Brief reports · Tiedonantoja

Winter feeding by the Great Tit, *Parus major,* on eggs of the European pine sawfly, *Neodiprion sertifer*

Einar Olofsson

The biology of the European pine sawfly, *Neodiprion sertifer,* has been thoroughly studied (for references see Pschorn-Walcher 1982), but there are only a few reports of predation on the eggs by birds. In one area in Belgium, Galoux (1952) found that 67 % of the eggs were eaten by tits; at one site in Canada, Lyons (1964) reported 10 % mortality, "probably by birds"; and in Finland Juutinen (1967) noted that a few eggs were eaten by birds. There are no previous reports of sawfly egg predation by birds in Sweden.

The sawfly is fairly common in pine forests in southern and central Sweden. Outbreaks occur at irregular intervals and may cover a few hectares or entire provinces. An outbreak usually lasts for a few years and may cause total loss of needles, except on the current year's shoots, which are avoided by the larvae. Between outbreaks, however, population densities are often very low. Therefore, sawfly eggs are not normally a readily available food for birds during the winter, and there are no other insects in Scandinavia that deposit their eggs in the same position.

The eggs of this sawfly are laid in the fall, mainly during September. A female normally deposits all her eggs, between 30 and 120, in adjacent needles, and the egg clusters are usually found below the tip on the current year's shoots. The eggs are placed individually inside the needles. A short cut is made by the ovipositor in the needle edge and some needle tissue is removed before an egg is inserted. Usually between 5 and 10 eggs can be found in each needle. The eggs are not visible on the surface of the needle, but after oviposition the needle tissues gradually turn yellowish on both sides of the needle where an egg is located (Fig. 1A). The eggs overwinter in the needles and hatch in late May or early June.

Sawfly eggs were studied in 13 outbreak areas between 1976 and 1985. Egg predation was seen in only two of these areas: at Vallnäs in the province of Småland in 1981, and at Vada in the eastern part of the province of Uppland in 1984. At Vada the eggs of only a few scattered clusters were eaten, but at Vallnäs the predation level reached ca. 5 %. The observations made at Vallnäs are described in this paper.

The sawfly outbreak occurred in a 55-hectare area with 6–11-year-old lodgepole pines, *Pinus contorta.* The outbreak began in 1978 and peaked 1981, but the sawfly populations remained large for another 4 years. Egg predation was not observed until 1981, when about 5 % of the eggs were eaten. In 1982 the eggs in only a few scattered colonies suffered predation, and from 1983 to 1985 no eggs were eaten.

Usually most of the eggs in a cluster were eaten. The needles showed more or less triangular holes at the position of the egg, and the edge of the needle was usually torn (Fig. 1B). Great Tits, *Parus major,* were observed feeding on the eggs, but the possibility that other species behaved similarly cannot be excluded.

The abundance of sawfly eggs was estimated in the beginning of April. A sampling unit comprised all shoots at the end of a twig. Sawfly eggs were found in 47 % of the samples (n = 1960), the average number in the infested samples being 224 eggs (n = 42, SD = 227, range: 10 to 1055 eggs). The total number of eggs in the 55-ha area was estimated to be 200 million. Of the sampled eggs 5 % were eaten by birds. This was extrapolated to 10 million eggs for the entire stand.

The energy intake required by a Great Tit is about 25 Kcal/day (Gibb 1957). The weight of the eggs collected in November was 0.16 ± 0.01 mg (mean ± SD, n = 27). The energy value of sawfly eggs is not known, but from the data given by Gibb (ibid.) it was estimated to be between 0.4 and 0.5 cal/egg. Thus, a bird feeding exclusively on eggs would have to find at least 50 000 eggs a day. This is clearly not possible; it would require that an egg was eaten in less than 0.6 seconds, assuming that the tit spent 90 % of a 9-hour day feeding (data from Gibb 1960). On the other hand, with the very high egg density at the study site the time spent searching for a new egg cluster would be short. Further, the number of eggs on a twig was unusually large; in most cases the eggs from only one female are found on a branch tip. If the tits concentrated their search around the tips of the shoots, they would by able to find a new cluster within a few seconds. The sawfly eggs were thus a highly predictable source of food at this site, once this feeding pattern was established. Provided that the tits sometimes found other food items while searching for eggs and that they used other search strategies during part of the day, the eggs would be a valuable source of food in spite of their small size.

The energy available in the 10 million eaten eggs would sustain a Great Tit for about 200 days, so obviously a group of tits had adopted this behaviour. If, for instance, there were 20 Great Tits in the area which obtained 20 % of their energy requirements from sawfly eggs, then these eggs would be eaten in about 50 days.

The observation of Great Tits eating sawfly eggs provides an example of their well-known ability to utilize rare or un-

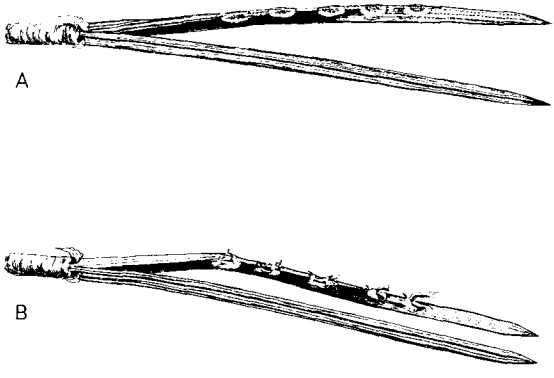

Fig. 1. Pine needles with intact eggs niches of the European pine sawfly (A), and with eggs removed by tits (B).

usual food sources (Ulfstrand 1962). The scarcity of observations of egg predation in Sweden, even during large sawfly outbreaks, indicates that feeding on sawfly eggs requires learning by the birds. Furthermore, due to the small size of the sawfly eggs, this behaviour is likely to be reinforced only at very high egg densities. It is possible that the egg eating behaviour becomes established more easily on lodgepole pine, since the yellowish marks over the egg niches contrast much more with the normal colour of the needles than they do on the native Scots pine.

The overall effects of egg predation by birds on populations of the European pine sawfly can be assumed to be negligible. A high egg density is apparently required before this behaviour is profitable to the birds. Even at high egg densities it seems unlikely that predation can reach high levels, because the time needed to find a new egg cluster will gradually increase as more egg clusters are destroyed. The availability of other food items can also be expected to influence the level of predation on sawfly eggs.

Acknowledgements. I wish to thank Karin Eklund for participation in the field work, Roland Sandstedt for observing the feeding of Great Tits, Rune Axelsson for the drawing, Arja Kaitala for translating the summary into Finnish, and Prof. Hubertus H. Eidmann and Birger Risberg for comments on the manuscript.

Selostus: **Ruskean mäntypistiäisen munat talitiaisen ravintona**

Ruskean mäntypistiäisen munia tutkittiin 13 tuhoalueella, mutta lintujen havaittiin syöneen niitä vain kahdella alueella. Itä-Upplannissa havaittiin vain muutamia syötyjä munia, mutta Smålannissa, 55 hehtaarin nuoressa Pinus contorta-männikössä, 5 % munista oli syötyjä. Tällä alueella munatiheys oli erittäin suuri. 1 960 vuosikasvainnäytteestä 47 %:ssa oli munia. Yhdessä vuosikasvainnäytteessä oli keskimäärin 224 munaa. Metsikössä arvioitiin olleen 200 miljoonaa munaa, ja lintujen arvioitiin syöneen niistä 10 miljoonaa. Talitiaisten havaittiin syövän munia.

Munat ovat neulasen sisällä, mutta neulasen pintaan muodostuu vastaavaan paikkaan keltainen piste. Yksi muna painaa vain n. 0.16 mg. Talitiaisen arvioitiin tarvitsevan päivässä vähintään 50 000 munaa. Tähän se ei kuitenkaan pystyisi, mutta esimerkiksi 10 lintua, joista kukin käyttäisi munien syömiseen 20 % päivittäisestä ruokailuajastaan, pystyisi aiheuttamaan havaitun predaation noin 100 päivässä.

Ruskean mäntypistiäisen munien syöminen talvella on luultavasti kannattavaa vain, jos munatiheys on hyvin suuri, jolloin munaryhmät voidaan löytää nopeasti. Munapredaatiohavaintojen harvinaisuus jopa tuhoalueella viittaa siihen, että tämä käyttäytyminen vaatii linnuilta oppimista. Loppupäätelmänä on, että lintujen munapredaatiolla ei ole merkittävää vaikutusta ruskean mäntypistiäisen populaatiodynamiikkaan, mutta munat voivat ajoittain olla talitiaisen ja ehkä muidenkin tiaisten talviruokaa.

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Mercury content in eggs of the Great Crested Grebe *Podiceps cristatus* and the Horned Grebe *Podiceps auritus* in the archipelago of Korsnäs, Gulf of Bothnia

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Accumulating in food chains, mercury can become a threat to successful reproduction in birds, especially piscivorous species.

In eggs of migratory species, such as the Goosander in the south-western archipelago of Finland, high mercury contamination has been traced to the overwintering area (Wahlberg et al. 1971). Mercury and other biocides in the eggs of seven aquatic birds breeding in Lake Päijänne have also been assumed to derive mainly from the winter quarters, as the birds lay their eggs soon after arriving in Finland (Paasivirta et al. 1981).

In this study, I measured mercury content in the eggs of two species which feed largely on fish (Fjeldså 1973, von Haartman et al. 1963-72).

The aim was to determine the mercury levels in an area which is supposed to be relatively free from mercury, as the closest known sources of mercury pollution are situated 50 km north and south of the study area (Nuorteva 1971).

I also had in mind to determine whether there is a decrease in the mercury level of grebes' eggs during the breeding season, as this would indicate that the birds can eliminate mercury, a capacity which has been established in the Osprey (Häkkinen & Häsänen 1980) and several other species (Fimreite 1979).