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**OVIPOSITION BY *DENDROSOTER PROTUBERANS* (HYMENOPTERA: BRACONIDAE) ON LARVAE OF *SCOLYTUS MULTISTRIATUS* (COLEOPTERA: SCOLYTIDAE) OCCUPIED BY LARVAE OF *ENTEDON LEUCOGRAMMA* (HYMENOPTERA: EULOPHIDAE)**

Bruce H. Kennedy<sup>1</sup>

*Dendrosoter protuberans* (Nees) was introduced into the United States from France as a possible addition to the existing spectrum of hymenopterous parasites of the smaller European elm bark beetle, *Scolytus multistriatus* (Marsham). *D. protuberans* is an external parasite; it oviposits through bark onto or next to late-instar larvae of *S. multistriatus* (Kennedy 1970) (Fig. 1).

The biology of *Entedon leucogramma* Ratzeburg has been described by Beaver (1966). *E. leucogramma* is an endoparasite of *S. multistriatus*. The female of *E. leucogramma* enters the egg gallery as it is being developed by the female bark beetle and oviposits in newly deposited bark beetle eggs. The female wasp advances into and retreats from the bark beetle egg gallery as the female bark beetle works in and out of the gallery. The larva of *E. leucogramma* develops internally in the larva of *S. multistriatus* as the latter matures. As the larva of *S. multistriatus* matures to a late instar, the parasite larva completes development, emerges from the remains of the bark beetle larva, and pupates. (Figs. 2 and 3.)

The purpose of this paper was to find out if *D. protuberans* oviposits on late-stage larvae of *S. multistriatus* already parasitized internally with a larva of *E. leucogramma*.

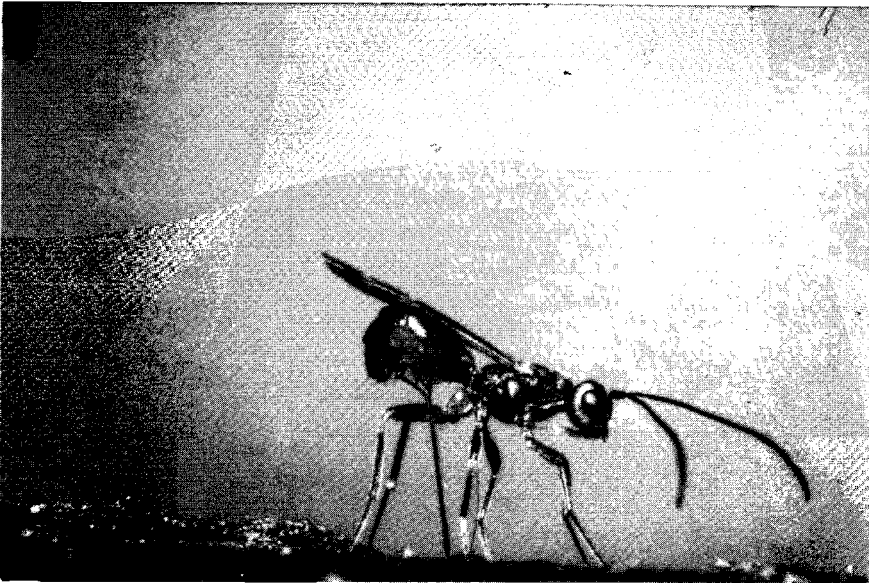


Fig. 1. Ovipositing adult female of *D. protuberans*.

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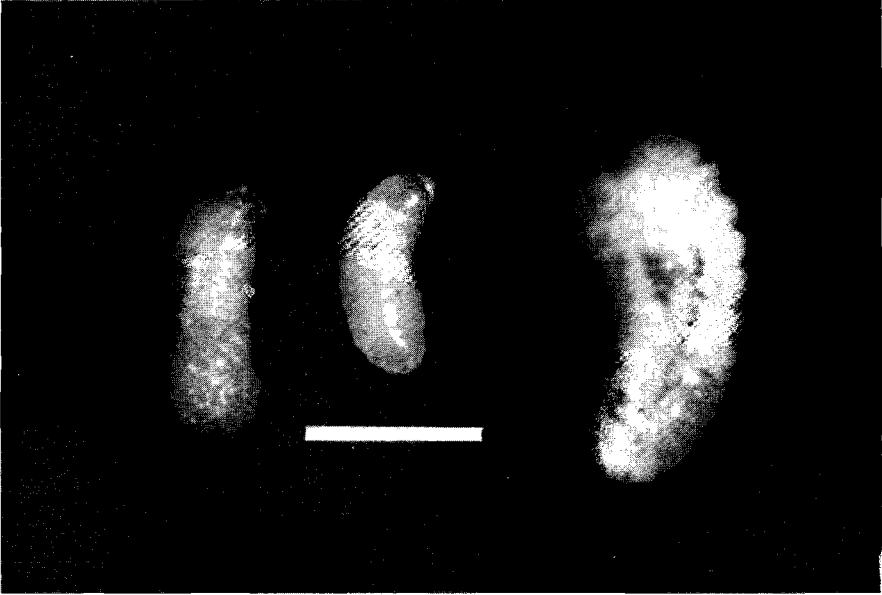


Fig. 2. Normal larva of *S. multistriatus* (right); larval bag of *S. multistriatus* (left); larva of *E. leucogramma* (middle). Bar = 1.75 mm.



Fig. 3. Pupa and adult of *E. leucogramma*. Bar = 1.0 mm.

## METHODS

Seventeen bolts, each approximately 25.4 cm long and 5.0 cm in diameter, were cut from elm wood infested with larvae of *S. multistriatus* under natural conditions, some of which were parasitized by *E. leucogramma*. The bolts were exposed individually to varying numbers (12 to 40) of mated *D. protuberans* for 24 to 72 h. The bolts were dissected and larvae of *S. multistriatus* with eggs of *D. protuberans* (Group A) and those without eggs (Group B) were separated. The eggs of *D. protuberans* were counted and immediately removed from Group A. On those bolts that were not dissected until 72 h, some *D. protuberans* larvae emerged from the eggs and were present on some of the beetle larvae (Group C); these parasite larvae also were removed, and the beetle larvae held separately. The beetle larvae in the three groups were kept in petri dishes on moistened filter paper until the study was concluded.

## RESULTS

A total of 1,905 *S. multistriatus* larvae were removed from the dissected elm bolts; 727 had one or more eggs of *D. protuberans* on or next to them. The beetle larvae in Group A yielded 41 adults plus seven defective (incomplete metamorphosis) individuals of *E. leucogramma*. Group B larva (1,034) yielded 60 adults of *E. leucogramma* plus nine defective individuals of *E. leucogramma*. Additionally, 95 larvae of *S. multistriatus* from which early-instar larvae of *D. protuberans* were removed (Group C) yielded 11 adults and two defective individuals of *E. leucogramma*.

A group of 18 larvae of *S. multistriatus*, each showing an internal late-stage larva of *E. leucogramma* (Fig. 4), were oviposited on by *D. protuberans*. These beetle "larval bags"

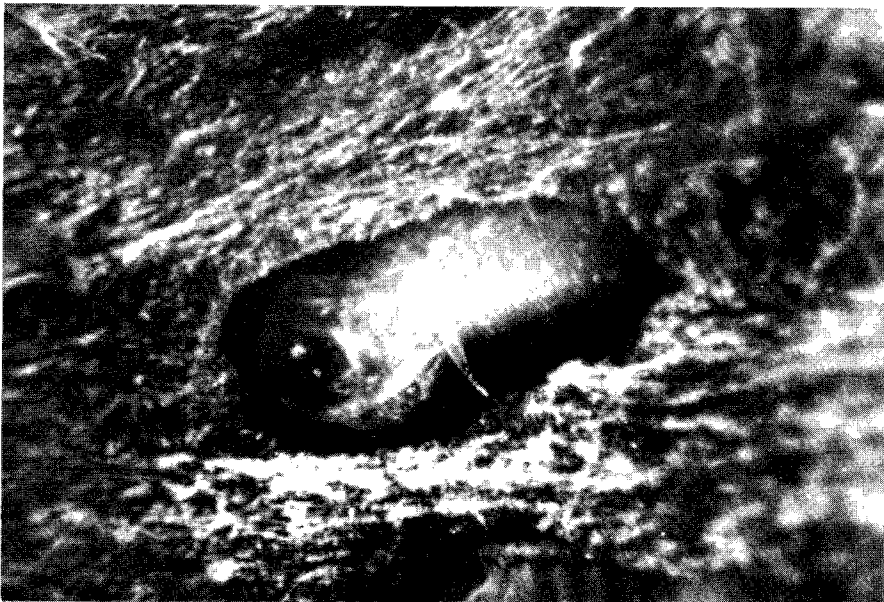


Fig. 4. Larval bag of *S. multistriatus* with internal larva of *E. leucogramma* and egg of *D. protuberans*.

yielded six adults and 12 defective individuals of *Entedon*. Also 22 larvae of *S. multistriatus*, each showing an internal larva of *E. leucogramma* but no oviposition by *D. protuberans*, yielded 19 adults and three defective individuals of *E. leucogramma*.

A group of nine *S. multistriatus* larval bags containing *E. leucogramma* were removed from an elm bolt and observed; each bag had an attached egg of *D. protuberans*. Eight of the nine eggs of *D. protuberans* hatched (one egg disappeared), and the larvae of *D. protuberans* remained on the bags until the larvae of *E. leucogramma* emerged. After the *E. leucogramma* larvae emerged, the *D. protuberans* larvae desiccated and died. From the original nine beetle bags, seven larvae of *E. leucogramma* emerged, pupated, and yielded adults. One larva of *E. leucogramma* partially emerged and died. Another emerged from the larval bag, partially pupated, and died.

Of the *S. multistriatus* larvae removed from the dissected logs, 53 had two *D. protuberans* eggs, 31 had three eggs, 10 had four eggs, and five larvae had six eggs. Fourteen pupae of *Cheirpachus colon* (L.), a parasite of *S. multistriatus*, were removed from the dissected elm bolts, as were 16 larvae and two pupae of *E. leucogramma*. All were free of eggs or larvae of *D. protuberans*.

*D. protuberans* oviposited on 44.6% of the *S. multistriatus* larvae (including larval bags) removed from the elm bolts and 9.4% of the *S. multistriatus* larvae were parasitized by *E. leucogramma*. Of those beetle larvae from which *E. leucogramma* emerged, 49.2% were oviposited on by *D. protuberans*.

*E. leucogramma* larvae emerged from the remains of the *S. multistriatus* larvae in 2 to 7 days. Pupation occurred in 2 to 13 days and adults emerged in 10 to 17 days.

Incomplete development of larvae of *E. leucogramma* might be attributed to the probing of the ovipositor of *D. protuberans* during oviposition, even if no egg is deposited. Larvae of *S. multistriatus* on which oviposition by *D. protuberans* has occurred usually are quiescent, as if stung and paralyzed. Incomplete development of larvae and pupae of *E. leucogramma* could be due to activity of early-instar larval feeding by *D. protuberans*, even though the larvae of *E. leucogramma* eventually emerge from the larval bag.

In this study, *D. protuberans* oviposited on beetle larvae previously parasitized by *E. leucogramma*. The survival of an *E. leucogramma* larva when oviposition by another parasite occurs on its host may depend on its stage of development within the host. When the *E. leucogramma* larva has reached the larval bag stage, its chances for survival may be greater than if oviposition by another parasite occurs at an earlier stage of development.

Under natural conditions, parasitism of *S. multistriatus* by *E. leucogramma* might be obscured by subsequent oviposition by *D. protuberans* or, for that matter, by *C. colon* or by *Spathius benefactor* Matthews, another parasite of *S. multistriatus*. The latter two parasites are well established in *S. multistriatus* populations, but their relationship with *E. leucogramma* was not investigated in this study. It is also possible that parasitism by the aforementioned parasites might be obscured by the survival of *E. leucogramma* following oviposition by the secondary parasite.

#### LITERATURE CITED

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