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Parasitization in *Petrova resinella* (Lepidoptera, Tortricidae) galls in relation to industrial air pollutants

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Parasitization of *Petrova resinella* in the gall stage was studied in the surrounding of Harjavalta, SW Finland, in relation to industrial air pollution. Of the studied 283 galls, 28 % produced a moth, 52 % of the larvae/pupae were parasitized, and 20 % were empty or contained a dead larva. The proportion of parasitized galls did not depend on the distance from emission sources of industrial air pollutants.

Harjavallan kaupungin ympäristössä tutkittiin pihkakääriäisen äkämävaiheessa elävien loishyönteisten runsautta suhteessa teollisuuden aiheuttamaan ilmansaastumiseen. Tutkituista 283 äkämästä 28 %:sta kuoriutui perhonen, 52 % oli loisittu ja 20 % äkämistä oli tyhjiä tai sisälsi kuolleen perhostoukan. Loisittujen äkämien osuus ei ollut olennaisesti riippuvainen paikan etäisyydestä saastutuslähteestä.

Key words: *Pinus sylvestris,* Scots pine, air pollution, Finland

ODC 174.7 Pinus sylvestris+425.1+453+145.7×18.28 Petrova resinella + 181.45

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1. Introduction

The effects of air pollutants on the occurrence and abundance of an insect species may not be as expected. There are several indisputable examples of mass outbreaks of insects caused by air pollutants (for a review, see Alstad et al. 1982). Causalities are often unclear and difficult to detect, and the ultimate reasons for mass outbreaks are not usually known. When investigating the possible effects of pollutants on the population dynamics of an insect species, the following main points have to be investigated: 1) change in food quality, 2) change in physiology of the pest, and 3) susceptibility of the natural enemies to pollutants (e.g. Alstad et al. 1982, Führer 1985). The latter aspect is preliminary examined in this study with respect to the pine resin gall moth, *Petrova* *resinella* (L.) (Lep., Tortricidae).

During the two-year life cycle the larva of the pine resin gall moth in pine shoots is a host for several predators and parasitoids. More than 40 parasitic insect species have been reared from galls formed by the larvae of this tortricid moth (Mjöberg 1909, Wolff & Krausse 1922, Escherich 1931). The occurrence of *P. resinella* has earlier been investigated in the surrounding of Harjavalta, an industrialized town in southwestern Finland (Heliövaara 1986). The density of galls containing a living larva was highest a few kilometres from the factories, but the total density of galls – including cankers from earlier years – was highest in the vicinity of the factory complex. The occurrence of parasitoids in the galls of *P. resinella* in the same study area was investigated in the present study. Their possible role as factors affecting moth mortality in the polluted area is also discussed. The problems associated with this kind of a study are briefly reviewed.

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2. Material and methods

The air in Harjavalta (Grid 27°E 680:24), the present study locality in southwestern Finland, is polluted by two large factories situated close to each other. One of the factories produces copper and nickel and the other sulphuric acid and fertilizers. The flora in the area has been seriously affected by industrial activities since the 1940s. The deposition of heavy metals, for instance, is considerably high in the vicinity of the factories, even judging by international standards (Hynninen 1983, Hynninen & Lodenius 1986).

Altogether 283 galls of the moth were collected on eighteen sample plots in May, 1986. The sample plots were located at logarithmic distances from the emission point along two transects running in a southeast – northwest direction (cf. Hynninen 1983, Heliövaara 1986). The emerged parasites were recorded during a period of one month, at the end of which period every gall was analysed. Regression analysis was used in comparing the proportions of moths, parasites and empty galls in relation to the distance from the factory complex.

3. Results

Of the gall material examined, 79 (27.9 %) galls produced a pine resin gall moth, parasitoids emerged from 148 (52.3 %) galls and 56 (19.8 %) galls were empty or contained a dead larva. Some of the parasites had emerged earlier in the spring and could not be identified. However, their exit holes were counted. *Macrocentrus* spp. (Braconidae) and *Liotryphon* spp. (Ichneumonidae) were the most abundant among the emerged parasitic Hymenoptera. Unidentified species belonging to Chalcididae and Tachinidae (Diptera) were also recorded.

The proportions of moths, parasites and empty galls at different distances from the emission source are presented in Fig. 1. Although the proportion of moths varied from 13.0 to 37.2 %, the value does not appear to depend on the distance from the emission source along the 9-km-long transect studied here. Number of emerged moths was slightly lower in the vicinity of the factories compared with that several kilometres away. However, the differences are small (t = 0.53, NS, df = 7). The proportion of parasitized galls varied rather insignificantly (43.3 – 56.5 %) as a function of distance. The proportion of parasitized galls was somewhat higher at a distance of 2000–5000 m from the factories than elsewhere, but the differences are, again, small (t = 1.41, NS). The proportion of empty galls or galls containing a dead larva varied widely (9.1 – 33.3 %) without exhibiting any distinct dependence on the distance from the emission source (t = 0.17, NS).

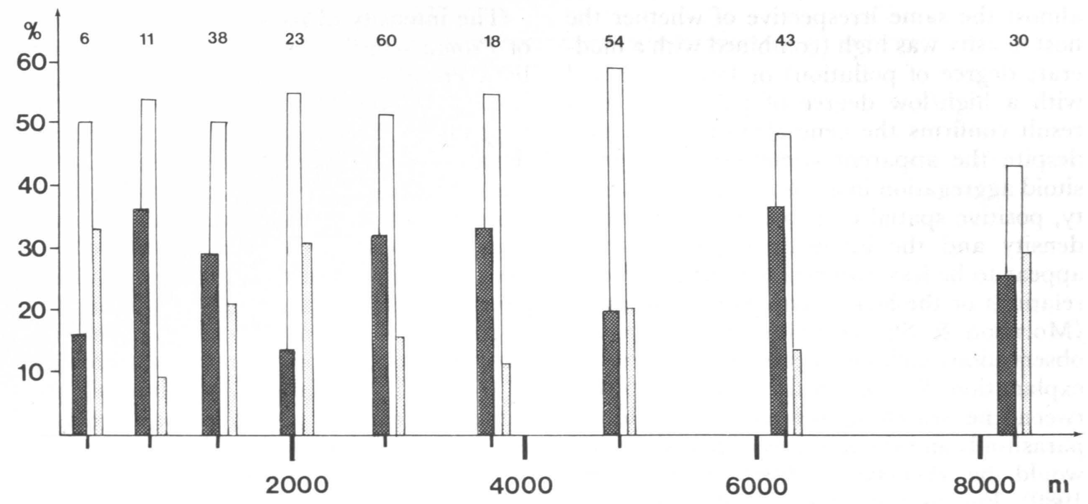

Figure 1. Proportion of healthy (black), parasitized (shaded) and empty galls (white) of *P. resinella* at different distances from the emission source of industrial air pollutants. The number of galls studied is given above each group of columns.

4. Discussion

Bud and shoot-boring and wood or gall-inhabiting insects such as *P. resinella* are better protected against immediate contamination by pollutants compared with external feeders. Non-external feeders are, however, also affected by the indirect effects of pollutants, i.e. physical changes in the host plant or reduction in parasitization.

Entomophagous species can be assumed to be more susceptible to air pollutants than phytophagous, if a parallel is drawn with pesticides (Führer 1985). The great number of aphids observed near highways is presumed to be at least partly due to the detrimental accumulation of lead in the parasitoids of aphids (Flückiger & Oertli 1978, Braun & Flückiger 1984). Parasitioids, especially tiny wasps, are known to be sensitive to dust due to its desiccative action (Finney & Fisher 1964). Templin (1962) noticed that some microlepidopterous pests showed mass propagation on pines damaged by air pollution, and assumed that this was due to the reduction of natural enemies of the host. As a whole, quantitative studies on this subject are very scarce.

In the Nordic countries, the parasitization of *P. resinella* has previously been studied by Mjöberg (1909) in an almost completely unpolluted area. In his restricted material 32 % of the galls produced an adult *P. resinella*, 51 % were parasitized and 15 % were empty. He concluded that the high number of empty galls was due to the fact that the larvae had left them to pupate in the ground. In the present study, the proportion of moths was slightly higher and the proportion of empty galls lower, but the proportion of parasitized galls almost the same as in Mjöberg's study.

In our study the density of parasitoids was almost the same irrespective of whether the host density was high (combined with a moderate degree of pollution) or low (combined with a high/low degree of pollution). This result confirms the general observation that despite the apparent commonness of parasitoid aggregation in areas of high host density, positive spatial correlations between host density and the intensity of parasitization appear to be less common than negative correlations or the lack of any correlation at all (Morrison & Strong 1980). However, such observations lack an unequivocal theoretical explanation. Studies on the relationships between the searching behaviour of different parasitoids and the intensity of parasitization would be necessary (Morrison & Strong 1980). Furthermore, the spatial scale of the study should be taken into account, since the variation in host dispersion patterns frequently depends on the scale on which the measurements are made (Southwood 1978) and parasitoids may respond in different ways to variations in host density occurring on these different scales (Hassell & May 1973).

The intensity of parasitization in the galls of *Petrova resinella* did not vary significantly between areas subjected to varying levels of aerial pollution. Although the result naturally depends on the steepness of the gradient and the absolute amount of pollutants, it suggests that parasitoids are not necessarily always more sensitive to environmental pollutants than their hosts are. More accurate conclusions also require further studies on different parasitoids. However, the investigation of total parasitism of *P. resinella* seems to be very a laborious task. During the two-year life cycle of the moth, predators, including all predators, parasitoids and hyperparasitoids of eggs and small larvae should be examined in the first year, and predators of large larvae (galls) in the second year. Annual fluctuation in the parasite populations may be problematic, although chronic pests, such as *P. resinella,* presumably maintain more stable populations of parasitoids than several needle-eating species with strikingly fluctuating populations.

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