

Ichneumonid parasitoids (Hymenoptera: Ichneumonidae) reared in North Europe from pupae of *Chelis puengeleri* (Bang-Haas, 1927) (Lepidoptera: Erebidae, Arctiinae)

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Four ichneumonid species were reared for the first time from pupae of *Chelis puengeleri* in North Europe. One female of *Pimpla sodalis* Ruthe, 1859 (Pimplinae) was reared in Cievrracohkka, N Sweden in July 2012. One male of *Ichneumon formosus* Gravenhorst, 1829 (Ichneumoninae) was reared in Nissuntjärro, Torne Lappland, Sweden in July 2012. One male of *Ichneumon vafer* Tischbein, 1876 (Ichneumoninae) was reared in July 1999 in the Iremel Mountain reserve, Baskiria, South Ural, Russia. Two females and one male of *Ichneumon holarctiae* Riedel et Vikberg **sp. n.** (Ichneumoninae) were reared in June and July 2004 and 2012 in Finnmark, North Norway.

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1. Introduction

As a result of a recent phylogenetic study of the subtribe Arctiina (Rönkä *et al.* 2016), the arctiine genus previously well-known as *Holarctia* Ferguson, 1984 (Lepidoptera: Erebidae, Arctiinae)

was synonymized with *Chelis* Rambur, 1866. The genus is represented by two species in Europe: the type species of the genus *Holarctia*, *C. cervini* (Fallou, 1864) in the Alps, and *C. puengeleri* (Bang-Haas, 1927) in northern Europe (Pöyry & Kullberg 1997). *Chelis puengeleri* has a

wide but disjunct Holarctic distribution, and the taxon is divided into several subspecies. The nominate subspecies, *C. puengeleri puengeleri*, is known from the Sayan, the Hamar-Daban and the Stanovoi Mountains in Southern Siberia. The North European subspecies, *C. puengeleri fridolini* (Torstenius, 1971), is distributed through arctic Asia to Alaska. The subspecies *C. puengeleri iremelica* Dubalov, 2007 occurs at high altitudes in a restricted area of the southern Ural Mountains, Russia. This rare moth lives on almost bare areas of fields at 600–1,400 m above sea level. Eggs, larvae, cocoons and pupae can be found under stones (Silvonen *et al.* 2014).

Hitherto no parasitoids have been recorded from *Chelis* (as *Holoarctia*) *puengeleri*, but two ichneumonids have been reared from pupae of *Chelis cervini* (Horstmann 2001). In this article, we report four ichneumonid species, which we have reared from pupae of *C. puengeleri* in Norway, Sweden and southern Ural, Russia. One of them is described as new to science.

2. Materials and methods

2.1. Excursions

Excursions to the localities where pupae of *C. puengeleri* were found are as follows:

- Norway, Finnmark, Porsanger: P. Savolainen, K. Tahvanainen and J. Tiittanen have made several excursions to the area. Many pupae of *C. puengeleri* were found, but only one male of the moth and one parasitoid were reared (in 2012).
- Russia, Baskiria, Iremel Mountain reserve: Four excursions to the area were made during 23.–27.VI.1996 and 11.–14.VII.1997 by K. Nupponen *et al.*, 25.–27.VI.1999 by T. & K. Nupponen and 16.–17.VI.2001 by K. Nupponen (Nupponen & Fibiger 2002). Altogether about 40 adults of *C. puengeleri* were reared from pupae, but only a single parasitoid emerged (from a pupa found 25.VI.1999).
- Sweden, Torne Lappmark, Nissuntjärro: Two collecting trips were made during 29.–30.VI.2009 by T. and K. Nupponen and 4.–5.VII.2012 by T. Nupponen. Altogether about 70

adults of *C. puengeleri* were reared from pupae, but only a single parasitoid emerged (from the 2012 rearings).

- Sweden, Torne Lappmark, Karmatschokka: P. Savolainen, K. Tahvanainen and J. Tiittanen made two collecting trips to the area in 2015. They found some 20 larvae and some 220 pupae of *C. puengeleri*, most of which were already empty. Some 20 pupae were parasitized (one ichneumonid was reared) and just one male and one female of *C. puengeleri* were reared.

A typical habitat of the host moth, *C. puengeleri*, is shown in Fig. 1.

2.2. Examination of the reared ichneumonid specimens

The reared ichneumonid specimens were studied and identified by V. Vikberg and M. Riedel. The photographs were taken by P. Malinen and M. Riedel and they were included in the photo archives Kotka of the Finnish Natural History Museum, where their details can be examined by zooming in. The links to the photos in Kotka are given under each species. The specimens will be deposited in the zoological collection (MZH) of the Finnish Natural History Museum, Helsinki, the Zoologische Staatssammlung Munich (ZSM) and the personal collection of M. Riedel.

The following abbreviations are used:

- POL: Postocellar line, measured as the distance between the inner margins of the lateral ocelli.
- OOL: Ocello-ocular line, measured as the distance between the outer margin of one lateral ocellus and the inner margin of the compound eye of the same side.
- OD: Ocellar diameter, measured as the maximum width of one lateral ocellus.

DNA barcodes for one specimen of *Ichneumon holoarctiae*, one specimen of *I. vafer*, one specimen of *I. formosus* and one specimen of *Pimpla sodalis* were analysed within the framework of the Finnish Barcode of Life project. The sequenc-



Fig. 1. Habitat of *Chelis puengeleri* in Swedish Lapland, Abisko. Photo taken on 29.VI.2009 by K. Nupponen.

ing was carried out in the Canadian Centre for DNA Barcoding (CCDB, Biodiversity Institute of Ontario, University of Guelph) following the protocols shown at: <http://www.dnabarcoding.ca/page/research/protocols>. Full COI sequence information, including GenBank accession numbers, collection data and voucher images, are publicly available in BOLD and can be accessed under dx.doi.org/10.5883/DS-ICHPUE.

3. Ichneumonid species reared from *Chelis puengeleri*

3.1. *Pimpla sodalis* Ruthe, 1859 (Pimplinae)

One female of *P. sodalis* was reared on 2.VII. 2015 from a pupa of *C. puengeleri* in Cievrracohkka, Swedish Lapland by P. Savolainen and K. Tahvanainen (in MZH). DNA-barcoding of the reared female confirmed its identification. The body of the female is 8.9 mm long, fore wing 7.2 mm, ovipositor sheath 2.8 mm, of which 2.4 mm projects beyond the apex of the metasoma. Width of the head is 1.61 mm. The filiform antennae have 36 flagellomeres.

Link to photos of the reared female: <http://id.luomus.fi/GL.7183>.

The female was identified by using the key in

Kasparyan (1981). Both sexes of *P. sodalis* were originally described from Iceland (Ruthe 1859).

Pimpla sodalis has a wide holarctic distribution (Yu *et al.* 2016) and it occurs in arctic areas and further south in mountains. In the Alps, it occurs usually above timberline up to 3,000 m a.s.l. A long series of *P. sodalis* was reared from *Chelis cervini* (Erebidae: Arctiinae) in two localities at high altitudes (about 3,000 m a.s.l.) of the Alps: Zermatt, Valais (Switzerland) and Ötztal, Nordtirol (Austria) (Horstmann 2001). No specimens of *Pimpla hirsuta* Strobl, a closely related species occurring high in the Alps, were among those reared from this arctiine moth. In Finnish Lapland, the incidence of the otherwise rare *P. sodalis* rose distinctly during a calamitous outbreak of *Epirrita autumnata* (Borkhausen) (Geometridae) on birches on a subarctic fell (Nuorteva & Jussila 1967, as *Coccygomimus*).

The recorded hosts of *P. sodalis* belong to five families of Lepidoptera: Nymphalidae, Geometridae, Erebidae, Noctuidae and Pyralidae (Horstmann 2001).

3.2. *Ichneumon formosus* Gravenhorst, 1829 (Ichneumoninae)

One male of *Ichneumon formosus* was reared from a pupa of *C. puengeleri* in Nissuntjärro,

600–800 m, Torne Lappmark, Sweden by T. Nupponen (in MZH). The pupa of *C. puengeleri fridolini* (Torstenius) was found on 4.VII.2012, and the parasitoid emerged on 21.VII.2012. The body of the male is 14 mm long, the length of the fore wing is 10.7 mm and the width of the head is 2.35 mm. The bristle-shaped antennae have 40 flagellomeres, with tyloids on 6–19.

Link to photos of the reared male: <http://id.luomus.fi/GL.7182>.

The male was identified by using the key to males of *Ichneumon* in Hilpert (1992). DNA-barcoding showed that the reared male is close to the only named earlier specimen of *Ichneumon formosus*.

The colouration of the present male differs slightly from the description given by Hilpert (1992): the face and scapus are completely black, the hind femur is black but yellow-red in basal 1/10, the hind tarsus is completely yellow and scutellum and pterostigma are yellow.

The species is divided into two subspecies (or forms, see Hilpert 1992): *Ichneumon formosus formosus* Gravenhorst and *I. formosus microcephalus* Stephens, 1835. The reared male has the 2nd and 3rd tergites extensively red and on those grounds probably belongs to the nominate subspecies, although its face is entirely black – a rare variety (in one of 220 males) found in *Ichneumon formosus microcephalus* but none among 180 studied males of the nominate form (Hilpert 1992).

Among its recorded hosts are *Euphydryas maturna* (Linnaeus, 1758) (Grönblom 1964), *Phragmatobia fuliginosa* (Linnaeus, 1758) (Grönblom 1964, Hinz 1998, Hinz & Horstmann 2007), *Parasemia plantaginis* (Linnaeus, 1758) (Meyer 1933) and *Bupalus piniarius* (Linnaeus, 1758) (Meyer 1933). Although literature records are open to suspicion, it appears to be a regular parasitoid of at least one arctiine. In culture, overwintered females have been recorded to oviposit in the pupa of *Ph. fuliginosa* inside its cocoon, and both the ichneumonid and the host have one generation per year (Hinz & Horstmann 2007) or *Ph. fuliginosa* is widely bivoltine.

3.3. *Ichneumon vafer* Tischbein, 1876 (*Ichneumoninae*)

One male was reared from a pupa of *C. puengeleri* in the Iremel Mountain reserve, Bashkiria, 1,300 m a.s.l., South Ural (54.5°N 58.8°E), Russia by T. and K. Nupponen (in MZH). The pupa was found on 25.VI.1999 and the male emerged on 13.VII.1999. The habitat is dry mountain tundra.

Link to photos of the reared male: <http://id.luomus.fi/GL.7181>

Remarks. In the key to *Ichneumon* males by Hilpert (1992), this species runs to *Ichneumon vafer* Tischbein, but differs slightly from the description given by Hilpert (1992): hind femur is narrowly reddish yellow basally and the 2nd and 3rd tergites are black with chestnut-red colouration basally and laterally. DNA-barcoding of the reared male unfortunately failed. It is provisionally regarded as an aberrant male of *I. vafer* and its characters are described below.

Description of the male. Body length 16 mm, length of fore wing 11 mm, width of head 2.52 mm. Flagellum with 41 flagellomeres; 1st flagellomere length 2.2 × width. Tyloids on flagellomeres 6–16, long-oval, maximal length 0.7 of their flagellomeres, situated basally. Head covered with brownish setae. Temple strongly and roundly narrowed behind eye. OOL 1.2 × OD. Frons, face and clypeus rugose-punctate. Malar space length 0.6 × width of mandibular base.

Mesosoma covered with brownish setae. Mesoscutum closely punctate and finely granulate, more or less shining. Mesopleuron and metapleuron rugose-punctate, metapleuron partly striate. Scutellum moderately elevated, punctate and granulate, without lateral carina. Propodeum with square area superomedia; spiracles slit-shaped; dentiparal edge with small stout tooth. Hind coxa ventrally rugose-punctate. Hind femur densely punctate, length 4.2 × height. Fore metatarsus with a small apical tooth.

Postpetiolus strongly widened, median field with fine aciculation. 2nd tergite length 0.83 × width. Gastrocoelus strongly impressed, with longitudinal ribs; thyridia oblique, 0.8 × as wide as interval between them. 2nd to 5th tergites densely punctate and granulate, matt; 6th and 7th tergites with superficial punctures, shining.

Colour black, including flagellum, head and mesosoma. Metasoma black; 2nd and 3rd tergites chestnut-red anteriorly and laterally. Coxae, trochanters and femora black; fore and middle femora reddish apically, hind femur with a narrow reddish-yellow basal ring. Legs otherwise reddish-yellow; hind tibia infuscate in apical 1/4; distal hind tarsomere brownish. Wings hyaline, prestigma yellow.

Distribution and hosts. *Ichneumon vafer* has a rather wide distribution in Europe. Its synonym *I. conjugalis* Holmgren was described from Sweden, *I. rogenhoferi* Kriechbaumer from Italy and *I. quartanus* Perkins from England. It has been recorded from European Russia as *I. rogenhoferi* by Rasnitsyn and Siytan (1981). The lectotype of *I. rogenhoferi* was reared from *Parasemia plantaginis* (as *Arctia pl.*). It has been experimentally reared from *Parasemia plantaginis* (Hinz 1998, Hinz & Horstmann 2007). The overwintered female oviposited eggs in pupae of *P. plantaginis* inside its cocoons. An interesting old rearing record is that from *Chelis simplonica* (Anderregg in Boisduval, 1840) by Dittrich (1909).

3.4. *Ichneumon holoarctiae* Riedel et Vikberg, sp. n. (Ichneumoninae) Figs 2–3

Type material. Holotype: Female, Norway, Porsanger, EIS 174 FN, 29.VI.2004, J. Engdal leg., ex pupa of *C. puengeleri* 20.VII.2004 (ZSM). Paratypes: Female, data as in holotype (coll. Riedel); male Norway, Finnmark, Porsanger, 7.VII.2012, K. Tahvanainen leg., ex pupa of *C. puengeleri* in (MZH).

Link to photo of pupa of *C. puengeleri* from which the male of *I. holoarctiae* emerged: <http://id.luomus.fi/GL.7179>. Link to photos of the reared male: <http://id.luomus.fi/GL.7180>

Description. Female: Body length 11.5 (holotype) or 13 (paratype) mm; fore wing 8.2 (holotype) and 9.5 (paratype) mm. Antenna with 39 (holotype) and 41 (paratype) flagellomeres, slightly lanceolate; 1st flagellomere length $1.7 \times$ width, 5th to 7th flagellomeres square; widest flagellomeres $1.4 \times$ wider than long; preapical flagellomere $0.7 \times$ as long a wide.

Temple long, slightly and roundly narrowed behind eye, about as wide as eye. OOL $1.3 \times$ OD.

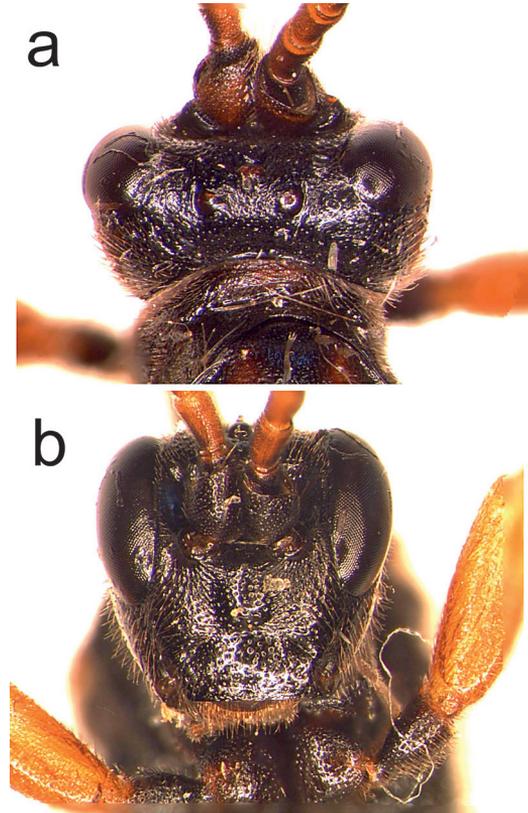


Fig. 2. Head and face of *Ichneumon holoarctiae* sp. n. holotype. – a. Head in dorsal view. – b. Face in anterior view.

Frons rugose-punctate. Face and clypeus with dense punctures, central face partly rugose. Gena in ventral 1/3 with scattered punctures. Malar space long, length $1.3 \times$ width of mandibular base. Genal carina reaching hypostomal carina far from mandibular base; hypostomal carina slightly elevated.

Mesosoma with fine pale brownish setae. Side of pronotum with fine punctures in dorsal 1/3, with striation in ventral 2/3. Notaulus indistinct. Mesoscutum closely punctate and shining. Mesopleuron densely punctate, with striation in caudal half; metapleuron completely punctulostriate; coxal carina present. Scutellum flat, as long as wide, with scattered punctures, not carinate laterally. Propodeum with square area superomedia, costula indistinct; spiracles slit-shaped. Hind coxa densely rugose-punctate ventrally, without scopa or sharp edge. Hind femur densely punctate, but punctures in ventral 1/5 su-

perforated and scattered, length $4.0 \times$ height. Tarsomeres slightly widened; 3rd tarsomere of middle leg some $1.6 \times$ longer than wide.

Areolet pentagonal, anterior distance of intercubiti 1–2 \times their diameter; nervulus slightly postfurcal.

Metasoma strongly oxygygous, stout. Postpetiolus strongly widened; median field with fine aciculation. 2nd tergite length $0.65 \times$ width. Gastrocoelus slightly impressed, with fine longitudinal ribs; thyridia small, transverse, $0.7 \times$ as wide as interval between them. 2nd and 3rd tergites densely punctate and granulate, matt; following tergites with superficial punctation and fine granulation, more or less shining. Ovipositor sheath not surpassing metasomal apex.

Colour black. Flagellum with basal 11 flagellomeres dark reddish, apically black. Head black. Mesoscutum chestnut-red, with diffuse blackish median stripe. Scutellum blackish (paratype) or with chestnut-red spot (holotype). Tegula reddish; pronotum completely black. 2nd tergite reddish, with apico-median blackish mark. 6th and 7th tergites with small apical ivory spots (on 6th tergite smaller than on 7th tergite in holotype). Coxae and trochanters black. Legs including trochantelli otherwise reddish; distal tarsomeres more or less brownish. Wings hyaline, pterostigma yellowish.

Male: Length of body 13 mm, fore wing 11.2 mm. Antenna about 9.3 mm.

Left antenna with 40 flagellomeres (right antenna missing), 1st flagellomere length $2.1 \times$ width in lateral view, 2nd flagellomere length $1.3 \times$ width, 10th flagellomere about square. Narrow, oval tyloids on flagellomeres 5–16(17), on flagellomere 12 its size 0.15×0.07 mm and situated basally and leaving apical 0.2 free.

Head $0.86 \times$ as high as wide. In dorsal view $1.7 \times$ as wide as long, temple slightly longer than eye, narrowing and slightly rounded apically, covered with long dark setae directed towards eyes. POL $1.23 \times$ as wide as OOL, OOL $1.75 \times$ OD. Temple maximally $1.08 \times$ as long as eye width. Malar space $0.88 \times$ as long as width of mandibular base. Mandible with two apical teeth, almost parallel, lower $0.25 \times$ as long as upper tooth. Scutellum strongly convex, its highest point anterior to middle. Area supermedia fused with area basalis, combined cell broadest anteriorly



Fig. 3. Basal part of metasoma of *Ichneumon holoarctiae* sp. n. holotype.

ly (0.80 mm), its length 0.75 and breadth posteriorly 0.65 mm. Hind wing with 17–18 distal hooks.

Postpetiolus distinctly aciculate, very broad ($3.2 \times$ as wide as long, its length measured as distance between spiracle and hind margin), broadest point near posterior margin.

Length of 2nd tergite medially $0.64 \times$ length of its maximum width. Area between gastrocoeli distinctly aciculate, $1.06 \times$ as wide as one gastrocoelus, which is short. Thyridia distinct, rather weak, about $0.9 \times$ as wide as interval between them. 2nd sternite with rounded fold (artifact?), 3rd sternite with indistinct fold, 4th sternite without distinct fold (artifact?). Apical margin of hypopygium slightly produced medially, rounded.

Colour black. Apical half of mandible reddish brown. Palpi brownish yellow, basal joint of maxillary palpus and whole labial palpus infuscate. Pterostigma brownish yellow. Femora brownish red, basal 0.6 of fore and basal 0.75 of mid-femur black on underside; hind femur black, with basal 0.2 and apical 0.07 red. 2nd tergite red, with large blackish area medially and posteriorly. Lateral margin of 3rd tergite with narrow red area. 2nd to 4th sternites reddish, slightly infuscated medially.

Etymology. The specific name was derived from the earlier name of the host genus, *Holoarctia*.

Taxonomic remarks. In the key of Hilpert (1992), the females of this new taxon run to *Ichneumon thomsoni* Holmgren, which is known from Scandinavia. They differ from *I. thomsoni*

by slenderer 1st flagellomeres, slenderer hind femur, black pronotum, completely black petiolus and black 3rd tergite. The male runs to boreomontane *Ichneumon nigroscutellatus* Kriechbaumer, 1897 in the key to males (Hilpert, 1992) but differs mainly by the reduced red colouration of the metasoma.

Whether the male is conspecific with the females at all is somewhat questionable. The material was sent for DNA-barcoding, but barcoding of the females revealed no useful results. Therefore, the matter should be verified by additional material in the future.

Because the 4th sternite of the reared male has no clear medial fold, the author V. V. first supposed that it could belong to the genus *Diphys* Kriechbaumer. However, DNA-barcoding showed that its nearest earlier named species was *Ichneumon intricator* Wesmael.

4. Discussion

In this article, four species of Ichneumonidae are reported for the first time reared from *Chelis puengeleri*. However, only a few specimens of each parasitoid were available. Thus, further rearings are needed to get a better idea about the ichneumonid and other parasitoids feeding on that rare arctic moth. In the future, it would be helpful to study more females of the reared species of Ichneumoninae. In the subfamily Ichneumoninae, females often have better morphological characters for an unequivocal identification than the corresponding males.

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References

Dittrich, R. 1909: Hymenopterologische Bemerkungen. — Jahresheft des Vereins für Schlesische Insektenkunde 2: 38–46. [In German.]
 Dubatolov, V. V. 2007: New tiger moth taxa from Eurasia (Lepidoptera, Arctiidae). — *Atalanta* 38(3/4): 351–359.
 Grönblom, T. 1964: Einige aus Schmetterlingszuchten hervorgegangene Schlupfwespen (Hym., Ichneumo-

noidea). — *Annales Entomologici Fennici* 30: 104–111. [In German.]
 Hilpert, H. 1992: Zur Systematik der Gattung *Ichneumon* Linnaeus, 1758 in der Westpalaearkt (Hymenoptera, Ichneumonidae, Ichneumoninae). — *Entomofauna Supplement* 6: 1–389. [In German.]
 Hinz, R. 1998: Zucht einiger *Ichneumon*-Arten aus ihren Wirten I. (Hymenoptera, Ichneumonidae). — *Entomofauna* 19 (30): 493–500. [In German.]
 Hinz, R. & Horstmann, K. 2007: Über Wirtsbeziehungen europäischer *Ichneumon*-Arten (Insecta, Hymenoptera, Ichneumonidae, Ichneumoninae). — *Spixiana* 30(1): 39–63. [In German.]
 Horstmann, K. 2001: Revisionen von Schlupfwespen-Arten V (Hymenoptera: Ichneumonidae). — *Mitteilungen der Münchener Entomologischen Gesellschaft* 91: 77–86. [In German.]
 Kasparyan, D. R. 1981: [A guide to the insects of the European part of the USSR, Ichneumonidae, subfamily Pimplinae (Ephialtinae)]. — *Opredeliteli Faune SSSR* 3(3): 41–97. [In Russian.]
 Meyer, N. F. 1933: Keys to parasitic Hymenoptera (family Ichneumonidae) of the USSR and adjacent countries. Vol. 1. Introduction and Ichneumoninae. — Zoological Institute of the Academy of Sciences of the USSR 9(1): 1–438. Translated from Russian, Israel Program for Scientific Translations, Jerusalem 1968.
 Nuorteva, P. & Jussila, R. 1967: Seasonal and zonal distribution of Ichneumonidae (Hym.) on a subarctic fell during a calamity of the geometrid moth *Oporinia autumnata* (Bkh.) on birches. — *Annales Entomologici Fennici* 33: 155–163.
 Nupponen K. & Fibiger M. 2002: Contribution to the knowledge of the fauna of Bombyces, Sphingae and Noctuidae of the Southern Ural Mountains, with description of a new *Dichagyris* (Lepidoptera: Lasiocampidae, Endromidae, Saturniidae, Sphingidae, Noctodontidae, Noctuidae, Pantheidae, Lymantriidae, Nolidae, Arctiidae). — *Phegea* 30(4): 121–185.
 Pöyry, J. & Kullberg, J. 1997: Taxonomic revision of *Holoarctia*, Ferguson 1984 (Arctiidae). — *Nota Lepidopterologica* 20(1/2): 45–65.
 Rasnitsyn, A. P. & Siytan, U. V. 1981: [A guide to the insects of the European part of the USSR, Ichneumonidae, subfamily Ichneumoninae]. — *Opredeliteli Faune SSSR* 3(3): 505–636. [In Russian.]
 Rönkä, K., Mappes, J., Kaila, L. & Wahlberg, N. 2016: Putting *Parasemia* in its phylogenetic place: a molecular analysis of the subtribe Arctiina (Lepidoptera). — *Systematic Entomology* 41(4): 844–853. doi: <https://doi.org/10.1111/syen.12194>
 Silvonon, K., Top-Jensen, M. & Fibiger, M. 2014. Suomen päivä- ja yöperhoset – maastokäsikirja. (A field guide to the butterflies and moths of Finland). Östermarie, Denmark. 820 pp. [In Finnish.]
 Yu, D.S.K., Achterberg van, C. & Horstmann, K. 2016: World Taxapad 2016, Ichneumonoidea. Taxonomy, Biology, Morphology and Distribution. On USB flash-drive. www.taxapad.com, Nepean, Ontario, Canada.