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Biology of Parasitoid *Aganaspis daci* (Weld) (Hymenoptera: Eucoilidae)

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Abstract. In view of the importance of *Aganaspis daci* (*Trybliographa daci*) and *Diachaishmimorpha longicaudata* parasitoids in the use of fruit fly control, biology of *A. daci* was studied under controlled temperature and humidity conditions. *A. daci* was found to be more dominant and easy to use as a biological control agent than the *D. longicaudata.*

Keywords: biological control, fruit fly, *Aganaspis daci*, *Trybliographa daci*, *Bactrocera dorsalis*

Introduction

Fruit flies attack fruit trees and vegetables and not only reduce their yield but also affect the quality. Damage to fruits cause loss of about 7 billion rupees to farmers annually in Pakistan besides the losses to traders, retailers and exporters. The host fruits and vegetables attacked by fruit flies like *Bactrocera zonata* and *Bactrocera dorsalis* include guava, plum, peach, apricot, loquat, bitter gourd, citrus, mango, sponge gourd and pear. Some fruits such as guava were severely damaged by fruit flies causing up to 100% loss of harvested fruits at Huripur, Kohat. (Syed *et al.,* 1970; CIBC, 1972) and 76.5 % at Bannu (Marwat *et al.,* 1992). Some of the American species like *A. pelleranoi* (Brèthes) and *Aganaspis nordlanderi* (Wharton) can be easily differentiated from the Asian species group {*A. daci* (Weld), *A. contracta* (Lin), *A. ocellata* (Lin), and *A. major* (Lin)} by several morphological features such as the shape of the scutellar disc, female antennae, absence of setae on the eyes and lack of the median depression in the metapleuron (Wharton *et al.,* 1998). Fruit flies are biological controled by these specific parasitoids.

Profusion of fruit flies. *Bactrocera zonata* and *Bactrocera dorsalis* are serious pests of soft fruits and affect most of economically important fruits. Syed *et al.* (1970) reported that *B. dorsalis* is dominant in the foot hills of Rawalpindi, Haripur and common in Peshawar valley but rare in Saidu, Muzafarabad and Abbotabad. In recent studies, it was found that the large numbers of *B. dorsalis* males were caught almost throughout by the methyl eugenol baited troop in Rawalpindi Islamabad by PARC-CIBC (1987). On the other hand *B. zonata* is dominant in the plains, semi deserts, coastal and sub coastal areas, and lower altitudes in South western hills whereas rare in the foot hills of Rawalpindi and Peshawar valley (Syed *et al.,* 1970).

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Control strategies for fruit flies. Fruit flies are controlled by different techniques such as male annihilation technique (MAT) with methyl eugenol baited traps. It has been very successful in eradication of oriental fruit fly from Rota Island, Amami Island and Okinawa Island. Sterile insect technique (SIT) was also used to eradicate *Bactrocera dorsalis* from the Ogasawara Islands and *Bactrocera cucurbitae* from Kume Island, Japan (Shiga, 1989).

Biological control through parasitoids (natural enemies). In previous studies it was demonstrated that these fruit flies are biologically controlled by natural enemies like *A. daci* and *D. longicaudata.* The present studies on parasite have been carried out in the field as well as in the laboratory of CAB International, Rawalpindi. *D. longicaudata* is wide spread in Pakistan with parasitism rate exceeding 36% on *B. dorsalis* in the foot hills whereas *Aganaspis daci* with *D. longicaudata* parasitized more than 44 % on *Bactrocera zonata* in unsprayed orchards in the plains (CIBC, 1972).

A. daci (originally described as *Trybliographa daci* Weld), was first collected in Malaysia and Borneo, and introduced into Hawaii as a potential biocontrol agent for *B. dorsalis* (Hendel) (Clausen *et al.,* 1965). This species is the only one of the four Asian species for which hosts have been recorded. *A. daci* was introduced in Florida (USA) where it established successfully on *Anastrepha suspense* (Loew), although in low numbers (Baranowski *et al.,* 1993). It was released in Mexico (Jiménez-Jiménez, 1956), and Costa Rica (Wharton *et al.,* 1981) for biological control of *Anastrepha* spp., but its establishment in both countries is doubtful (Wharton *et al.,* 1998). In a cladistic analysis of the subfamily Eucoiline (Fontal-Cazalla *et al.,* 2002), the genus *Aganaspis* was included in the "Neotropical grade", an unresolved group of Neotropical taxa representing a morphological transition between the *Zaeucoila* group of genera and the 5 genus groups of higher eucoilines (The *Ganaspis*

Foerster, *Chrestosema* Foerster, *Trybliographa* Foerster, *Rhoptromeris* Foerster, and *Kleidotoma* Westwood groups) recognized by Nordlander (1982).

Life cycle of *Diachashmimorpha longicaudata.* The biology of *A. daci* is not well known but the biology of its related species like *D. longicaudata* is known, which was introduced in South Florida in 1965. It is a solitary endoparasite which parasitizes larvae of the Caribbean fruit fly, *Anastrepha suspense; D. longicaudata* was introduced in Hawaii from the Asia for control of fruit flies in 1948; it was imported, from the introduced populations of Mexico and Hawaii, into Florida in 1972 (Baranowski, 1987) with the cooperation of the public. Thousands of parasite releases were made during the next five years and DPI trapping data indicated 40% reduction in the Caribbean fruit fly population compared to trap catches before the releases (Baranowski, 1987).

The length of adult female without ovipositor is 3.6-5.4 mm and the length of adult male is 2.8 mm – 4.0 mm. The whole body and eye is reddish brown in color. Antennae are longer than the body and black shaded in colour from the fourth segment outward. Wings of *D. longicaudata* are also clear. The gaster of female is different from the male; the female gaster has a dorsal central black band, whereas the male gaster is dark brown to black from the dorsal posterior segments. The ovipositor is black in colour from the tip and longer than the female's entire body (Wharton and Marsh, 1978).

D. longicaudata females are detected only in normal and moving larvae (Lawrence, 1981). It was demonstrated that the female lays 13-24 eggs per day (Lawrence *et al.*, 1986) by using her elongated ovipositor in fruit fly larvae inside fruit. These eggs were hatched in 2-5 days and progress through larval instar, emerging as adult wasps from the fruit fly pupa (Lawrence *et al.*, 1986). Their eggs require 18-23 days in third instar larvae at 24-27 °C to develop into adults (Ashley and Chambers, 1979; Lawrence *et al.*, 1986). The parasites are also quite tolerant to various handling procedures such as chilling, anaesthesis and aspiration.

During this research, the life cycle of *A. daci* was studied in the laboratory of CAB International, Rawalpindi. All growing conditions for *Aganaspis daci* such as temperature and humidity were optimized for the parasitoid growth. The objectives are related to developmental stages, fecundity, longeivity and mating period of *A. daci.*

Materials and Methods

The research was conducted at CABI Regional Biosciences Centre, Rawalpindi during 2002-2003 focused on mass rearing and developmental biology of *A. daci.*

Mass rearing of *A. daci.* *A. daci* was reared in the laboratory under controlled temperature (24-26 °C) and humidity (54-56%). The fruit fly *Bactrocera zonata* larvae were placed in dishes containing guava pulp and covered with nylon cloth. The dishes were put in the cages containing parasitoid adults. Female wasps laid eggs in the fruit fly larvae. After 24 h of exposure the fruit fly larvae were kept in a jar and further reared in the guava pulp. Jars contained sand at the bottom and the fruit fly larvae entered the sand after completing larval development. The pupae were isolated from the sand and placed in separate jars for adults' emergence. After emergence, adult pairs were placed in separate jars for the study of longevity and fecundity.

Developmental period of parasitoid. Developmental period started from the emergence up to adult stages. After emergence the male and female parasitoid were held in separate vials and constantly observed for 5 h to record the mating of the parasitoid. The longevity of both male and female parasitoids were studied in separate jars containing guava pulp, moisture and honey, provided for their nourishment. Fecundity of female was studied by the parasitization method that is the number of eggs laid by the female parasites. Female *A. daci* crawled on the dish and laid eggs in the exposed larvae of the *Bactrocera zonata* in the dish.

Results And Discussion

Biology of *A. daci.* During this study, the developmental period of parasitoid was kept under observation. *A. daci* was grown in laboratory under controlled conditions, after emergence both male and female became mature after 4-5 h. Mating period started after the emergence whereas *D. longicaudata* matured after 16 days and mated immediately after emergence. After mating 40-50 larvae of fruit fly *Bactrocera zonata* were parasitized. The day of parasitization was same for all larvae. The oviposition behavior immediately occurred after mating whereas *D. longicaudata* showed oviposition after 15 days. The larvae of *Bactrocera zonata* had three instars; its pupation period was about 2 days while that of *D. longicaudata* was 10 days. The parasitized host larvae entered the sand after completing their larval development for pupation. Parasitized host pupae were dark brown in colour and had clear segments. Pupation day was same for all parasitized host larvae. The exposure of pupation period was 24 h. The emergence period of *A. daci* varied from individual to individual. These pupae were collected from the sand and placed in separate jars for the emergence of adult parasitoids. The average period of emergence was 2-3 days. After 12 days, *A. daci* emerged from these parasitized host larvae. Male individual was smaller than female like *D. longicaudata*. The antennae of male individual

Table 1. Analysis of variance for longevity of male *A. daci*

Sum of variance	Degree of freedom	Treatment sum of square	Mean square	F. calculated,	F. tabulated	Coefficient of variance
Treatment	2	0.3	0.15	0.45	5.14 (0.05)/10.92 (0.01)	10.6
Error	6	2	0.333			

Table 2. Analysis of variance for longevity of female *A. daci*

Sum of variance	Degree of freedom	Treatment sum of square	Mean square	F. calculated,	F. tabulated	Coefficient of variance
Treatment	2	2	1	1.50	5.14 (0.05)/10.92 (0.01)	10.2
Error	6	4	0.666			

were smaller as compared to the female antennae. The ovipositor of female was clearly visible.

Longevity of male *A. daci* was 5-6 days after the period of mating, while longevity of female was 8-9 days (Fig 1. The result of longevity of both male and female was checked by the analysis of variance. The coefficient of variance of the longevity of male was 10.6 (Table 1) while that of female was 10.2 (Table 2). In the previous studies of *D. longicaudata,* the longevity of male and female was found to be 16-24 days and 20-42 days, respectively. The result of fecundity was also checked by the analysis of variance. The coefficient for the fecundity was 5.56. Mostly 40-50 larvae of *Bactrocera zonata* were parasitized in each experiment.

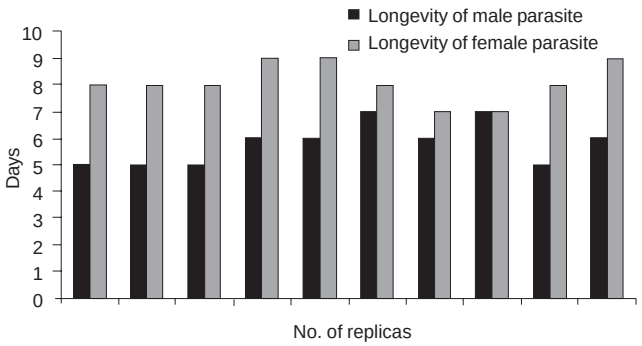

Fig. 1. Longevity of male and female *A. daci.*

Duration of the whole life cycle of male and female *A. daci* was 16-18 days and 18-20 days, respectively. These days were distributed as 10-12 days for egg to adult's development period; 4-5 days of life of male *A. daci*; 8-9 days of female *A. daci*. On the other hand the whole life cycle of *D. longicaudata* was 40-42 days.

Conclusion

From this study, it is concluded that *A. daci* is more dominant than *D. longicaudata.* The ovipositor is not as clear as *D. longicaudata* ovipositor. The life period of both male and female *A. daci* is smaller than that of the *D. longicaudata*. *A. daci* are easy to rear in the laboratory than *D. longicaudata* and easy to use as biological control due to their short life cycle.

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