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# EFFECT OF DEFOLIATION ON PINE LOOPER (*Bupalus piniarius* L.) POPULATION DYNAMICS

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**Introduction.** The pine looper (*Bupalus piniarius* L.) is one of the most harmful defoliating insects on Scots pine. During outbreaks trees are often completely defoliated. In general, leaves on defoliated trees often differ in biochemical composition compared with leaves on non-defoliated trees (Karban & Baldwin, 1997). Thus, future generations of insects feeding on defoliated trees may suffer higher mortality, slower growth or reduced fecundity than conspecifics feeding on non-defoliated trees (Haukioja, 1990). The pine looper shows strong preference for mature needles as food and egg-laying substrate. We, therefore, hypothesized that current-year needles are suboptimal food for pine looper. Pine looper larvae feeding on previously defoliated trees may show lower performance either because of induced resistance or because larvae have to feed on suboptimal food (current instead of mature needles). In addition, female realised fecundity may be reduced in the absence of the preferred substrate for oviposition, i.e. mature needles.

**Methods.** The study was conducted at Hökenås in southern Sweden where an extensive outbreak of *B. piniarius* occurred in 1996. Larval performance was studied in an experiment where larvae were reared on (*i*) shoots naturally defoliated the previous year, and thus, bearing only current-year needles – defoliated treatment, (*ii*) non-defoliated shoots where larvae had access only to current-year needles – limited access treatment, and (*iii*) control shoots with access to both current and mature needles – control treatment. The experiment was carried out outdoors protected from direct sunlight. Larvae were monitored from hatching until III-IV instar (the experiment was terminated on August 15). Larval survival and relative growth rate were measured. Effect of defoliation on realised fecundity was studied in an experiment carried out in a climate room at 20°C, 20/4 light regime, and ~70% humidity. Pupae were separated in weight classes in 5 mg increments. Two treatments were assigned – current-year needles, where females had access only to current-year needles, and control treatment where females had access to both current-year and mature needles. Number of realized eggs were counted daily. Potential fecundity was estimated by dissecting newly emerged females. Only eggs with at least some yolk deposition were counted. Survival of eggs on current-year needles and on mature needles were followed outdoors.

**Results**. There was no support for the induction hypothesis. Larval survival was lower on naturally defoliated shoots than on control shoots (81.3% vs 90.9), but survival was lower also on non-defoliated shoots where larvae had access only to current-year needles (78.8%) (Fig.1). There were significant differences between control and both defoliated and limited access treatments, but no significant difference between defoliated and limited access treatments. Main larval mortality appeared in the first week of development. Needle nitrogen concentration of current-year needles was 38% higher on defoliated trees than on non-defoliated trees. There was a strong correlation between pupal weight and female realised fecundity. There were highly significant differences in realized frcundity between the two treatments current-year needles and control branches (both current-year and mature needles

present). Females with access only to current year needles realised 15.4 % less eggs than females on control branches (Fig.2). In the outdoor experiment, 26.7% of eggs laid on current year needles were lost during the three weeks of egg development. Eggs fall down due to needle elongation and unusual placement of eggs (scales on needle bases).

**Discussion.** The success of larval survival on current-year needles was significantly lower than on control branches. However, total mortality was low also in the defoliated treatment and it is unlikely that it can be significant in terms of population dynamics. We did not find any support for hypotheses of induced host plant response. However, it is possible that any negative effect was ameliorated by increased nutritional quality of needles from defoliated trees. We conclud that larvae suffer more from feeding on suboptimal food (current-year needles) than from induced effect. It seems as if defoliation has larger effects on *B. piniarius* realised fecundity. It is possible that there has been selection for a behavior to discriminate against current-year needles because many eggs on these needles are lost.

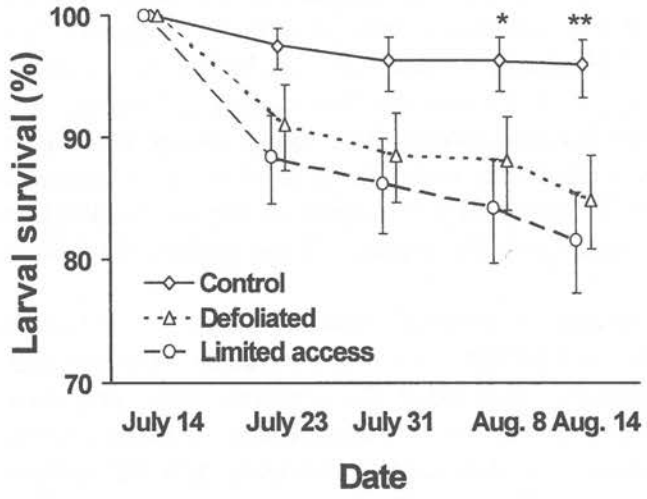


**Fig. 1.** Survival of young larvae of *Bupalus piniarius* raised on different types of *Pinus sylvestris* needles: control - both current-year and mature needles present, limited access - only current-year needles, mature needles removed prior to the experiment, defoliated -only current-year needles, natural defoliation of mature needles in the previous season. On August 14, larvae were in instar III-IV. Error bars represent standard errors. * and ** represent significant differences among treatments - $P<0.05$ and $P<0.01$ respectively.

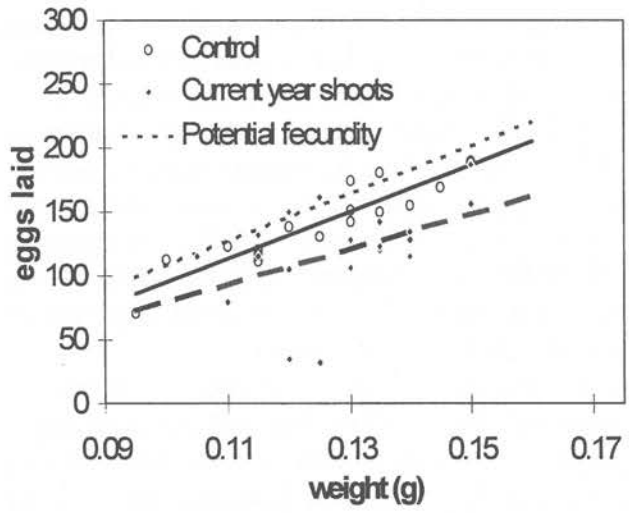


**Fig. 2.** *Bupalus piniarius* realised fecundity on current-year and mature needles. Potential fecundity corresponds to number of eggs with at least partial yolk deposition after emergence. Weight corresponds to pupal weight from which females emerge.

**References.**

1. Karban, R. & Baldwin I.T. (1997) *Induced Responses to Herbivory*. The University of Chicago Press, Chicago.
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