Effect of Temperature on Termination of Diapause in Larvae of *Laspeyresia strobilella* (L.) (Lep., Tortricidae)

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Abstract

Diapausing larvae of *Laspeyresia strobilella* from cones of *Picea abies* were kept individually in glass tubes. Parts of the material were stored under outdoor conditions and transferred to 22°C at different dates during the winter. Others were kept at different constant temperatures from October. In October diapause was determined in 10% and in December in the entire population of larvae stored outdoors. The time required for termination varied considerably within the population in late fall, whereas the population was homogeneous concerning this characteristic in early spring. Only a few larvae kept at 18° and 22°C constant temperature terminated the diapause, whereas all, except those which were sick or in prolonged diapause, terminated at 15°, 12°, and 9°C after varying periods of time.

Introduction

*Laspeyresia strobilella* is one of the most serious seed-destroying insects in cones of Norway spruce in Europe. Flight and oviposition take place during the pollination period when the scales of the young cones are open (Bakke, 1963). The duration of this period is about a week, and the life span of the moth is only 3-4 days. A successful regeneration of the species depends, therefore, on synchronisation of the moth's flight period with the pollination period of spruce.

The synchronisation has been obtained by the development of a diapause mechanism. When the larvae are full-grown in July-August, they enter a diapause which suppresses further development during the fall and leads to pupation in spring and emergence of the moths when the spruce starts pollinating. Parts of the population enter a prolonged diapause with suppressed development for a year or more.

Even if the general features of the life cycle are known, no information has been published on the time in winter when diapause is terminated, and the temperature conditions which are necessary to terminate the diapause.

Material and methods

Cones of Norway spruce (*Picea abies*) from the 1967 and 1968 production infested with larvae of *Laspeyresia strobilella*, were collected in Flesburg, county of Buskerud in South-Norway in September 1968. At the laboratory the cones were opened and the larvae transferred individually to small glass tubes. They were gathered in groups of 100 larvae (from 1968 cones) or 50 larvae (from 1967 cones).

Nine groups of the 1968-larvae were handled in the same way and transferred to cabinets with the following constant temperatures: 31°, 28°, 25°, 22°, 20°, 18°, 15°, 12°, and 9° C.

On 4 Oct. five groups of the 1968-larvae were placed separately in cabinets, with constant temperature of 22°, 18°, 15°, 12°, and 9° C.

On 1 March when the diapause was terminated in larvae kept outdoors, 10 groups of the 1968-larvae were transferred to cabinets with the following constant temperatures: 31°, 28°,

Fig. 1. Progress of pupation when groups of 100 larvae of Laspeyresia strobilella of last summer's production were transferred from outdoor to indoor conditions (22°C) at different dates during the winter.

25°, 22°, 18°, 15°, 12°, 9°, 6°, and 4° C.

The larvae were kept in darkness outdoors as well as in the laboratory. In the laboratory each larva was continuously observed and the date of pupation noted. Total number of larvae used in the experiment was 2750.

Results

Termination of diapause under natural winter conditions

The progress of pupation in larvae transferred to 22°C at different dates during the winter, varied considerably (Figs. 1 and 2). Only a few larvae of those exposed to outdoors temperatures until October were able to pupate, whereas pupation took place in a relatively large number of the larvae transferred to the laboratory later in the season. Some larvae did not pupate even in spring. They were either in prolonged diapause or killed by parasites or other mortality factors.

There were only small deviations in ability to pupate at various dates between larvae which had undergone prolonged diapause (Fig. 2) and those from last summer's production (Fig. 1).

The pupation progress described in Fig. 1 can be analysed with regard to two factors: the ability to pupate, and the time required before pupation takes place.

In the population from last summer (1968) about 65-70% of the larvae were able to pupate. The others were attacked by parasites and diseases or in a prolonged diapause, and can not be accounted for. The percentage of larvae able to pupate at various dates is demonstrated in Fig. 3. In October diapause was terminated in only 10%. The percentage increased during November, and in December the entire population pupated.

The number of days required, from the larvae were brought into the laboratory until pupation, varied considerably. In March all larvae had pupated after 7 days whereas 33 days were necessary in December. The differences will appear more clearly if we consider the period when 50% of the larvae had pupated. Sick or prolonged-diapausing larvae are