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ORIGINAL ARTICLE

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Laboratory rearing of the solitary egg-larval parasitoid, *Chelonus oculator* Panzer (Hymenoptera: Braconidae) on a newly recorded factitious host *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae)

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Abstract *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae) is recorded as a new factitious host for the solitary egg-larval parasitoid, *Chelonus oculator* Panzer (Hymenoptera: Braconidae). A short biology and rearing method of the parasitoid on the new host were studied at 30 ± 1°C, 60–70% relative humidity, with a photoperiod of 16:8 (L: D). *Chelonus* eclosed from 74.60% of parasitized hosts. No significant difference was found between development times of male and female parasitoids. Development of the parasitoid was completed in 28.14 ± 0.47 days in male, and 28.87 ± 0.58 days in female. However, a significant difference was found between adult sizes of male and female parasitoids. Adult dry mass was found 0.88 ± 0.04 mg in male, and 1.99 ± 0.11 mg in female. In addition, *C. oculator* was successfully reared from *P. interpunctella* in twenty generations with the explained method. Significant knowledge about biology of *C. oculator* is still lacking. However, the parasitoid can be candidate for future research as a biological control agent against some important lepidopteran pests, and *P. interpunctella* may be suitable factitious host for mass rearing of *C. oculator*.

Keywords *Chelonus oculator* · Egg-larval parasitoid · Factitious host · *Plodia interpunctella* · Rearing method

Introduction

The solitary egg-larval parasitoid, *Chelonus oculator* Panzer (Hymenoptera: Braconidae) may be a candidate for future research as a biological control agent against some important lepidopterous pests. Five families of Lepidoptera (Noctuidae, Phycitidae, Pyraustidae, Coleophoridae and Tortricidae) are listed as hosts for *C. oculator* (Tobias 1995). The parasitoid wasp was recorded from five noctuid species: *Spodoptera exigua* Hb., *Helicoverpa armigera* Hb., *Heliothis viriplaca* Hfn., *H. peltigera* Den. & Schiff., *Photedes elymi* Tr.; a phycitid: *Etiella zinckenella* Tr.; a pyraustid: *Pyrausta sticticalis* L.; a coleophorid: *Coleophora anatipennella* Hb., and a tortricid: *Zeiraphera isertana* F. The parasitoid has been reported from Caucasus, Kazakhstan, Central Asia, Western Europe, North Africa and Iran.

No laboratory studies have previously been reported about *C. oculator*, an egg-larval parasitoid of some lepidopteran pests. In June 1998, average 300 young instars larvae of *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) were collected from cotton fields in Adana (south part of Turkey). The larvae were cultured in an insect rearing laboratory at University of Ankara, Faculty of Agriculture, Department of Plant Protection. The observation of the culture of *S. littoralis* revealed an adult braconid wasp. The laboratory colonies were then established from resulting parasitoid adults using eggs of *S. littoralis* and *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae). The parasitoid was identified as *C. oculator*. *S. littoralis* and *E. kuehniella* were recorded as new hosts for the parasitoid (Ozkan and Ozmen 2001).

Biology of *C. oculator* on its two new hosts, *E. kuehniella* and *S. littoralis* was studied by Ozmen et al. (2002). They reported that the parasitoid had high reproductive rate and ease of rearing on *E. kuehniella* made this parasitoid a good agent for the biological control of lepidopterous pests. They found that a female produced on average 2,344 progeny on eggs of *E. kuehniella*. The authors suggested that egg-larval parasitoid, *C. oculator*, represents a very successful result in the sense of biological control. Because the parasitoid not only caused reduction of overall number of adult hosts emerging but, as observed in *S. littoralis*, it also led

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to a significant decrease in food consumption mainly due to absence of actively feeding last larval stadium.

Effects of adult nutrients on the longevity of *C. oculator* were studied (Tunca et al. 2002). They found that honey, glucose, fructose, lactose (10% solution) and sucrose (10% solution) increased the longevity 10, 5.9, 6.9, 3.1 and 1.1 times in male parasitoids, and 8.3, 8.6, 8.7, 3.2 and 1.2 times in female parasitoids, respectively. In addition, the authors also found that mating and oviposition could affect the longevity of the parasitoids.

Literature study shows that important knowledge about *C. oculator* is still lacking. This study investigates host suitability of *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae) for the parasitoid. In addition, some biological characteristics and a rearing method of the parasitoid on *P. interpunctella* were presented. This investigation will enable us to evaluate the potential of *C. oculator*, and will also provide important information for mass rearing of this parasitoid in the laboratory, a critical step in any field release program.

Materials and methods

Plodia interpunctella (Hübner) (Lepidoptera: Pyralidae) was reared in clear plastic containers (20 cm length, 14 cm width, 7 cm height) on a 2:1:0.25:0.50:0.25:0.25 mixture of rough wheat bran, corn flour, dry yeast, honey, milk powder, glycerin containing approximately 250 g sterilized food and 500 eggs. Each plastic container was covered with cloth and kept at 30 ± 1°C, 60–70% relative humidity (RH). Emergence rate of the moth was on average 85%, and development time of *P. Interpunctella* from egg to adult completed in approximately 26 days. Adult moths were collected with the help of an aspirator and transferred into ovipositing cages. Eggs of *P. interpunctella* were collected from the ovipositing cages with the help of a soft brush.

For the experiments, a colony of *C. oculator* was obtained from *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae). Suitability of *P. interpunctella* for the solitary egg-larval parasitoid, *C. oculator* was investigated at 30 ± 1°C, 60–70% RH, with a photoperiod of 16:8 (L: D). In this experiment, 24–48 h old eggs of *P. interpunctella* were used. To obtain singly parasitized host, eggs were presented individually to adult parasitoids. After parasitization, host eggs were placed singly into vials with excess diet until parasitoid eclosion. As a host diet, 2:1:0.25:0.50:0.25:0.25 mixture of rough wheat bran, corn flour, dry yeast, honey, milk powder, glycerin was used. Data were obtained from 126 parasitized host eggs. Parasitoid eclosion was checked several times during the day to ensure development time and mortality rate to be accurately recorded. After the eclosion, parasitoids were killed by freezing. They were then placed individually on an aluminium tray, oven dried for 5 days at 60°C and weighed on a Cahn automatic electrobalance to accuracy of 1 μg . An ANOVA was used to define the development times and adult sizes of male and female parasitoids.

In the rearing method of *Chelonus oculator*, eggs of *P. interpunctella* were used. Studies were conducted at 30 ± 1°C, 60–70% RH, with a photoperiod of 16:8 (L: D). Newly (< 24 h) emerged ten pairs of *C. oculator* were transferred into clear plastic containers (20 cm length, 14 cm width, 7 cm height). Pure honey was given to adult parasitoids by smearing a small amount on the lid of the containers. Parasitoids were left to mate and feed for 24 h before host eggs were supplied. Approximately, 500 eggs of *P. interpunctella* which were 24–48 h old were glued on a paper sheet (1.5 x 10 cm) with the help of 5% Arabic gum solution, and introduced into the container. The parasitoids were left to forage and oviposit for 6 h. Parasitized egg sheet was then transferred into another clear plastic container on a 2:1:0.25:0.50:0.25:0.25 mixture of rough wheat bran, corn flour, dry yeast, honey, milk powder and glycerin containing approximately 250 g sterilized food. Rearing attempts of the parasitoid were materialized in twenty generations.

Results and discussion

Of the 126 parasitized host eggs, 30 male and 64 female parasitoids eclosed successfully, only three produced adult moths. Further, 29 parasitoid died during the experiment. Host suitability studies showed that eggs of *P. interpuctella* were successfully parasitized by *Chelonus oculator* and fertile offsprings were produced. This result shows that *P. interpuctella* may be a suitable host for the parasitoid. Suitability, as defined by Mackauer (1973), Vinson and Iwantsch (1980); Barbosa et al. (1982) describes those host types, which can successfully be parasitized and the degree to which they produce fertile offspring. Development time of the parasitoid from egg to adult lasts approximately 28.37 ± 0.37 days. An ANOVA on the development time of *C. oculator* didn't reveal a significant interaction between male and female ($F = 0.82$, df = 1, $P = 0.366$). Development of the parasitoid was completed in 28.14 ± 0.47 days in male, and 28.87 ± 0.58 days in female. However, adult size of the parasitoid revealed a significant interaction between male and female ($F = 7.34$, df = 1, $P = 0.009$). Development time of female was found to be significantly longer than that of male (Duncan; $P < 0.05$). An average adult dry mass was found to be 0.88 ± 0.04 mg in male, and 1.99 ± 0.11 mg in female.

C. oculator was able to parasitize young and older stage of eggs of *P. interpunctella* and completed its development successfully. The eggs were laid on the host eggs singly. The eggs of the parasitoid hatched in the host eggs, and first and second instar of the parasitoid fed internally. In its third instar, the parasitoid larvae left the host to feed externally, consuming all except the skin and head capsule. The parasitoid then spanned its cocoon in the pupal cell previously prepared by the host

larva. The reproduction of the parasitoid was arrhenotoky, in which only male progeny developed from unfertilized eggs. Superparasitism was observed in the case of insufficient host. However, only one parasitoid completed its development.

The solitary egg-larval parasitoid, *C. oculator* was successfully reared from *P. interpunctella* in twenty generations with the explained method. *Chelonus* progenies didn't fail to eclose from more than 30% of parasitized hosts in each generation. It was suggested that several factitious hosts were successfully used for mass rearing of *Chelonus* species in the laboratory for biological control programmes. *Chelonus blackburni* Cameron was mass reared on *Corcyra cephalonica* (Stnt.) in the laboratory and released for the biological control of *Pectinophora gossypiella* (Saund.), *Earias vittella* (Fabricius) and *Helicoverpa armigera* (Hübner) on cotton (Pawar et al. 1983). *Chelonus* sp., a parasitoid of the coconut pest *Batrachedra arenosella* (Wlk.), was reared in the laboratory using *Phthorimaea operculella* (Zell.) as the host (Baringbing 1984). *Chelonus inanitus* (L.), one of the most effective parasitoids of the cotton pest *Spodoptera littoralis* (Boisd.), was successfully reared on *Ephestia kuehniella* Zeller (Hafez et al. 1980). *Chelonus* sp. near *curvimaculatus* Cameron originally reared from *P. gossypiella* was successfully reared on *P. operculella* (Legner and Thompson 1877). *Chelonus eleaphilus* Silv., a parasitoid of *Prays oleae* (Bern.), was successfully reared on *Ephestia kuehniella* Zeller (Arambourg et al. 1970).

It appears that important knowledge about biology of *C. oculator* is still lacking. However, *C. oculator* can be candidate for future research as a biological control agent against some important lepidopteran pests as mentioned in introduction section, and *P. interpunctella* may be suitable factitious host for mass rearing of *C. oculator*.

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