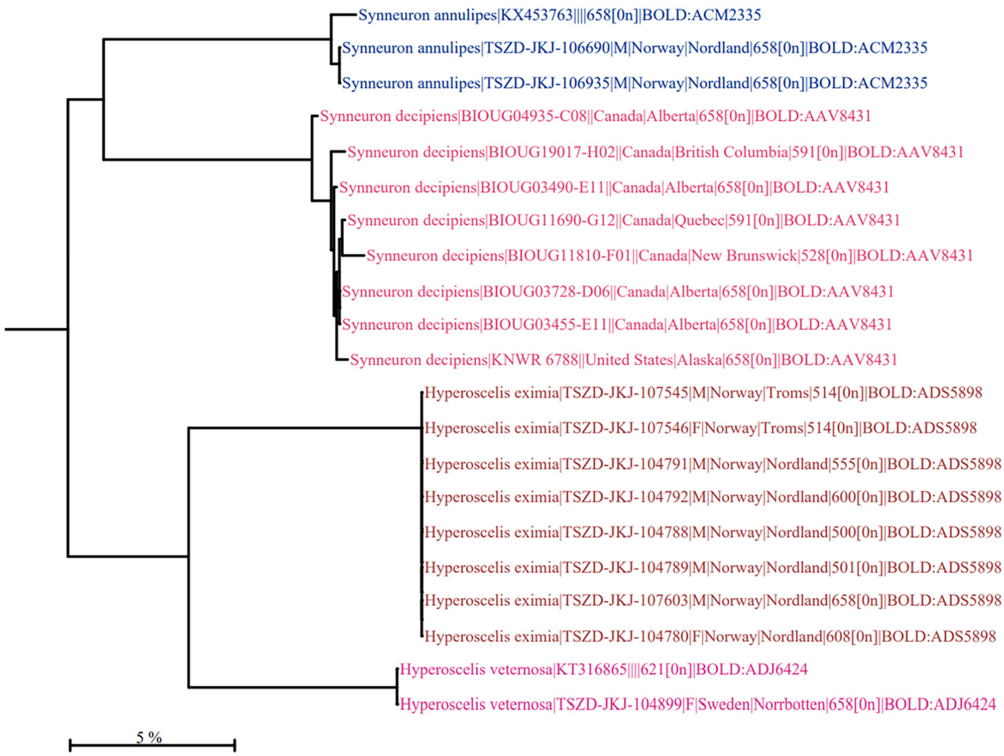

FIGURE 4. ID-tree (Kimura-2-distance) obtained from BOLD with the 11 new barcodes presented here and their BINs, together with public barcodes of the family Canthyloscelidae from the Holarctic region.

sweepnet over a huge, decomposing log of spruce. The inclusion of the *reliktmygga* in the category "near threatened" (NT) in the Swedish Red list of flies (Diptera) (Cederberg *et al.* 2010, Sandström 2015) should be regarded as an expression of old-growth, unmanaged forest being a threatened habitat in Sweden.

In Norway, the species, here named *huldremygg* (a hulder is a female seductive forest creature in Scandinavian folklore), was first recorded by Greve (1993), who found a single male in a Malaise trap sample taken in 1982 at Gol, Engene, in Buskerud county. The Norwegian Red list maps this record and mentions "a few, scattered records from southern Norway" without further details, resulting in that the species is currently referred to as "endangered" (EN) (Gammelmo *et al.* 2015). In that respect it is reassuring to report here a vital population (32 specimens caught with two Malaise traps in June-July 2018) inside the newly (2017) protected Auster-Vefsna Nature Reserve! Worth a note, this locality lies less than 70 km southwest of the Swedish type locality of *H. eximia*. The sampling locality (Figure 5B) is a mesohygrophilic to mesotrophic, mixed (*Alnus, Betula, Picea*), largely old-growth forest with plenty of dead wood in various successions. The area forms a steep, east-facing hillside along a quiet stretch of the river Auster-Vefsna. Another specimen, a single male, was collected at the stream Tørråga in Vik, close to Rognan in Saltdal. This locality is natural, mixed deciduous forest, but with spruce plantations nearby. The third Norwegian locality, in Rostadalen, Troms county (Figure 5C), is also a wet, mixed forest of similar tree composition as in Auster-Vefsna, but with a more grassy understorey. The presence of Norway spruce at this locality should be attributed to plantations, with the closest, natural range of spruce forest found some 120 km to the southeast

FIGURE 5. Photos of new collecting localities for *Hyperoscelis species*. **A**. Storspissan NR in Östergötland, Sweden (58°20´N 14°39´E). Photo downloaded from website: http://www.stationlinne.se/sv/forskning/the-swedish-malaise-trap-project-smtp/traps/trap-id-15-storpissan/. **B**. Stillelva, Auster-Vefsna NR in Nordland, Norway (65°32´N 13°43´E) Photo: Jostein Kjærandsen. **C**. Innset, Rostadalen, inner Troms (68°58´N 19°45´E) Photo: Trond Elling Barstad. **D**. Kaltisbäcken NR, Messaure (66°41´N 20°22´E, locality for *H. veternosa*). Photo: Jostein Kjærandsen.

in Sweden. Rostadalen is situated almost at 69 degrees north, which is far north of the polar circle, rendering it the northernmost locality reported for *H. eximia*. All previous records of the species are from south of the polar circle (Figure 6).

Hyperoscelis veternosa Mamaev & Krivosheina, 1969

New records: **SWEDEN**: **LU**, Jokkmokk, Kaltisbäcken Nature Reserve 1 km NNE Messaure, 66°41’26”N, 20°22’37”E, 250 m a.s.l., Malaise trap, 21 June-12 July 2004, leg. J. Kjærandsen & K. Hedmark, 1 female (TSZD-JKJ-104899). **First and only verified record in Sweden.**

Barcodes: The examined female was successfully DNA-barcoded (658 BP, 0n) on BOLD and assigned to the Barcode Index Number **BOLD:ADJ6424** (Figure 4). Currently this BIN has a single additional member, mined from GenBank (accession number **KT16865** and published by Ševčík *et al.* (2016)), which is 99.67% similar. Its nearest neighbour is *H. eximia* in **BOLD:ADS5898** at 12% distance (Figure 4).

Remarks: Our specimen is the second confirmed record of *H. veternosa* in Fennoscandia, after the Finnish record by Hardy & Nagatomy (1960) under the name *H. eximia* (see Hutson 1977 for a discussion). The Swedish locality, Kaltisbäcken Nature Reserve near Messaure, Lule lappmark, is yet another renowned destination for entomologists. The reserve includes a

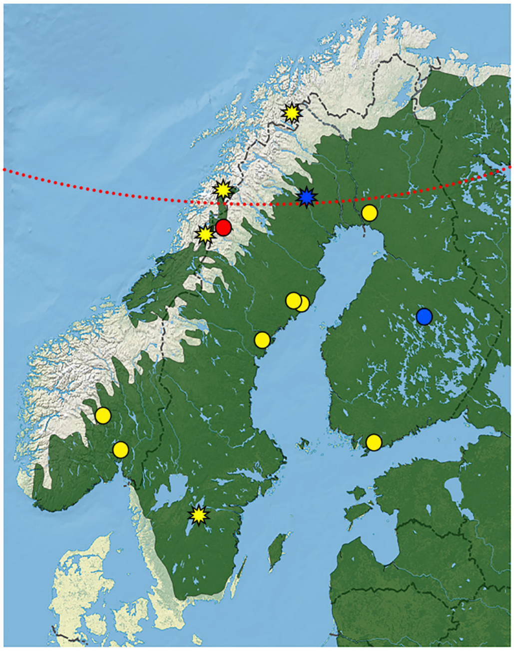

FIGURE 6. Map of known Fennoscandian records of the genus *Hyperoscelis*. Green background shows the distribution of Norway spruce, *Picea abies*. The dotted red line marks the arctic circle. Red circle = type locality of *Hyperoscelis eximia*; yellow circles = published and grey published records of *Hyperoscelis eximia*; yellow stars = new records of *Hyperoscelis eximia* presented here; blue circle = only published record of *Hyperoscelis veternosa* in Finland; blue star = new, first record of *Hyperoscelis veternosa* from Sweden.

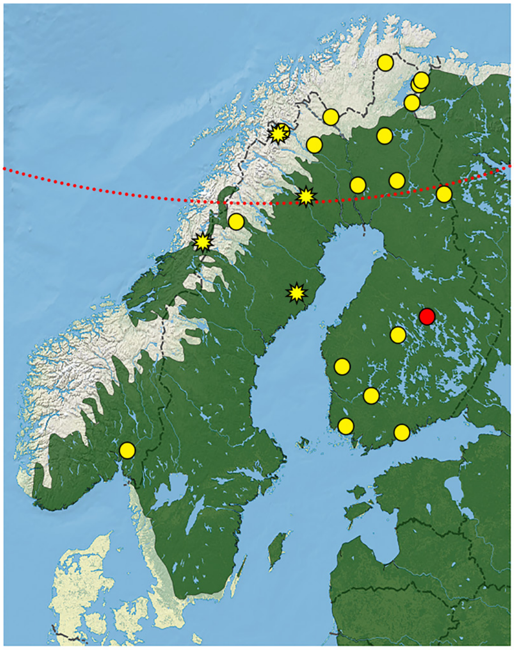

FIGURE 7. Map of Fennoscandian records of *Synneuron annulipes*. Green background shows the distribution of Norway spruce, *Picea abies*. The dotted red line marks the arctic circle. Red circle = type locality; yellow cirles = published records and grey published records; yellow stars = new records presented here.

large stretch of wet, old-growth riverine forest of predominantly Norway spruce and aspen (*Populus tremula*), with rich soil and understorey vegetation and surrounded by drier and younger coniferous (*Picea abies*, *Pinus sylvestris*) forest where the Malaise trap capturing *H. veternosa* was placed (Figure 5D). This record confirms that the species is still present in northern Fennoscandia, somewhat contradicting the decision to red list it as "regionally extinct" (RE) in Finland (Hyvärinen *et al.* 2019). Images of a live female "*H. eximia*" from Ångermanland (Skallsjön, Ytterlännäs, 26 June 2011, photographed, but not collected, by Kurt Holmqvist) published on Artportalen in our view display the wing characters typical of *H. veternosa*; this record should, therefore, be referred to as an unidentified *Hyperoscelis*.

Synneuron annulipes Lundström, 1910

New records: **NORWAY**: **NSI**, Grane: Holmvassdalen Nature Reserve, Holmvassdalen 2 (Naturbase), 65°19'29"N, 013°19'05"E, Malaise trap, 30 May-1 August 2018, leg. J. Kjærandsen, J. P. Lindemann & P. Dominiak, 2 males (TSZD-JKJ-106690 & TSZD-JKJ-106935). **SWEDEN**: **LU**, Jokkmokk, Messaure, 66°40'57"N, 20°21'48"E, 175 m a.s.l., labelled "at Ecological station, 12-14 W", 24-31 July 1972 (leg. K. Müller), 1 male (TSZD-JKJ-107078); **TO**, Kiruna, Abisko, 68°21'01"N, 018°49'50"E, 385 m a.s.l., labelled "LF-02, 150-500 m W Naturv. stn.", 21-28 July 1975 (leg. K. Müller), 1 male (TSZD-JKJ-107319); same locality, labelled "LF-04, 150-500 m W Naturv. stn.", 12-19 July 1976 (leg. K. Müller), 15 males (TSZD-JKJ-107320, TSZD-JKJ-107321, TSZD-JKJ-107322, TSZD-JKJ- 107323, TSZD-JKJ-107324, TSZD-JKJ-107325, TSZD-JKJ-107326, TSZD-JKJ-

107327, TSZD-JKJ-107328, TSZD-JKJ-107329, TSZD-JKJ-107330, TSZD-JKJ-107331, TSZD-JKJ- 107332, TSZD-JKJ-107333, TSZD-JKJ-107334), 1 female (TSZD-JKJ-107335); **VB**, Vindeln, Kulbäckslidens försökspark, edge of Degerö stormyr (bog), 64°10’54”N, 019°33’33”E, 1-18 August 2003, leg. Swedish Malaise Trap Project (trap 59, collecting event 211).

Barcodes: The two examined males from Norway were successfully DNA-barcoded (658 BP, 0n) on BOLD and assigned to the Barcode Index Number **BOLD:ACM2335** (Figure 4). Currently this BIN has a single additional member, mined from GenBank (accession number **KX453763** and published by Ševčík *et al.* (2016)), which is 99.07% similar. Its assigned nearest neighbour on BOLD is currently (October 2019) a species of Tortricidae (Lepidoptera), but *Synneuron decipiens* from North America in **BOLD:AAV8431,** at some 13% distance (Figure 4), is still found as the top match by searching the entire database.

Remarks: In Fennoscandia, *Synneuron annulipes* appears to be more frequently encountered than *Hyperoscelis eximia*; at least in Finland records of this species are quite numerous and well distributed across the country, all the way up to Utsjoki at 70 degrees north (Figure 7). In Norway, Andersen *et al.* (2013) found *S. annulipes* at two localities in the Pasvik Valley, at 69°40 and 69°44 degrees north, respectively. Our new records from Holmvassdalen Nature Reserve in Nordland originate from a Malaise trap deployed in an old-growth Norway spruce forest, with the trap placed across a stony stream bed next to the entrance of a cave. The immediate vicinity was rich in decaying spruce logs (Figure 8A). As regards Sweden, we had the opportunity to study, among others, large light trap samples from Abisko Scientific Research Station, probably a previously unstudied part of the same material in which Andersson (1982) found the species. This locality is quite different from all other collecting sites of *S. annulipes* in that it consists of subalpine birch forest at 385 m altitude (Figure 8B), although it had at the time of collection a few sporadic stands of Scots pine (*Pinus sylvestris*) and even Norway spruce (see Sonesson & Lundberg 1974).

Discussion

The DNA-barcoding results obtained on BOLD demonstrate the utility of this method for separating both the similar species pairs *H. eximia* vs. *H. veternosa*, and *S. annulipes* vs. *S. decipiens* (with the distributions of the latter two species being separated by an effective geographic barrier, making it unlikely that both are confused with each other). Even though sample sizes are rather small (except for *S. decipiens*, which has 36 public barcodes on BOLD), the barcode gaps found are unambiguous and leave no doubt, for example, about the identity of *H. veternosa* as occurring in Sweden, even though the only Swedish record is based on a single female. The average within-species distance of the 21 specimens shown in Figure 3 is 0.37% (0–1.55, SE 0.01), the within-genus distance is 14.17% (12.7–15.75, SE 0.02) and the within-family distance is 19.38% (15.82–21.27, SE 0.01). These large gaps support the presumption of high phylogenetic age of both the family, Canthyloscelidae, and the included species (Nagatomi 1983, Wiegmann *et al.* 2011).

Krivosheina (1991) regards *Hyperoscelis eximia* “the most common [dipteran] inhabitant of brown rots”, an affection of conifers (mostly spruce) usually caused by the polypore *Fomitopsis pinicola*. This fungus is common throughout most of Fennoscandia and may occasionally infest deciduous trees, especially birch (*Betula pubescens*). Mamaev & Krivosheina (1969) reported larvae of both *Hyperoscelis* and *Synneuron* mostly from what in the translated version is referred to as “red spruce wood” (meant here is apparently not the red spruce, *Picea rubens*, of eastern North America), but also *Synneuron* larvae in white-rotted wood of birch, in light-coloured mould under the bark of an aspen tree (*Populus tremula*), and *Hyperoscelis* larvae in “cedar and other wood”. According to Krivosheina (l.c.), the occupation of the fungus-infected wood by xylophagous insects, such as *H. eximia*, “takes place quite long after fungi inoculation”, which explains why these insects depend on dead wood left undisturbed for long time periods. Data presented here corroborate the idea of canthyloscelids being associated with

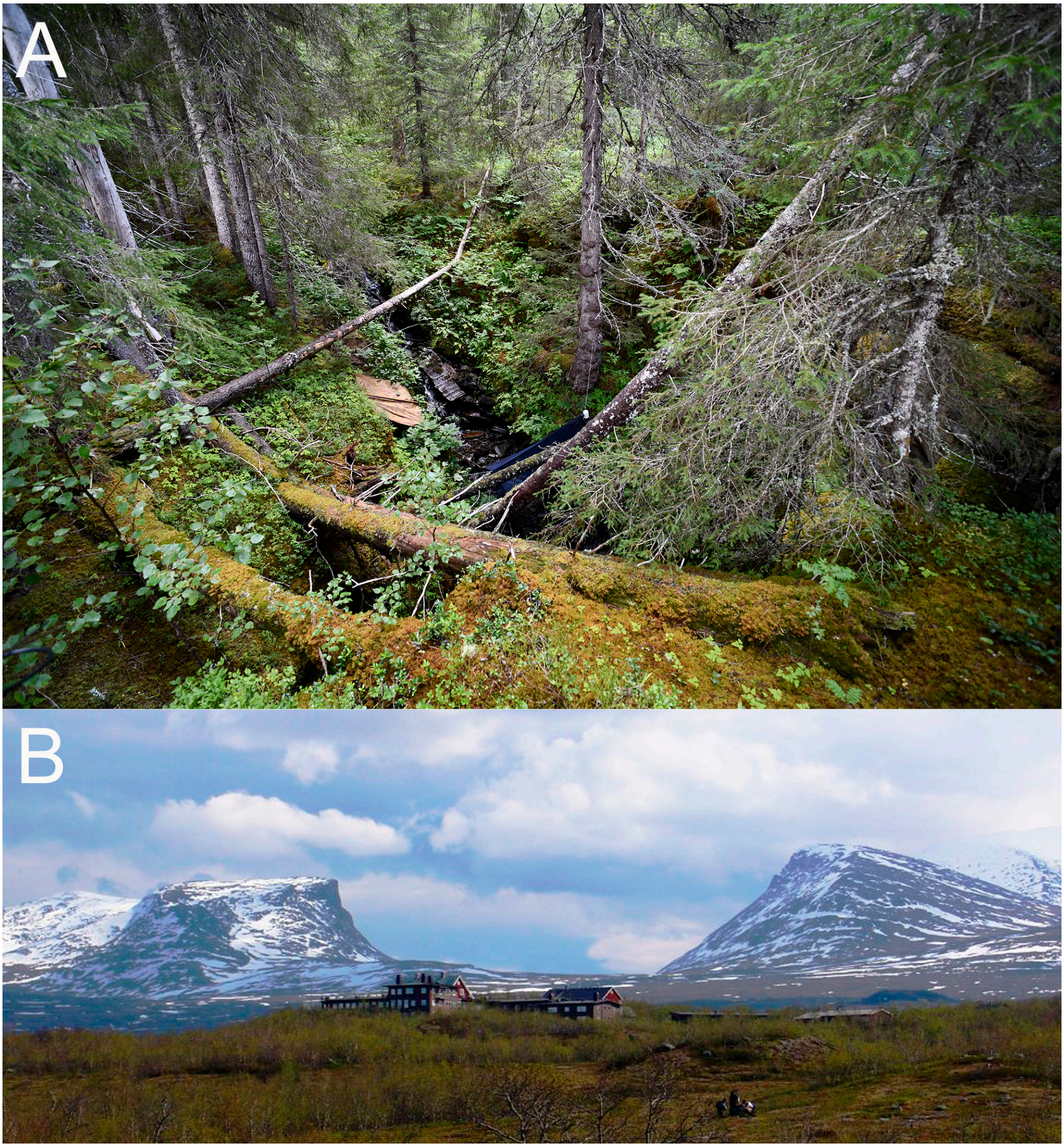

FIGURE 8. Photos of the new collecting localities for *Synneuron annulipes*. **A**. Holmvassdalen NR in Nordland, Norway (65°19´N 13°19´E). Photo: Jostein Kjærandsen. **B**. Abisko Scientific Research Station in Swedish Lapland (68°21´N 18°50´E). Photo downloaded from website: https://eu-interact.org/field-sites/abisko-scientific-resarch-station/.

decaying coniferous wood of large dimension, especially Norway spruce (present at / near several of our collecting sites, such as Storpissan and Messaure in Sweden, and Auster-Vefsna and Holmvassdalen in Norway). The northernmost localities, however, lie far distant from the nearest natural, continuous stands of spruce (Figures 6&7), a fact calling for an explanation. On the one hand, plantations and/or small natural stands of Norway spruce were found temporarily both at Rostadalen (where *H. eximia* occurs) and, according to Sonesson & Lundberg (1974), even at Abisko (where *S. annulipes* occurs). On the other hand, wood other than spruce may serve as a larval habitat of *S. annulipes*, which we regard as likely in Abisko. Non-spruce habitats might even serve as stepping stones for the dispersal, or as refuges for the survival of canthyloscelids, until the favoured resource is regained. Another environmental factor that seems important for the occurrence of canthyloscelids is the vicinity to wetlands, where humid conditions are likely to facilitate the development of brown rots. Cool temperatures might have a similar effect, as suggested by two sites where *S. annulipes* was found occurring: at Holmadalen (where the nearby cave constantly releases cool air) and Abisko (where cold, subalpine climate prevails).

It is obvious that our knowledge of canthyloscelid biology, both larval and adult, is too sparse as to satisfactorily explain the observed phenomena. Why, for instance, are adult *Hyperoscelis eximia* so abundantly collected by Malaise traps, while light traps work similarly effective with adult *Synneuron annulipes*? Is it a collecting bias that adult *Hyperoscelis veternosa* are so rarely collected by any method? To what extent reflect abundances in trap samples abundances in nature? Could it be that canthyloscelids (especially *Hyperoscelis*) are so weak and/or infrequent flyers that the trap must be deployed virtually above the site of emergence for the adults to be captured? Which are the factors determining the occurrence of larval *H. veternosa* in natural habitats, and vary those factors between Norway and Finland? These are just a few of the relevant issues when it comes to assess the status of Canthyloscelidae in the context of Red Lists. In the absence of such knowledge – now and in the foreseeable future – the best thing one can do is to protect canthyloscelids as a group**—**as a collective that, in turn, is a part of the xylophagous insect guild that depends on the availability of dead wood of large dimension. For the time being, it is obviously most promising to orient protecting measures to the habitat rather than to species (a strategy that guarantees beneficial effects for countless other organisms whose biology in detail is similarly poorly known).

In our modern era, often described using attributes like digital and molecular, one can notice two trends at work that both are aiming at increasing our knowledge of biodiversity, including faunistic knowledge of organisms as problematic (i.e. rarely encountered, small in size, notoriously difficult to identify to species) as the Canthyloscelidae. Although pursuing basically the same goal, both trends operate in parallel worlds rather than join forces. On the one hand, initiatives like iBOL document species and their geographic distributions in an entirely new manner, i.e. through molecular data (BIN's) made available in online databases and search engines (BOLD, GenBank), which are comparable to grey literature. Those having the resources (such as knowledge, time, and funding) available to participate in the game contribute to building the ever increasing DNA reference library and, at the same time, gain instant and worldwide access to data that confirm their ID's via semi-anonymous contributions by others (given that the BIN indicating the respective ID was previously generated). This, used with care, has an enormous potential for enhancing taxonomic accuracy, but expels other interested parties (such as skilled, ambitious amateurs lacking such resources) from taking advantage of these platforms. Instead, those outsiders find a home in parallel online databases and discussion forums where faunistic findings are often presented by more or less useful pictures. Considering the large number of "data reporters", it is just a question of likelihood that even taxa regarded as rare, including Canthyloscelidae, emerge increasingly more frequently, although not seldom to the disadvantage that findings cannot be validated by "never-failing" tools, such as morpho-taxonomic expertise or DNA barcoding (see the example of *Hyperoscelis veternosa* in Ångermanland). On the one hand, DNA barcodes that are uncritically related to taxonomic names have the potential to spread misidentifications like viruses on BOLD and GenBank, while, on the other hand, poorly photo-documented but uncollected specimens fall short of subsequent, closer scrutiny. Both phenomena may create considerable quantities of data poor in quality. How to resolve this dilemma? Voucher specimens, appropriately preserved and easily accessible in public collections, are crucially important, both for validating records based on uninformative pictures and for verifying taxonomic names related to BIN's. Considering that the morphological validation of taxonomic identifications is a laborious task (especially with large amounts of data to be validated), it seems unrealistic to expect that the taxonomic community at large would take on the task on a voluntary, self-organized basis. This might work for species-poor and somehow charismatic taxa like the Canthyloscelidae but is likely to fail or be a long shot with most diverse, let alone megadiverse, groups with only one or two taxonomic specialists worldwide. Unless, of course, a shift in the prevailing funding practise from big-scale and blind scanning of the biodiversity, towards building the reference libraries up from the bottom by expert taxonomists, takes place. In this respect, the local NorBOL initiative in Norway, with its tight connection to the Norwegian Taxonomy Initiative, has been a tremendous success. Another aspect that in our opinion needs reconsideration is how the parallel worlds described above can be combined to the benefit of data quality. One way might be that non-professionals lacking access to DNA barcoding seek collaboration with institutions having such facilities at their command, on condition that institutions are prepared to accept such requests as a free service.

In the end, it has always been like that: intellectual integrity is the foremost guarantor for reliable data. Worth striving for is a reality where the quality matters as much as the quantity of data. We doubt that resources spent on creating large amounts of data without integrated, effective quality check is economically reasonable.

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