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Flight pattern of *Entephria caesiata* (Lepidoptera: Geometridae) in E Finnish Forest Lapland[1]

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The flight pattern of *Entephria caesiata* (Denis & Schiffermüller, 1775) was studied using light traps in the Värriötunturi fell area in E Finnish Forest Lapland during the summers 1978–1982. The beginning of flight varied between 7 and 23 July and the yearly flight period was on average 49 days long, varying between 39 and 63 days. The last specimens were caught between 31 August and 11 September. Fifty percent of the yearly catch of males was obtained on average 7.6 days before that of females.

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1. Introduction

The geometrid *Entephria caesiata* (Denis & Schiffermüller, 1775) is one of the most abundant lepidopterans in light trap catches in Lapland (Linnaluoto & Koponen 1980, Itämies et al. 1982). Hence, its phenology can be analyzed more accurately than that of most other northern moths. Linnaluoto & Koponen (1980), whose data consists of 7-day samples, found the occurrence of *E. caesiata* to be often bipartite, the moths having two distinct peaks during the flight period. They hypothesized the phenomenon to be indicative of two differently behaving subpopulations in the area, which might have different food plant preferences and developmental rates.

The purpose of the present paper is to provide records on the flight pattern of *E. caesiata* in E Finnish Forest Lapland during five successive summers where the traps were emptied every morning.

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2. Material and methods

The material was collected in the years 1978–1982 in the Värriötunturi fell area, E Finnish Forest Lapland (67°44'N, 29°37'; Grid 27°E 752:61). The trapping was carried out using eleven light traps (model "Jalas") located in the following virgin habitats:

1) three traps on a dry heath forest of old Scots pines (*Pinus sylvestris*);

2) three traps in a ravine covered by a spruce-dominated mixed forest (*Picea abies*);

3) three traps in a mountain birch forest (*Betula pubescens* ssp. *tortuosa*) on the northern slope of Värriötunturi fell and

4) two traps on the treeless summit of Värriötunturi fell.

The lights (500 W blended light lamps) were switched on for the period 2000–0800 each night from mid-May to mid-October. The catches were collected each morning, and summed daily.

The period of continuous daylight in the Värriötunturi area lasts from 10 May to 14 July. The winter snow melts by the last days of May on average and forms again by the middle of October.

3. Results

Entephria caesiata are easy to detect when flying in the study area. As soon as the first specimens were seen in flight, they were also

caught by the light traps. Indicating a typical population fluctuation the total catch of these geometrids decreased during the course of the study period (Table 1). The catch was dominated, except in 1978, by males, although this dominance was not overwhelmingly high.

The earliest *E. caesiata* specimens were caught in 1980 (on 7 July), while the first individuals were caught only on 23 July in 1978 and 1981. The last specimens were caught between 31 August and 11 September. The length of the yearly flight period varied between 39 and 63 days, being on average 49 days long.

A bipartite occurrence of *E. caesiata* was obvious in light trap catches during the two first study summers, and to some extent also in 1981. This may be partly due to cold weather periods falling in the middle of the flight period. The minimum nightly temperatures seem to influence the amount of these geometrids caught each night, although they are naturally not the only factor involved here (Fig. 1).

The difference between the flight periods of males and females was greatest in 1978 and 1979 (Fig. 2, Table 2). This can be seen, for instance, in the dates when 50 percent of each sex was caught; in 1978 there was 14 days' difference and in 1979 11 days' difference, the females occurring later than the males. The dates when half of the catch was reached varied remarkably, too (Fig. 2). The earliest date for the 50 percent catch of males was recorded in 1979 (26 July), the corresponding date for the females being 5 August (in 1980). The latest medium recorded for the males was 14 August (in 1982) and that for the females 24 August (in 1978) (Table 2).

The total lengths of the flight periods of males and females constituting those *E. caesiata* specimens between 10 % and 90 % of the total catch appear to be close to each other, i.e. 21.6 and 22.6 days, respectively. This gives a better picture of the occurrence of the species in question than the total flight period, which the accidental early and late specimens may prolong misleadingly (Table 2).

Table 1. Light trap catches and their sex ratios of *Entephria caesiata* records in the Värriötunturi fell area of E Finland in 1978–1982.

	1978	1979	1980	1981	1982	Total
Males	1144	794	1022	646	272	3878
Females	1288	568	574	398	207	3035
Total	2432	1362	1596	1044	479	6913
Males/ females	0.89	1.40	1.78	1.62	1.31	1.28

4. Discussion

Since great numbers of *Entephria caesiata* can be caught and since they are immediately caught by light traps when they appear on the wing, an opportunity arises for some population analyses. Thus, Linnaluoto & Koponen (1980) obtained a remarkable catch of these geometrids in the vicinity of the Kevo Subarctic Research Station in northernmost Finnish Fell Lapland, and stated that the two peaks appearing in the data indicate two differently behaving subpopulations in that area. A similar two peaks may also be obtained in Finnish Forest Lapland, especially when the population is abundant and the catch is high (Fig. 1).

The present case, in which these geometrids were also sexed, does not support the hypothesis of two differently behaving subpopulations. Firstly, one of the factors involved here is supposedly the cold spell which appeared to coincide with the middle of the flight period, especially during the first two study summers, since nightly temperatures of below 5°C seem to reduce catches radically. Secondly, the different flight patterns of male and female moths have their own influence on these peaks, the males dominating before the "saddle" and the females after it.

E. caesiata appears to belong to the rather common lepidopterous group in which males emerge before females. Here the essential assumption is that the light trap catches indicate the real situation in the wild. A lot of attention has recently been paid to this evolutionarily interesting phenomenon, i.e. protandry (e.g. Wiklund & Fagerström 1977, Bowden 1979, Tabashnik 1980, Fagerström & Wiklund 1982). The main point of this debate has been which sex has mating strategies, males, females, or both. All these alternatives have been suggested.

E. caesiata hibernates as a larva but its instar(s) are not exactly known (Seppänen 1969). Thus, this species belongs to that majority of Lappish moths which hibernate only as larvae

Table 2. Summarized data concerning flight periods of *Entephria caesiata* caught in light traps in the Värriötunturi fell area of E Finland in 1978–1982. d1 = difference between first date of males and females in days; d2 = difference between date when 50% of sexes is achieved in days; d3 = difference between last date of males and females in days.

	1978	1979	1980	1981	1982	Mean
First date of males	23.7	9.7.	7.7.	23.7	23.7	17.7
First date of females	27.7	15.7	12.7	28.7	2.8	23.7
d1	4	6	5	5	10	6
50% of males	10.8	26.7	31.7	3.8	14.8	5.8
50% of females	24.8	6.8	5.8	6.8	19.8	12.8
d2	14	11	5	3	5	7.6
Last date of males	10.9	22.8	7.9	27.8	31.8	1.9
Last date of females	12.9	28.8	9.9	10.9	31.8	5.9
d3	2	6	2	14	0	4.8
Length of period in days	52	49	63	42	39	49
Length of 2–98%	40	35	35	34	28	34.4
Length of males 10–90%	27	25	21	16	19	21.6
Length of females 10–90%	29	30	22	17	15	22.6

(see Mikkola 1980) resulting in the flight period occurring in mid- and late summer. Temperature and other weather conditions may, however, result in some variation in this timing, as we have seen in the present case (see Figs. 1 and 2). This strategy has a remarkable advantage in that the female does not take into consideration the developmental stage of the food plant when laying its eggs, presuming that the hatching small larvae do not need to eat any special parts of the food plants. *E. caesiata* feeds on a variety of plants, e.g. *Empetrum, Vaccinium, Calluna, Salix, Betula nana, Sorbus* (Nordström et al. 1941, Mikkola et al. 1985) which means that the female can easily find acceptable food for its offspring.

This simplifies the reproductive strategy of females, from the standpoint of which it is essential that each female becomes mated, and that there are suitable flowers which they can visit. It is a natural goal of the male to maximize the number of females with which it mates. This is a question of the timing of the flight of both sexes, but it is also a question of investment. The female invests in eggs it is going to lay, and the male in pairings with females. The latter means that a male consumes its time and energy in locating as many females as possible. This can be performed by active flying, the male thus being a "patrolling" one rather than a "parching" one (see Scott 1974). The females can then be more passive insects.

E. caesiata lives in northern Finland in unpredictable conditions where low night temperatures may last for weeks and may also be associated with heavy rains. The point is, whether it is more reasonable for the males to emerge or only to commence flying earlier than the females or simultaneously with them. The former pattern seems to be more reasonable than the latter, especially if there is more severe competition for mates among males than among females, as suggested by Fagerström & Wiklund (1982) in their more general contribution. This means that the early flying males run the risk of falling victim to predators before they have succeeded in mating. Investment in "pre-mating" flight falls into this strategy. The strategy also means that there are always males available when females are flying, the main idea of protandry.

E. caesiata is one of the most abundant geometrids in the subarctic region of Finnish Lapland. Its reproductive strategy appears to be very relevant in these conditions. The larva may tolerate low ambient temperatures in winter (see Mikkola 1980), especially if its gut is empty (Salt 1953). The larvae, which have presumably not eaten before diapause, are ready to benefit from the early growth period of food plants in early summer, the food plants being characterized at that time by rapid protein synthesis, and high protein and mineral contents (see Klein 1965). Adults emerge in mid- or late summer when there is time for males to commence flying earlier than the females, and the females have no problems in timing their oviposition in relation to the phenology of the food plants.

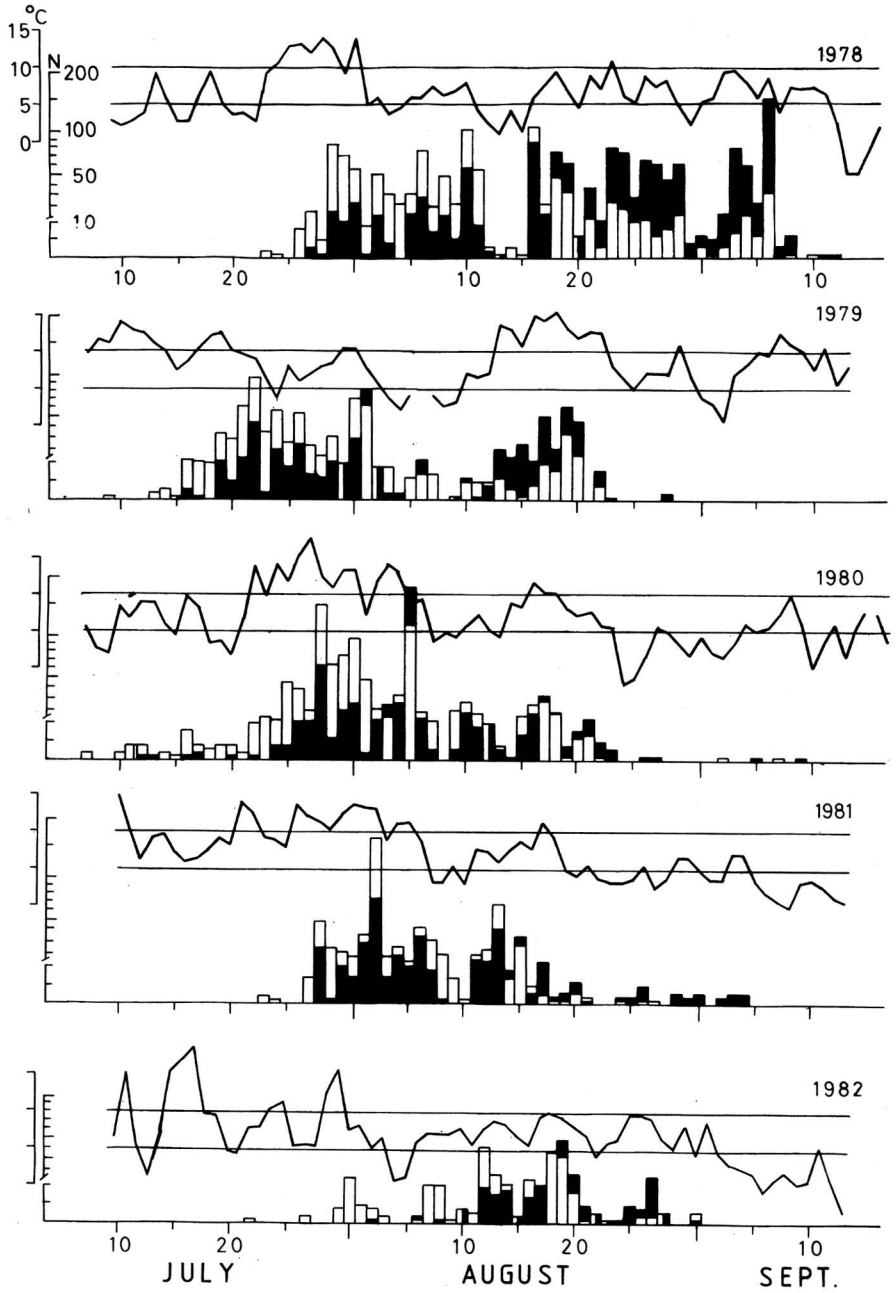

Fig. 1. Occurrence of *Entephria caesiata* (Lep., Geometridae) in light trap catches at Värriötunturi fell area in E Finnish Forest Lapland. Height of columns = real number of sex in question (the predominating sex is the uppermost shown in each case; white = males; black = females; line indicates the nightly minimum temperatures.

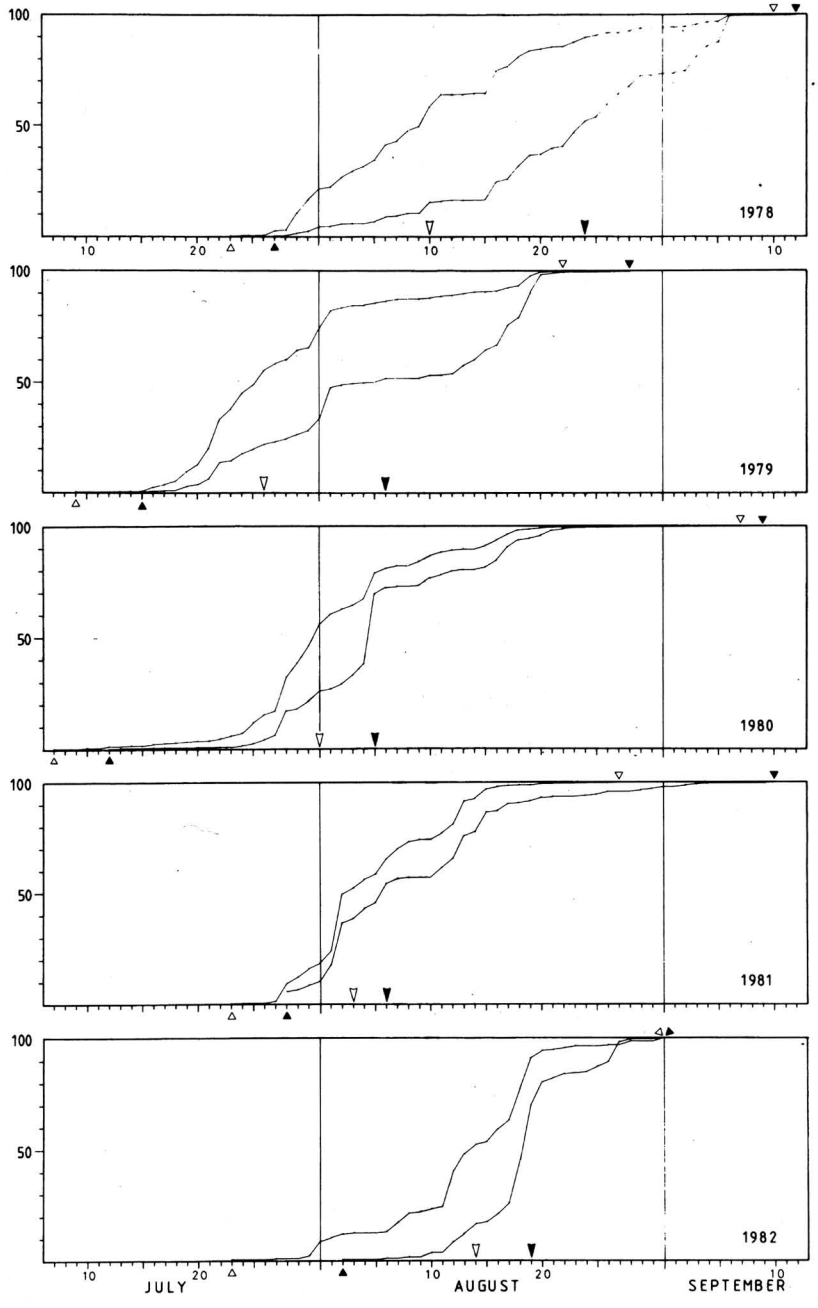

Fig. 2. Cumulative percentage occurrence of *Entephria caesiata* (Lep., Geometridae) in light trap catches at Värriötunturi fell area E Finnish Forest Lapland. Triangles = first and last date of flight; arrows = date when 50 % of catch was achieved: white = males; black = females.

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