

New records of parasitic Hymenoptera associated with ants, including four new species to Norway

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This paper present the first records of *Paralipsis enervis* (Nees, 1834) (Braconidae, Aphidiinae), *Neoneurus clypeatus* (Foerster, 1862), *Elasmosoma luxemburgense* Wasmann, 1909 and *Elasmosoma berlinense* Ruthe, 1858 (Braconidae, Euphorinae) new to Norway. *Paralipsis enervis* is associated with root aphids in nests of the ant *Lasius niger* (L., 1758). *Neoneurus clypeatus* is a primary parasitoid of *Formica rufa* sensu lato, and *Elasmosoma luxemburgense* is a primary parasitoid of *Formica rufibarbis* Fabricius, 1793. New records and new host associations of *Neoneurus auctus* (Thomson, 1895), and *Hybrizon buccatus* (de Brébisson, 1825) (Ichneumonidae, Hybrizoninae) are reported. A short review of each species biology is given.

Key words: Braconidae, Euphorinae, Aphidiinae, *Elasmosoma luxemburgense*, *Elasmosoma berlinense*, *Neoneurus auctus*, *Neoneurus clypeatus*, *Paralipsis enervis*, *Hybrizon buccatus*, myrmecophile, Ichneumonoidea, Hymenoptera, Norway

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Introduction

The diversity of parasitic wasps is enormous and their taxonomy and ecology are to a large extent poorly studied. The highly diverse families Braconidae and Ichneumonidae are among the least known groups (Quicke 2015). In Norway, there are so far registered 352 species of Braconidae (Riedel & Hansen 2014), and almost 1900 species of Ichneumonidae (Riedel & Hansen 2015). The species are important parasitoids on different stages of a wide range of invertebrates. The present study aims to focus on ant associated species among the Braconidae and Ichneumonidae.

Material and methods

The material in this report is collected by malaise traps (MT), pitfall traps (PT), flight interception traps (FIT) and sweep netting over ant colonies. Reference material is kept in the insect collections at Norwegian Institute for Nature Research (NINA) in Trondheim. The material is collected by several entomologists and their names are abbreviated: Anders Endrestøl (AE), Arne Fjellberg (AF), Arnstein Staverløkk (AS), Frode Ødegaard (FØ), Oddvar Hanssen (OH). Images were made using the photography technique termed focus stacking. Several partially focused images were taken with Nikon D800 mounted on a Nikon PB-6 Bellow with a Nikon 50mm AI-S F1.8 lens, then combined in the software program

Zerene Stacker© (2016). All pictures are taken by the first author.

Records

BRACONIDAE, EUPHORINAE

Elasmosoma luxenburgense Wasmann, 1909

Material. TELEMARK coastal [TEY], Kragerø: Jomfruland [EIS 19, N58.880831° E9.608341°], 6♀♀, 13 May–21 June 2009, PT, (Figure 1), leg. FØ & OH, coll. NINA.

Biology, hosts and distribution. It has been observed that *Elasmosoma* spp. oviposit into the metasoma of adult ants, and *Elasmosoma* spp. has been reared from *Formica*-nests on various occasions (Poinar 2004). Gómez Durán & Achterberg (2011) observed the ovipositing behavior of *E. luxenburgense* when it attacked *Formica rufibarbis* Linnaeus, 1761 workers by grasping on to the ants' metasoma, and insert the ovipositor somewhere between the pygidium and the hypopygium, probably through the anus.

Formica sanguinea Latreille, 1798, *Formica cunicularia* Latreille, 1798 and *Polyergus rufescens* (Fabricius, 1804) also have been observed as hosts in Spain (pers. comm. José Maria Gómez Durán). In our pitfall trap, we also found specimens of *F. rufibarbis*. *E. luxenburgense* is not known from any of the other Nordic countries (Achterberg 2014).

Elasmosoma berolinense Ruthe, 1858

Material. BUSKERUD eastern [BØ], Lier: Toverud [EIS 28, N59.92003° E10.34197°], 1♂ (Figure 2A), 1 September–2 October 2014, MT, leg. FØ & OH, coll. NINA; SØR-TRØNDELAGE coastal [STY], Snillfjord: Moldtun [EIS 91, N63.564836° E9.483737°], 2♀♀ 17 August 2016, sweep netting, (Figure 2B), leg. AS, coll. NINA; FINNMARK eastern [FØ], Sør-Varanger: Gjøkåsen [EIS160, N69.159816° E29.209926°], 8♂♂, 23 June–11 July 2016, MT, leg. FØ & OH, coll. NINA; FINNMARK interior [FI], Karasjok: Skarfånjunni [EIS167, N69.4394155° E25.837304°], 2♂♂, 26 June–12 July 2016, MT, leg. FØ & OH, coll. NINA.



FIGURE 1. *Elasmosoma luxenburgense* Wasmann, 1909, female. From Jomfruland in Telemark, Norway.



FIGURE 2A. *Elasmosoma berlinense* Ruthe, 1858, male. From Lier in Buskerud, Norway.



FIGURE 2B. *Elasmosoma berlinense* Ruthe, 1858, female. From Snillfjord in Sør-Trøndelag, Norway.

Biology, hosts and distribution. Lachaud & Lachaud (2012) give a list of ant species that are hosts of *E. berolinense*. These are *Camponotus* spp., *Camponotus vagus* (Scopoli 1763), *Formica fusca* Linnaeus 1758, *Formica pratensis* Retzius 1783, *Formica rufa* Linnaeus 1761, *Formica sanguinea*, *Formica* spp., *Lasius niger* (Linnaeus 1758) and *Polyergus* Latreille, 1804, of which are found in Norway. In addition, we report *Formica aquilonia* Yarrow, 1955 as new host species. The species shows similar ovipositing behavior as in *E. luxemburgense* (Gómez Durán & Achterberg 2011). This is the first published record of *E. berolinense* in Norway, but there exist some unpublished records from south-eastern part of Norway at the Natural History Museum in Oslo (pers. comm. Lars Ove Hansen). The species is not yet known from any of the other Nordic countries (Achterberg 2014).

Neoneurus auctus (Thomson, 1895)

Material. SØR-TRØNDELAGE interior [STI], Malvik: Bromsetåsen [EIS 92, N63.40815° E10.65358°] 2♀♀, 11 June 2016, leg. AS., coll. NINA. Two female specimens hovering over *Formica aquilonia* ant hill. One specimen collected (Figure 3A); SØR-TRØNDELAGE coastal [STY], Snillfjord: Moldtun [EIS 91, N63.566214° E9.481950°], 2♀♀, 17 August 2016, leg. AS., coll. NINA. Specimens collected hovering and showing ovipositing behavior over *F. aquilonia* ant hill; SØR-TRØNDELAGE interior [STI], Trondheim: Jonsvatnet [EIS 92, N63.38132° E10.59894°], 1♀, 16 August 2016, observation AS., (Figure 3B); AUST-AGDER coastal [AAY], Grimstad, Sandkleiv [EIS 6, N58.34640° E08.53387°], 1♀, 7 August–19 September 2015, MT, leg. FØ & OH., coll. NINA; FINNMARK eastern [FØ], Sør-Varanger: Gjøkåsen [EIS 160, N69.159816° E29.209926°], 2♂♂, 11 July–14 August 2016, MT, leg. FØ & OH., coll. NINA; FINNMARK eastern [FØ], Sør-Varanger: 96-høyden [EIS 160, N69.451058° E29.919126°], 1♂, 11 July–16 August 2016, MT, leg. FØ & OH., coll. NINA.

Biology, hosts and distribution. See comments under *Neoneurus clypeatus* (Foerster, 1862).

Neoneurus clypeatus (Foerster, 1862)

Material. BUSKERUD eastern [BØ], Øvre Eiker: Hokksund, Nordre Haga [EIS 27, N59.77582° E09.93973°], one specimen, 6 June–5 July 2016, MT, leg. FØ., coll. NINA; SØR-TRØNDELAGE interior [STI], Malvik: Fjølstadvollen [EIS 92, N63.375125° E10.689788°], 1♀, 5 August 2016, (Figure 4), leg. AS., coll. NINA. The female sitting on the net, inside the Malaise trap; FINNMARK interior [FI], Karasjok: Skarfånjuni [EIS 166, N69.4394155° E25.837304°], 1♂, 11 July–16 August 2016, MT, leg. FØ & OH., coll. NINA; FINNMARK interior [FI], Karasjok: Guoikkaidoivi [EIS 166, N69.344261° E25.773782°], 1♂, 26 June–12 August 2016, MT, leg. FØ & OH., coll. NINA.

Biology, hosts and distribution. The *Neoneurus* species show largely the same ovipositing behavior as in *Elasmosoma*. Gomez Duran & Achterberg (2011) explain how the wasp hovers above a worker ant and then strike down to oviposit. *N. auctus* was first reported from Norway by Shaw (1992) from NSI, Hatfjelldal. Then by Riedel *et al.* (2002) from Ø, Rygge: Telemarkslunden. Shaw (1993) proposed a “raptorial hypothesis” on the wasps ovipositing behavior, to explain some morphological traits of *Neoneurus* species. The shape of the front legs suited for grasping on to the ant, head spinules that facilitate the positioning of the wasp when it hits the ant’s mesonotum, and the shape of the ovipositor that allows the insertion into the posteroventral part of the ant’s mesosoma. Gomez Duran & Achterberg (2011) confirmed this hypothesis with high-speed video recording of *Neoneurus vesculus* Gomez Duran & Achterberg 2011 ovipositing in *Formica cunicularia* in Madrid, Spain. *N. clypeatus* is reported as parasitoid on *Formica rufa*. The host at our sites is most likely to be *Formica aquilonia* due to the high frequency of *F. aquilonia* colonies close to the trap, and the absence of *F. rufa* colonies. Both species of *Neoneurus* is likely to be widely distributed all over the country. The species may be difficult to catch in traps if located far from potential ant-host colonies. Elsewhere in the Nordic countries, *N. auctus* is known from Sweden and Finland, while *N. clypeatus* is known from Sweden, Denmark



FIGURE 3A. *Neoneurus auctus* (Thomson, 1895), female. From Malvik in Sør-Trøndelag, Norway.



FIGURE 3B. *Neoneurus auctus* (Thomson, 1895), female, resting on a blueberry twig a few centimeters above a *Formica aquilonia* Yarrow, 1955 colony. From Trondheim in Sør-Trøndelag, Norway.

and Finland (Achterberg 2014).

BRACONIDAE, APHIDIINAE

Paralipsis enervis (Nees, 1834)

Material. BUSKERUD eastern [BØ], Øvre Eiker: Hokksund, Nordre Haga [EIS 27, N59.77582° E09.93973°], one specimen, 5 July–23 July 2016, MT, leg. FØ., coll. NINA; VESTFOLD [VE], Horten, Borrehaugene, [EIS 19, N59.11115° E10.24813°], 2♀♀, 15 October 2013, found under a stone in a field at Borre near Horten (Figure 5A & 5B), leg. AS., coll. NINA; TELEMARCK coastal [TEY], Porsgrunn: Brevik, Hellåsen [EIS 11, N 59.06932° E 09.69252°], one specimen found under a stone in a roadcut in mixed forest, 10 May 2010, leg. AF; TELEMARCK interior [TEI], Seljord: Heggenes [EIS 17, N59.44048° E08.78333°], one specimen, 29 July–18 August 2009, FIT, leg FØ & OH., coll. NINA. VEST-AGDER coastal [VAY], Kristiansand: Lykkedrang [EIS 2, N58.158° E 8.118°], one specimen, 7 July–1 August 2015, MT, leg. AS., coll. NINA.

Biology, hosts and distribution. The adult wasp lives in colonies of the ant *Lasius niger* (Linnaeus, 1758) and uses chemical and tactile signals for being accepted and fed by the ants (Völkl *et al.* 1996). The ants will usually mutilate the wings of adult wasps, which is then unable to fly after entering the colony (Stary 1976) The species is known to complete the life cycle in aphids of the genera *Anoecia*, *Anuraphis*, *Aphis*, *Brachycaudus*, *Chromaphis*, *Dysaphis*, *Forda*, *Geocia* and *Tetraneura* (Achterberg & Ortiz de Zugasti Carrón 2016, Yu *et al.* 2012). *P. enervis* is known from our neighboring countries Sweden, Denmark and Finland (Achterberg 2014).

ICHNEUMONIDAE, HYBRIZONINAE

Hybrizon buccatus (de Brébisson, 1825)

Material. ØSTFOLD [Ø], Halden: Fredriksten festning [EIS 20, N59.118919° E11.396614°], 1♀, 27 July–21 August 2010, MT, leg. FØ., coll. NINA; AKERSHUS [AK], Oslo: Bleikøya [EIS 28, N59.88.9695° E10.742705°], 1♀, 2 June–26 June 2009, MT, leg AE., coll.

NINA; TELEMARCK coastal [TEY], Kragerø: Jomfruland [EIS 11, N58.886041° E9.613759°], 7♀♀(Figure 6), 21 June–28 July 2009, PT, leg. FØ & OH., coll. NINA.

Biology, hosts and distribution. *H. buccatus* was long thought to be a parasitoid of adult ants, until Gómez Durán & Achterberg (2011) showed that the final instar ant larvae is used for ovipositing when the worker ants transport the larvae outside the nest. The wasp can hover over an ant trail for a long time waiting before they strike down to oviposit. Host records indicate that most ant larvae from the subfamily Formicinae (Formicidae) are preferred, but also larvae from non-Formicinae may be used (Gómez Durán & Achterberg 2011). First recorded in Norway by Riedel *et al.* (2000). Elsewhere in the Nordic countries, the species is known from Sweden and Finland (Achterberg 2014).

Discussion

In this paper we report on six species of parasitic wasps associated with ants in Norway. The number of ant-associated parasitic wasps is for sure much larger when we also include other groups like Ceraphronoidea, Chalcidoidea and Proctotrupoidea (Hölldobler & Wilson 1990). Like in most countries and regions, the sampling effort of parasitic wasps in Norway is far from complete, and many more species can be expected to be found in the future.

Myrmecophile parasitic wasps are likely to be most abundant near stable ant colonies, but the attack on the host does not necessary happen in the ant colony. Paths around the colony can also be a high risk area for the ants. Many of these parasitic wasp species are easy to spot when they hover over the ant colonies on warm and sunny days. Particularly, species of *Elasmosoma* and *Neoneurus* can be seen quite numerous hovering over *Formica* spp. pits during the hottest time of day.

Except for *Paralipsis enervis*, all reported species in this paper are primary ant-parasitizing species. *P. enervis*, differs from the others by parasitizing the ant's "livestock", the aphids.



FIGURE 4. *Neoneurus clypeatus* (Foerster, 1862), female, from Malvik in Sør-Trøndelag, Norway.



FIGURE 5A. *Paralipsis enervis* (Nees, 1834), female, lateral view. From Horten in Vestfold, Norway.



FIGURE 5B. *Paralipsis enervis* (Nees, 1834) together with *Lasius niger* (Linnaeus, 1758). From Horten in Vestfold, Norway.



FIGURE 6. *Hybrizon buccatus* (de Brébisson, 1825), female. From Jomfruland in Telemark, Norway.

These wasps are easily spotted in the colony of *Lasius niger* if they are present. If the ant colony is located under a rock, the wasps often tend to be running on the rock among the ants when turned.

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References

- Achterberg, C. van & Ortiz de Zugasti Carrón N.F. 2016. Revision of the genus *Paralipsis* Foerster, 1863 (Hymenoptera, Braconidae), with the description of two new species. *ZooKeys* 606, 25–39. doi: 10.3897/zookeys.606.9656
- Achterberg, C. van 2014. *Fauna Europaea: Braconidae*. In: Achterberg, C. van (ed.) 2014. *Fauna Europaea: Ichneumonoidea*. Fauna Europaea version 2.6.2. <http://www.faunaeur.org> [last accessed: 02. September 2016].
- Gómez Durán, J.M. & Achterberg, C. van. 2011. Oviposition behaviour of four ant parasitoids (Hymenoptera, Braconidae, Euphorinae, Neoneurini and Ichneumonidae, Hybrizontinae), with the description of three new European species. *ZooKeys* 125, 59–106. doi: 10.3897/zookeys.125.1754
- Hölldobler, B. & Wilson, E. O. 1990. *The Ants*. Cambridge, Mass. Harvard University Press. 732 pp.
- Lachaud, J.-P. & Lachaud, G.P. 2012. Diversity of Species and Behavior of Hymenopteran Parasitoids of Ants: A Review. *Psyche* 2012. 1–24 pp. doi: 10.1155/2012/134746
- Poinar, G. Jr. 2004. Behaviour and development of *Elasmosoma* sp. (Braconidae: Hymenoptera), an endoparasitoid of *Formica* ants (Formicidae: Hymenoptera). *Parasitology* 128, 1–11.
- Quicke, D. 2015. *The Braconid and Ichneumonid Parasitoid Wasps: Biology, Systematics, Evolution and Ecology*. 704 pp. Wiley-Blackwell, Oxford, UK.
- Riedel, M., Hansen, L. O. & Berg, Ø. 2000. Ichneumonidae (Hymenoptera) new for the fauna of Norway. *Norwegian Journal of Entomology* 47, 163–176.
- Riedel, M., Hansen, L.O. & Berg, Ø. 2002. Braconidae (Hymenoptera) of Norway, Part I. *Norwegian Journal of Entomology* 49, 97–108.
- Riedel, M. & Hansen, L.O. 2014. Braconidae (Hymenoptera) of Norway, Part II. *Norwegian Journal of Entomology* 61, 147–159.
- Riedel, M. & Hansen, L.O. 2015. Ichneumonidae (Hymenoptera) new for the fauna of Norway, Part 7. *Norwegian Journal of Entomology* 62, 180–187.
- Shaw, S.R. 1992. Seven new North American species of *Neoneurus* (Hymenoptera: Braconidae). *Proceedings of the Entomological Society of Washington* 94(1), 26–47.
- Shaw, S.R. 1993. Observations on the ovipositional behaviour of *Neoneurus mantis*, an ant-associated parasitoid from Wyoming (Hymenoptera: Braconidae). *Journal of Insect Behaviour* 6(5), 649–658.
- Starý, P. 1976. *Aphid parasites (Hymenoptera: Aphidiidae) of the Mediterranean area*. 101 pp. Dr. W. Junk Publishers The Hague. ACADEMIA Prague.
- Völkl, W., Liepert, C., Birnbach, R., Hübner, G. & Dettner, K. 1996. Chemical and tactile communication between the root aphid parasitoid *Paralipsis enervis* and trophobiotic ants: consequences for parasitoid survival. *Experientia* 52(7), 731–738.
- Zerene Stacker® software Version 1.04. 2016. Zerene Systems, LLC. <http://www.zerenesystems.com>

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