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IMMATURE STAGES AND ECOLOGICAL OBSERVATIONS OF *EOPARARGYRACTIS PLEVIE* (PYRALIDAE: NYMPHULINAE)

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Eoparargyractis plevie was described by Dyar (1917) from an adult female. Lange (1956) hypothesized that the unknown larvae in this genus feed on the rock-encrusting periphyton of small lakes. Our observations from Mirror Lake, New Hampshire, indicate that, in fact, the larvae of *E. plevie* feed on several species of aquatic macrophytes.

Collections of the plant species *Lobelia dortmanna* L., *Isoetes tuckermani* A. Br., and *I. muricata* Dur. in 1974 and 1975 frequently included larvae of this species. Leaves of infested macrophytes were usually damaged, suggesting that the larvae were feeding on the macrophytes themselves, rather than on any sparse periphyton they might have supported. Behavioral observations in the laboratory confirmed this interpretation. Apparently there are no previous reports of insects feeding on these species.

The following report (1) describes the previously unknown larva and pupa of *Eoparargyractis plevie*; (2) establishes that the pupal stage is passed underwater and possesses what may be a stridulatory apparatus; (3) provides the first information on larval feeding habits in the genus; and (4) is the first discussion of insect feeding on aquatic rosette plants.

Description of Immature Stages

Larva: Head (Fig. 4C) 0.96 mm wide. Right mandible (Fig. 3C) with 5 cusps, slightly curved along outer margin and with a simple peg-like tooth basal to the first cusp. Ventral margin of mandible with a broadly produced flange having ing two setae inserted at its base, the proximal one less than ½ length of the distal. Labrum (Fig. 2) with three highly modified setae on each side of midline (Fig. 3A, 3B). Head capsule translucent yellow, pigmented black only along adfrontal region and around ocelli. Total body length 11 mm. Prothoracic coxae nearly

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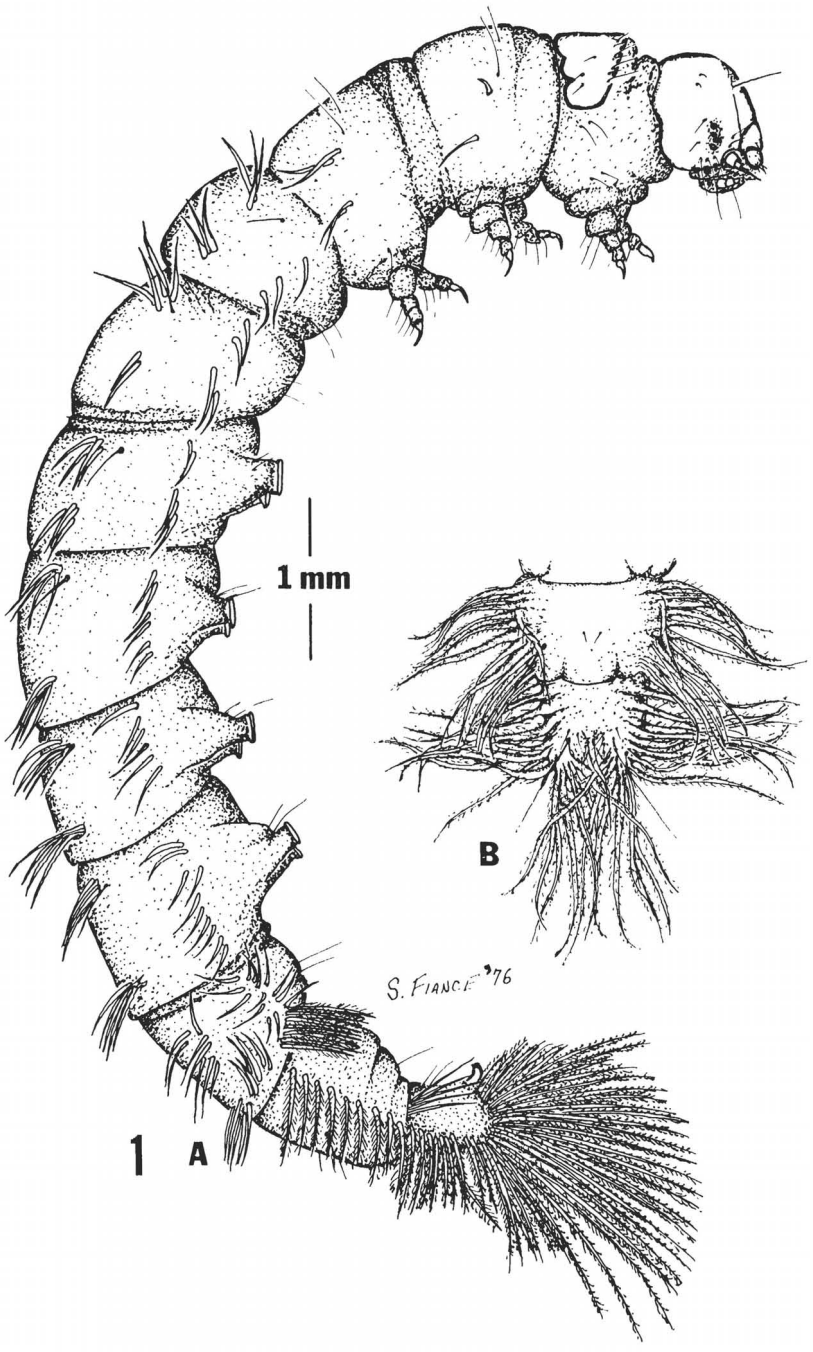


Fig. 1. Mature larva of *E. plevie*: A, habitus, lateral view; B, dorsal view of terminal abdominal segments.

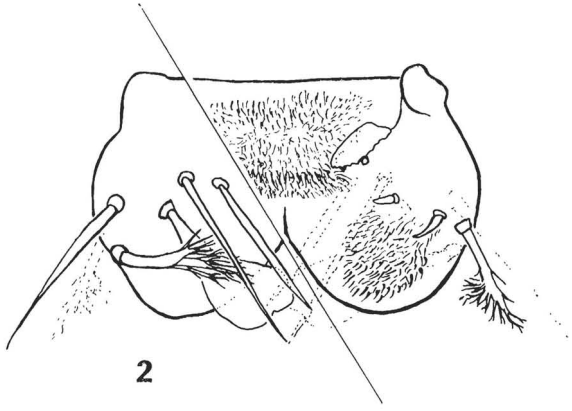


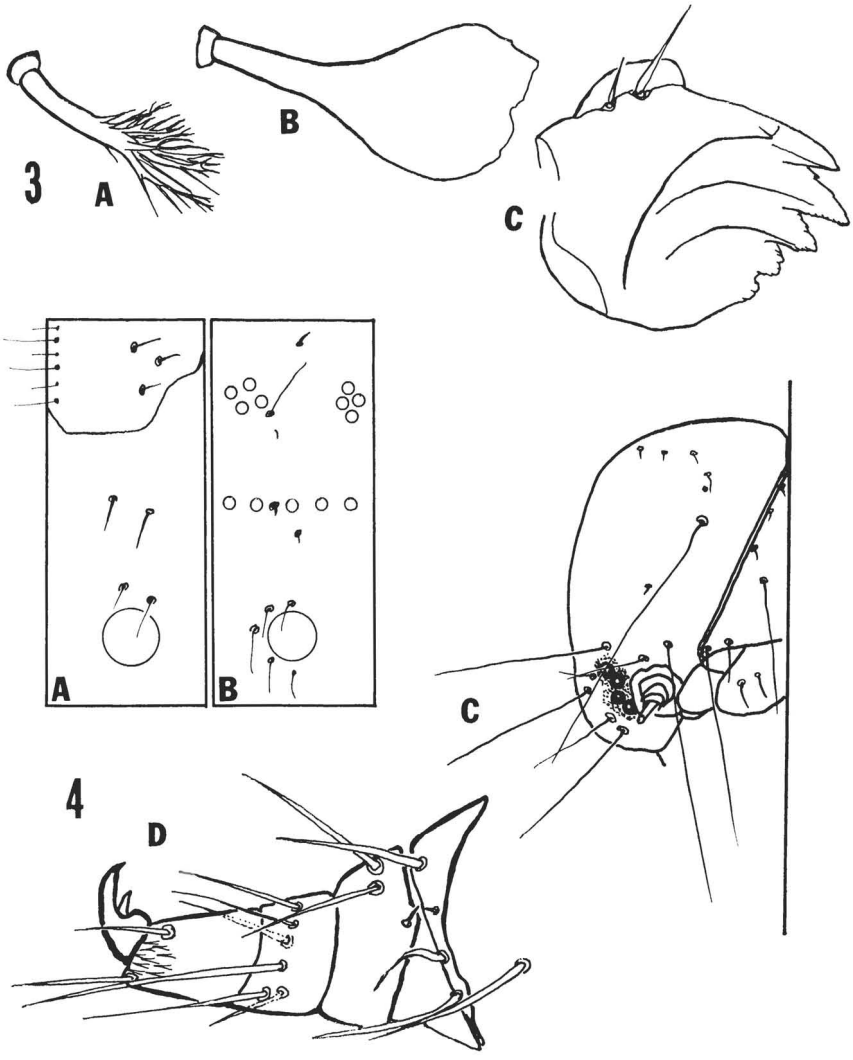
Fig. 2. Labrum of larva of *E. plevie* (outer surface to the left and inner surface to the right of diagonal line).

contiguous; metathoracic coxae widely separated. Dorsal abdominal setae ¾ to equal length of antero-dorsal abdominal gills. Integument spiculate, with coarse, very short setae arising from knob-like projections, setae becoming longer toward caudal end. Setation of head as in Fig. 4C. Integument in living condition unpigmented, light green interior showing through. Gills as in Fig. 1, unbranched with one exception, or arising from a common base, present on last two thoracic and all abdominal segments. Last gill cluster on margin of tenth abdominal segment having 5 branches. Gills variable in number and exact position, those of segments 8–10 beset with fine hairs around their entire periphery, and forming a flap-like extension of the last abdominal segment (Fig. 1B). Crochets a uniserial biordinal circle on prolegs 1–4 and a uniserial biordinal mesoseries on anal proleg. Setation of first thoracic and third abdominal segments in Figs. 4A & B respectively.

Material examined: NEW HAMPSHIRE, Grafton Co.: W. Thornton, Mirror Lake; 8 September 1975, Robert E. Moeller; 10 larvae killed immediately; same locality: 22 October, 1 larva reared, killed 11 December 1975. NEW YORK, Herkimer Co.: Webb Township, Upper Sylvan Pond; 10 June 1975, Leo M. Demong; 3 larvae. NEW YORK, Herkimer Co.: Webb Township, Panther Lake; 8 October 1975, Leo M. Demong; 2 larvae.

Pupa: Cocoon (Fig. 7) spun on leaf at rosette base (*Lobelia dortmanna*), often ornamented with bits of vegetation. Inner silken sheath complete on all sides, no gap or holes along leaf. Total length of pupa 6–7 mm. Unpigmented. Four respiratory tubercles on abdominal segments 2 & 3 (Fig. 6A). Cremaster as in Figs. 5B, 6B. Metathoracic tarsi heavily sclerotized, each bearing a long tooth at tip (Fig. 5A). Two series of raised ridges present on abdominal sternites closest to tips of metathoracic legs (Fig. 5B).

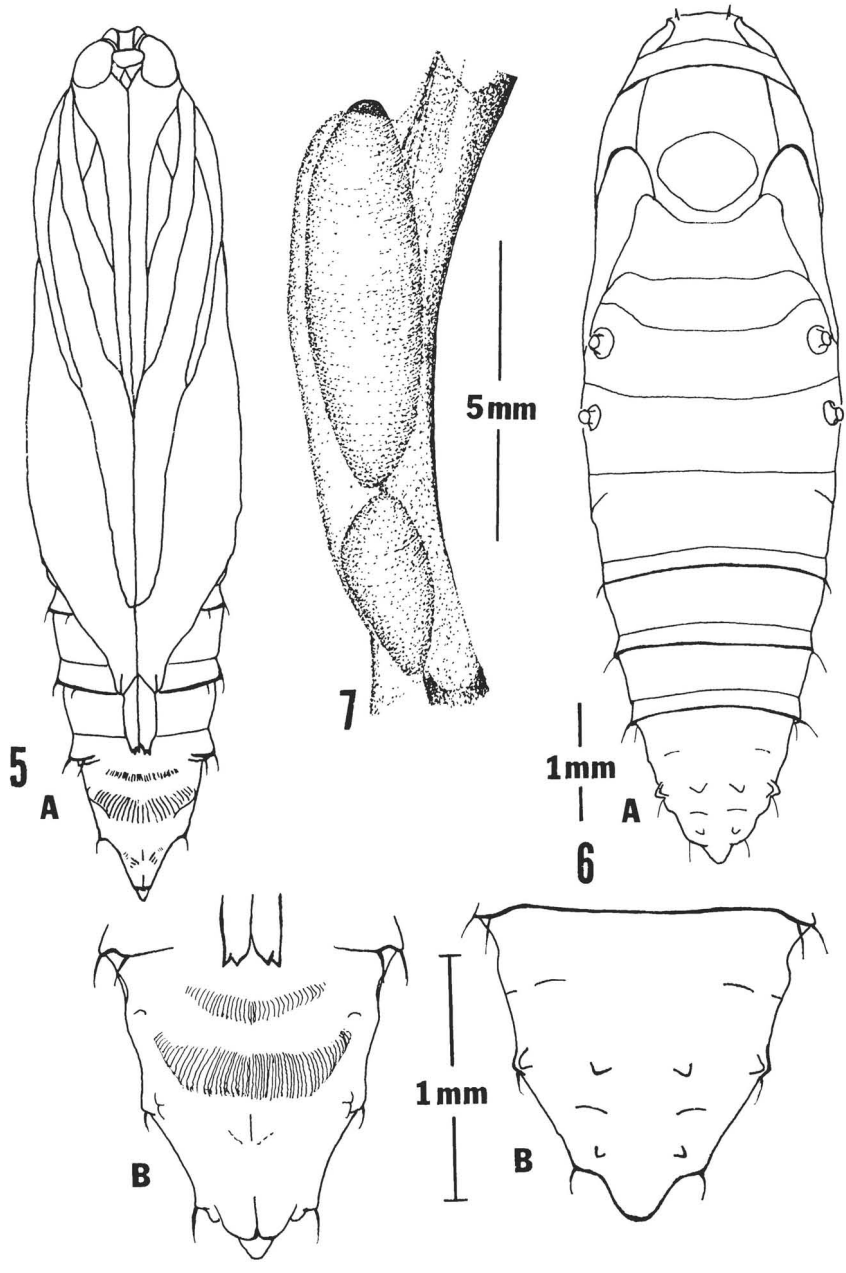
Hinton (1948) reviewed a number of mechanisms of sound production in lepidopterous pupae. He concluded that stridulation probably frightens predators and parasites, thus serving as a defense mechanism. According to Hinton, an elongated proboscis is rubbed against raised ridges of the fifth abdominal sternite producing a hissing sound in *Gangara thyrsis* F. *E. plevie* has a similar morphological arrangement (Fig. 5). Although sound production by the pupae of *E. plevie* has not been demonstrated, stridulation by this species is suggested by the two series of raised ridges on the abdominal sternites near the heavily sclerotized teeth at the tip of the metathoracic tarsi. In view of the aquatic habit of the pupae of



Figs. 3, 4. Larva of *E. plevie*: 3A & B, enlarged views of modified setae borne on labrum; C, view of inner surface of right mandible. 4, setation diagrams of first thoracic segment (A) and third abdominal segment with small circles indicating positions of gills (B); frontal view of right half of head, excluding modified setae of labrum (C); setation of left prothoracic leg (D).

E. plevie, an alternative hypothesis involving the defense of localized resources (a rosette) seems in order.

Material examined: NEW HAMPSHIRE, Grafton Co.: W. Thornton, Mirror Lake; larvae collected October and November 1975, Robert E. Moeller. Reared on *Lobelia dortmanna*, 5 cocoons recovered January 1976 containing 4 pupal exuvia, 1 pupa.



Figs. 5–7. Pupal stage of *E. plevie*: 5, ventral view of pupa, habitus (A) and cremaster (B); 6, dorsal view of pupa, habitus (A) and cremaster (B); 7, cocoon attached to leaf of *Lobelia dortmanna*, containing pupa and exuvia of last larval instar.

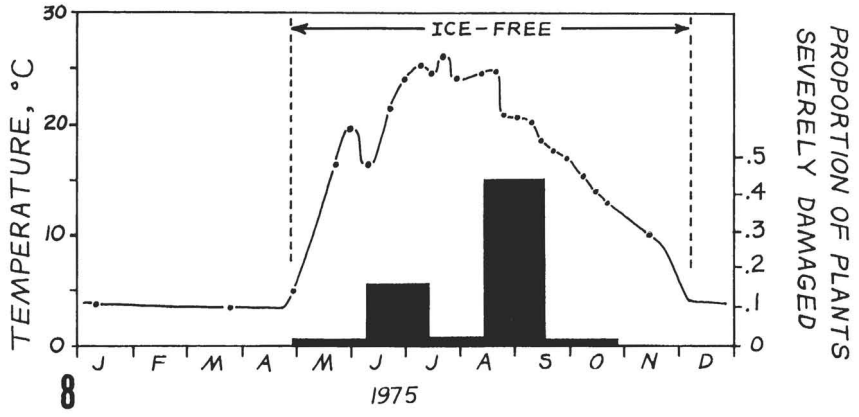


Fig. 8. Temperature during 1975 at a depth of 2 m in Mirror Lake, New Hampshire (curve) and temporal incidence of severely damaged, dead, or vanished *Lobelia dortmanna* as a proportion of the experimental population (histogram).

Distribution: Maine, Massachusetts, Nova Scotia, Quebec; NEW RECORDS from New Hampshire and New York. Larval and pupal voucher specimens are deposited at the Canadian National Collection and the Cornell University Collection.

Ecological Observations

In Mirror Lake, New Hampshire, larvae are frequently encountered during late summer on *Lobelia dortmanna*, *Isoetes tuckermani*, and *I. muricata*. These small (1–5 cm high) plants consist of a rosette of stiff, narrow leaves at the base of which the larvae construct a protective purse of silk and detritus. Larvae cut through and ingest the thin epidermis that surrounds the intercellular air spaces of the largely hollow leaves. Damage to the plant can be severe; badly injured leaves die and separate from the plant, and growing leaves may be deformed by the silken tube attachments. Defoliated plants have been encountered, as well as decayed plants that had died as a result of the defoliation. Although no more than a single larva has been found on any *Lobelia dortmanna* plant, several may occur on a single rosette of *Isoetes tuckermani*. Muskrats (Gaevskaya, 1966) and ducks (Fassett, 1969) have been reported to feed on rosette species, and muskrats occasionally feed on *L. dortmanna* and other plant species in Mirror Lake. *E. plevie* seems to be the first reported insect herbivore on these plants.

The period of most intensive feeding in Mirror Lake was estimated from a plant growth experiment carried out on *Lobelia dortmanna* during the summer of 1975. Seventy-five individual rosettes over a depth range of 0.5–1.5 m were marked, and the appearance of new leaves was followed

at 4-week intervals over the growing season (May–September). Fig. 8 (histogram) indicates the temporal incidence of severely damaged, dead, or vanished plants. Much of this mortality was due to *E. plevie*, but additional factors cannot be discounted. The early summer peak probably corresponds to feeding of late-instar larvae before pupation, and the late summer peak with feeding of the newly hatched larvae of the next generation. Although these results suggest a very great impact of the insect on the host plant population, it appears that the experimental plants suffered heavier infestation than the population as whole, perhaps as the result of greater spacing between experimental plants.

Mirror Lake contains approximately 20 species of aquatic macrophytes (Moeller, 1975). Larvae of *E. plevie* have been found on the three species already listed, and could occur on others that have been less intensively examined. They do not occur on *Utricularia purpurea* Walt., *Nuphar variegatum* Engelm., or *Nitella flexilis* (L.) Ag. The known distribution of *E. plevie* (Munroe, 1972) coincides with regions of soft-water, oligotrophic or dystrophic lakes in which *Lobelia dortmanna* and *Isoetes* species are common, and to which many of them, including *L. dortmanna*, are restricted (Fassett, 1930; Swindale & Curtis, 1957). Larvae of *E. plevie* from New York came from an oligotrophic Adirondack lake where *Isoetes* sp. is abundant. This insect's distribution may be determined by the restriction of its host plants, *Lobelia* and *Isoetes*, and possibly other rosette plants, to unproductive lakes in regions of granitic bedrock (northern New England and eastern Canada) or sandy outwash (Cape Cod and Martha's Vineyard).

Life Cycle

Larvae have been collected in Mirror Lake from August through mid-November. The absence of plant damage after the middle of September indicates that the larvae have become quiescent, but if disturbed, they will move about. Forbes (1923) described overwintering larvae in the closely related genera *Nymphula* and *Parargyractis*. *E. plevie* also overwinters as a larva. The pupal stage is passed underwater, cocoons being constructed at the bases of *Lobelia dortmanna* rosettes in laboratory-reared specimens. Pupation and emergence have not yet been observed on Mirror Lake, but the observed pattern of damage to *L. dortmanna* is consistent with the July–August flight period known elsewhere (Munroe, 1972).

Larvae collected 22 October and reared at 20–25°C on *Lobelia dortmanna* emerged 8 weeks later on about 20 December. Larvae collected 12 November emerged about 10 January, again after about 8 weeks.

These development times are consistent with a flight period of late July if the overwintering larvae resume development above a 16–18°C threshold at the end of May (Fig. 8, showing temperature at a depth of 2 m, representative of the 0.5–3 m recorded range of the insect). The absence of significant new damage to Mirror Lake *L. dortmanna* after mid-September indicates a slowdown in feeding and development below 18–20°C.

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