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## **BIOLOGICAL STUDIES ON THE AFRICAN FIG FLY, ZAPRIONUS INDIANUS GUPTA (DIPTERA: DROSOPHILIDAE)**

### **SUMMARY**

The African fig fly, *Zaprionus indianus* Gupta, is a widely distributed polyphagous drosophilid fly of tropical origin. Its occurrence in Jordan was first reported on date palms from the Central Jordan Valley in June 2012. Studies on biological aspects of a fly population collected from Northern Jordan Valley were carried out under laboratory conditions at 25±1°C, 75±10% RH, and 14 h photoperiod. Mashed banana fruits with dry active yeast of *Saccharomyces cerevisiae* were used for the first time as a diet for larval and adult stages. The data obtained showed that the average mating period was 2.5 days, the pre-oviposition period 2.7 days, the oviposition period 42.7 days, incubation period 24.5 h, hatching of eggs was 91.7%, duration of larval stage 7.4 days, pupal stage 6.8 days, adult male life span 42.2 days, adult female life span was 37.7 days. The larval stage had the highest mortality followed by the pupal stage and then the egg stage. The life cycle lasted 13.9 to 23.2 days with an average of 17.9 days. Emerged adult flies showed a sex ratio of 1.0. The obtained results provided basic data that may help in the management of this pest in Jordan.

**Keywords:** *Zaprionus indianus*, biology, life cycle, laboratory rearing.

### **INTRODUCTION**

*Zaprionus indianus* Gupta is a polyphagous drosophilid fly of tropical origin (Pasini and Link, 2011). It successfully colonized the Indian subcontinent more than four decades ago, and more recently South America and North America (Yassin et al., 2008). It was recorded recently for the first time in Jordan (Al-Jboory and Katbeh-Bader, 2012). This species cannot survive at high latitudes and this explains its restriction to tropical and subtropical climates (Karan et al., 1999). Its optimum temperature ranged from 20 to 30°C (Amoudi et al., 1993). In Saudi Arabia, the mean generation life cycle was recorded as 22.4

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days at 25°C which was shorter than that recorded at 30°C (Amoudi *et al.*, 1991), while in Brazil it was at an average of 13 to 20 days (Stein *et al.*, 2003). The number of generations/year varies from 12 to 16 (Karan *et al.*, 2000; Setta and Carareto, 2005; Nava *et al.*, 2007). Field and laboratory studies on Indian populations showed that *Z. indianus* overwinters in the egg stage and to a few extents as pupae. Eggs remain in quiescent stage until the weather become warmer.

There are no biological data related to the fly populations from Jordan. Therefore, studies on some of its biological aspects for a Jordanian population collected from Jordan Valley 220 m below sea level were carried out under laboratory conditions. Obtained data will be helpful for the establishment of efficient management strategies against the fly populations.

### MATERIAL AND METHODS

A stock colony of *Z. indianus* was started with 200 adults collected from sour orange orchard (*Citrus aurantium* L.), Northern Jordan Valley (32°25'54"N/35°35'30"E, 213 m below sea level) in March 2013. The flies were maintained in the laboratory at a temperature of (25±1)°C, relative humidity of (75±10)% in plastic jars (120 x 160 mm) capped with a fine cloth. Small plastic plates (55 x 25 mm) containing mashed banana fruits seeded with dry and active yeast *Saccharomyces cerevisiae* were placed inside the jar for adult feeding and oviposition and were renewed every 3-4 days. All biological experiments were conducted in an incubator at 25±1°C, relative humidity of (75±10)%, and 14 hr photoperiod. One virgin female and one male (one day old) were randomly taken to be the parents of experimental flies, and placed into a plastic jar (80 x 75 mm). The procedure was repeated six times. The plastic plates were inspected daily under a stereomicroscope at 40X. Duration of premating, mating, pre oviposition, oviposition and post oviposition periods were recorded. Ten eggs (≤ 2 hr old) were transferred to each plate (30 x 25 mm, containing mashed banana fruits) for a total of 60 eggs. Observations were performed at 6 hr intervals. Duration of incubation, fertility and percentage of hatched larvae in each plate were recorded. The hatched larvae (one day old) were transferred in groups of ten larvae to 6 plastic plates (55 x 25 mm) containing mashed banana fruits (a total of 60 larvae). Each plate was placed in a plastic jar (80 x 75 mm) capped with a fine cloth and placed in the incubator.

Observations were performed daily and the duration of each larval instar and percentage of pupae in each plate were recorded. Pupae (one day old) were transferred in groups of ten to six plastic plates (55 x 25 mm) containing moistened filter paper on the bottom of the plate (a total of 60 pupae). Each plate was placed in a plastic jar (80 x 75 mm) capped with a fine cloth and placed in the incubator. Observations were performed daily and the duration of the pupal stage and percentage of emerged adults in each plate were recorded. Female to male ratio was recorded. Longevity of sexually active flies was studied by placing ten couples of virgin flies (one day old) each pair into a glass vial (25 x

95 mm) capped with cotton, and transferred to new vials with fresh media until their death, at intervals of 2-3 days to keep the quality of the media and to avoid toxic effect of metabolites. The same procedure was followed for longevity of sexually inactive flies by placing them separately. Vials were autoclaved and contained Formula 4-24 Instant *Drosophila* medium (Carolina Biological Supply Company, USA). The used vials were washed in a 10% chlorine bleach solution each time renewing the media. Vials were inspection daily and the dead flies were removed. Longevity of adult flies were recorded. For all investigated parameters, simple mean values were calculated.

## RESULTS AND DISCUSSION

All studied biological parameters are shown in Table 1. Our results represent the first data of biological features of Jordanian populations of *Z. indianus* which showed variations in some biological characteristics when compared to other fly populations from different geographical areas.

The mating duration in Jordanian populations of the fly was close to that obtained by Müller *et al.* (2012) which ranged between 18 s to 6 min and 56 s, with average of 2 min and 16 s). The obtained pre mating and pre oviposition durations were similar because the mated females laid eggs after mating due to availability of ideal oviposition substrate.

Table 1. Parameters of *Z. indianus*

Parameter	Range	$\bar{x}$
Premating duration (day)	2 - 4	2.67
Mating duration (min.)	2.12 - 3.02	2.48
Preoviposition duration (day)	2 - 4	2.67
Oviposition duration (day)	16 - 63	42.67
Postoviposition duration (day)	0 - 10	6.00
Sex ratio (F/M)	4-6/3-6	4.5-4.3
Incubation period (hr)	22 - 28	24.50
Fertility %	80 - 100	91.67
Larval duration (day)	5 - 10	7.36
Larval viability %	50 - 100	75.00
Pupal duration (day)	6 - 8	6.83
Pupal viability %	70 - 100	88.33
Longevity of sexually active female flies (day)	4 - 79	37.70
Longevity of sexually active male flies (day)	12 - 77	42.20
Longevity of sexually inactive female flies (day)	14 - 35	26.00
Longevity of sexually inactive male flies (day)	5 - 78	37.20

*Z. indianus* premating, mating, preoviposition, oviposition, postoviposition durations (n=6), egg incubation period, fertility percentage, larval and pupal duration and viability, sex ratio (n=60), and longevity of sexually active and sexually inactive adult flies (n=10).

The preoviposition duration (2-4 days) was very close to that obtained at 25°C by Pires *et al.* (2008) and lower than that recorded by Amoudi *et al.*, (1991) which ranged from 5 to 8 days in Saudi populations at the same experimental

temperature. The duration of oviposition and postoviposition recorded in the present study were 16–63 and 0–10 days, respectively which were similar to Saudi populations (9–62 and 0–12 day of oviposition and postoviposition, respectively, Amoudi *et al.*, 1991). However, in the Brazilian populations oviposition period lasted 14–98 day at 25°C (Setta and Carareto, 2005). The incubation period was ranged from 22–28 hr and fertility from 80–100%. In comparison, Amoudi *et al.* (1991) reported higher incubation period (28–60 hr) and lower fertility (53–92%). While Stein *et al.* (2003) reported an incubation period of 1–1.5 day and viability of 88.89% which are similar to our results. In Saudi Arabia, Amoudi *et al.* (1991) studied the effect of different temperatures on the life cycle of *Z. indianus*, and recorded duration of 4–11 days for the larval development and 5–9 days for pupa development at 25°C which was similar to our recorded values. In Brazil, Nava *et al.* (2007) reported a larval duration of 8.2–11.3 day and a pupal 3.4–5.5 day at 25°C. Matavelli *et al.* (2013) reported a pupal duration of 4–6 days. These results show higher values of larval duration and lower values of pupal duration in comparison with values obtained in our study. The differences in larval duration can be attributed to the composition of the diet provided to the larva which was Formula 4-24 instant *Drosophila* medium in study performed by Amoudi *et al.* (1991), Vilela's diet in Brazilian study performed by Nava *et al.* (2007) and artificial diet based on banana in another Brazilian study conducted by Matavelli *et al.* (2013), while mashed banana fruits with dry and active yeast *Saccharomyces cerevisiae* for larval development in our study.

Brazilian populations of the fly showed mean larval viability of 76% and mean pupal viability of 87.88% (Stein *et al.*, 2003) which were very close to our findings. Also Saudi populations of the fly showed similar mean pupal viability to our findings which was 89%, but higher mean larval viability which was 88% (Amoudi *et al.*, 1991). On the other hand, the mean mortality in egg, larval, and pupal stages recorded in the present study were 8.33, 25, and 11.67 %, respectively. . Similar results were obtained in Brazil as 11.11, 24, and 12.12 % representing the mean mortality in egg, larval, and pupal stages, respectively (Stein *et al.*, 2003).

The evaluation of the number of females and males emerged from 60 pupa was obtained by identifying the sex ratio (F/M) which was 1.04. Similar results were recorded in Brazil as 1.32 and 1.11 which represents higher numbers of females than males (Setta and Carareto, 2005, Matavelli *et al.*, 2013), which confirms our findings.

The mean duration of life cycle of *Z. indianus* at 25°C recorded in our study (17.9 days with a range of 13.9 - 23.2 days) was similar to that reported in Brazil by Setta and Carareto (2005) at the same experimental temperature, which was 18.5 day with a range of 15–25 day, also to that reported in Brazil too by Stein *et al.* (2003) who recorded the mean life cycle as 16.78 day with a range of 13–23.50 day at the same temperature.

The exception was observed when we compared with Saudi populations of the fly, the mean life cycle recorded at 25°C by Amoudi *et al.* (1991) was 22.4 days and is considered higher than that we obtained, despite being at the same geographical area; they had variable latitude and longitude which may contribute to such differences. The viability data and total development time results agree with findings reported by Nava *et al.* (2007) who found that the temperatures near to 28°C are the thermal optimum for egg-adult development, allowing shorter development time and high viability. Furthermore, these results indicated that the diet used in this experiment was convenient for rearing this species and achieving successful development under the laboratory conditions.

The mean longevity of sexually active female flies obtained in our study was lower than those recorded by Amoudi *et al.* (1991) for Saudi population of *Z. indianus* which was 50.4 days, while the mean longevity of sexually active male flies obtained in our study has the same value of that recorded by Amoudi *et al.* (1991) which was 42.2 days.

Döge *et al.* (2009) studied the effect of marking virgin adult flies of South American strains of *Z. indianus* with marker pen ink on persistence of marks and longevity at 25°C and using cornmeal media for rearing adult flies. They obtained mean longevity of non-marked virgin females of 32.9 day which was similar record as in our study, and mean longevity of non-marked virgin males of 18.7 day which was lower than we recorded..

However, studies of longevity of sexually active and inactive flies carried out by Setta and Carareto (2005) for Brazilian population, which were reared on banana-agar media at 25°C, were found to be higher than that obtained for the Jordanian population of the fly. Also it was observed that sexually active and inactive females lived longer than males, while results from our study showed that females died earlier than males.

Pires *et al.* (2008) evaluated the longevity of sexually active adult flies from two geographic strains of Brazilian population, the Jaboticabal strain and the Valinhos strain at 25±2 °C. Our results are in line with the findings of Valinhos strain which had males mean longevity of 53.51 day and females mean longevity of 33.53 day.

Females had a shorter life cycle than males in both cases, due to the oviposition process which was observed in sexually active and inactive female flies and it may cause depletion of protein and energy for egg production. Also we found that the mean longevity of sexually active female flies (37.7 day) is higher than that of sexually inactive female flies (26.0 day), despite they laid fertile eggs at high rate. These differences in longevity values could be due to the experimental conditions such as the culture medium used for feeding adult flies, controlled temperature, photoperiod and uncontrolled relative humidity.

In general, these overall variations in biological parameters from our results could be related to different photoperiod, relative humidity and type of diet provided to parental adult flies for feeding and oviposition. In addition, different fly populations from different geographical areas were studied; flies

were collected in Saudi Arabia from Taif area which is about 1600 m above sea level (Amoudi *et al.*, 1991), while flies in the present study were collected from Jordan Valley about 220 m below sea level.

It will be interesting to verify the lower temperature threshold for development and the thermal constant (Degree-Days) values for the egg, larval and pupal stages, which can be used when applying control measures during fruits storage and exportation, especially fig fruits. Finally, there is a need of further research on the ecology of *Z. indianus* to investigate its seasonal dynamics.

### CONCLUSIONS

The African fig fly was successfully reared under laboratory conditions at  $25\pm 1^{\circ}\text{C}$ ,  $75\pm 10\%$  RH, and 14 h photoperiod on mashed banana fruits with dry active yeast for the first time. Most life cycle parameters were comparable to other populations of the fly in other countries such as Saudi Arabia and Brazil. However, some differences were found which could be due in part to differences in experimental conditions and diet components. The results could be helpful in the management of this pest in Jordan.

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