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156

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Spear-Marked Black Moth

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The spear-marked black moth, *Rheumaptera hastata* (L.) (Lepidoptera: Geometridae) is a serious defoliator of paper birch *(Betula papyrifera* Marsh.) in interior Alaska. Epidemic populations have occurred at 15- to 17-year intervals, persisted for 2 years, and then collapsed. Recorded outbreaks occurred in 1941, acreage unknown; from 1957 to 1958, 5 million acres (2 million hectares) were attacked; and from 1974 to 1975, 2.5 million acres (1 million hectares) were affected. The areas of Alaska infested by the moth have traditionally extended from Tok (near the Canadian boundary) west to Ruby on the Yukon River, and from Fairbanks south to Talkeetna.

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The insect is circumpolar in distribution and is particularly widespread in North America, occurring from Alaska east to Labrador and Newfoundland and south to northern California, New Mexico, and North Carolina (fig. 1).

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Figure 1. — Distribution of the spear-marked black moth in North America.

Hosts

Paper birch is the preferred host in Alaska, but larvae also feed on species of alder *(Alnus)*, willow *(Salix)*, and rose *(Rosa)*. Although interior Alaska hardwood forests are composed primarily of paper birch, quaking aspen *(Populus tremuloides* Michx.), and balsam poplar *(P. balsamifera* L.), the latter two species are completely avoided by *R. hastata* larvae. In Canada, the insect also feeds on sweetgale *(Myrica)*.

Larvae of this geometrid (looper) feed predominantly on the upper layers of leaf tissue (fig. 2). Early feeding is often inconspicuous because the larvae feed within enclosures formed by leaf rollers or within two leaves webbed together in a sandwich-type enclosure. Defoliation is evident by early August when damaged leaves remaining on the tree begin to turn brown. Residents of interior Alaska often think the browning is early development of fall leaf coloration.

Tree mortality has not been reported from past epidemics, primarily because the epidemics collapsed after two growing seasons. However, radial and terminal growth is substantially reduced, spring bud development is delayed 2 to 3 weeks on previously defoliated trees, and branch dieback is quite common.

Description

The adult is a black moth with white markings on the wings and body (fig. 3). Many combinations of the two colors are found in Alaska, but adults usually have a white spear-shaped marking on the fore- and hind-wings. The head, thorax, abdomen, and legs are black with scattered white scales. All specimens found in Alaska during the recent outbreak had a white spear-shaped marking as part of the white band on the forewings and usually on the hindwings. Adults are 0.35 to 0.45 inch (9 to 11.5 mm) in length, with a wingspread of 1.0 to 1.2 inches (26 to 30.5 mm).

Field identification of male and female adults can be made by examining the terminal abdominal segments. In males, the last visible terminal abdominal segment, the eighth, appears elongated and is bisected in a dorsal-ventral plane. This segment encloses the ninth and tenth genital segments. The seventh abdominal segment is the last visible segment in fe-

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Figure 2.— Birch leaf (top) and forest (bottom) defoliated by spear-marked black moth larvae.

male adults and encloses the eighth, ninth, and tenth genital segments. The valvulae of the ovipositor can often be seen extruding from the seventh abdominal segment. Slight pressure with the

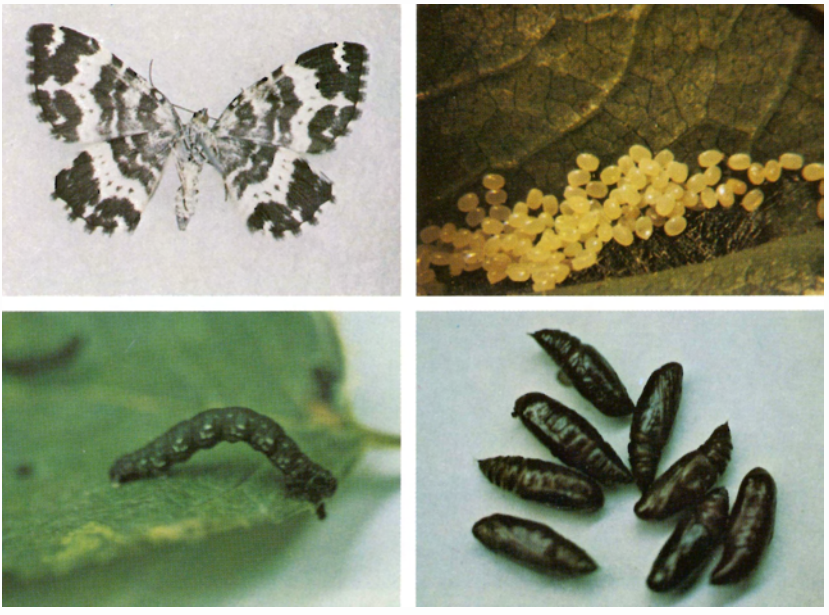

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Figure 3. — Life stages of the spear-marked black moth: top left, adult; top right, eggs; bottom left, fourth instar larva; bottom right, pupae.

fingers on the last visible abdominal segments of both sexes will reveal the normally retracted genital segments.

Eggs are oblong, flat, yellowish white, and about 0.01 to 0.02 inch (0.50 mm) wide by 0.03 inch (0.75 mm) long. Color changes from white immediately after oviposition to a yellowish white 1 hour later. The dark body and head of the first instar larva are readily visible inside the egg shell prior to hatching.

During larval development, the larval head is colored shades of brown, but body color varies. The thoracic legs of each instar are the same color as the body, but the ventral and anal prolegs are light brown in all instars. Newly hatched larvae are 0.09 inch (2.5 mm) long and have grayish-green bodies and light-brown heads. As larvae advance into the second and third instars, the body turns black. The third and fourth instars have a whitish-pink spiracular spot on each body segment. In addition, the third instar usually has two rows of white spots along the side area of each segment, but some larvae were found to have four rows of spots. Mature larvae are about 0.62 inch (16 mm) long and have black bodies with a whitish-pink spiracular spot on each body segment and dark-brown heads.

Pupae are shiny brown; the anterior end is sharply rounded and the posterior end has two hooks

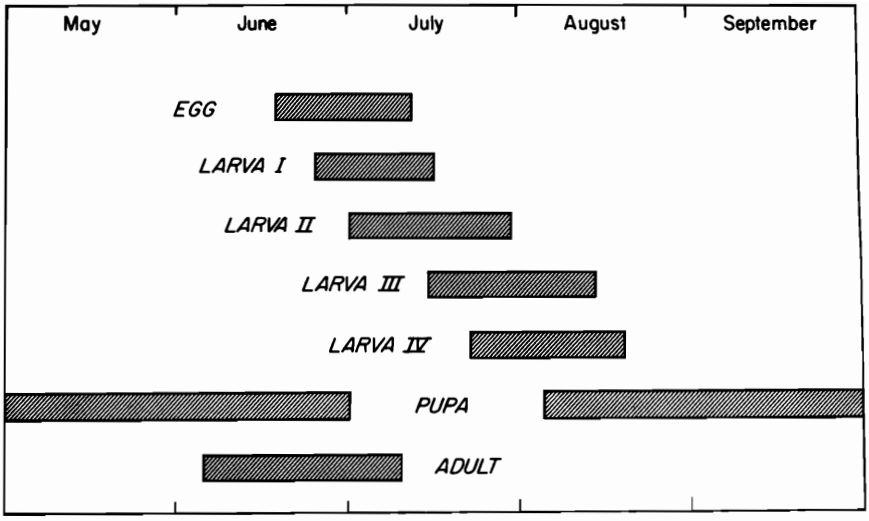

Figure 4. — Seasonal development of the spear-marked black moth in interior Alaska.

and spines. Pupae are about 0.43 inch (11 mm) long and 0.15 inch (3.5 mm) wide. Sexes can be separated by the position of the genital opening. In male pupae, the genital opening is located ventrally on the ninth abdominal segment anterior to the anal opening, located on the tenth abdominal segment. The female genital opening is located on the eighth abdominal segment anterior to the anal opening, also located on the tenth abdominal segment.

Life Cycle

The spear-marked black moth has one generation a year (fig. 4) and overwinters as a pupa. Adults appear from early June to early July and have a lifespan of 2 or 3 weeks. Following emergence, moths spend the first 3 days ingesting water and are usually found aggregated *en masse* in moist areas such as streambanks, drainage ditches, and road banks.

Females produce a sex pheromone that induces mating behavior in males. About 72 hours after emergence, mating occurs on low-growing plants within 6.5 feet (2 m) above ground level. Sex pheromone production, mating, and flight occur throughout the 22 hours of light that is present in interior Alaska in June. Within 24 hours after mating, females fly upward to the tree crowns and begin a random search for sites on which to deposit their eggs. Eggs are laid singly or more often in clusters on the upper surface of leaves or in folds of leaves that have been rolled by leaf rollers. An average of 70 eggs is laid per female over a period of 3 days. Egg laying occurs from mid-June to early July, and larval hatch begins 7 days after eggs are deposited.

Young larvae feed gregariously

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Figure 5. — Leaves webbed together to form larval feeding enclosures.

(fig. 5) between two leaves that have been webbed together to form a sandwich-type shelter or along with leaf roller larvae in rolled leaves until the third or fourth instar, when individual larvae web one or two leaves together to form a shelter.

Larvae feed on both new- and old-growth foliage of birch, alder, willow, and rose. Feeding usually is confined to the upper layers of leaf tissues, giving the leaves a lacelike appearance.

Larvae mature during the latter part of July to early August and drop to the ground on silken threads; pupation occurs in the leaf litter and is completed by late August.

Control

Parasites, predators, disease organisms, and weather are responsible for population declines of the spear-marked black moth. Six species of parasites have been reared from overwintering pupae: *Aoplus ruficeps vagans*, *Coccygomimus (=Pimpla) aquilonius aquilonius*, *Cratichneumon* sp., *Gelis* sp., *Mesochorus* sp., *Hemitelini* sp. One species was reared from mature larvae, *Meteorus niveitarsis*. Predaceous larvae of a carabid beetle, *Calosoma* sp., feed on the larval stage. Birds such as juncos, redpolls, and chickadees consume large numbers of moths. Disease organisms that infect mature larvae include a granulosis virus, a fungus, *Entomopthora* sp.; a protozoan, Microsporidia *Nosema* sp.; and several bacteria. Subfreezing temperatures prior to snowfall in September and October or a low accumulation of snow during the winter may be lethal to overwintering pupae. Deep snow insulates pupae from extremely cold air temperatures, and pupal survival increases with increased snow depth (fig. 6).

Direct control measures have not been recommended for this insect pest in Alaska. Populations usually decline within 2 years from natural causes. Spraying with chemicals is economically impractical to control epidemics that cover millions of acres of paper birch forest land receiving low-intensity management.

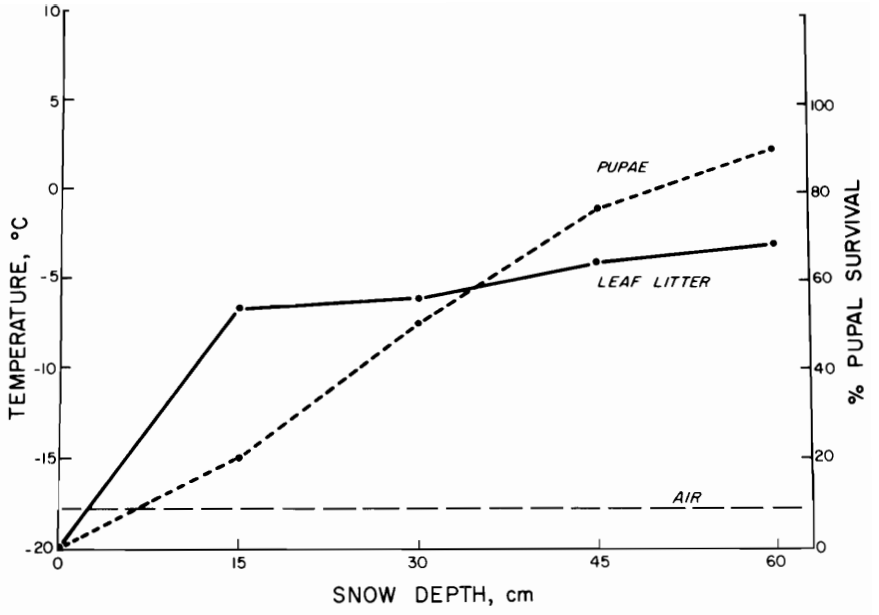

Figure 6. — The effect of snow depth on survival of overwintering pupae of the spear-marked black moth in interior Alaska.

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