Two species of ant symbionts in colonies of *Tetramorium caespitum* (Linnaeus, 1758) new to Norway

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Two species of symbionts associated with the ant species *Tetramorium caespitum* (Linnaeus, 1758) are recorded for the first time in Norway; *Chennium bituberculatum* Latreille, 1807 (Coleoptera; Staphylinidae; Pselaphinae) and *Tetramopria cincticollis* Wasmann, 1899 (Hymenoptera; Diapriidae, Diapriinae). Additional data on *Rhabdepyris myrmecophilus* Kieffer, 1904 (Hymenoptera; Bethylidae) and *Centrotoma lucifuga* Heyden, 1849 (Coleoptera; Staphylinidae; Pselaphinae) are given.

Key words: Hymenoptera, Diapriidae, *Tetramopria cincticollis*, Coleoptera, Staphylinidae, Pselaphinae, *Chennium bituberculatum*, myrmecophily, Formicidae, *Tetramorium caespitum*, Myrmecinae, *Rhabdepyris myrmecophilus*, *Centrotoma lucifuga*, Norway, Fennoscandia, new records.

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Introduction

Several species of arthropods can be found as symbionts in association with ant colonies. The most common groups are by far beetles (Coleoptera). However, groups like wasps (Hymenoptera), flies (Diptera), and spiders (Aranea) are also well represented. The symbionts may have different type of relations with the ants from strongly associated myrmecophilous species, which are totally dependent on the ants, to more facultative ant guests that occasionally benefit from coexistence with the ants (Parker 2016). A total of 125 myrmecophilous species are reported from Norway (Ødegaard *et al.* 2018). Most myrmecophilous species show a large degree of host specificity, at least at the genus level of ants. Ant symbionts of wood ants are quite well studied in the northern regions (Päivinen *et al.* 2002, Parmentier *et al.* 2016) in contrast to ants with colonies underground such as *Tetramorium caespitum* (Linnaeus, 1758). This species is quite widely distributed in southeastern parts of Norway along the coast, and can also be found in xerothermic localities away from the coast and in western Norway (Ødegaard *et al.* 2018). *T. caespitum* is known as a host for several species of beetles, parasitic wasps and social parasitic ants (Hölldobler & Wilson 1990), but none of these were found in Norway until recently. Hansen (1995) reported *Rhabdepyris myrmecophilus* Kieffer, 1904 from Buskerud, Norway. Females of this species are found in association with nests of *T. caespitum*, however it is unclear whether the wasps utilize the ants directly, or if they are associated with another symbiont (Hedqvist 1975). Ødegaard *et al.* (2015) reported the social parasitic ants *Anergates atratulus* (Schenck,

1852) from colonies of *T. caespitum* in Vestfold and Telemark. Further Ødegaard (2021) reported the symbiont pselaphid beetle *Centrotoma lucifuga* Heyden, 1849 from Telemark. In this paper we report another two species of symbionts of *Tetramorium* from Norway.

Material and methods

The material was collected by specific search in colonies of *Tetramorium caespitum* (Linnaeus, 1758). Reference material is deposited in the insect collections at Norwegian Institute for Nature Research (NINA) and NTNU University Museum in Trondheim (NTNU). The material was collected by the authors and their names are abbreviated as follows: Arnstein Staverløkk (AS) and Frode Ødegaard (FØ). Several partially focused images were taken with a Nikon DSLR and a microscope objective mounted on a bellow (NIKON P-5), and then combined in the software program Zerene Stacker© (2016). The coordinates are given in decimal degrees (Grid: Latitude/Longitude hddd.dddd°; datum: WGS84). All photos taken by the first author. The faunistic division within Norway follows Økland (1981) and is given in bold. The new county division introduced from 1 January 2020 has not been implemented in this study. The female of *Rhabdepyris myrmecophilus* was DNA-barcoded (CO1) and compared with the CO1 sequence of one of the males of *R. myrmecophilus* reported in this study. DNA-barcoding of the male was performed through NorBOL and BOLD systems (Ratnasingham & Hebert 2007) and the sequencing of the female was done at Eurofins Genomics (Germany).

FIGURE 1. The collection site for *Tetramopria cincticollis* Wasmann, 1899 at Heggenes in Seljord municipality, 19 May 2021.

The species

Tetramopria cincticollis Wasmann, 1899

Four females and one male were found in colonies of *Tetramorium caespitum*, all established under rocks. Unlike the ants when exposed, *T. cincticollis* were moving slowly in the cavities and small passages among the ants. All the specimens found in spring were fully winged, while the female found in September had the wings torn off.

Records: Norway, **TELEMARK [TEI]**, Seljord: Heggenes (Figure 1), N59.44181, E8.78982, 130 m asl., 19 May 2021, 2♀ (Figure 2), leg. AS, 1♀ 1♂ (Figure 3), leg. FØ. **AUST-AGDER [AAY]** Risør: Søndeled; Regårdsheia, N58.75071, E9.10607, 130 m asl., 22 September 2021, 1♀, leg. AS.

Biology. The biology of *T. cincticollis* is poorly known, but the species shows a number of features correlated with myrmecophile habits in diapriids which includes reduced eye size, reduced pigmentation, additional setation, and dealation by the host ant (Notton 1994). The other European congeneric species, *T. aurocincta* Wasmann, 1899 has been reared from the puparia of tachinid flies parasitic on lepidopterans (Szelènyi 1957, Huggert & Masner 1983).

Distribution. *T. cincticollis* is known from Britain, The Netherlands and Sweden (Johnson 2021, pers. comm. Peter Nilsson).

Chennium bituberculatum Latreille, 1807

The Pselaphinae of Norway have recently been revised (Ødegaard 2021), and here we report another new species to Norway. With these records of *Chennium bituberculatum,* a total of 43 native species of Pselaphinae have been found in Norway.

Records: Norway, **AUST-AGDER [AAY]**, Risør: Søndeled; Regårdsheia, N58.75071, E9.10607, +-10m, 130 m asl., 20 May 2021, 3 ind., leg AS; 1 ind., leg FØ.; 22 September 2021, 1 ind. leg. AS (Figure 4–7).

Biology. *C. bituberculatum* is considered a "synoecio-symphilic myrmecophil" which is a combination of feeding on detritus, various residuals, mildews, etc., and being fed by the ants by rendering a sweet secretion from special glands to their hosts. The species is rarely found and lives in well preserved xerothermic biotopes (Franc 1992).

Distribution: *C. bituberculatum* is rare in collections and according to the Fauna Europaea database, *C. bituberculatum* is recorded from Austria, Bulgaria, Corsica, Croatia, Czech

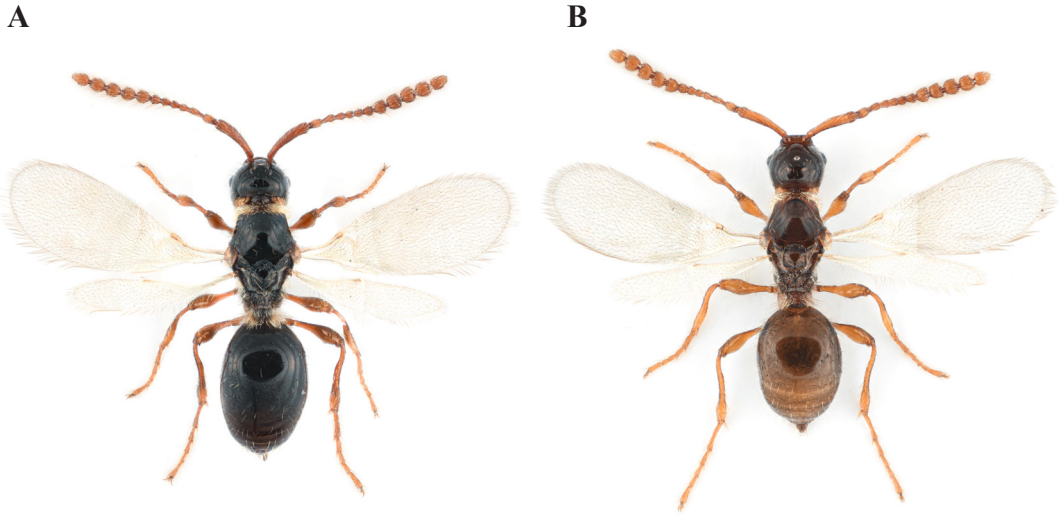

FIGURE 2A–B. Females of *Tetramopria cincticollis* Wasmann, 1899 from Heggenes in Seljord municipality, 19 May 2021.

FIGURE 3. Male of *Tetramopria cincticollis* Wasmann, 1899 from Heggenes in Seljord municipality, 19 May 2021.

FIGURE 4. Dorsal view of *Chennium bituberculatum* Latreille, 1807 found in colony of *Tetramorium caespitum* (Linnaeus, 1758) at Søndeled in Risør municipality, 20 May 2021.

FIGURE 5. Lateral view of *Chennium bituberculatum* Latreille, 1807 found in colony of *Tetramorium caespitum* at Søndeled in Risør municipality, 20 May 2021.

FIGURE 6. *Chennium bituberculatum* Latreille, 1807 in a colony of *Tetramorium caespitum* (Linnaeus, 1758) at Søndeled in Risør municipality, 20 May 2021.

FIGURE 7. Collecting site for *Chennium bituberculatum* Latreille, 1807 and *Tetramopria cincticollis* Wasmann, 1899 at Søndeled in Risør municipality, 20 May 2021.

Republic, France, Germany, Italy, Poland, Portugal, Slovakia, Spain, Sweden (Öland and Gotland), Switzerland, The Netherlands, Ukraine and Yugoslavia (Vit 2021).

***Rhabdepyris myrmecophilus* Kieffer, 1904**

The species was first reported from Norway by Hansen (1995). We here report the first female found in Fennoscandia under a rock together with a colony of *Tetramorium caespitum*.

Records: Norway, **AUST-AGDER [AAY]**, Risør: Søndeled; Regårdsheia, N58.75071, E9.10607, 130 m asl., 22 September 2021, 1♀ (Figure 8a), leg. AS. The identity of the female was confirmed by comparing CO1 barcode sequences of the female with a male (BOLD SampleID: HYMNI 845 in project NODRY) from Norway reported below. The sequences gave 97,84% ID-match. Additional records of males: Norway, **BUSKERUD [BØ],** Øvre Eiker: Lilleby/ Harastokkåsen, N59.77895, E9.93294, Malaise trap, 16 August to 8 September 2012, 2♂, leg. FØ; N59.77895, E9.93377, 19 July to 3 August 2021, 1♂ (Figure 8b), leg. AS; **TELEMARK [TEI]**, Porsgrunn, Prestemoen, N59.12178, E9.69790, Malaise trap, 16 July to 10 August 2014, 1♂, leg. FØ**,** BOLD SampleID: HYMNI845.

Biology. Unknown, probably parasitoid of a beetle associated with *Tetramorium* (Evans 1979).

Distribution. Norway, Sweden, Germany, The Netherlands (Dyntaxa 2021, Hansen 1995, Peters *et al.* 2004, Polaszek 2021).

***Centrotoma lucifuga* Heyden, 1849**

This species was published new to the Nordic countries by Ødegaard (2021) based on a male found in a malaise trap. A new record from the same site is reported here.

Records: Norway, **TELEMARK [TEI]**, Seljord: Heggenes, N59.44181, E8.78982, 130 m asl., 22 September 2021, 1♀, leg. AS (Figure 9). The specimen was found under a small rock together with a colony of *T. caespitum* and had a particularly quick response when detected.

Biology: The species has an obligatory association with *Tetramorium caespitum*, and the specimens are normally found in the ant colonies (Jeannell 1950, Besuchet 1974).

Distribution: *Centrotoma lucifuga* is widely distributed in central Europe north to Germany and Poland. The Norwegian occurrence of the species seems geographically isolated (Ødegaard 2021).

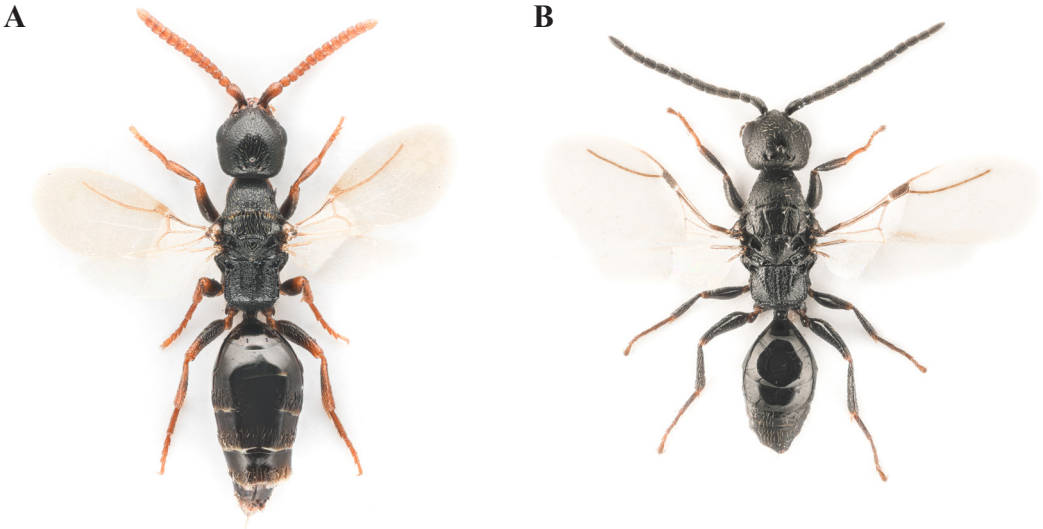

FIGURE 8A–B. *Rhabdephyris myrmecophilus* Kieffer, 1904. **A**. Female from Søndeled in Risør municipality. **B**. Male from Lilleby in Øvre Eiker municipality.

FIGURE 9. Female of *Centrotoma lucifuga* Heyden, 1849, found in a nest of *Tetramorium caespitum* at Heggenes in Seljord municipality.

Discussion

This study has shown that *Tetramorium caespitum* has a rich fauna of symbionts even at high latitudes in Norway. Xerothermic localities are hotspots for many insects, and particularly for ants. Soil dwelling ants use rocks not only as shade and shelter. Early and late in the season, when the sun reaches these rocks through naked trees and scarce vegetation, they become important heating reservoirs for the colonies. Along with the ants, symbionts tend to live in the upper part of the colony trail system under half buried stones. Apparently, such conditions perform optimal microclimate for the ants and their heat loving ant symbionts in the Northern hemisphere. Both localities in the present study, Heggenes and Søndeled, are seminatural xerothermic roadsides with rock deposits from the time the roads were constructed. Many of these rocks were half buried in soil and had ant colonies underneath. In similar biotopes in the south-east of Norway, extensive colonies of *T. caespitum* can be found among peat in cracks on the bedrock. However, since the symbiont species have a very specialized and concealed way of living, they may very well be overlooked elsewhere in Fennoscandia. The findings emphasize the importance of targeted search for such specialized species. During the recent years, several studies on ants have led to the discovery of new myrmecophilous species in Norway (Ødegaard *et al.* 2015, Staverløkk & Ødegaard 2016). With emphasis of *T. caespitum*, there are still possible to find more species of symbionts in our region. Particularly, *Tertamopria aurocincta* (Diapriidae) and the social parasitic ant *Strongylognatus testaceus* (Schenck, 1852), which both have been recorded from southern Scandinavia, are likely to be found in Norway in the future.

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