Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(2): 1149-1153

Received: 14-01-2019
Accepted: 18-02-2019

A Vasudha
Department of Entomology,
Dr. Rajendra Prasad Central Agricultural University
Pusa, Samastipur, Bihar, India

Md. Abbas Ahmad
Department of Entomology,
Dr. Rajendra Prasad Central Agricultural University
Pusa, Samastipur, Bihar, India

ML Agarwal
Department of Entomology,
Dr. Rajendra Prasad Central Agricultural University
Pusa, Samastipur, Bihar, India

Correspondence
A Vasudha
Department of Entomology
Dr. Rajendra Prasad Central Agricultural University
Pusa, Samastipur, Bihar, India

Life history traits and immature stages of *Zeugodacus (Zeugodacus) tau* (Walker) (Diptera: Tephritidae)

A Vasudha, Md. Abbas Ahmad and ML Agarwal

Abstract
Experimental studies on life history traits and immature stages of pumpkin fruit fly, *Zeugodacus* (*Zeugodacus*) *tau* (Walker) revealed that the pre-oviposition and incubation periods were 11-13 days and 1.21 ± 0.06 days, respectively. Per cent hatchability of eggs was 80.0 ± 7.07 per cent. The average duration of larvae was 6.60 ± 0.15 days and larval survival was 75.00 ± 11.18 per cent. The average pupal duration was 7.45 ± 0.23 days and the percentage of adult emergence from pupae was 70.00 ± 7.07 per cent. Sex ratio (male: female) was 1:1.27 and life-cycle was completed in 15.26 ± 0.23 days. The freshly laid eggs were elliptical, glistening white measuring 1.3-1.4 mm long and 0.22-0.24 mm wide. The three larval instars measured 1.8-3.0, 3.8-7.0 and 7.8-9.0 mm, respectively. Pupa was exarate, 4.9-5.5 mm long, brownish or reddish-brown, with free appendages, encapsulated within a puparium. Illustrations for various life stages of *Z. tau* have been included.

Keywords: Life history traits, *Zeugodacus tau*, immature stages, tephritidae

1. Introduction
Cucurbits (Family: Cucurbitaceae) are one among the largest number of summer and rainy season fruits and vegetables grown extensively all over the India. Cucurbits share about 5.6 per cent of the total vegetable production in India and used/ consumed in various forms. Some of these, e.g. bitter gourd are well known for their unique medicinal properties. Cucurbits are infested with various pest insects' right from the primordial stages of the crop to harvest of the products (Rai *et al*., 2008) [17]. Among them dacine fruit flies (Tephritidae: Dacinae: Dacini) are the most serious pests causing considerable losses both in yield and quality of nearly all kinds of cucurbits. In India, fruit flies belonging to the genera *Dacus* Fabricius and *Zeugodacus* Hendel are most serious cucurbit infesting pests causing enormous direct losses. All Dacini members are frugivorous or florivorous and about 10 per cent of the 932 currently recognized species are pests of commercial fruits and vegetables (Doorenweerd *et al*., 2018) [5]. At least 50 species of fruit flies have been considered to be important pests in tropical and subtropical areas of the world, many of which are highly polyphagous (White and Elson-Harris, 1992) [22]. The adults of polyphagous species have high mobility, relatively long life span (often more than three months), high fecundity (> 1000 eggs/female) (Vargas *et al*., 1984) [21], scramble type competition in the larval stage, several generations per year and the ability to pass unfavourable periods of the year in a facultative reproductive diapause when necessary (Fletcher, 1987) [7].
Pumpkin fruit fly, *Zeugodacus* (*Zeugodacus*) *tau* (Walker) (= *Bactrocera* (*Zeugodacus*) *tau*) damages a number of host plants species belonging to 23 families, but plants belonging to the family Cucurbitaceae are preferred most. *Zeugodacus tau* consists of a complex of different species which feed on varieties of agricultural crops (Allwood *et al*. 1999; Shi *et al*. 2017) [2] [19]. The losses caused by fruit flies particularly by *Z. tau* have been estimated to be as high as 40 per cent of the production in Indonesia (Hasyim *et al*., 2004) [9]. The fly is well distributed throughout the Oriental region (Agarwal and Sueyoshi, 2005 [1]; Drew and Romig, 2013) [6]. In India, hosts of *Z. tau* have been listed by (Narayanan and Batra, 1960 [16]; Kapoor and Agarwal, 1983 [13]; Kapoor, 1993) [12]. Liquido *et al*. (2016) [14] mentioned that *Z. tau* infests 77 suitable hosts while 30 are undetermined hosts. Hosts of *Z. tau* have also been listed on the websites of (CABI, 2018 [4] and by Jaleel *et al*., 2018) [10]. The knowledge of life history traits and different life stages of any pest is helpful in developing effective and timely management

strategies and information pertaining to the life history traits and morphology of immature stages of *Z. tau* has been given here.

2. Materials and Methods

The studies pertaining to biology and morphology of *Zeugodacus tau* (Walker) were conducted in the laboratory of the Department of Entomology, Dr. Rajendra Prasad Central Agricultural University (RPCAU), Pusa (Samastipur), Bihar. The adults were reared from infested cucurbits collected in the field which were kept in glass rearing jars filled with dry sand up to 5cm thick, in which emerging larvae can pupariate. The jars were covered with muslin cloth. Pupae were separated from sand and kept in glass bottles, and then covered with muslin cloth for the emergence of adult flies. Adults of *Z. tau* were separated and released in large rearing cages and were fed upon protein hydrolysate, honey, fruit juices and water soaked in foam. The adult flies were provided with cucurbits host (bitter gourd) with artificially made punctures to facilitate oviposition.

Observations pertaining to feeding, pre-oviposition period, oviposition, development and survival were taken in the laboratory during September and October, 2018. For determining the per cent hatchability of eggs and incubation period ten freshly laid eggs were taken. Ten newly hatched larvae were placed in the fresh host (bitter gourd) in Petri plate. Four such sets were maintained and larval duration and survival percentage were determined. Matured larvae ready for pupation were taken out of the sand and kept in glass tubes covered with muslin cloth for studying the pupal period and survival percentage. Sex ratio of hatched flies was also determined.

Morphological studies of immature stages were carried under a stereozoom binocular microscope and compound microscope. For the study of body structures of larval instars, they were boiled in 10 per cent potassium hydroxide (KOH) solution for 5-10 minutes and allowed to soak in this solution for 2-3 hours. Different body structures of larvae, *viz*. cephalopharyngeal skeleton, anterior and posterior spiracles were dissected, washed in water, stained with mercurochrome (1 % solution of stain powder mixed in water) and then temporarily mounted in glycerol for further study.

3. Results and Discussion

3.1 Life history traits: *Z. tau* is polyphagous, multivoltine, with high fecundity, actively mobile adults, have no obligatory diapausing stage and the number of generations per year is largely determined by the climate. For mating the female approaches the male by taking short flights and/ or walking. Male female encounter occurs, and their orientation is usually frontal (face to face). When the female is nearer the male, it attempts copulation and alights on the abdomen of the female; heads of both remain in the same direction and that of male touching the scutellum of the female. The extended ovipositor is then fixed to the genital orifice of the male by jerking movements. The mating duration was more than one hour after which they separate.

In *Z. tau* the pre-oviposition period after adult emergence was 11-13 days. Gravid female explores the host surface by using sensilla on proboscis and tip of aculeus and after site selection, the ovipositor is protruded and inserted in host tissues by its forward and backward movements. The ovipositor forms a cavity in host's tissues for deposition of eggs. The complete act of oviposition took about 5-6 minutes. The female laid 6-12 eggs/ day. Data pertaining to life history traits of *Z. tau* is depicted in tables 1 - 2, figure 1. The average incubation period was recorded as 1.21 ± 0.06 days. Per cent hatchability of eggs was 80.0 ± 7.07 per cent. The average duration of larvae was 6.60 ± 0.15 days and survival of larvae after hatching from eggs till they attain full maturity was 75.00 ± 11.18 per cent. The average pupal duration was 7.45 ± 0.22 days. The percentage of adult emergence from pupae was 70.00 ± 7.07 per cent. Adult emerges from puparium by breaking the front of the puparium and usually the flies emerged in the morning. Sex ratio (male: female) was 1:1.27 in *Z. tau* and the life-cycle was completed in 15.26 ± 0.23 days. The duration of life stages in fruit flies is greatly influenced by temperature and also varies with the host on which the larvae feed (Fletcher, 1989 [8]; Yang and Dowell, 1994 [23]). Kabir *et al*. (1997) [11]) reported that in *Z. tau* mean pre-oviposition period was 15.67 ± 3.73 days; incubation period lasted 1-3 days (mean 1.83 ± 0.65 days) depending on the seasons; larval stage lasted 10 to 19 days (mean 13.08+or-2.83 days) while the pupal life occupied 7 to 13 days (mean 8.83 ± 2.07 days). The total life cycle lasted for 29 to 58 days. Liu and Lin (2000) [15] reported that in *Z. tau* developmental time for egg required 7.48 days at 10°C, while it took only 0.87 days at 35°C. The developmental time was longest for larval stage (29.75 days) at 10 °C, while only 8.23 days were required at 30 °C. The developmental time for pupae of *Z. tau* was 25.36 days at 15 °C and 7.23 days at 30 °C. Singh *et al*. (2010) [20] reported that in *B. tau* (presently *Zeugodacus tau*) pre-oviposition period was 11.7 ± 4.49 days. The oviposition rate was 9.9 ± 8.50 eggs; females mate only once and fecundity was 464.6 ± 67.98 eggs/ female. The egg period lasted for 1.3 ± 0.41 days; larval duration was 1.2 ± 0.42, 1.7 ± 0.48 and 4.0 ± 0.94 days for first, second and third instars, respectively. Pupal period was 7.0 ± 0.47 days. The life cycle was completed in 14.2 ± 1.69 days. However, the significant difference has been observed in development time of fruit flies at the following temperatures 18, 21, 24, 27, and 30 °C (Shen *et al*., 2014) [18]. Present findings corroborate the results published by (Kabir *et al*., 1997 [11]; Liu and Lin, 2000 [15]; Singh *et al*., 2010 [20] and Shen *et al*., 2014) [18].

3.2 Morphology of immature stages

3.2.1 Egg (figures 2a, 3a)

Elongated, elliptical, glistening white, gradually pointed at anterior micropyle end and blunt at other; chorion covered with polygonal microsculpturing; length 1.3-1.4 mm and width 0.22-0.24 mm.

3.2.2 Larva

Three larval instars, creamy-whitish, amphipneustic, with tapering anterior end; twelve segmented; a small head, 3 thoracic (T_1-T_3) and 8 abdominal (A_1-A_8) segments. Last abdominal segment (caudal segment) represents fused segments A_8-A_{10}.

3.2.2.1 First instar larva: Elongated, creamy-white, almost translucent, 1.8-3.00 mm long with distinct body segmentation; head segment with antennal and maxillary sense organs; cepahalopharyngeal skeleton weakly sclerotized; mouthhooks without preapical teeth; hypopharyngeal and pharyngeal sclerites fused forming a long, rod-like structure; pharynx supported by weakly

sclerotized dorsal and ventral cornua; anterior spiracles not developed, posterior spiracles with two oval openings and sometimes form a complete ring; posterior spiracles with interspiracular hairs arranged in four groups.

3.2.2.2 Second instar larva: Creamy-whitish; 3.8-7.0 mm long; anterior spiracles present on T_1, with 14-16 tubules; cephalopharyngeal skeleton well developed, mouthhooks heavily sclerotized, slightly thicker at apices, brownish in apical half and black in posterior half, preapical teeth absent; hypopharyngeal sclerite small and parastomal bars lie above hypopharyngeal sclerite; pharynx supported by weakly sclerotized dorsal and ventral cornua posterior spiracle with 3 elongated slits and situated on weakly sclerotized spiracular plate; spiracular hairs arranged in four groups; ecdysial scar or button present on inner side of each spiracle.

3.2.2.3 Third instar larva (figures 2b, 3b): Elongate, tapering anteriorly, range from 7.8-9.0 mm; whitish to yellowish; head with well developed cephalic lobes and antennal and maxillary sense organs; antenna 2-segmented; mouthhooks heavily sclerotized, without preapical teeth; cephalopharyngeal skeleton (figure 3c) well developed, small dental sclerite below mouthhooks, parastomal bars elongate; anterior sclerite (figure 3d) present on either side of pharyngeal sclerite; pharynx supported by dorsal and ventral cornua, dorsal cornu clefted distally; thoracic segments (T_1-T_3) with discontinuous rows of dorsal spinules; anterior spiracles elevated, with 14-16 tubules; posterior spiracle (figure 3e) with 3 long and slender slits that lie on a sclerotized spiracular plate and with heavily sclerotized rimae; spiracular hairs arranged in dorsal and ventral bundles (with 14-18 hairs) and lateral bundles (with 5-9 hairs); anal lobes simple, not protuberant (figure 3f); ecdysial scar present.

3.2.3 Pupa (figures 2c, 3g): Pupa exarate, 4.9-5.5 mm long, brownish or reddish-brown, with free appendages, encapsulated within a barrel-shaped puparium; 11 segmented; number of tubules in anterior respiratory spiracles and comparative size of both spiracles same as in third instar larva.

The characters of immature stages of *Z. tau* as cited in earlier publications of Batra (1968) [3]; White and Elson-Harris (1992) [22]; Singh *et al*. (2010) [20]; Liu and Lin (2000) [15] and CABI (2018) [4] are in agreement with present results.

Table 1: Life-history traits of *Zeugodacus tau* on bitter gourd

No. of eggs	Incubation period (in days)	No. of larvae hatched	Per cent hatchability	Larval duration (in days)	Pupal duration (in days)	Total duration (in days)
10	1.30	8	80	6.70	7.50	15.50
10	1.17	7	70	6.50	7.80	15.47
10	1.13	8	80	6.80	7.20	15.13
10	1.25	9	90	6.40	7.30	14.95
Average	1.21 ± 0.06	8.0 ± 0.70	80 ± 7.07	6.60 ± 0.15	7.45 ± 0.22	15.26 ± 0.23

Table 2: Survival percentage of larvae and pupae and sex ratio of *Zeugodacus tau* on bitter gourd

No. of larvae	Larvae survived	Survival percentage	No. of pupae	Flies hatched	Survival percentage	Sex ratio (Male: Female)
10	8	80	10	7	70	1:0.75
10	7	70	10	6	60	1:2.00
10	9	90	10	8	80	1:1.00
10	6	60	10	7	70	1:1.33
Average	7.50± 1.11	75.00 ±11.18	10	7.0 ±0.70	70.00 ±7.07	1:1.27

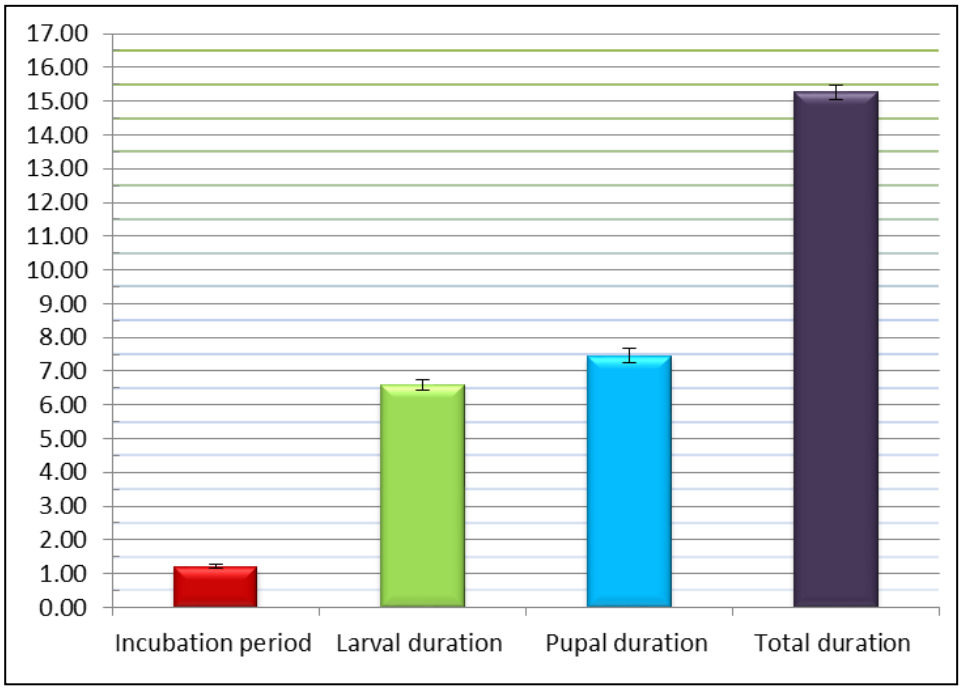

Fig 1: Duration of life stages of *Zeugodacus tau* on bitter gourd

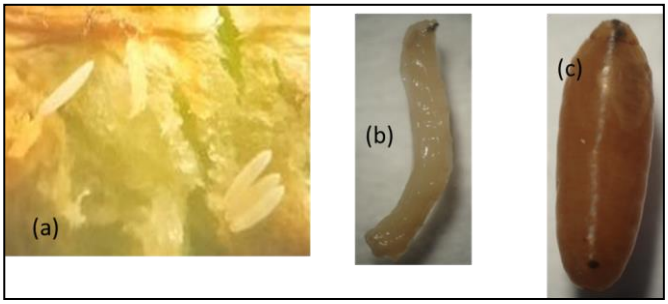

Fig 2: *Zeugodacus tau* (Walker): (a) – eggs, (b) - 3rd instar larva, (c) – pupa

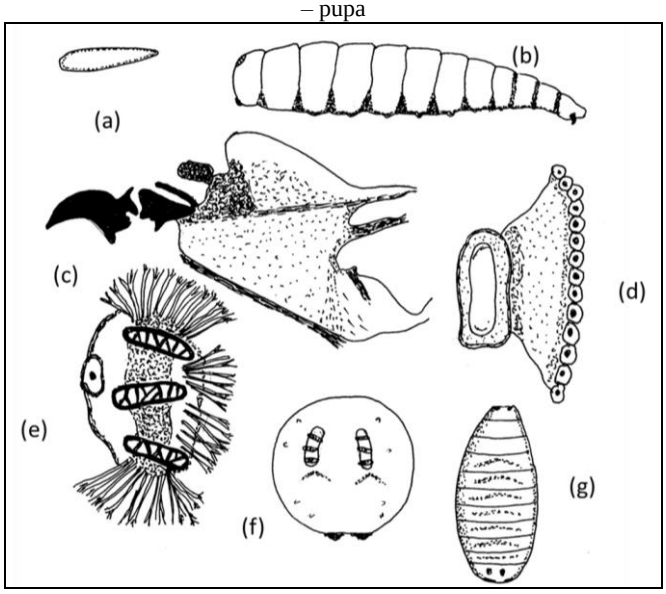

Fig 3: *Zeugodacus tau* (Walker): (a) – egg, (b) – 3rd instar larva, (c) – cephalopharyngeal skeleton of 3rd instar larva, (d) – anterior respiratory spiracle, (e) – posterior respiratory spiracle, (f) – caudal segment of 3rd instar larva, (g) – pupa

4. Conclusion

According to the studies conducted it was observed that the total life-cycle of *Z.* (*Z.*) *tau* was completed in 15.26 ± 0.23 days under laboratory conditions. The incubation period was 1.21 ± 0.06 days while per cent hatchability of eggs was 80.0 ± 7.07 per cent. The average durations of larval stages and pupa were 6.60 ± 0.15 days and 7.45 ± 0.23 days, respectively. Egg was elongated, elliptical, glistening white, gradually pointed at anterior micropyle end; chorion covered with polygonal microsculpturing. Larvae were creamy-whitish, amphipneustic, twelve segmented and pupa was exarate, brownish or reddish-brown, with free appendages, encapsulated within a barrel-shaped puparium; 11 segmented.

5. References

1. Agarwal ML, Sueyoshi M. Catalogue of Indian fruit flies (Diptera: Tephritidae). Oriental Insects. 2005; 39:371-433.
2. Allwood AJ, Chinajariyawong A, Kritsaneepaiboon S, Drew RAI, Hamacek EL, Hancock DL *et al*. Host plant records for fruit flies (Diptera: Tephritidae) in South East Asia. The Raffles Bulletin of Zoology, Supplement. 1999; 7:1-92.
3. Batra HN. Biology and bionomics of Dacus hageni de Meijere. Indian Journal of Agricultural Sciences. 1968; 38(6):1015-1020.
4. CABI, Bactrocera tau. Invasive species compendium. https://www.cabi.org/isc/datasheet/8741. 27 March, 2018.
5. Doorenweerd C, Leblanc L, Norrbom AL, San Jose M, Rubinoff D. A global checklist of the 932 fruit fly species in the tribe Dacini (Diptera, Tephritidae). Zoo Keys, 2018; 730:17-54.
6. Drew RAI, Romig MC. Tropical Fruit Flies (Tephritidae: Dacinae) of South-East Asia. CAB International, Wallingford, 2013, 653.
7. Fletcher BS. The biology of dacine fruit flies. Annual Review of Entomology. 1987; 32:115-144.
8. Fletcher BS. Life history strategies of tephritid fruit flies. In: Fruit Flies: Their Biology, Natural Enemies and Control. World Crop Pests. 3B. Robinson AS, Hooper G. (eds.). Elsevier Science Publication, Amsterdam. 1989, 195-208.
9. Hasyim A, Muryati, Khairul M, Riska, Kogel WJ de. Fruit fly control in Indonesia. Annual Report, Research Institute of Fruit Solok. Unpublished Report (In Bahasa Indonesia), 2004.
10. Jaleel W, Lu L, He Y. Biology, taxonomy, and IPM strategies of Bactrocera tau Walker and complex species (Diptera: Tephritidae) in Asia: a comprehensive review. Environmental Science Pollution Research. 2018; 25(10):19346-19361. Published online, 2 June 2018.
11. Kabir SMH, Rahman R, Moll MAS. Biology of Dacus (Zeugodacus) tau Walker (Tephritidae: Diptera). Bangladesh Journal of Zoology. 1997; 25(2):115-120.
12. Kapoor VC. Indian Fruit Flies (Insecta: Diptera: Tephritidae). (ed. 1), Oxford & IBH Publications Company, New Delhi, 1993, 228.
13. Kapoor VC, Agarwal ML. Fruit flies and their increasing host plants in India. In: Fruit Flies of Economic Importance. Cavalloro R. (ed.), CEC/IOBC Symp. Athens 1982. Balkema, Rotterdam, 1983, 252-257.
14. Liquido N, McQuate G, Suiter K. USDA Compendium of fruit fly host information (CoFFHI) In: Proceedings 9th International Symposium on Fruit Flies of Economic Importance (ISFFEI). Sabater-Muñoz B, Vera T, Pereira R, Orankanok W. (eds.), Bangkok, Thailand, May 12-16th, 2014, 420-434.
15. Liu YC, Lin MY. Morphology, development, longevity and mating behaviour of Bactrocera tau (Diptera: Tephritidae). Chinese Journal of Entomology. 2000; 20(4):311-325.
16. Narayanan ES, Batra HN. Fruit Flies and Their Control. Indian Council of Agricultural Research Publication, N. Delhi, 1960, 60.
17. Rai M, Pandey S, Kumar S. Cucurbit research in India: a retrospect. In: Cucurbitaceae 2008. Proceedings IX EUCARPIA Meeting on Genetics and Breeding of Cucurbitaceae. Pitrat, M (ed.). INRA, Avignon (France), May 21-24th, 2008, 285-293.
18. Shen K, Hu J, Wu B, An K, Zhang J, Liu J *et al*. Competitive Interactions between Immature stages of Bactrocera cucurbitae (Coquillett) and Bactrocera tau (Walker) (Diptera: Tephritidae) under laboratory conditions. Neotropical Entomology. 2014; 43(4):335-343.
19. Shi W, Yang TY, Ye H, Cao J. Impact of host plants on genetic variation in the Bactrocera tau (Diptera: Tephritidae) based on molecular markers. Journal of Entomological Sciences. 2017; 52:411-426.
20. Singh S, Kumar D, Ramamurthy VV. Biology of Bactrocera (Zeugodacus) tau (Walker) (Diptera: Tephritidae). Entomological Research. 2010; 40:259-263.

21. Vargas RI, Miyashita D, Nishida T. Life-history and demographic parameters of three laboratory reared tephritids (Diptera: Tephritidae). Annals of the Entomological Society America. 1984; 77:651-656.
22. White IM, Elson-Harris MM. Fruit Flies of Economic Significance: Their Identification and Bionomics, (ed. 1). CAB International Publishing, Wallingford. 1992; 512pp.
23. Yang P, Carey J, Dowell R. Host-specific demographic studies of wild Bactrocera tau (Walker) (Diptera: Tephritidae). Pan-Pacific Entomologist. 1994; 70:253-258.