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Development of the *Euplectrus* sp. Near *Bicolor* (Hymenoptera: Eulophidae) on *Zonoplusia ochreata* (Lepidoptera: Noctuidae)

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Abstract The larval ectoparasitoid *Euplectrus* sp. near *bicolor* (Eulophidae: Hymenoptera), is a gregarious ectoparasitoid of the pennywort cutworm larvae (*Zonoplusia* ochreata). Biological investigation of *Euplectrus* sp. near *bicolor* was conducted in the laboratory (27-35ºC; 60-70%RH). The female adults copulated only once for their life time and deposited eggs singly or in clusters of two to eight eggs on the second or third abdominal segment of their larval hosts, which were mostly in the second or third instars. The parasitoids' eggs had an incubation period of 1.0–3.3 days (2.61 ± 2.10 days). The larvae stayed in a cluster and did not move until they were ready to pupate. The larval period took 2.1–3.8 days (2.82 ± 0.48 days). Pupation occurred on the underside skin of the dead host in a loosely woven silk cocoon that formed in between the host remains and adjacent leaves. The pupal period was ranged from 5.0–7.9 days (6.42 ± 0.89 days). Mating took place immediately after adult emergence, and the adults lived for 2.9–10.8 days (7.51 ± 2.58 days). The total duration of the life cycle from egg to adult emergence was 13.0–25.8 days.

Keywords: development, ectoparasitoid, *Euplectrus* sp. near *bicolor*

Introduction

The species of *Euplectrus* sp. near *bicolor* (Hymenoptera: Eulophidae) is an ectoparasitoid which feed on its host and grow after parasitization (Down *et al.*, 1999). The Eulophid subfamily Eulophinae includes species which mainly develop as ectoparasites of various insects, including leaf-miners. Of the four recognized subfamilies of Eulophidae the Entedoninae is certainly the most derived one. It has derived from some ancestral forms close to the present Eulophinae. The venomous materials or various substances injected by the female wasps into hosts'body during parasitization to make hosts available for them (Beckage, 1993; Thompson, 1993). Developing larvae also secrete some substances that cause physiological changes in their hosts (Zhuo *et al.*, 2013)

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Euplectrus sp. near *bicolor* was found in Asiatic pennywort growing areas in Thailand which this species is very close to *Euplectrus bicolor* (Swederus) introduced into the Hawaii islands from Mexico. It is gernerally against pennywort cutworm (*Zonoplusia ochreata*) which is considered an important key pest of Asiatic pennywort. *Euplectrus* sp. has been used as a biological agent of noctuidae, army worm (*Spondoptera litura*). From Hawaii, *E. platyhypenae* was introduced to the Philippines against *Spodoptera litura* (Boisd.), but did not establish (Uichanco, 1934). It was also introduced from Hawaii to Fiji against *Levuana iridescens* Bethune-Baker in 1925 (Rao *et al*., 1971). *E. laphygmae* was introduced from East Africa to Israel during 1969–1970 to control *Spodoptera littoralis* (Boisd). In 1975, *E. puttleri* Gordh was introduced from Colombia, South America against *Anticarsia gemmatalis* (Hübner) in the U.S.A., and established (Puttler *et al.*, 1980; Waddill and Puttler, 1980).

The objective was to study morphological and biological aspects of *Euplectrus* sp. near *bicolor* on its principal host.

Materials and methods

Sample collection

Larvae and pupae of *E*. sp. nr. *bicolor* were collected from parasitized host (*Z. ochreata*) whereas the adults were collected by sweeping in Asiatic pennywort farm at King Mongkut's Institutes of technology Ladkrabang. They were kept in a 15 cm diameter of petri dish for further studies on some biological and morphological aspects. The date and places of collection was recorded.

Insect rearing in the laboratory

The adult parasitoids and their host were all reared at room temperature (27-35ºC) and 60–70% relative humidity in a lighting program of 16 h light: 8 h dark condition. The adults were reared with honey smeared on the inner side of the lid. Single, mated female wasps were released for 24 h into a petri dish that contained larvae of *Z. ochreata* according to previously described methods (Nakamatsu and Tanaka, 2003). Their egg laying behaviour and the duration of each life stage in the progeny generation were recorded.

Development of parasitoid E. sp. nr. Bicolor

Directly after adult emergence, these parasitoids were supplied with honey on the inner surfaces of the Petri dish. Mating occurred and the females usually oviposited readily on pennywort cutworms were supplied. As a rule all the adult parasitoid which developed from a five newly mated female parasitoids parasitized host were confined together in a 15 cm Petri dish., due to the presence of succulent plant material provided as food for the host larvae. The ovipositing females have been interfered with hosts (for interference 1st-5th instars). For individual observations for hosts were kept single in the 15 cm petri dish for further observations.

Results

Morphology of Euplectrus sp. nr. bicolor

Egg is bean-shaped with both ends smoothly rounded, the anterior end, being slightly narrower. Egg oviposition is about 2-8 eggs in grouped on the abdominal segment of hosts. Egg length was 1.41±0.14 mm and 0.73±0.18 mm wide. Most eggs are observed on the second and third abdominal segment of the second to third instar larvae of pennywort cutworm (Fig. 1-2). After few days of egg deposition, the color becomes a pearly white. The newly hatched parasitoid larva is white, later it turns into a green tinge. During the larval development, the colour change to pale green, and later to greenish yellow in the last instar larve which its body is 0.9±0.018 mm wide and 1.17±0.016 mm long. The pre-pupa stage, brown color, stops feeding and its body length 0.73±0.18 mm wide and 1.41±0.14 mm long.

After a prepupa contracted in the cocoon, pupation occurred on the underside of the dead host larva in a loosely woven silk. Cocoon was formed between the host remains and adjacent leaves, or sometimes backwards, they usualy arrange themselves in a single row between the venter of the host and the substrate, always with their ventral aspects against their host. As this occurs, the host larva is usualy raised off the substrate (Fig. 3-4).

Adult parasitoid description:a dark brown head; reddish brown eyes; pale yellow antennae; a dark brownish black thorax, hyaline wings; uniformly yellownish brown legs with body length 1.68 mm (Fig. 5).

Developmental time of the Euplectrus sp. nr. bicolor

The parasitoids' eggs had an incubation period of 1.0–3.3 days (2.61±2.10 days). The colour of the eggs changed from white to light green when larvae were about to hatch. The larvae stayed in a cluster and did not move until they were ready to pupate. The larval period took 2.1–3.8 days (2.82±0.48 days). Pupation occurred on the underside of the dead host larva in a loosely woven silk cocoon formed between the host remains and adjacent leaves. The pupal period ranged from 5.0–7.9 days (6.42±0.89 days). Mating took place immediately after adult emergence, and the adults lived for 2.9–10.8 days (7.51±2.58 days). The total duration of the life cycle from egg to adult emergence was 13.0–25.8 days (Table 1).

Figure 1. Egg deposition on the second and third abdominal segments of the third instar larva of pennywort cutworm (*Z. ochreata*)

Figure 2. The third instar larva of pennywort cutworm (*Z. ochreata*) with a number of last instar larvae of *Euplectrus* sp. nr. *bicolor*

Figure 3. The last instar larva regared as a prepupa

Figure 4. Pupation occurred on the underside of the dead host skin in a loosely woven silk cocoon formed between the host remains and adjacent leaves

Figure 5. Adult of the *Euplectrus* sp. nr. *Bicolor*

Table 1. Developmental time of the *Euplectrus* sp. nr. *bicolor* under the laboratory condition

Parasitoid stages	Developmental time (day)	Average ± SD
Egg	1.0-3.3	2.61±2.10
Larva	2.1-3.8	2.82±0.48
Pupa	5.0-7.9	6.42±0.89
Adult	2.9-10.8	7.51±2.58

Discussion

Many ectoparasitoids reported to be permanently paralyse or kill their hosts before the parasitoid egg hatches (Askew and Shaw, 1986). Ectoparasitoids belonging to the family Eulophidae, however, let the host larvae feed and grow without paralyzing them during larval development (Coudron *et al.*, 1990; Nakamatsu and Tanaka, 2003). *Euplectrus* are multivoltine, gregarious ectoparasitoids of the Lepidoptera larvae (Gerling and Limon, 1976), mainly Noctuidae (Prinsloo, 1980; Nakamatsu *et al.*, 2002). Females sting their larval host before oviposition and causes temporary paralysis. The venom injected and triggers larval-larval ecdysis, which is a common phenomenon in this genus (Coudron, 1991). Females of *E. laphygmae* predominantly laid eggs on the second to fourth larval instars (Neser, 1973; Jones and Sands 1999).

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