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A New Egg Parasitoid for Possible Biological Control of the Asiatic Maize Borer in Malaysia

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ABSTRAK

Satu spesis parasitoid telur yang telah dikenalpasti sebagai Trichogramma papilionis *Nag. menyerang kelompok telur* Ostrinia furnacalis *Guenee. Ianya merupakan parasitoid telur tunggal yang ditemui sepanjang masa kajian. Edaran hidup parasitoid ini disempurnakan dalam masa 9 hari dengan 2, 4 dan 3 hari diperingkat telur, larva dan pupa. Nisbah seks (betina:jantan) ialah 3:1 yang mana didapati tinggi daripada nisbah 2:1 yang biasanya diperolehi bagi* Trichogramma *spp. Superparasitisme telah dapat diperhatikan dimana 3 individu telah dihasilkan dari sebiji telur perumah. Semua telur boleh diserang dalam masa 4 hari pada nisbah 2:1 (hos:parasitoid). Parasitoid betina menunjukkan kecekapan memburu pada tahap yang tinggi dimana ianya akan menyerang kesemua telur dalam sesuatu kelompok sebelum menyambung pemburuan. Parasitoid betina menggunakan 40% daripada keseluruhan masa untuk memburu dipermukaan atas daun jagung, 30% dipermukaan bawah daun dan 30% dipinggir daun. Kelakuan parasitoid ketika memburu dan menyerang hos menuruti geraf respon "functional" jenis III. Parasitoid betina menunjukkan respon positif terhadap bauan daun jagung menandakan kemungkinan adanya penglibatan sejenis kairomon atau kimia komunikasi kontak.* T. papilionis *adalah dianggap sejenis parasitoid telur* O. furnacalis *yang amat berkesan dan calon baik untuk program kawalan biologi perosak.*

ABSTRACT

A species of egg parasitoid tentatively identified as Trichogramma papilionis *Nag. was found attacking egg masses of* Ostrinia furnacalis *Guenée. The life cycle of the parasitoid was completed within 9 days; the egg, larval and pupal stages lasted for 2, 4 and 3 days, respectively. The female: male sex ratio was 3:1, higher than the usual 2:1 sex ratio for* Trichogramma *spp. Superparasitism was observed whereby 3 individuals were produced from one host egg. All eggs were parasitized in 4 days at 2:1 (host: parasitoid) ratio. The female parasitoid showed a high degree of searching efficiency and normally parasitized all eggs in a batch before continuing her search for the next egg batch. The female spent 40% of the time searching on the upper surface of a maize leaf, 30% on the lower surface and 30% on the leaf edges. The female searching and parasitization behaviour followed the Type III functional response curve. The female parasitoid showed positive response to the odour of the maize leaf, indicating a possibility that a kairomone or contact communication chemical is involved.* T. papilionis *appeared to be a very efficient egg parasitoid of* O. furnacalis *and a good candidate for a biological control programme of the pest.*

INTRODUCTION

The Asiatic maize stem borer, *Ostrinia furnacalis* Guenee (Lepidoptera: Pyralidae) generally can be controlled by the application of insecticides (Hussein and Kameldeer 1988). With the growing interest in the important role of biological agents (predators, parasitoids and pathogens) in integrated pest management (IPM) programmes, in 1988 Universiti Pertanian Malaysia (UPM) started research on the natural enemies of *O. furnacalis* to evaluate the possibility of using parasitoids as a major component in its management.

Among its parasitoids are a larval-pupal parasitoid, *Brachymeria lasus* Walker (Hymenoptera: Chalcididae) and a larval parasitoid, *Xanthopimpla stemmator* Thunberg (Hymenoptera: Ichneumonidae) (Hussein *et al.* 1983). An egg parasitoid, identified as *Trichogramma papilionis* Nag. (Hymenoptera: Trichogrammatidae), was recently found parasitizing eggs of *O. furnacalis* in the maize field at Serdang, Selangor (Hussein and Ibrahim 1992). It was considered that the parasitoid might be a successful control agent. This paper reports various biological studies carried out on the parasitoid.

MATERIALS AND METHODS

Life History

A study was carried out to determine the developmental period of the egg, larval and pupal stage of the parasitoid. Twenty-four hours after oviposition, eggs of *O. furnacalis* were individually reared and exposed to the parasitoid. Four days after oviposition, 100 eggs of the parasitoid were observed through the larval and pupal period of development in the laboratory at 25 ± 3°C and 60 ± 10% R.H.

Longevity

Longevity and mortality rates of the parasitoids were determined, comparing adults fed with (1) sucrose and water, and (2) water only. Fifty adult parasitoids were included in the test. The numbers of live and dead parasitoids were recorded daily.

Sex Ratio

The sex ratio of the parasitoid was determined by rearing individuals on eggs of *O. furnacalis* until the adults emerged. A total of 700 eggs were parasitized and kept for observation. The adults emerging from the host were immediately sexed, based on antennal morphology (Pak and Oatman 1982).

Superparasitism

A total of 100 24-h-old eggs of the host were exposed to allow maximum parasitism by *T. papilionis* inside a large closed petri dish (15 cm diameter) for a period of 4-5 days. The eggs were left in the laboratory until pupation of the parasitoid occurred. Each host egg was then dissected and the number of parasitoids present was counted.

Maximum Parasitization

Twenty different sized batches of host eggs were each exposed to a single newly mated female parasitoid in a closed plastic petri dish. The number of eggs parasitized was recorded daily for 5 days until all the eggs had been parasitized. The sequence of parasitizing individual eggs was recorded.

Host: Parasitoid Ratio and Parasitization Rate

The relationship of host:parasitoid ratio to the rate of parasitization was determined using a factitious host egg of *Corcyra cephalonica* under laboratory conditions. The number of host eggs was 5, 10, 14, 20 and 25. Regression analysis was performed on the data.

Functional Response

Eggs of the factitious host, *C. cephalonica*, were glued on pieces of 3 × 3 cm paper card in a regular pattern. Seven different host densities were tested: 1, 5, 9, 22, 36, 72 and 108 eggs per 9 cm^2 with 10 replications. The eggs were then placed in a closed plastic petri dish (5 cm diam). A single newly mated *T. papilionis* was released into each dish for 5 h. The parasitoid was then removed and the dish left for another 4 days, after which the number of parasitized eggs was counted. The data were fitted to Holling's Type III model of functional response (Holling 1965).

Searching Behaviour

The preference of the parasitoid to search for its host on either the upper or lower surface of the maize leaf was measured. A freshly picked maize leaf blade was stretched horizontally between two vertical wooden sticks and illuminated from above with strong fluorescent light. One female parasitoid was released at the centre of the leaf. Several aspects of behaviour and positioning were recorded and timed using a stopwatch.

Kairomones

Four extracts were assessed for attractiveness to adult parasitoids. Two were prepared by soaking eggs of *O. furnacalis* in hexane and methanol respectively for at least 6 hours. The other two from scales of the moth, similarly soaked in hexane and methanol, were then filtered. Bioassay tests using a petri dish were run following the method described by Jones *et al.* (1973). Olfactometery tests were also carried out using a glass Y-tube (Schilthuizen 1989).

RESULTS AND DISCUSSION

The developmental period of *T. papilionis* from egg stage to adult emergence was 9 days. The egg, larval and pupal stages lasted for 2, 4 and 3 days, respectively. These periods are quite close to those of *T. australicum* (8 days) but differ from those of *T. minutum* (6 days) and *T. fasciatum* (6 days) (Metcalf and Breniere 1969). The development period of *Trichogramma* species in general is very similar (Metcalf and Breniere 1969).

In this study, the sex ratio varied around 3:1 (female:male). The females are always predominant. Usually, the sex ratio for *Trichogramma* species is 2:1. *T. papilionis*, in this study, follows the biparental and arrhenotokous mode of reproduction. The longevity of unmated female *T. papilionis* was 9-10 days when fed on sucrose and water. Females lived for only 3 days when fed on water alone.

Superparasitization was observed in *T. papilionis* parasitizing eggs of *O. furnacalis*; as many as three individuals were produced from one host egg. The phenomenon is common to all *Trichogramma* species. In general, the number of both hosts parasitized and the number of progeny increase initially with increasing host density but level off after reaching a threshold (Pak and Oatman 1982).

In the laboratory the parasitoid was able to parasitize all the maize stem borer eggs presented in a batch as it often does in the field. In this study, the maximum parasitization rate was achieved in 4 days regardless of the size of egg batch as long as the ratio was kept at 2:1 (host:parasitoid). The rate of parasitization rapidly increased at lower host ratios (*Fig. 1*). No parasitization was observed at 5:1 ratio if only 5 eggs/batch were presented. At 10 eggs/batch or more and at 3:1 ratio only 10-20% parasitization occurred. Pak and Oatman (1982) found the rate to be lower if older (> 36-h-old) host eggs are used. In this study, the host eggs used were < 36-h-old.

Not all egg parasitoids are adapted to parasitizing host eggs that are laid in batches. *T. papilionis*, as shown in this study, is very efficient in parasitizing batches of *O. furnacalis* eggs in the laboratory as well as in the maize field. When the oviposition behaviour was traced egg by egg in different batch sizes, a regular pattern was discerned (*Fig. 2*). Upon encountering an egg batch, the female parasitoid first parasitizes all the eggs before continuing her search for another batch. Burbutis *et al.* (1983) also observed the same behaviour when *T. nubilale* parasitized eggs of the European corn borer, *Ostrinia nubilais*.

The female parasitoid spent 40% of her searching time on the upper surface of the maize leaf, 30% on the lower surface and 30% on the edges of the leaf. Most

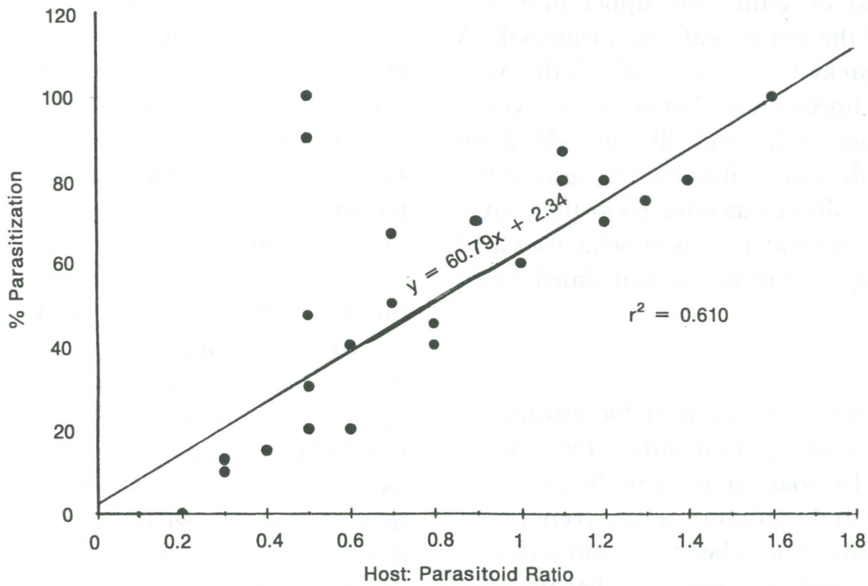

Fig 1. Effect of host-parasitoid ratio on percentage parasitization of Ostrinia furnacalis *by* Trichogramma papilionis

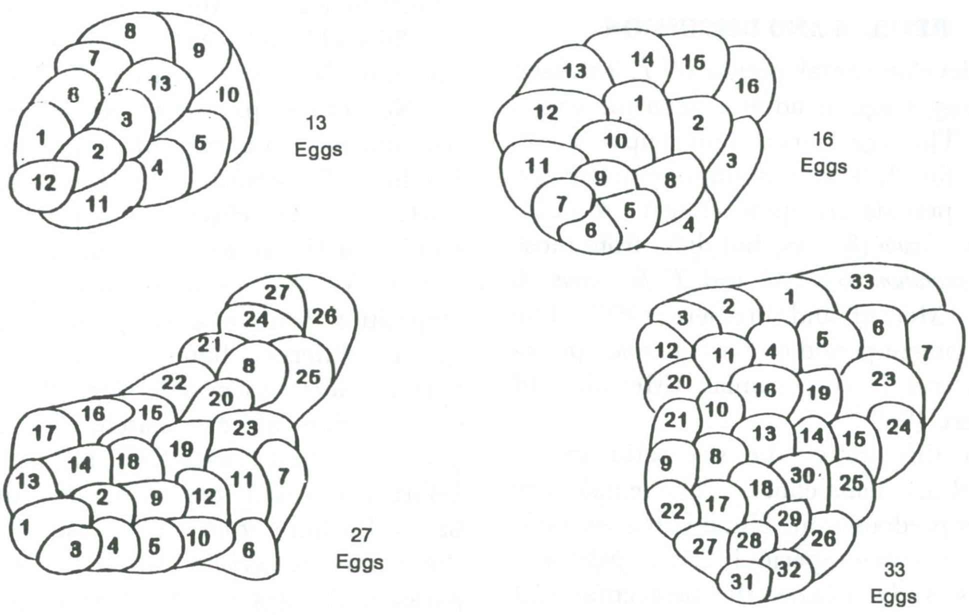

Fig 2. Sequence of egg parasitization by Trichogramma papilionis *on the different sized clusters of* Ostrinia furnacalis *eggs*

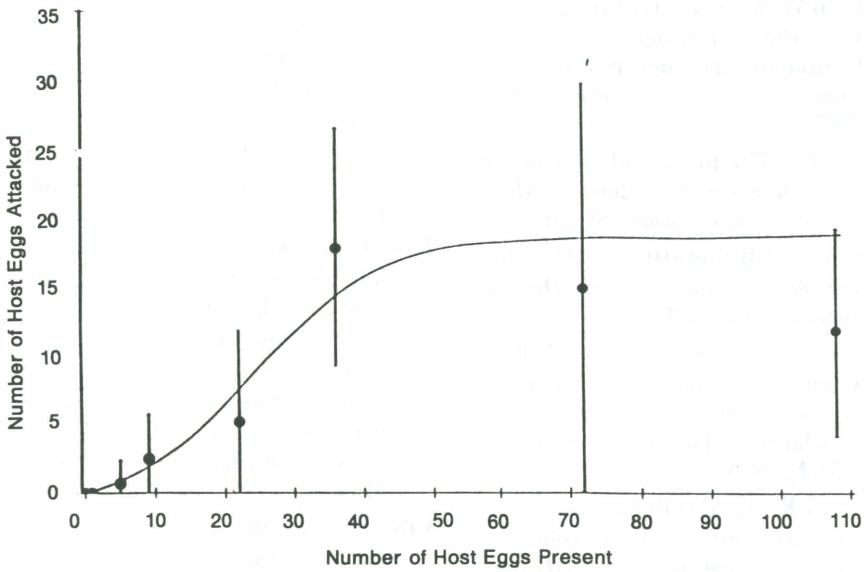

Fig 3. Functional response of Trichogramma papilionis

Trichogramma species generally prefer to search the more exposed parts of the plant (Metalf and Breniere 1969; Vinson 1976). Parasitoid searching behaviour was further elucidated by the Type III functional response curve (*Fig. 3*). The sigmoid response curve confirmed the observation mentioned earlier that at low host density some female parasitoids may find it difficult to encounter any eggs after a certain period of time and react by stopping their search.

Several egg parasitoids use kairomones to guide them while searching for host eggs in the field. In this study, attempts to demonstrate the presence of semiochemicals on the egg surface or moth scales did not produce a positive result from adult *T. papilionis* that could be detected using the petri dish method. However, using the Y-tube olfactometer, the female parasitoid showed some response to the odour of maize leaf. Whether a kairomone or a contact chemical was involved remains to be investigated.

CONCLUSION

Trichogramma papillionis can be reared successfully on eggs of *C. cephalonica*, in the absence of eggs of *O. furnacalis*. In Serdang, it parasitizes high numbers of egg masses, and almost no egg escaped parasitization. The parasitoid is well adapted to a host that produces egg masses instead of single eggs. A type III functional response indicates that relatively more hosts are attacked at high host densities. The chemical communication aspect of the parasitoid searching behaviour needs further investigation and is crucial in developing techniques to increase the success of parasitization in the field.

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