The social parasite bumblebee *Bombus hyperboreus* Schönherr, 1809 usurp nest of *Bombus balteatus* Dahlbom, 1832 (Hymenoptera, Apidae) in Norway

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This paper presents the first documented case of nest parasitisme (usurpation) of the bumblebee Bombus balteatus Dahlbom, 1832 by the social parasite bumblebee Bombus hyperboreus Schönherr, 1809. One nest of B. balteatus was found and excavated in Hessdalen in Sør-Trøndelag, Norway in July 2003. The nest contained sexuals of Bombus hyperboreus together with workers of B. balteatus.

Key words: bumblebees, *Bombus hyperboreus, Bombus balteatus*, social parasitism, usurpation

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Introduction

Social parasitism is well known in bumblebees. Late emerging queens sometimes take over (usurps) an established nest of others of their own species or related species. The usurper attacks and kill the queen, and enslaves the killed queens daughters (Alford 1975). Usurpation is said to occur only within species of the same subgenus (Hobbs 1965). Thus for example *Bombus terrestris* (Linnaeus, 1758) will often attempt to usurp its sister species, *B. lucorum* (Linnaeus, 1761), which tends to emerge slightly earlier (Goulson 2003). Bergwall (1970) described that a colony of *B. jonellus* (Kirby, 1802) in Swedish Lapland was invaded by *B. hyperboreus*, an example on usurpation of a species of another subgenus (Pyrobombus Dalla Torre, 1880). Socially parasitic bumblebees (subgenus *Psithyrus* Lepeletier, 1832) were for many years placed in a separate genus to the social bumblebees, but are now included in the genus *Bombus* Latreille, 1802. They do not have pollen baskets and are unable to produce wax, and so they now have an obligate dependency on social bumblebees (Goulson 2003). *Bombus hyperboreus* (subgenus *Alpinobombus* Skorikov, 1914) resembles the *Psithyrus* bumblebees in having an obligate dependency on social bumblebees, but differs from them in having pollen baskets and in doing pollen collecting.

From arctic North America, *B. hyperboreus* frequently usurps *B. polaris* Curtis, 1835 (=*B. arcticus* Kirby, 1821) (Milliron & Oliver 1966, Richards 1973). *Bombus polaris* has also been shown to have been usurped by *B. hyperboreus* on Greenland (Friese 1935, Løken 1973, Pape 1983). Stenström & Bergman (1998) claimed that *B. alpinus* (Linnaeus, 1758) is the potential host of *B. hyperboreus* in northern Sweden, where these two were the most abundant bumblebee species. But they did not describe any case of nest parasitism between these two species.

In this paper the first documented case of usurpation of *B. balteaus* by *B. hyperboreus* is given.

Material and methods

A nest site of *Bombus hyperboreus* was found at Bergshøgda, Hessdalen in Sør-Trøndelag, Norway (62°40'N 11°7'E) at approximately 1000 m a.s.l. on 3 July 2003. It was discovered by seeing a queen of *B. hyperboreus* with full pollen baskets flying several times to the nest entrance under a stone on an upland dwarf-shrub heath. The locality was visited again on 25 July the same year and the nest was excavated. All bumblebees flying from the nest were captured. The specimens were identified by the author using Løken (1973, 1985).

Results

The nest was found inside an abandoned rodent nest of grass about 35 cm below the surface of the ground beside a flat stone. The nest had a diameter of about 55 mm. The content of the nest was several honey pots of different sizes and one pollen pot together with cocoons and bumblebees. There were four cocoons including one empty queen cocoons (about 20 mm long and two cocoons of same size with unhatched queen pupa), and one smaller cocoon 15 mm long with unhatched male pupa. One *B. hyperboreus* queen

Table 1. Content of a nest of *Bombus balteatus* usurped by *B. hyperboreus*, excavated in Norway (Hessdalen, Sør-Trøndelag) 25 July 2005.

B. hyperboreus, old queen	1
B. hyperboreus, newly hatched queen	1
B. hyperboreus, queen pupae	2
B. hyperboreus, male pupae	1
B. balteatus, worker of normal size	6
B. balteatus, worker of small size	3

Figure 1. Content of the same nest as in table 1. Upper row from left: *Bombus hyperboreus* old queen, young queen, newly hatched male and three, empty male coccns, two coccons with queen pupae and one empty queen coccon. Middle row: 9 *Bombus balteatus* workers. Lower row: hony pots and pollen pot.

with a typical, though strongly faded colour pattern and worn wings was captured flying from the nest. Inside the nest was another newly hatched queen of the same species. In addition nine workers of *B. balteatus* were caught in and outside the nest. Six of the workers were of normal size (about 15 mm long), whereas the other three were very small and narrow (about 9 mm long) (Table 1, Figure 1).

Discussion

The fact that *B. hyperboreus* usurps *B. balteatus* is in accordance with the belief that usurpation only occur within species of the same subgenus (Hobbs 1965). These two species are both in the subgenus *Alpinobombus*. Richards (1973) describe *B. hyperboreus* as an obligate interspecific nest parasite. Workers of *B. hyperboreus* have been found in Scandinavia, Russia and Greenland a few times (Enwald 1881, Skorikov 1922, Elfving 1960, Løken 1973, Milliron 1973), which proves that workers are at least occasionally produced. It is however still not known if the species sometime rear broods without usurping other bumblebee species. It is therefore still uncertain whether *B. hyperboreus* is being a facultative or an obligatory inquilines. There is only one other *Bombus* species (*B. inexspectatus* (Tkalcu, 1963)), outside of the subgenus Psithyrus which is suspected to have adopted an obligate parasitic lifestyle. No workers of *B. inexspectatus* have been recorded, and it is thought that this species may be an obligate parasite of its close relative *B. ruderarius* (Yarrow 1970). This was confirmed by Müller (2006), who found a freshly enclosed queen of *B. inexspectatus* in a *B. ruderarius* nest. In comparison to *B. hyperboreus*, the total absence of pollen loads in all *B. inexspectatus* queens known so far and the reduced armature of the hind basitarsus indicate that *B. inexspectatus* may be a step ahead in the evolution of behavioural and physiological parallelism to *Psithyrus* (Müller 2006).

Apparently, *B. hyperboreus* queens is actively collecting nectar and pollen in Scandinavia. The queen of the nest gathered more nectar than the combined efforts of the five workers of *B. jonellus* usurped by her (Bergwall 1970). In contrast to this, Michener (1974) mentioned that *B. hyperboreus* has not been seen collecting or carrying pollen in arctic Canada. In alpine and arctic habitats, with a short growing season (2–3 months), the bumblebees will only produce one or two worker batches before batches of sexual (queens and males) are laid. Hence, this will result in small alpine and arctic bumblebee colonies (Milliron & Oliver 1966, Bergwall 1970, Løken 1973, Pape 1983). The nest of *B. balteatus* described in the current paper had only nine workers. This low number could be a result of the killing of the *B. balteatus* queen by the *B. hyperboreus* queen, before she had finished egg laying. Ove Meidell excavated on 7 July 1936 a *B. balteatus* nest at Øvre Sandsvann (Sauda, Rogaland) at 1050 m with 31 progeny, included four workers from the first brood and five workers from the second brood (Løken 1973). Another nest described by Hasselrot (1960) had offspring of only eight workers, three queens and three males, and one unhatched worker pupae, which indicates that this species can have small numbers of workers also without being usurped. Hobbs (1964) concluded that *B. balteatus* during the life cycle alters from being a pocketmaker when rearing worker larvae up to the last instar, to a pollen-storer when rearing last-instar larvae and all instars of male and female larvae. A number of possible explanations for the large size differences in bumblebee workers have been suggested (Goulson 2003). Differently sized workers are likely to differ in their optimal ambient temperature range for activity. The sizes produced may, however not be the optimal with regard to thermoregulation, particularly if the colony is constrained by a shortage of pollen when the queen has to gather food singlehandedly (Goulson 2003). Johnson (1986) suggested that the small bumblebees were primarily nest workers.

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