

Notes on the larval biology of *Xestia borealis* (Lepidoptera: Noctuidae)

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Observations on a larva of *Xestia borealis* found in nature are presented. Our findings support the view that the species has a two-year life cycle with two obligatory winter diapauses. Like *Xestia sincera*, *X. borealis* seems to prefer buds and fresh shoots of spruce in its diet. Both species overwinter for the first time as large III–IV instar larvae, after overwintering rapidly complete their larval development, and subsequently fall into a long summer diapause. We also discuss some features of larval biology of other boreal *Xestia* species with a two-year life cycle.

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1. Introduction

Xestia (Anomogyna) borealis (Nordström, 1933) is distributed in the boreoalpine parts of Eurasia (Mikkola & Jalas 1977, Skou 1991). In Fennoscandia, it occurs in old-growth spruce forests of the Scandinavian Mountains (350 m a.s.l. upwards) as well as in similar habitats of lowland taiga forest in northern and northeastern Finland (Sommerma 1997). The species is known from a few localities in the whole world, and it seldom occurs in large numbers. Nonetheless, in Siberia, *X. borealis* is relatively common in the mountains south and east of Lake Baikal (K. Mikkola pers. comm.).

Xestia borealis belongs to the boreal *Xestia* species with alternate-year flight (Mikkola 1976). In the Scandinavian Mountains and in western Finnish Lapland, its flight years are mostly (Mikkola 1976, Imby & Palmqvist 1978) but not

always (Palmqvist 1996) the even years, while in eastern Finnish Lapland the odd years (Mikkola 1976, Ahola & Várkonyi unpubl.).

The natural history basis of periodic occurrence of *Xestia* moths in the subgenera *Anomogyna* and *Pachnobia* is fixed two-year development with two larval winter diapauses (Mikkola 1976, Lafontaine *et al.* 1987, Várkonyi *et al.* in prep.). In nature, larvae of periodic *Xestia* species overwinter the first time in I–IV instar (*see below*; Várkonyi *et al.* in prep.). *Ex ovo* rearings show, however, that the first winter diapause is not strictly obligatory (Ahola unpubl.), but is rather a result of the inability of the larva to reach maturity in a single season (Lafontaine *et al.* 1987). In turn, the second larval winter diapause in V (final) instar is obligatory for successful pupation (Lafontaine *et al.* 1987, Várkonyi *et al.* in prep.).

Since *Xestia borealis* is fairly rare and because

its known habitats are out of reach for most lepidopterologists, the biology of the species has remained almost fully unknown. This is particularly emphasized in case of immature stages, as there is only one known observation on a larva in nature (Zolotareno 1970) and two observations on adult females laying her eggs (Imby & Palmqvist 1978, Skou 1991).

Lepidopterologists in the Nordic countries have several times successfully reared larvae from eggs that were laid by captured females of *X. borealis*. In the rearings, larvae were fed by beard lichen (*Usnea*) (Somerma 1997) and leaves of various plants, e.g. bilberry (*Vaccinium myrtillus*) (Skou 1991), larch (*Larix decidua*) (H. Lonka pers. comm.) and aspen (*Populus tremula*) (Zolotareno 1970).

We here present new data on larval diet and life cycle of *Xestia borealis* as well as compare these features with the natural history of congeneric species.

2. Observations on a larva of *Xestia borealis*

A fourth instar larva of *Xestia borealis* was found on a low branch of a large spruce tree (*Picea abies*) on 14 June 1998 at 1600 hours in Värriö region, eastern Finnish Lapland (Ks: Salla, 7520:610, leg. J. Karhunen & G. Várkonyi). The identification has been confirmed by the second author on the basis of morphological characteristics of the larval head. The larva was sitting approx. 1.5 m above ground level, near to the top buds of the branch. The host tree was situated on a steep slope in a spruce-dominated forest strip along a small streamlet. In the previous years, two larvae of *Xestia sincera* had been found in other spruce trees in the very vicinity (see e.g. Itämies *et al.* 1996). *Xestia borealis* imagines had already been observed in the area and even caught by a light trap (Itämies & Pulliainen in prep.).

The larva was reared outdoors in the nearby research station until the next winter. The larva was kept in \pm natural temperature and fed with fresh food collected around the finding place. The larva was offered buds of bilberry and spruce, and it first preferred bilberry but ate also spruce. When the buds of bilberry had opened, it ate only buds

and newly opened shoots of spruce. It grew quickly and became full-grown V instar larva by 5 July — after that it ate and moved hardly at all. Obviously it had fallen into diapause. This stage lasted until early September, when the larva ate a bit again. Then it continued its diapause, but did not survive the subsequent winter.

3. Evidence of larval biology of *Xestia borealis*

These data clarify our knowledge about some features of the larval biology of *Xestia borealis*. Firstly, the species has a two-year life cycle with two larval winter diapauses, since (a) the larva was found in IV instar one week after the continuous snow cover had melted, and (b) it fell into diapause after reaching its full size without any sign of preparing itself for pupating before the following winter. This result is consistent with Zolotareno's (1970) findings: that larva overwintered successfully (for the second time) and pupated in the following May. This is the common life cycle pattern in the boreal *Xestia* species with alternate-year flight. *Xestia borealis* has also been suggested to follow this pattern (Imby & Palmqvist 1978), obviously because of its alternate-year flight pattern. However, this is the first indication of two-year life cycle in *X. borealis* based on larval biology.

Secondly, the larva overwintered for the first time in (III–)IV instar. So far only *Xestia sincera* and *X. gelida* (Várkonyi & Ahola unpubl.) have been known to do so, while other Fennoscandian species in the subgenera *Anomogyna* and *Pachnobia*, including at least *X. alpicola*, *X. laetabilis*, *X. rhaetica*, *X. speciosa* and *X. tecta*, spend their first winter in the I or II instar (Várkonyi & Ahola unpubl.).

Thirdly, the larva ate mainly buds of spruce like larvae of *Xestia sincera* (see Itämies *et al.* 1996) after their first winter diapause. Zolotareno's (1970) observation on a *X. borealis* larva, feeding on aspen, has been made on a clear-cut, surrounded by fir (*Abies*) forest, i.e. not exactly in the natural habitat of the species. Our observation shows that the larvae may favour a spruce diet after the first winter diapause. However, the host plant of the small larva before the first winter diapause still remains un-

known.

Fourthly, the larva fell into a long summer diapause after becoming fully-grown. Similar behaviour is typical for *Xestia sincera* (N. Hydén pers. comm.). Periodic boreal *Xestia* species that overwinter the first time in I or II instar (*see above*), reach their full size later in the summer, and keep feeding until their second winter diapause (Várkonyi & Ahola unpubl.).

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