

## Caterpillars overwintering on spruce roost near their food

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### Abstract

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We studied roosting positions of caterpillars of five cryptically coloured moth species (Lepidoptera, Geometridae: *Thera variata*, *Pungeleria capreolaria*, *Peribatodes secundarius*, *Hylaea fasciaria* and *Alcis repandata*) during winter 2006/2007 (November–April). The separate caterpillars were bred in outdoor conditions, placed in transparent plastic vials (60 ml), each containing a dry and a green spruce twig. We observed the place where the caterpillars roosted during the day. We found caterpillars of all species roosting on green twigs of their host plant, in most cases stretched along a single needle (in direct contact with the source of food). This position allowed them to use effectively short periods in winter, with favourable conditions for feeding, and it also allowed them to use their cryptic colouring and shape in avoiding the predators.

### Key words

behaviour, caterpillars, Lepidoptera, Norway spruce, roosting positions, winter

### Introduction

In most insect species is supposed that they are inactive during winter and that they spend adverse weather periods in specific shelters. During winter are the predators limited only to visually orientating insectivorous birds noticeably reducing insect populations on spruce branches (JANSSON and VON BROMSSEN, 1981).

Some of the insect species are able to feed during warmer winter periods (TAUBER et al., 1986; MAJERUS, 2002). This was also proved in some species of spruce caterpillars (VARGOVÁ and KULFAN, 2007).

The aim of our study was to find where roosted caterpillars of selected Lepidoptera species feeding on spruce that are active during the winter (VARGOVÁ and KULFAN, 2007).

### Material and methods

Our observations were focused on cryptic caterpillars of five Lepidoptera species of the family Geometridae.

These caterpillars are free-living, feeding on spruce needles, and they overwinter in larval stage (PATOČKA et al., 1960; KULFAN, 1995).

The caterpillars of *Thera variata* (Den. & Schiff., 1775) (Fig 1) and *Pungeleria capreolaria* (Den. & Schiff., 1775) (Fig 2) are green-coloured with bright-white longitudinal stripes. We made 138 observations of caterpillars of *T. variata* (n = 4) and 322 observations of *P. capreolaria* (n = 12). The initial size of the observed individuals of both species was about 9 mm, whereas in their last instar they reached a length of 20–25 mm and 25–28 mm, respectively (PATOČKA et al., 1960).

The caterpillars of *Peribatodes secundarius* (Den. & Schiff., 1775) (Fig 3), *Hylaea fasciaria* (Linnaeus, 1758) (Fig 4) and *Alcis repandata* (Linnaeus, 1758) (Fig 5) are brown-coloured. We made 331 observations of *P. secundarius* (n = 12), 33 observations of *H. fasciaria* (n = 1) and 166 observations of *A. repandata* (n = 4). The initial size of *P. secundarius* and *A. repandata* was about 11 mm, whereas both species are in the last instar 25–30 mm long (PATOČKA et al., 1960). The initial

length of *H. fasciaria* was 14 mm. In the last instar this species reached 25–30 mm (PATOČKA et al., 1960).

The caterpillars used in our study were obtained by beating spruce branches in the Veporské vrchy hills and Poľana Mts (central Slovakia, 800–950 m asl), in autumn 2006. After being transported to the laboratory, they were identified and put into glass jars with fresh food. At the beginning of November, we measured the length of caterpillars. Then the separate caterpillars were placed in transparent plastic vials (60 ml). Each vial was provided with a fresh green spruce twig and a dry spruce twig without needles. The vials were put in the external environment (natural conditions – temperature and photoperiod). The place was shaded from direct solar radiation. The temperature inside the vials was the same as the air temperature.

The roosting positions of individuals were observed always at 10 am, 3 times a week (intervals of 2–3 days), from November 2006 to April 2007. We recorded the background preferred by the caterpillars for roosting: either green (1) or dry (2) twig of Norway spruce. When they roosted on the green twig, we recorded whether they were (a) stretched along a single needle, (b) stretched from one needle to another, (c) stretched from a needle to the sprig or (d) stretched on the sprig.

During our experiment, the caterpillars of the observed species were active for most of the days. Their feeding activity was deduced from presence of their droppings.

### Data analysis

We supposed that if the caterpillars select places for roosting randomly, the number of the observed situations in each category should be the same. It means that the number of cases when caterpillars roost on green twigs should be the same as on dry twigs. The same should also hold for the four positions of caterpillars roosting on green twigs. We tested this hypothesis by using  $\chi^2$  test (ZAR, 1984) comparing between the expected number of events and the number of the events observed.

### Results

We made a total of 990 observations on 33 individuals belonging to 5 species of the family Geometridae.

Caterpillars of all five species roosted on green twigs exclusively, that means very close to their food source. We did not observe roosting on dry twigs. The



Fig 1. *Thera variata*



Fig 2. *Pungeleria capreolaria*



Fig 3. *Peribatodes secundarius*



Fig 4. *Hylaea fasciaria*



Fig 5. *Alcis repandata*

caterpillars did not select their roosting places on green twigs randomly (*P. capreolaria*:  $\chi^2 = 329.1$ , *T. variata*:  $\chi^2 = 271.4$ , *P. secundarius*:  $\chi^2 = 30.1$ , *H. fasciaria*:  $\chi^2 = 22.2$ , *A. repandata*: 166.7;  $p < 0.001$  for each species).

Both green-coloured caterpillar species mimicking spruce needles (*P. capreolaria* and *T. variata*) roosted in most cases stretched along a single green needle (in 68.3% or 85.5%, respectively).

The brown-coloured caterpillars of *A. repandata* and *H. fasciaria* roosted stretched on a single needle in 66.3% and 57.6% of observations, respectively. Caterpillars of *H. fasciaria* often roosted also on the brown central sprigs (27.2% of observations) that they imitated by the colour of their body and also by the structure of their skin. *P. secundarius* did not manifest such differences among roosting positions as the other species. The caterpillars of this species usually roosted stretched between two green needles (34.7% of observations) (Fig 6). Interesting was also their roosting position, recorded in 16% of our observations: the caterpillars roosted fastened with their prolegs to the terminal parts of needles, making an angle of 45° with the needle axis. In other species, we did not notice such a case.

## Discussion

Spruce, as a host plant, provides caterpillars (and also other herbivores) with an important advantage: the needles represent an available source of food also during the winter. Caterpillars feeding on assimilatory organs of deciduous trees also overwinter in litter (PATOČKA et al., 1999). The spruce caterpillars observed in this study fed on needles also during warmer periods in winter (VARGOVÁ and KULFAN, 2007), which allowed them to shorten their spring development and, consequently, to avoid the pressure of predators elevated during their last instar (VARGOVÁ and KULFAN, 2008).

We observed that caterpillars of the five studied species of the family Geometridae roosted during the winter period on the green spruce twigs with sufficient

food supply. This behaviour has the following benefits: (1) caterpillars do not have to waste energy for moving to the food, (2) reduced risk of predation during moving between the roosting place and the place where they feed (BETTS, 1955; BERGELSON and LAWTON, 1988; HEINRICH, 1993; BERNAYS, 1997).

The caterpillars of the studied species in winter generally do not reach the needle length. The caterpillars that we studied often roosted stretched along a single needle. This position has some advantages: (1) the caterpillar is in direct contact with the food source, (2) the whole abdominal part of caterpillar is mechanically protected by the needle, (3) contact with the needle inhibits sudden fluctuation of body temperature in the caterpillar.

Caterpillars associated with spruce have been adapted to the environment in which their host plant grows naturally, that means an environment with occurrence short periods suitable for the insect development. In these conditions, the caterpillars take advantage from roosting near the food source (on green spruce twigs). They also make use of their crypticity (mimicking a green needle, dry needle or a brown sprig) as a defence against predators.

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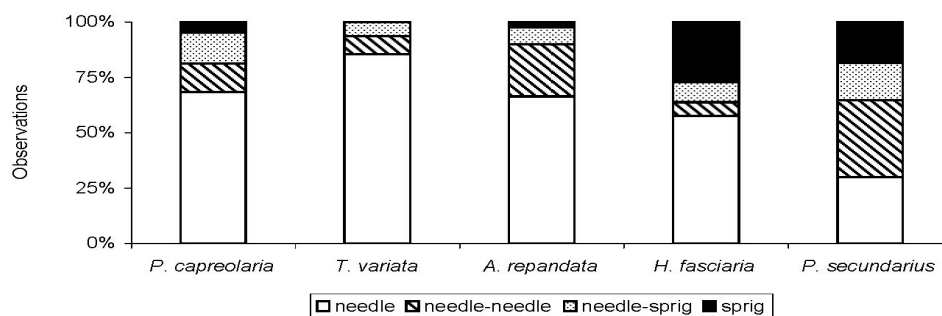


Fig 6. Position of five overwintering species of caterpillars on green spruce twigs during their roosting

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## Húsenice zimujúce na smreku odpočívajú v blízkosti svojej potravy

### Súhrn

Húsenice viazané svojím vývinom na smrek sú adaptované na podmienky, v ktorých sa táto drevina prirodzene vyskytuje, t. j. na miesta s krátkymi časovými periódami vhodnými pre vývin hmyzu. Niektoré druhy húseníc aktívne prijímajú potravu aj počas zimného obdobia, preto je miesto ich odpočívania pre ne strategicky dôležité. Počas zimného obdobia (november 2006 – Apríl 2007) sme chovali húsenice 5 druhov motýľov (Lepidoptera, Geometridae: *Thera variata*, *Pungeleria capreolaria*, *Peribatodes secundarius*, *Hylaea fasciaria* a *Alcis repandata*) vo vonkajšom prostredí v prirodzených teplotných a svetelných (fotoperióda) podmienkach. Húsenice boli umiestnené individuálne v 60 ml plastových transparentných nádobkách, kde mali k dispozícii suchú (bez ihlíc) a čerstvú (so zelenými ihlicami) vetvičku smreka. Zaznamenávali sme miesto, kde húsenice počas dňa odpočívali. Zistili sme, že húsenice všetkých druhov odpočívali na zelenej vetvičke hostiteľskej rastliny, t.j. priamo pri zdroji svojej potravy. Táto stratégia im umožňuje efektívne využívať obdobia s vhodnými podmienkami pre príjem potravy a zároveň využívať svoje krytické sfarbenie a tvar (napodobňovanie zelenej ihlice, suchej ihlice alebo hnedého konárika) na ochranu pred predátormi.

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