

Faunistic data and biology on the subfamily Cerocephalinae (Hymenoptera, Pteromalidae) including the first record of *Theocolax formiciformis* Westwood, 1832 from Norway

ARNSTEIN STAVERLØKK & LARS OVE HANSEN

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A single specimen of *Theocolax formiciformis* Westwood, 1832 is reported together with new data on *Cerocephala cornigera* Westwood, 1832 and *Cerocephala rufa* (Walker, 1833) in Norway. Notes on the mating behaviour of *C. cornigera* and the purpose of the ornamental growths of the males are discussed. Species in this group parasitize on wood-boring Coleoptera and are hyperparasitoids on other species of Hymenoptera parasitoids. The biology and distribution of each species are briefly discussed.

Key words: Hymenoptera, Chalcidoidea, Pteromalidae, Cerocephalinae, *Cerocephala*, new records, *Theocolax formiciformis*, male-male competition, intraspecific behaviour, Norway, malaise traps.

Arnstein Staverløkk, Norwegian Institute for Nature Research (NINA), Høgskoleringen 9, NO-7034 Trondheim, Norway. E-mail: arnstein.staverlokk@nina.no

Lars Ove Hansen, Natural History Museum, P.O. Box 1172 Blindern, NO-0318 Oslo, Norway. E-mail: l.o.hansen@nhm.uio.no

Introduction

The diversity of parasitic wasps is enormous, and their taxonomy and ecology are poorly studied. Cerocephalinae is a subfamily of the family Pteromalidae, which is the largest family next to Eulophidae and Encyrtidae, within the order Hymenoptera. Worldwide there are approximately 3506 described species distributed in 31 subfamilies and 588 genera. The number of described Chalcidoidea is nearly 22.000 (Noyes 2017). The European species of Pteromalidae are treated in detail by Graham (1969) and Bouček & Rasplus (1991). Many species in this family attack hosts inhabiting plant tissue such as leaf miners, gall inducers, as well as stem and wood-borers

(Graham 1969, Bouček & Rasplus 1991, Noyes 2017). Ottesen (1993) estimated the number of pteromalid species in Norway to 500. In Sweden, 692 species are reported (Dyntaxa 2018), while in Norway only 276 species are recorded so far, and of these only 62 are mentioned in publications (Lindemann & Hansen 2017, Noyes 2017). Only the genus *Cerocephala* Westwood, 1832 has been recorded from the subfamily Cerocephalinae in Norway (Hansen 2000). The characteristic morphology of this group makes them easy to distinguish from other species of Pteromalidae. The aim of this report is to highlight the biology, the occurrence and distribution of Cerocephalinae in Norway, and to contribute to a check-list of Pteromalidae species in Norway.

Material and methods

The material in this paper is collected manually using aspirator and with malaise traps. All records refer to fully labeled specimens deposited in the collections at Norwegian Institute for Nature Research (NINA) in Trondheim, and the Natural History Museum in Oslo (NHMO).

Stacked 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© (2017). Live images were taken with Nikon D3S DSLR, 20mm extension rings and Nikon Macro 60mm F2.8. All photos were taken by the first author.

The species

Theocolax formiciformis Westwood, 1832

HORDALAND coastal [HOI], Masfjorden: Kvingo, Storemyra EIS 40, [N60.74316° E5.39588°], 1♀, 23 July 2016, (Figure 1), leg. Arnstein Staverløkk, coll. NINA. The specimen was manually collected in the afternoon as it suddenly appeared on a bench in the garden close to a house. No specimens were caught in a malaise trap nearby during the summer (Figure 2). Ten pitfall traps were set up for one week on the same locality in July 2017, without any *T. formiciformis* catch. The traps were set up alongside a house where the timber was more and less infested with the common furniture beetle, *A. punctatum*. After identifying *T. formiciformis*, the first author went back to the locality and searched on the inside of windows in different buildings close to the locality. No *T. formiciformis* was detected, only several specimens of the braconid wasp *Spathius exarator* (Linnaeus, 1758) (Family Braconidae) were found. *S. exarator* is also a known parasite of *A. punctatum* and is a common species in almost all of Europe (Hedquist 1998).

Biology, hosts and distribution: Most individuals of *T. formiciformis* are brachypterous. It is reported as parasitoid of the woodboring beetle *Anobium punctatum* De Geer, 1774 (Coleoptera,



FIGURE 1. *Theocolax formiciformis* Westwood, 1832 from Kvingo in Masfjorden, Hordaland.



FIGURE 2. From the location in Masfjorden, Hordaland, where *Theocolax formiciformis* Westwood, 1832 was found.

Anobiidae) (Table 1). The species seems attracted to infested plywood (Hickin 1958). The adult insect is rarely seen at daytime, and its habits seems apparently crepuscular (Graham 1969). In Europe the species is known from Sweden, Great

TABLE 1. Hosts of Cerophalinae species recorded in Norway (Noyes 2017). (*) New host association

		<i>Theocolax formiciformis</i> Westwood, 1832	<i>Cerocephala cornigera</i> Westwood, 1832	<i>Cerocephala rufa</i> (Walker, 1833)
Primary hosts				
Order Coleoptera				
Family Anobiidae	<i>Anobium punctatum</i> Panzer, 1799	x	x	x
	<i>Xestobium rufovillosum</i> (De Geer, 1774)	x		
Family Scolytidae	<i>Hylesinus fraxini</i> (Panzer, 1779)	x	x (*)	
	<i>Hylesinus toranio</i> (Danthoine, 1788)			
	(= <i>oleiperda</i> (Fabricius, 1792)	x		
	<i>Scolytus rugulosus</i> (P.W.J. Müller, 1818)		x	
Family Buprestidae	<i>Agilus</i> sp.			x
Parasitoid hosts				
Order Hymenoptera				
Family Braconiodae	Braconidae sp.			x
	<i>Dendrosoter</i> sp.			x
	<i>Spathius</i> sp.			x
	<i>Spathius exarator</i> (Linnaeus, 1758)			x

Britain, Northern Ireland, Germany, Belgium, Czech Republic and Poland. Other regions include the Northwest Palearctic, the Nearctic- and the Australian region (Mitroiu 2018).

***Cerocephala cornigera* Westwood, 1832**

Material NINA: VESTFOLD [VE], Horten: Østøya (mixed forest), malaise trap. EIS 19, [N59.44205° E10.47643°] 1♂ 1♀ (Figure 3 and 4), 1 July – 7 August 2014. Leg. Arnstein Staverløkk, coll. NINA; Horten: Østøya (mixed forest), malaise trap. EIS 19, [N59.44567° E10.47585°] 1♀ 1♂, 1 July–12 August 2015. Leg. Arnstein Staverløkk, coll. NINA; Horten: Mellomøya, (mixed deciduous forest), EIS 19, [N59.44179° E10.46396°] 5♀♀, 29 June 2016. Manually collected with aspirator. Leg. Arnstein Staverløkk, coll. NINA; Horten: Mellomøya, (mixed deciduous forest). EIS 19, [N59.441688° E10.463600°] 2♀♀ 29♂♂, 4 July 2017. Manually collected on trunk of a dead ash tree (*Fraxinus excelsior* L.) infested with *Hylesinus fraxini*

(Panzer, 1779) (Coleoptera, Curculionidae) (Figure 5 and 6). Leg. Arnstein Staverløkk, coll. NINA. **Material NHMO: OSLO [AK]** Oslo: Østensjøvannet, Abildsø, EIS 28, [N59.88758° E10.81927° ±10m] 1♂1♀, 1–31 July 1996; 1♀, 1–31 August 1996, malaise trap, leg. Morten Falck; Asker: Bjørkås EIS 28, [N59.79185° E10.49738° ±25m] 1♀, 2 July–24 August 1994, malaise trap, leg. Lars Ove Hansen & Oddvar Hanssen (Hansen 2000, but with more accurate data); **Telemark [TEI]** Seljord: Heggeneset EIS 17, [N59.4402° E8.7789° ±10m] 1♀, 11 June–17 July 2015, malaise trap in dry slope, leg. Kjell Magne Olsen.

Biology, hosts and distribution: *Cerocephala cornigera* is a parasitoid of wood boring beetle larva and has many known hosts in its distribution area. Three of these known primary hosts are distributed in Norway, and this report adds *Hylesinus fraxini* (Panzer, 1779) as host (Table 1). The *C. cornigera* is previously known from Asker in Akershus and Oslo (Hansen 2000). In Europe the species has a wide distribution and



FIGURE 3. *Cerocephala cornigera* Westwood, 1832, male, from malaise trap material from Horten.



FIGURE 4. *Cerocephala cornigera* Westwood, 1832, female, from malaise trap material from Horten.



FIGURE 5. The dead ash tree infested with bark beetles had full activity of *Cerocephala cornigera* (Walker, 1833), *Eurytoma maura* Boheman, 1836, *Torymus arundinis* (Walker, 1833), *Cheilopachus quadrum* (Fabricius, 1787) at Mellomøya, Horten.

is known from all our neighboring countries (Mitroiu 2018).

Cerocephala rufa (Walker, 1833)

Material NHMO: Vestfold [VE] Larvik: Middagskollen EIS 19, [59.09739N 9.97198E ±1000m] 1♂ (Figure 7), 15 June–6 July 1997; 1♀ (Figure 8), 6 July–20 August 1997, malaise trap, leg. Arne Fjellberg. Hansen (2000) but with more accurate data.

Biology, hosts and distribution: *Cerocephala rufa* is a parasitoid of tree living beetle larva, but not many hosts are known (Table 1). The species is also a hyperparasitoid on already parasitized beetle larva. Several braconid wasps are hosts (Table 1). *C. rufa* is previously reported from Middagskollen in Larvik, Norway (Hansen 2000). In Europe the species is known from Sweden, Great Britain, Germany, Belgium, Czech Republic, Poland, Croatia, Romania, Serbia and Montenegro. Outside Europe, *C. rufa* is also



FIGURE 6. *Cerocephala cornigera* (Walker, 1833), female, manually collected from dead ash-tree.

known from Morocco, Tunisia and the Nearctic region (Mitroiu 2018).

Discussion

The subfamily Cerocephalinae is not commonly trapped in conventional traps as malaise traps or pitfall traps. If this were the case, there would have been many more observations and records of these spectacular looking and most interesting wasps all over Europe. The host beetle for *Teocolax formiciformis*, *Anobium punctatum*, is regarded as a pest species. Furniture stored in barns and even tree products inside houses may be attacked and damaged by this beetle larva. Because of the humid winters, *A. punctatum* is a very common pest in old wooden houses along the western coast of Norway, and therefore *T. formiciformis* should have a wide distribution in these areas, but several traits make it difficult to find. The female is brachypterous and 2–3 mm long and makes it hard to catch with conventional traps. Though *Cerocephala* species are bigger, they are



FIGURE 7. *Cerocephala rufa* (Walker, 1833), male, from Middagskollen, Larvik.



FIGURE 8. *Cerocephala rufa* (Walker, 1833), female, from Middagskollen, Larvik.

also rare to find in traps. Large size is often an advantage in fighting. Females are usually the larger sex among Hymenoptera, but where males

are larger than females it is generally believed to be a consequence of intra-sexual selection (i.e. competition between males). An interesting observation was done at Mellomøya 4 July 2017. Several specimens of *C. cornigera* were detected on a standing trunk of a dead ash tree (*Fraxinus excelsior* L.) (approx. 10cm diameter) (Figure 5). The trunk was full of emerging holes from a wood-boring beetle, probably *Hylesinus fraxini*. A closer look revealed other species of parasitic wasps ovipositing in the trunk (Table 2). The wasps of *C. cornigera*, which were mostly males, were acting like ants as they were running all over the trunk searching for preemerging females. As with many other chalcids (e.g. Agaonidae, Eulophidae, Pteromalidae), males emerge before the females to have more time to locate where the females will emerge (Gibson *et al.* 1993, Assem & Beukeboom 2004) The moment a male found a hole with an emerging female, it became very clear that this male had to defend this special hole, as more males would approach until the female wasp emerged out (Figure 9).

TABLE 2. Species of parasitic wasps observed on the same dead ash tree together with *Cerocephala cornigera* Westwood, 1832.

Family	Associated species
Torymidae	<i>Torymus arundinis</i> (Walker, 1833)
Pteromalidae	<i>Cheilopachus quadrum</i> (Fabricius, 1787)
Eurytomidae	<i>Eurytoma maura</i> Boheman, 1836
Braconidae	<i>Coeloides</i> spp.

**FIGURE 9.** Many males of *Cerocephala cornigera* Westwood, 1832 were attracted to the hole of the emerging female. The dominant male was busy chasing other males away from his “territory”.

The variation of size of the males on the trunk were distinct. Some males were much larger than others, especially the size of the head. This trait is crucial in the chances of defending the territory. The large male guarding the emerging female at one point, seemed to be the strongest one. He was constantly being challenged by smaller males that obviously shared the same goal when the female emerged (Figure 10).

Territorial fights occurred all the time. When two males met, they approached each other with the antennas in a measuring ritual (Figure 11). Then they crushed their heads together just like two

goats fighting (Figure 12). The wasps protruding ornaments appear to have the same function as the goat’s horns. After a quick fight with their heads, the smallest male retreated every time. When a large *C. cornigera* were busy fighting, the smaller males had access to the emerging female. Mendel (1986) reports intraspecific aggressive behaviour in males of two parasitoid species, *Dendrosoter caenopachoides* Ruschka, 1925 and *D. protruberans* (Nees, 1834). As in *C. cornigera*, the males are larger than the females. Males of *D. protruberans*, which occurs in Norway, showed similar behaviour by forming a tight circle of 2–8



FIGURE 10. Dominant male (over) is challenged by two minor males of *Cerocephala cornigera* Westwood, 1832.



FIGURE 11. Huge differences between the males of *Cerocephala cornigera* Westwood, 1832 on the small *Fraxinus* tree.



FIGURE 12. Two males of *Cerocephala cornigera* Westwood, 1832 crush their heads together, fighting over the emerging female.



FIGURE 13. Female followed by males, *Cerocephala cornigera* Westwood, 1832.

individuals, pressing on each other with their legs, antennae and wings. They remained motionless, unless the female began to emerge, or a new male tried to join the circle.

There are numerous examples where small males gain access, by sneaking, to females which are fought over by larger males, also among parasitic wasps (King *et al.* 1969). This was also observed with *C. cornigera*. While the biggest male was busy fighting, some smaller males came close to the emerging female. If the female had emerged at this point, the smaller males would have had the chance to mate before the fighting males. As soon as the female emerged, a bunch of males were right on her to mate (Figure 13). For males who must compete in mating, it is important to be larger and stronger. As for other species where females emerge before the males, the male dimensions are probably less important due to the fact that unmated females usually will mate with any male of her kind when it manages to mount her, while a mated female usually refuses to mate (Mendel 1986).

From 8 May to 4 October a malaise trap was located just 10 meters from observed *C. cornigera*. A small ash tree was cut down and used as a pole on the trap when mounted on 8 May. When returning on 4 July the pole had been attacked by bark beetles and there were a lot of activities of parasitoids. Mostly *Coleiodes* spp. and *Eurytoma maura* Boheman, 1836, but also a few specimens of *Cerocephala* were observed. In the, later examined trap material, there were many *Coeloides melanotus* Wesmael, 1838, *Eurytoma* sp. and *Torymus* spp., but no *Cerocephala*. Cutting down any small tree early in May to attract wood boring beetles, could be a great way to study parasitoids and their behaviour during the whole season. With the addition on *T. formiciformis* the number of recorded Pteromalidae in Norway is 277.

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References

- Artsdatabanken 2017. *Artsdatabanken: Pteromalidae*. Retrieved from <http://data.artsdatabanken.no/Taxon/72372> [Last accessed 15 February 2017].
- van den Assem, J & W. Beukeboom, L. 2004. A review of *Nasonia* (Chalcidoidea, Pteromalidae) courtship and mating behaviour, with some additional, new observations. *Proceedings of the section Experimental and Applied Entomology of the Netherlands Entomological Society*, 15.
- Bouček, Z. & Rasplus, J.Y. 1991. *Illustrated key to West-Palearctic genera of Pteromalidae (Hymenoptera: Chalcidoidea)*. Institut National de la Recherche Agronomique (INRA). Paris France. 76 pp.
- Dyntaxa 2017. *Svensk taksonomisk database – Swedish taxonomical database*. Version 1.1.6183.21129. Retrieved from <https://www.dyntaxa.se/?search=pteromalidae> [Last accessed 15 February 2018].
- Graham, M.W.R. de V. 1969, The Pteromalidae of north-western Europe (Hymenoptera: Chalcidoidea). *Bulletin of the British Museum (Natural History) (Entomology)* Supplement 16, 582
- Gibson, G.A.P., Huber, J.T. & Woolley, J.B. (Eds) 1993. *Annotated keys to the genera of Nearctic Chalcidoidea (Hymenoptera)* 794 pp. National Research Council of Canada, Ottawa,
- Hansen, L.O. 2000. The pteromalid subfamily Cerocephalinae (Hymenoptera, Pteromalidae) in Norway. *Norwegian Journal of Entomology* 47(2), 196.
- Hedquist, K.J. 1998. Bark beetle enemies in Sweden II. Braconidae (Hymenoptera). *Entomologica scandinavica Supplement No. 52*, 3–87.
- Hickin, N. E. 1958. Woodworm and its control. *The New Scientist*. 19 June 1958. Pp. 202–204.
- King, P.E.; Askew, R.R.; Sanger, C. 1969, The detection of parasitised hosts by males of *Nasonia vitripennis* (Walker) (Hym., Pteromalidae) and some possible implications. *Proceedings of the Royal Entomological Society of London (A)* 44, 85–90.

- Mendel, Z. 1986. Hymenopterous parasitoids of bark beetles [Scolytidae] in Israel: Relationships between host and parasitoid size, and sex ratio. *Entomophaga* 31 (2), 127-137.
- Mitroiu, M.-D. 2018. *Fauna Europaea: Pteromalidae*. In: Mitroiu, M.-D. *Fauna Europaea: Chalcidoidea*. *Fauna Europaea*, version 2.6. <http://www.fauna-eu.org> [Last accessed: 14 February 2018].
- Noyes, J.S. 2017. *Universal Chalcidoidea Database*. World Wide Web electronic publication. <http://www.nhm.ac.uk/chalcidoidea> [Last updated: September 2017. Accessed: February 2018].
- Ottesen, P.S. 1993. Norske insektfamilier og deres artsantall. *NINA Utredning* 55, 1–40.

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