A LOCAL OUTBREAK OF THE NORTHERN PINE PROCESSIONARY MOTH
THAUMETOPOEA PINIVORA ON GOTLAND, SOUTH SWEDEN

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Abstract

An outbreak of the northern pine processionary moth Thaumetopoea pinivora is currently occurring on Pinus sylvestris in an area of about 3,000 ha at the northern limit of its distribution on the Baltic island of Gotland, south Sweden. It is not clear how long the population has been present on Gotland, but from observations made by the local residents it appears that it has been present at least since the 1930s. Thaumetopoea pinivora has a two-year development cycle on Gotland, with discrete year classes; high larval densities occur in even years and much lower densities in odd years. The larvae feed between April and July on mature pine needles, and release microscopic hairs that can cause severe allergic reactions in humans. Presumably, the population escaped from controlling factors, but no strong control agent has been identified. A tachinid fly (Blondelia nigripes) is present in the population, but no precise data on degree of parasitism are available.

Keywords: Thaumetopoea pinivora, Pinus sylvestris, Gotland, outbreak.

1. Introduction

The northern pine processory moth Thaumetopoea pinivora Treitschke 1834 (Lepidoptera: Notodontidae) is morphologically and ecologically similar to the cedar processory moth T. bonjeani Powell and the better known Mediterranean T. pityocampa (Denis & Schiffermüller) (Frérot & Démolin 1993), but T. pinivora has a more northerly distribution. An outbreak of T. pinivora is currently occurring on the Baltic island of Gotland, south Sweden, at the northern limit of its distribution. Here we report details on T. pinivora biology, and estimates from 2006 on the distribution and abundance of the Gotland population.

2. Distribution of T. pinivora

The global distribution of T. pinivora is poorly known. High larval densities were recorded in northern Germany in the early 1950’s (Koch 1953), but with little information on the dynamics. In mountainous areas of Spain a high density population was documented in the 1970s (Montoya & Robredo 1972). No other detailed accounts on T. pinivora ecology are published. The distribution seems to be concentrated around the Baltic Sea. Apart from Gotland T. pinivora is established at least since the 1930s on the Danish island Bornholm (Per Stadel Nielsen, personal communication). There are also reports from Poland and Lithuania (Schwenke 1978). Outside the Baltic region and Spain, T. pinivora has been reported from France, Romania, and the Czech Republic (Schwenke 1978).
The population on Gotland is by far the biggest in Sweden. A small population is established on the island of Öland, also in the Baltic Sea. There is no reliable information on how long the populations have been on Gotland and Öland, but at least on Gotland there are reports from local residents that larvae were present at least in the 1930s. Lepidopterologists have caught flying individuals also along the Swedish east coast for at least twenty years (e.g., Palmqvist 1984, Franzén 2004); in these cases it is likely that it was males originating from the populations at Gotland, Öland or Bornholm. No established populations are known from the Swedish mainland.

3. Life history of *T. pinivora* on Gotland

*Thaumetopoea pinivora* is monophagous on *Pinus sylvestris* L. The insect has a two-year development cycle on Gotland. Adults emerge from the cocoons in the soil in mid July. Eggs are laid on the pine needles, shortly after female emergence, and hatch in late April the following year. The larvae go through five instars and feed until late July when they leave the trees in typical head-to-tail processions to search for suitable sites in the soil for cocoon spinning. The cocoon overwinters and stays in the soil for most of the following summer before emerging in late July. The Gotland population has discrete year classes with high larval densities in even years, whereas much lower densities occur in odd years (Fig. 1).

![Life history diagram](image)

**Figure 1. Life history characteristics of Thaumetopoea pinivora on Gotland, south Sweden.** *Thaumetopoea pinivora* has a two-year life cycle on Gotland with parallel year classes. High population densities of larvae occur in even years.

The details of the biology are poorly known. The following is an attempt to summarize current knowledge based on own field observations on Gotland, and from what is known about *T. pinivora* in Germany and Spain (Koch 1953, Hering 1968, Montoya & Robredo 1972). The females are short lived, probably living for only one or a few days. The dispersal capacity of the female is likely limited, as found for *T. pityocampa* (Battisti et al. 2006), whereas the males disperse over much longer distances and frequently are found outside...
Gotland. Females develop about 100-200 eggs (Fig. 2). The eggs are laid in batches and covered with scales produced by the female (Montoya & Robredo 1972). Groups of neonate larvae are full siblings, but larval groups commonly merge later at high population density sometimes forming aggregates of up to 1,000 individuals. They build no tents, in contrast to *T. pityocampa* and *T. processionea*. The larvae feed on mature needles, even in later instars when current-year needles have developed. The feeding mostly occurs during the night. First and second instar larvae have a distinct basking behaviour, forming dense clusters at the tip of branches directed towards the sun. During the day the late-instar colony hides on the trunk, or on a major branch. When ready to spin cocoons the larvae form processions that can wander tens of meters in search of a suitable site in the soil. The individual larvae have a very coordinated behaviour during the processions. When a suitable site is found they join in digging through the soil down to a depth of 5-20 cm. A certain proportion of the cocoons most likely has a prolonged diapause, as documented for *T. pinivora* in Spain (Montoya & Robredo 1972).

![Figure 2. Potential fecundity of *Thaumetopoea pinivora* as related to body size. Cocoons were sampled from the high-density year class in May 2005 at the outbreak area in Gotland, south Sweden, and moths were reared to eclosion in the laboratory.](image)

The larvae have urticating hairs about 0.1 mm in length. The hairs are situated in groups on the dorsal parts of the abdomen, as shown for *T. pityocampa* (Démolin 1963). There are no hairs present on first and second instar larvae. When the larvae are disturbed, hairs are actively released, and can cause severe allergic reactions in humans (Holm & Larsson 2006).
4. Distribution and abundance of *T. pinivora* on Gotland

The distribution of *T. pinivora* on Gotland is not known in detail. By far the highest density is found on the southernmost tip of the island (southern part of Sudret). We studied the distribution and estimated the abundance of *T. pinivora* in this area (7,000 ha), located south of the latitude 56°58′, in late May – early June 2006 at the time when the larvae were in late 2nd instar, and the needles on damaged shoots had turned yellow. We selected 1x1 km squares as our study units. Within the 7,000 ha area, 44 squares were found to host pine stands. In each of these, we selected three pine stands and systematically searched colonies for a period of 10 minutes each. We found 71% of the squares (about 3,000 ha) to have high population densities (>10 colonies found within the 30 min search) (Fig. 3).

![Map of Gotland showing distribution of Thaumetopoea pinivora](image)

**Figure 3.** The high density population of *Thaumetopoea pinivora* has a very restricted distribution on the southern tip of Gotland (the Sudret area). Our survey showed that almost all 1x1 km squares within an area of about 3,000 ha hosted *T. pinivora*, and 71% of the squares were scored as high density (>10 colonies found within a 30 min search). The southern part of the Sudret area (south of the east-west line) was systematically searched as described in the text. No stands with high densities were ever observed in the northern part of Sudret. Stands with single colonies, however, were documented at irregular visits in the northern area; these are also shown on the map.

In September 2005, a preliminary study was performed in order to estimate egg density at a high-density site in the outbreak area (almost complete defoliation in summer 2006). All egg batches were counted and their length measured, and needle biomass determined, on ten *P. sylvestris* trees (1.5-2.5 m high). Mean number of egg batches per tree was 28.9 (SE=6.39, n=10 trees). Egg batch size varied; mean batch size was 11.7 mm (SE=0.13, n=1,918). There were on average 6.64 (SE=0.16, n=30) eggs per mm batch. Many egg batches were small; 50% were smaller than the mean number of eggs in newly hatched female (cf. Fig. 2), indicating that the female divides her egg load into more than one batch. The mean total
length of egg batches was found to be 324 mm per tree. By combining this figure with the mean number of eggs per unit length of egg batch, it was estimated that the total number of larvae to hatch (assuming 80% egg survival, see below) was 1,721 larvae per tree. This figure indicated complete defoliation during the following summer, which was indeed the case (Fig. 4).

Figure 4. The highest populations of Thaumetopoea pinivora were found in Scots pine stands of low density on poor soils. In 2006, some of these stands were completely defoliated of their mature needles. The green in the foreground is juniper (Juniperus communis), not attacked by T. pinivora larvae.

There are no long-term data on T. pinivora density for the Sudret population. The high larval density that was recorded in 2006 is probably exceptional. The species has certainly been present on Gotland for many decades, but never at the present high densities. Based on observations made by the local residents it appears that the population build-up started in 2002 (Tommy Sjögren, pers. com.). It is unknown why T. pinivora presently occurs at such high density. Presumably, the population escaped from controlling factors, but no strong control agent acting in a density-dependent way has been identified. A tachinid fly (Blondelia nigripes Fallén) is present in the population, but no precise data on degree of parasitism are available. Surprisingly, no egg parasitoids have been observed; in T. pityocampa egg parasitoids are common and are thought to be important in controlling the population dynamics (Masutti & Battisti 1990). Ongoing population studies aim at identifying the factors that determine the limited spatial distribution of T. pinivora on Gotland and disentangle factor(s) that control the temporal dynamics of the Sudret population.
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6. References


