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The results of laboratory tests showed that mortality of adult eulophids, primarily, *Sympiesis sericeicornis* (Nees), *S. marylandensis* Girault and *Pnigalio flavipes* (Ashmead), was significantly (P < 0.05) lower than that of adult *Pholetesor ornigis* (Weed) when exposed to temperatures between 20° and 36 °C for 48 h. However, adult *P. ornigis* lived longer than those of the eulophids at 15 °C, but were shorter lived at 33 °C. The fecundity of *P. ornigis* was little affected at temperatures of 15°, 20°, 24° and 33 °C. Exposure of adult *P. ornigis* to 30 °C for 16 h resulted in reduced longevity of both sexes but did not affect fecundity or the proportion of females ovipositing. Mortality of pupae of the eulophids was significantly lower than that of pupae of *P. ornigis* at temperatures of 20°, 30° and 33 °C. The sex ratio of surviving adults was not affected by temperature.


The spotted tentiform leafminer (STLM), *Phyllonorycter blancardella* (Fabricius), has recently become a major pest of apple in Ontario following its development of resistance to organophosphorous (Pree et al., 1980) and later to synthetic pyrethroid (Pree et al., 1986) insecticides.

The leafminer has 3 generations per year and in each generation it is attacked by several parasitoids (Pottinger & Leroux, 1971; Johnson et al., 1976; Hagley, 1985). In Ontario, the most important parasitoid in the 1st and 3rd leafminer generations, which occur in the spring and fall respectively, is the braconid, *Pholetesor ornigis* (Weed) (Johnson et al., 1976; Hagley, 1985). In the 2nd leafminer generation, which occurs in the summer, eulophids predominate, the most important of which are *Sympiesis sericeicornis* (Nees) and *S. marylandensis* Girault (Johnson et al., 1976; Hagley, unpublished data). It has been suggested by other workers that the low levels of parasitism observed for *P. ornigis* in the 2nd generation might be due to hyperparasitism of *P. ornigis* by other parasitoids (Maier, 1984), and to host feeding by some eulophid species (Ridgway & Mahr, 1985). Weires et al. (1980) and Maier (1982) also suggested that insecticides applied for leafminer *P. crataegella* (Clemens) control were toxic to adult parasitoids and their use resulted in low levels of parasitism.
As daily temperatures vary during each generation period of *P. blancardella* in Ontario (Hagley, unpublished data), laboratory studies were undertaken to determine if differences existed in the temperature tolerance of the species of parasitoids and if these differences were large enough to influence their efficacy. The results obtained are herein reported.

**MATERIALS AND METHODS**

In 1987 and 1988 overwintering pupae of *P. blancardella* and of the parasitoids were obtained from infested apple leaves collected in late fall and stored in an unheated barn or in an open-sided insectary until late December or early January of the following year. Leaves were then placed in large (ca. 95 cm × 75 cm × 55 cm) wooden boxes held at 22-24 °C and adult insects collected daily in a glass jar (19 cm long × 8.7 cm int. diam.) at a light source. A moistened dental wick in the jar provided a source of water for the insects. Adult STLM and parasitoids less than 24 h old were released from the collecting jar into a wooden sleeve cage (ca. 45 cm × 35 cm) with sloping glass top.

Adult *P. ornigis* were sexed microscopically by aspirating 5 to 8 individuals into glass vials (12.0 cm long × 2.1 cm in diam.), the ends of which were then stoppered with fine saran mesh. Adult eulophids were sexed when species were identified. To determine the mortality of the parasitoids at different temperatures 3 to 4 vials containing a total of 10 ♀♀ and 10 ♂♂ were placed into incubators (Percival Refrigeration and Mfg. Co. Inc., Des Moines, Iowa) at temperatures of 15°, 20°, 24°, 27°, 30°, 33° and 36 ± 1 °C, 60-70 % R.H. and a 16L : 8D photoperiod. Mortality of the insects was recorded after 24 and 48 h. Adult *P. ornigis* were similarly exposed to 30 °C for periods of 0, 3, 6 and 16 h to determine if exposures of shorter duration at that temperature would affect their longevity and fecundity. After exposure to 30 °C the insects were held at 24 °C at which temperature observations on their longevity and fecundity were made.

The longevity of adult *P. ornigis* and eulophids, and the fecundity of *P. ornigis* were also determined at 4 constant temperatures viz 15°, 20°, 24° and 33 °C. The insects were handled as described above and mortality was recorded daily until all insects had died. The fecundity of *P. ornigis* females was determined by allowing female STLM to oviposit on potted apple seedlings and sap-feeding larvae (i.e. instars 1-3) obtained as previously described (Hagley & Barber, 1986). One male and 1 female *P. ornigis* were confined in a small cage made from 2 halves of a plastic Petri dish 5.3 cm in diam. and 1.2 cm high. A piece of plastic 4 cm in diam. was removed from one half and replaced with fine saran mesh, and a hole 1.5 cm in diam. bored in the centre of the other half. A leaf with 5 to 8 larvae of the STLM was placed in the half with the mesh bottom with the petiole protruding through a small notch on the rim and the 2 halves taped together. The parasitoids were introduced through the 1.5 cm diam. hole after collection in small vials which fitted snugly into the hole. Water was provided on moistened cotton. A cork was then placed in the hole and the petiole put in water to maintain leaf vigour during the test. Fresh leaves were provided at 24-48 h intervals until the death of the female. Males were not replaced if they died before the females. When the leaves were changed the STLM larvae were removed from the mines and dissected in Ringers physiological saline to determine the number of eggs deposited by individual females.

Mortality of pupae of the parasitoids at different temperatures was also determined. Pupae were dissected from field-collected material and 10 specimens placed on moistened filter paper in 7 cm diam. covered plastic Petri dishes. The Petri dishes were placed in incubators held at constant temperatures of 15° to 36 ± 1 °C, 60-70 % RH and a 16L : 8D photoperiod. The test was terminated when adult emergence was complete, usually after 21 d. Pupae from which adults did not emerge were dissected to verify mortality.