

The mating sites of the reindeer nose bot fly: not a practical target for control

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Abstract: The reindeer nose bot fly *Cephenemyia trompe* aggregates on hilltops/mountaintops to mate. Although active only for brief periods on certain days, males have been collected only from such sites. To evaluate possible suppression of the fly population by killing males (by insecticides or traps) at such sites, the density of sites and the number of males at each site were monitored in a summer grazing area of the semidomestic reindeer host (*Rangifer tarandus*) in Finnmark, northern Norway. In an area of ca. 20 km², 19 mating sites were detected and examined during 4 hours on one day. The number of males observed at most sites was 5–16 (range 3–60). Minor hilltops had few males but at some sites >20–60 flies were dispersed over an area of at least 100 m². It is concluded that mating sites in the study area are too numerous, and also used by many beneficial non-target species, to be practical targets for control of the species.

Key words: *Cephenemyia trompe*, mating, hilltopping, Norway.

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Introduction

The reindeer nose bot fly *Cephenemyia trompe* (Modeer) is an obligate endoparasite of reindeer and caribou (*Rangifer tarandus* L.) (Bergman, 1917; Hadwen, 1926; Breyev, 1958; Wood, 1987). Developing larvae have been reported to affect the host adversely by causing haemorrhage, inflammation and interference with breathing and feeding (Zumpt, 1965; Grunin, 1966). Reindeer are terrified by attacking adult flies (Espmark, 1968), which are responsible for harassment and disturbances during the summer grazing period (e. g. Helle & Tarvainen, 1984). In reindeer husbandry in northern Fennoscandia, *C. trompe* and the reindeer warble fly *Hypoderma* (= *Oedemagena*) *tarandi* L. are consi-

dered important economic pests (Nordkvist, 1967, 1972, 1980). Prophylactic methods have therefore been proposed (Hadwen, 1926; Palmer, 1934; Hearle, 1938; Saveljev, 1968; Washburn *et al.*, 1980; Folstad *et al.*, 1991) and antiparasitic treatments are common (Nordkvist, 1967, 1972, 1980, 1984; Nordkvist *et al.*, 1983, 1984; Persen *et al.*, 1982; Soveri *et al.*, 1990; Oksanen *et al.*, 1992, 1993; Haugerud *et al.*, 1993). For effective use of both kinds of control, knowledge about the biology and ecology of the species is crucial.

Bergman (1917) first clarified the general life cycle and biology of *C. trompe*, and since then several other papers have elucidated further details of the ecology and behaviour of this and congeneric speci-

es (e. g. Hadwen, 1926; Breyev, 1958; Espmark, 1961, 1968; Bennett & Sabrosky, 1962; Zumpt, 1965; Grunin, 1966; Reh binder & Nordkvist, 1983; Wood, 1987; Anderson & Nilssen, 1986, 1990; Nilssen & Anderson, 1995; Nilssen & Haugerud, 1994, 1995). Treatment of hosts with chemicals seems so far to have been the most efficient control method (review, see Haugerud *et al.*, 1993). One alternative method of reducing populations of oestrid flies sometimes mentioned, but never tried, is killing them at the aggregation (mating) sites (Möschler, 1935; Lindner, 1954; Gansser, 1956, 1957; Breyev, 1961; Catts *et al.*, 1965; Anderson, 1974).

After emergence from the pupae (in July and August), the newly eclosed flies search for a mating site. In *C. trompe* and related species, these sites are on the highest points in a locality. On selected hill tops and mountain peaks males often perch on cairns, trees, or various artificial constructions (Hadwen, 1926; Ullrich, 1939; Thomann, 1947; Chapman, 1954; Grunin, 1959, 1966; Catts, 1964, 1979; Lavigne, 1971; Cepelák *et al.*, 1972; Utsi, 1979; Downes *et al.*, 1985; J. R. Anderson & A. C. Nilssen, unpublished data). The mating behaviour of *C. trompe* has been studied in Canada (Downes *et al.*, 1985), in northern Sweden (Utsi, 1979), and in northern Norway (J. R. Anderson & A. C. Nilssen, unpublished), and is fairly well described. The choice of mating sites, however, must depend on what prominent geographic features are available, and how weather conditions may influence the utilization of specific aggregation sites. In high mountain terrain *C. trompe* is able to use the highest points in the landscape, even when the altitude exceeds 1000 m (Utsi, 1979).

In previous studies only males have been captured at these sites (Utsi, 1979; Downes *et al.*, 1985), but at mating sites in Finnmark county, Norway, we captured 5 pairs in copulo for other studies (unpublished data).

As larvae usually are dropped during the spring migration of reindeer and therefore become scattered over vast areas, mating aggregations tend to "concentrate" the population geographically. When aggregations of a species occur at only certain points that may be located easily by humans, it may be possible to modify these sites to control or eradicate local populations. Release of sterile males is a method that has been suggested for *Hypoderma lineatum* (Catts *et al.*, 1965) and other insects (Anderson, 1974), but capture with adhesive traps or killing by

insecticides are most often mentioned as possible control methods (Breyev, 1961; Catts, 1979; Catts *et al.*, 1965). There has been little discussion about the practical implications of such projects, but to be feasible, the aggregation sites must be few and easy to recognize.

The objectives of this study were to determine the number of *C. trompe* mating sites in a prescribed area and the number of males present at each site, and to describe and categorize each site. The study area was a typical vidda landscape used by semi-domestic reindeer during the summer.

Materials and methods

The study was carried out in a 65 km² area of Finnmark county, northern Norway, at 69° 40' N and 23° 30' E (Figure 1), about 40 km NE from the coast. The area is part of the Precambrian penep plain, the bed rocks consisting mainly of mica schist, metagreywacke, amphibolite and metarhyolite (Sigmond *et al.*, 1984). The altitude is generally between 450 and 550 m. The relief is generally low with only a few summits rising more than 100 m above the general level. The landscape is interspersed with numerous lakes and streams, which often are surrounded by mires with sedges (*Carex* spp.). The tree line terminates at about 490 m a. s. The surrounding forest is formed by mountain birch (*Betula pubescens* ssp. *tortuosa*), with individual trees as tall as 5 - 6 m. The field layer in the forest is a mixture of dwarf birch (*Betula nana*) and juniper (*Juniper communis*) in dry (elevated) locations, and willows (*Salix glauca* and *S. lapponum*) in moist (depressed) places, often creating a mosaic with shrub-less parts consisting of mosses, dwarf cornel *Cornus suecica*, bilberry *Vaccinium myrtillus* and mountain crowberry *Empetrum nigrum* ssp. *hermaphroditum*. Above the tree line, a dwarf shrub zone of *Salix lapponum*, *S. glauca* and dwarf birch often occurs, in unexposed areas constituting a mosaic with heaths of bilberry and mountain crowberry, mosses and grass and sedge tussocks. Due to grazing by reindeer there are few lichens left. The terrain is undulating, and the highest and most exposed parts consist of bare rocks and stones. According to data in Bruun (1967), the climate is subarctic and of a continental type. There is no permafrost. The Suolovuopmi meteorological station at 69° 35' N and 23° 32' E (altitude 374 m) records data representative of the area: Here the mean temperatures (1960-75) for May, June, July, August and

23°30'E

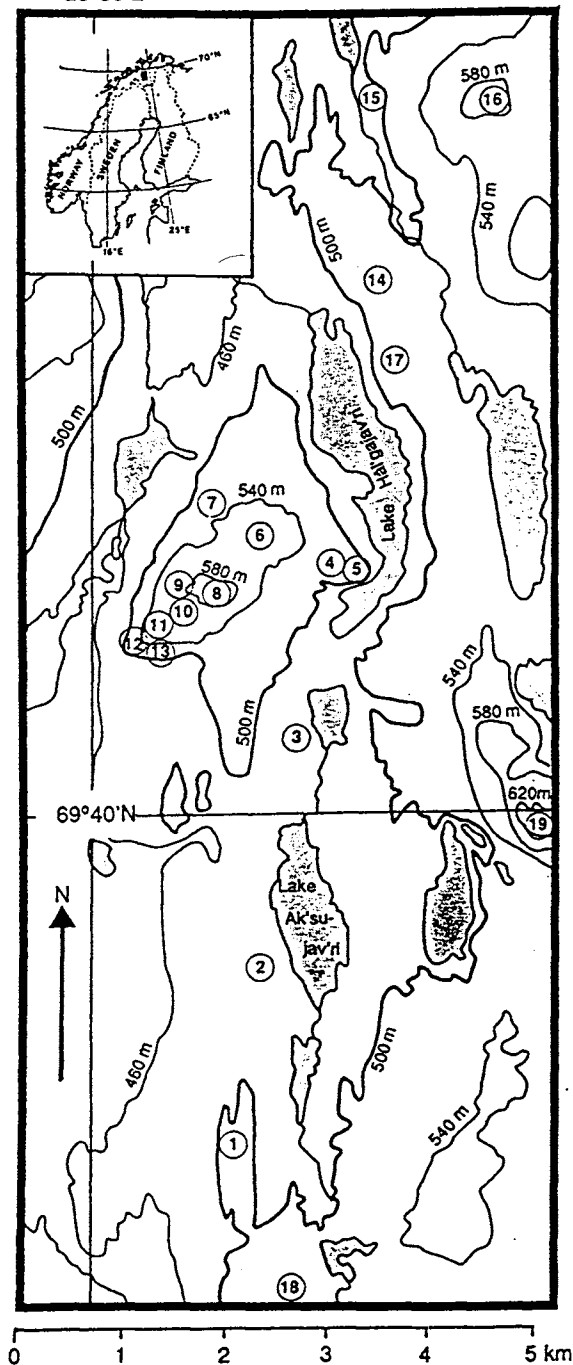


Fig. 1. Map of the study area. Contour intervals: 40 m. The largest lakes and rivers are also shown. Each site where *C. trompe* males were detected is mapped by a number. Details about these sites may be found in Table 1.

September were 1.6, 8.1, 12.3, 9.9 and 4.7 °C, respectively, and the precipitation for the same

months was 23, 46, 59 and 45 mm, respectively.

Sampling of first instar larvae of *C. trompe* from reindeer among different districts has shown that animals in the study area have the highest larval burden of this parasite in Norway (Nilssen & Haugerud, 1995). In 1985 the prevalence of infection was 100% and the relative density was 63. The number of reindeer that migrate, graze or calve in or near this area during the main larval exit period (May-June) was about 3500.

The study area was chosen for its high population density of *C. trompe* and because the many potential mating sites visited were easily accessible from a road passing through the central part.

To determine how many sites were used concurrently it was essential to observe as many male aggregation sites as possible in as short a time as possible. To do this, two people drove and walked through different parts of the area on a warm, sunny day inspecting previously-known mating sites and hilltops identified as potential mating sites. All potential mating sites were visited within a 3.5 hr. period, and all lower hilltops on the way to the highest ones were assessed for the number of *C. trompe* males present. The previously-known mating sites and the highest hilltops suspected of being potential mating sites were observed for 5-10 min each, depending on their size. Lower elevation hilltops on the way to the higher ones were examined for only 1-2 min. This was done because of the distances between the highest hilltops, and because many previous visits to several known possible hilltop mating sites had shown that surrounding lower elevation hilltops were not attractive to *C. trompe* males.

The survey was done on 16 July 1986 from 08.30 a.m. to 12.00 a.m. The air temperature was about 23 °C for most of this period, with bright sunshine (>100000 lux) and wind velocity <2 m/s. After 12.00 a.m. the temperature dropped abruptly due to increasing wind from the NE and incoming clouds. Observations were terminated then as numerous previous observations had shown, no *C. trompe* are present on mountain tops on overcast or cool days.

Results

Males were found on all of the highest mountain tops visited. A map of the study area (Fig. 1) shows all hilltops at which *C. trompe* males were present, and Table 1 provides other information about each

Table 1. Details about the aggregation sites of *C. trompe* observed on one and the same day (16 July 1986, except site 19, see below). Each site is depicted in the map in Figure 1. Time (Norwegian Standard Time) refers to time of the visit. 5 - 10 minutes were used for monitoring each site.

Site	Elevation (m a. s. l.)	Time	<i>C. trompe</i> males seen	Note
1	510	08.30 am	>15	Ridge 100 m
2	490	08.45 am	10	
3	492	09.00 am	>10	
4	529	09.30 am	>10	
5	508	09.35 am	> 5	
6	558	09.40 am	>10	
7	535	09.45 am	5	
8	588	09.55 am	>15	
9	565	10.00 am	5	
10	566	10.05 am	>10	
11	550	10.08 am	> 5	
12	530	10.12 am	3	
13	520	10.15 am	>20	Ridge 400 m
14*	534	10.20 am	>20	Area approx. 300 x 50 m
15	506	10.25 am	8	
16	598	10.30 am	>60	Radio link station at summit
17	514	11.30 am	> 7	
18*	533	12.00 am	10	Cairn at summit
19**	639	11.30 am	16	Highest point in the study area

* Investigated repeatedly for many years; both sites seem to be used every year on all good days in July and partly in August. Numbers higher than those found on this particular day were sometimes observed.

** Observation done the previous day (15 July).

occupied site. Because males are very active on warm, sunny days and often fly after other males, females, or other large insects, it was possible to provide estimates only of the number of males present at most sites. Of the 65 km² shown in Fig. 1, it was possible to survey only about 20 km² in the 3.5 hr period. As 19 mating sites were found, there was at least 1 mating site per km². Visual estimates showed that more than 218 males of *C. trompe* were concurrently present at all positive sites (Table 1). At most sites males aggregated at or near the summits, but at some sites they were dispersed along ridges or flattened hilltops (site 13 and 14). At site 18, the males aggregated on or around a prominent cairn. The largest number of males was seen on an artificial radio link station 15 m high (Table 1). The highest summit in the whole area (site 19; Luvdiideåk'ka, elevation 639 m) was investigated the previous day (15 July) during similar weather

conditions, but the number of flies present were no more than seen on many lower and smaller hill tops. No *C. trompe* males were seen on about 25 lower elevation hilltops briefly inspected on the way up to the higher hilltops positive for *C. trompe* males.

Discussion

Because our survey for *C. trompe* males covered only 20 km² within a 65 km² area, we believe that males also were present at several other higher elevation hilltops that we could not visit. For example, within the area shown in Fig. 1, there are 12 hilltops from 490 to 600 m a. s. l. that were not assessed for the presence of *C. trompe* males. Also, because positive minor hilltops at lower elevations had fewer males than nearby higher hilltops, it is possible that some of the lower elevation hilltops assessed as negative for *C. trompe* males may have had such low

densities (1-3) of males that they were missed in the brief 1-2 min assessment period. We therefore conclude that both the number of "positive" sites and the number of flies per site are minimal estimates for the area surveyed.

Aggregation on landmarks serves to assure the eventual contact of males and females that may have emerged from widely scattered areas. Due to the migratory movements of their hosts, mating aggregations of oestrids are common (Gansser, 1951, 1957; Grunin, 1959; Catts, 1964, 1979; Catts *et al.*, 1965; Anderson *et al.*, 1994). This type of mating strategy may be described as lek-like polygyny in which males assemble at distinct landmarks (Thornhill & Alcock, 1983). Females incite a male pursuit flight that sorts out males that either fly fast or have the best position within the site. Generally, this behaviour has been described as a "passive default strategy" of mate selection (Beehler & Foster, 1988). The other reindeer oestrid, the warble fly *Hypoderma* (= *Oedemagena*) *tarandi*, has a similar mating behaviour, but uses different "landmarks" (Anderson *et al.*, 1994) that have been more difficult for investigators to locate.

Breyev (1961), in discussing control of oestrids, stated that "...if such descriptions (of their aggregation sites) are given and the places can be found sufficiently quickly and accurately and treated with persistent contact insecticides, it should be possible to destroy the majority of the males and thus greatly reduce the numbers of the species.". Several others have suggested a similar approach to controlling oestrids (Möschler, 1935; Lindner, 1954; Gansser, 1956, 1957; Anderson, 1974).

However, the aggregation sites of *C. trompe* proved to be more numerous than previously determined for related species in other areas. We found at least one concurrently used aggregation site per km², each site mostly with 5-15 males present (Table 1 and Fig. 1). With so many aggregation sites in a relatively small area, it would be extremely difficult to carry out site-focused control measures of any kind. The flies are simply not aggregated enough.

Utsi (1979) found that during strong wind, the flies may utilize lower summits than during calm periods. In our investigation there was little wind (<2 m/s) and the temperature was high, conditions that seem to stimulate the flies to seek higher points. However, even under such conditions the flies used minor summits and less pronounced hilltops. The density of flies was as high on some minor

summits as on most major ones. It therefore appears that, in a landscape like this, *C. trompe* normally uses numerous aggregation sites for mating, with an inter-site distance of often less than 1 km (Fig. 1). Catts (1964) suggested that while inactive, *C. apicata* and *C. jellisoni* rested in or near the aggregation sites, and Utsi (1979) suggested that *C. trompe* males do not change aggregation sites, but extensive mark-release-recapture studies are needed to determine if, or how often, males change aggregation sites.

One reason why *C. trompe* mating sites may be more numerous in our study area than found for more mountainous areas (Utsi, 1979; Downes *et al.*, 1985) may be lack of distinct mountain peaks in our area (Fig. 1). If prominent landmarks are difficult to distinguish, flies may utilize less pronounced landmarks, e. g. more or less flattened hilltops, resulting in many more aggregation sites (Utsi, 1979). Another factor that might account for so many mating sites per km² in our study area, is the high population level of the fly due to the density of heavily infested hosts (Nilssen & Haugerud, 1995).

However, even if *C. trompe* males use far fewer mating sites in other mountainous areas, various logistical problems would discourage control efforts directed at mating sites. Eradication of males that are found on mountain peaks > 1000 m will involve so many practical problems (time, effort, expense) that it would not be worth the cost or effort. Utsi (1979) tried some traps that could be used without frequent inspection, but they caught few flies.

Use of insecticides or adhesive traps on hilltops also is contraindicated because insects from many orders use hilltops as mating sites (e.g. Alcock, 1984, 1985a, 1985b, 1989; Thornhill & Alcock, 1983). During several years of studying the mating behaviour of *C. trompe* (J. R. Anderson & A. C. Nilssen, unpublished data) we often observed and collected species of beneficial insects that used the same hilltops as mating sites (e. g. syrphids, tachinids, and several Lepidoptera). Several species of bumble bees also were seen and captured on flowering plants. The use of insecticides at such sites would, therefore, result in the destruction of many nontarget beneficial insects, and might remove a source of food for insectivorous birds.

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