

ARTÍCULO ORIGINAL

THE MELON FRUIT FLY, *Bactrocera cucurbitae* (COQUILLET) (DIPTERA: TEPHRITIDAE), A SERIOUS THREAT TO FRUIT PRODUCTION WORLDWIDE AND ITS QUARANTINE STATUS IN THE U.S.

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Introduction

Agricultural Importance

Bactrocera cucurbitae or the melon fruit fly is one of the most important pests for vegetable crops in particular for cucurbits. In Asia, the melon fruit fly is the major limiting factor in the production of bitter melon (*Momordica charantia*) according to Srinivasan (1959), Lall and Singh (1969), Mote (1975), and Rabindranath and Pillai (1986). Fruit infestation by melon fruit fly in bitter melon has been reported to vary from 41 to 89% (Lall and Sinha 1959, Narayanan and Batra 1960, Kushwaha et al. 1973, Gupta and Verma 1978, Rabindranath and Pillai 1986). The melon fruit fly has been reported to infest 95% of bitter melon fruits in Papua (New Guinea), and 90% snake melon and 60 to 87% pumpkin fruits in Solomon Islands (Hollingsworth et al. 1997). Singh et al. (2000) reported 31.27% damage on bitter melon and 28.55% on watermelon in India. In the United States the melon fruit fly is present in Hawaii and has been intercepted and eradicated in the continental part of the country in several occasions (see figures 1 and 2).

Distribution

The melon fruit fly is distributed all over the world, with India

considered to be its native home. The species has been particularly damaging in islands and its eradication has proven to be difficult, for instance in the Northern Mariana Islands the species was first detected in 1943 and officially eradicated in 1963 (Steiner et al. 1965, Mitchell 1980), until it was re-established from the neighboring Guam in 1981 (Wong et al. 1989) and in Nauru Island it was detected in 1982, eradicated in 1999, but was re-introduced in 2001 (Hollingsworth and Allwood 2002). In the U.S.A. the species is found in Hawaii where it was introduced from Japan in the late 1800s, it is absent from the continental United States (Weems and Heppner 2001). For a detailed worldwide

distribution of the pest see table by CABI 2013 at <http://www.cabi.org/dmpp/?loadmodule=review&page=4049&reviewid=15377&site=164> and figure 1 below. Figure 2 displays the present status of the melon fly in the United States.

Diagnosis and description of life stages

Egg

Eggs are usually 0.8 mm long, 0.2 mm wide, with the micropyle protruding slightly at the anterior end. The chorion is reticulate (not visible with a compound microscope) and with a yellowish-white coloration.

Figure 1. Worldwide distribution of *Bactrocera cucurbitae* (Coquillett) (Insecta: Diptera: Tephritidae). Modified from CABI, 2013.

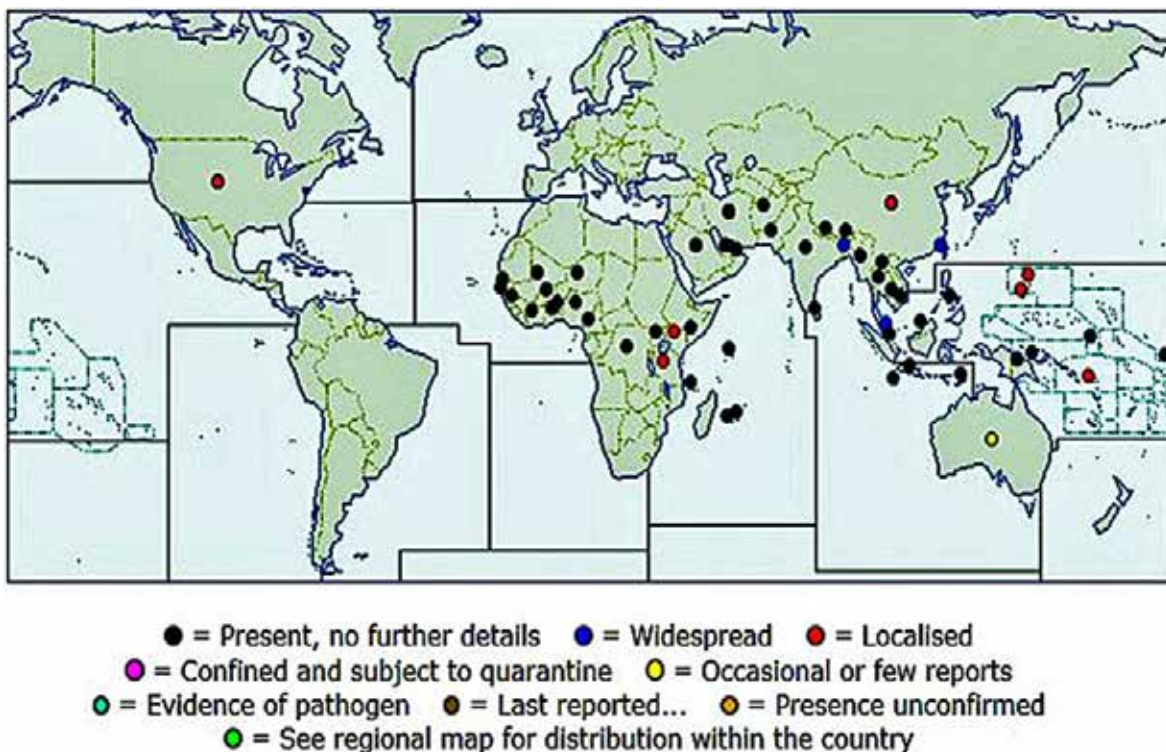


Figure 2. Survey status of the Melon Fruit Fly (*Bactrocera cucurbitae*) in the U.S. from 2010 to the present. Modified from USDA-APHIS, CAPS and CERIS.



Larva (last instar)

Usually 9.0-11.0 mm in length and 1.0-2.0 mm width. **Head** with stomal sensory organ small, completely surrounded by 6-7 large pre-oral lobes, some bearing serrated edges similar to oral ridges; oral ridges with 17-23 rows of moderately long, uniform, bluntly rounded teeth; accessory plates numerous, with serrated edges and interlocking with oral ridges; mouth hooks large, heavily sclerotized, each with a small, but well-defined pre-apical tooth. **Thorax and Abdomen** as follows: anterior portion of T1 with an encircling, broad band of spinules which dorsally and laterally form small plates 7-10 rows deep, becoming discontinuous rows ventrally; T2 with smaller, stouter spinules, forming 5-7 discontinuous rows around anterior portion of segment; T3 similar to T2, but reduced to 4-6 rows. Creeping welts obvious, with 9-13 rows of small spinules.

A8 with large well rounded intermediate areas, almost linked by a large, slightly curved, pigmented transverse line (mature larvae only). Tubercles and sensilla well defined. **Anterior spiracles** with 16-20 tubules; **Posterior spiracles** with spiracular slits large, with heavily sclerotized rimae; about 3 times as long as broad. Spiracular hairs long, fine and often branched in apical half; dorsal and ventral bundles of 6-12 spiracular hairs; lateral bundles of 4-6 hairs. **Anal area** with lobes large and with a lightly sculptured surface, surrounded by 3-7 rows of spinules. Around outer edges spinules small, in discontinuous rows; closer to anal lobes, spinules becoming stouter, and forming small groups below anal opening.

Puparium:

The puparium is barrel-shaped with most larval features unrecognizable,

the exception being the anterior and posterior spiracles which are little changed by pupariation. Its color is white to yellow-brown and the average size is usually about 60-80% the length of larva.

Adults:

Forewing with cell cup very narrow and long, with cross vein dm-cu covered by an infuscate area separated from other

parts of the wing pattern. First antennal flagellomere at least three times and long as broad. Wing pattern usually confined a costal band and an anal streak (genus *Bactrocera*). Scutellum not bilobed and with two marginal setae (although sometimes it can be four); post-pronotal lobes without well-developed seta; scutum with lateral and medial yellow-orange stripe and prescutellar acrostichal setae (subgenus *Zeugodacus*). See figures 3 and 4.

Figure 3. Habitus and maculation pattern of *B. cucurbitae* (after White and Elson-Harris, 1992).

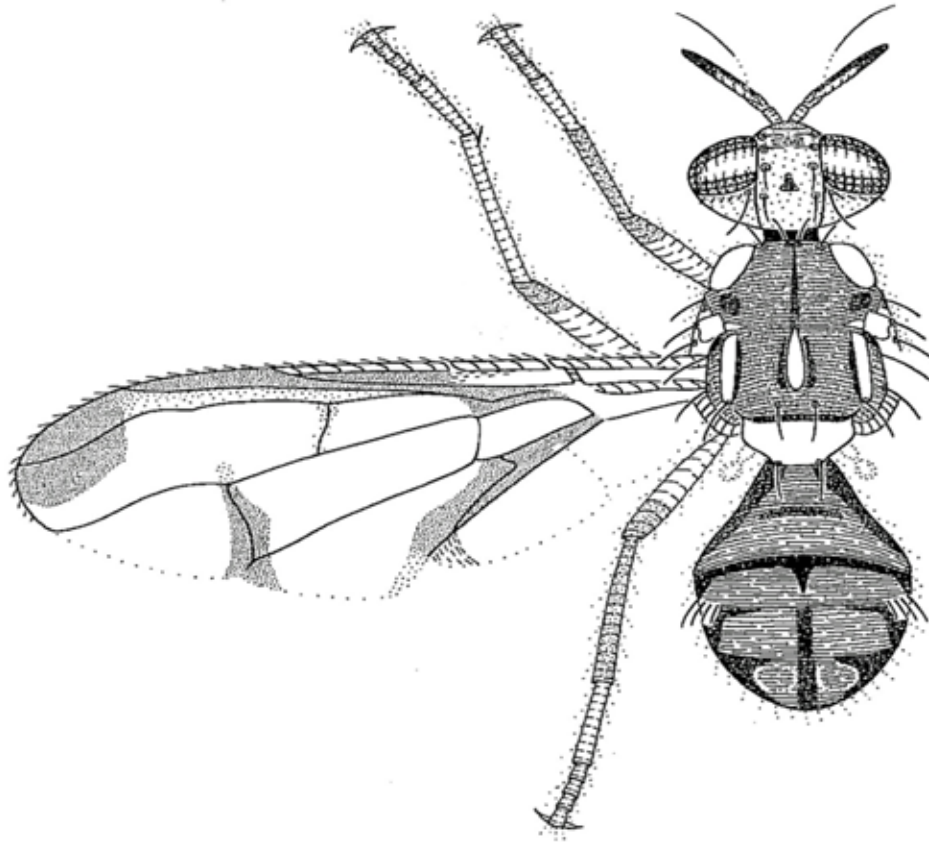
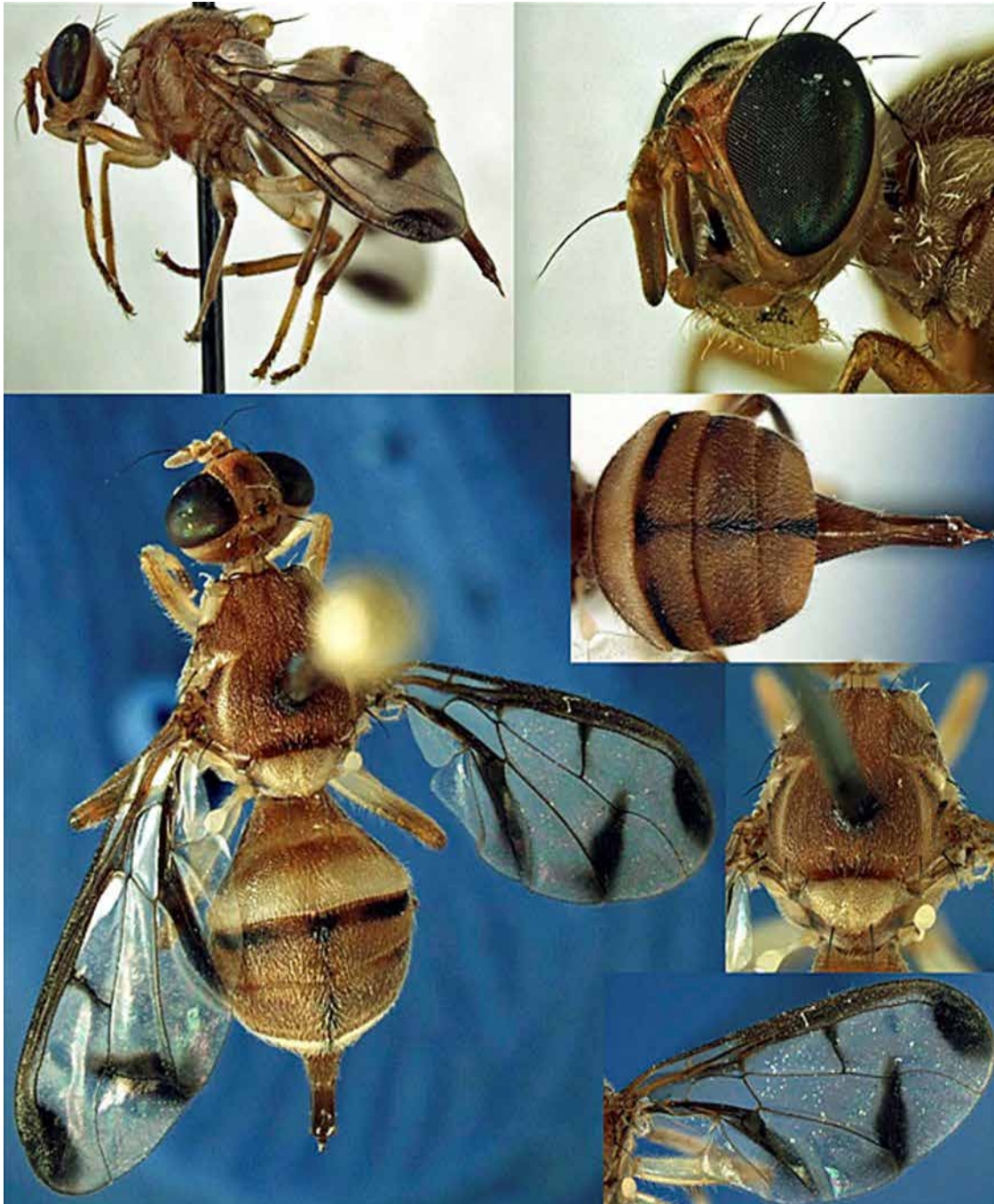




Figure 4. Female of *Bactrocera cucurbitae* intercepted in cargo in California (hitchhiker).
Photos by A.H. Smith-Pardo, USDA-APHIS-PPQ.



Hosts and Damage Produced

The melon fruit fly is considered a pest of more than 125 species of plants (some listed in the table below); however it prefers plants that belong to the Cucurbitaceae family (Allwood et al. 1999, Doharey 1983). Among the preferred hosts are bitter gourd (*Momordica charantia*), muskmelon (*Cucumis melo*), snap melon (*Cucumis melo* var. *momordica*) and snake gourd (*Trichosanthes anguina* and *T. cucumeria*).

Females lay their eggs mostly on soft fruit tissue (fruit in formation) and produce necrotic areas (brown dots) over the surface of the fruit and as a result the marketability of the product is reduced. Immature feed inside the fruits (although sometimes they can move to feed in other plant structures such as flowers or the stems), bore into the pulp tissue and make their feeding galleries, as a result fruits rot or becomes distorted. Normally, early instar larvae leave the necrotic areas of the fruit and move to healthy tissue expanding the damage and at the same time introducing various pathogens and hastening fruit decomposition. A complete list of host records for *B. cucurbitae* was produced by Dhillon et al. (2005) and presented in Table 1 below.

Material and Methods

Information regarding interceptions of *Bactrocera cucurbitae* was obtained using an ad-hoc query in the PestID database of the Agricultural Quarantine Activity System (AQAS) of the Department of Agriculture (USDA). The identification of the specimens

was provided for the most part by personnel at the Systematic Entomology Laboratory of the Agricultural Research Service (SEL), USDA - ARS.

Results

The consolidated search in AQAS from July 1988 to November 2013 yielded a total of 408 interceptions of *B. cucurbitae* at U.S. ports of entry. The state of Hawaii has by far the highest number of interceptions with a total of 314 most of them domestic contaminants (308) and the remaining from the Philippines (4) and Guam (2). The second state with the largest number of interceptions was California with a total of 19 interceptions (11 for the port of San Francisco and 8 for the port of Los Angeles), followed by New York and Texas each with 18 interceptions. In contrast to Hawaii, all interceptions in the other ports came from other countries and were found in fruits in baggage (89 interceptions) mostly from Nigeria (40 interceptions) and India (17 interceptions).

Table 1. Host plants of *Bactrocera cucurbitae* (Melon fruit fly). Modified from Dhillon et al. (2005).

Common name	Scientific name	References
Cucurbitaceous vegetables		
Bitter gourd	<i>Momordica charantia</i>	Narayanan 1953, Narayanan and Batra 1960, Wen 1985, Wong et al. 1989, Uchida et al. 1990, Pareek and Kavadia 1994, Hollisgworth et al. 1997, Altwood et al. 1999, Weems and Heppner 2001
Muskmelon	<i>Cucumis melo</i> , <i>C. melo</i> var. <i>conomon</i>	Narayanan 1953, Narayanan and Batra 1960, Wen 1985, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Snap melon	<i>C. melo</i> var. <i>conomon</i>	Narayanan 1953, Narayanan and Batra 1960, Altwood et al. 1999, Weems and Heppner 2001
Snake melon	<i>Trichosanthes anguina</i> , <i>T. cucumeria</i>	Narayanan 1953, Narayanan and Batra 1960, Hollisgworth et al. 1997, Altwood et al. 1999, Weems and Heppner 2001
Pumpkin	<i>Cucurbita maxima</i> , <i>C. pepo</i> , <i>C. moschata</i>	Back and Pembereton 1917, Narayanan 1953, Narayanan and Batra 1960, Wen 1985, Pareek and Kavadia 1994, Hollisgworth et al. 1997, Altwood et al. 1999, Weems and Heppner 2001
Cucumber	<i>Cucumis sativus</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Long melon	<i>Cucumis utilissimus</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Weems and Heppner 2001
Water melon	<i>Citrulus vulgaris</i> , <i>C. lanatus</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Chinese melon	<i>Benincasa hispida</i>	Narayanan and Batra 1960
Squash melon	<i>Benincasa hispida</i> , <i>Cucumis vulgaris</i> var. <i>fistulosus</i>	Back and Pembereton 1917, Narayanan 1953, Narayanan and Batra 1960, Altwood et al. 1999, Weems and Heppner 2001
Bottle gourd	<i>Lagenaria vulgaris</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Calabash	<i>Lagenaria siceraria</i>	Narayanan and Batra 1960, Wen 1985, Weems and Heppner 2001
Ribbed gourd	<i>Luffa cutangula</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Sponge gourd	<i>Luffa cylindrical</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Pointed gourd	<i>Trichosanthes dioica</i>	Narayanan 1953, Narayanan and Batra 1960, Pareek and Kavadia 1994, Altwood et al. 1999, Weems and Heppner 2001
Wild cucurbits	<i>Cucumis trigonus</i> , <i>C. pubescens</i> , <i>C. anguria</i> , <i>Citrulus colocynthis</i> , <i>Sicos</i> sp., <i>S. pachycarpus</i> , <i>lagenaria americana</i> , <i>Coccinia grandis</i> , <i>C. dipsaceus</i> , <i>Momordica charantia</i> var. <i>muricata</i>	Narayanan 1953, Narayanan and Batra 1960, Uchida et al. 1990, White and Elson-Harris 1994, Altwood et al. 1999, Weems and Heppner 2001, Dhillon et al. 2005b
Wild snake gourd	<i>Trichosanthes cucumerina</i>	Narayanan 1953, Narayanan and Batra 1960
Other vegetables		
Scarlet ivy gourd	<i>Cocconia indica</i>	Narayanan and Batra 1960
Kundru	<i>Cephalendar indica</i>	Narayanan 1953, Narayanan and Batra 1960
Grenadille	<i>Passiflora edulis</i> , <i>P. seemanni</i> , <i>P. quadrangularis</i>	Narayanan and Batra 1960, Weems and Heppner 2001

Tomato	<i>Lycopersicon esculentum</i>	Narayanan 1953, Narayanan and Batra 1960, Ranganath and Veenakumari 1997, Fontem et al. 1999, Weems and Heppner 2001
Brinjal	<i>Solanum melongena</i>	Narayanan 1953, Narayanan and Batra 1960, Weems and Heppner 2001
Chilly/Green pepper	<i>Capsicum frutescens</i>	Narayanan 1953, Narayanan and Batra 1960
Okra	<i>Abelmoschus esculentus</i>	Narayanan and Batra 1960, Kumagai et al. 1996
Kohl rabi	<i>Brassica culorapa</i>	Narayanan and Batra 1960, Ranganath and Veenakumari 1997
Cauliflower	<i>B. oleracea</i> var. <i>botrytis</i>	Narayanan and Batra 1960
Broccoli	<i>B. oleracea</i> var. <i>capitata</i>	McBride and Tanda 1949
Cantaloupe	Unidentified, <i>Melothria liukivensis</i>	Weems and Heppner 2001, Iwaizumi 1993
Vegetable marrow		Back and Pembereton 1917
Zingerone	<i>Bulbophyllum patens</i>	Hong and Nishida 2000
Dry onion	<i>Allium cepa</i>	McBride and Tanda 1949
Longan	<i>Euphoria longan</i>	McBride and Tanda 1949
Grain legumes		
Long bean or cowpea	<i>Vigna unguiculata</i> , <i>V. sinensis</i> , <i>V. sesquipedalis</i>	Narayanan and Batra 1960, Wong et al. 1989, Weems and Heppner 2001
String/French bean	<i>Phaseolus vulgaris</i>	Narayanan and Batra 1960, Wong et al. 1989, Weems and Heppner 2001
Lime bean	<i>Phaseolus limensis</i>	Narayanan and Batra 1960
Green gram	<i>Phaseolus radiculatus</i>	Narayanan and Batra 1960
Hyacinth bean	<i>Dolichos lablad</i>	Narayanan and Batra 1960
Pigeonpea	<i>Cajanus cajan</i>	Narayanan and Batra 1960
Other field crops		
Sunflower	<i>Helianthus annus</i>	White and Elson-Harris 1994
Sweet corn	<i>Zea mays</i>	White and Elson-Harris 1994
Fruits		
Balsam apple	<i>Diplocyclos palmatus</i>	Weems and Heppner 2001
Galls grape vine	<i>Vitis trifolia</i>	Narayanan 1953, Narayanan and Batra 1960
Shaddock pommel	<i>Citrus grandis</i>	Narayanan 1953, Tan and Lee 1982
Papaya	<i>Carica papaya</i>	Narayanan 1953, Narayanan and Batra 1960, Wong et al. 1989, Vargas et al. 1990, Weems and Heppner 2001
Guava	<i>Psidium guajava</i>	Narayanan 1953, Narayanan and Batra 1960, Wen 1985
Peach	<i>Prunus persica</i>	Narayanan 1953, Narayanan and Batra 1960, Weems and Heppner 2001



Date palm	<i>Phoenix dactylifera</i>	Narayanan 1953, Narayanan and Batra 1960
Pear	<i>Pyrus communis</i>	Narayanan and Batra 1960
Strawberry	<i>Fragaria chiloensis</i>	Narayanan and Batra 1960
Mango	<i>Mangifera indica</i>	Narayanan and Batra 1960, Weems and Heppner 2001
Tangerine	<i>Citrus reticulata</i>	McBride and Tanda 1949, Narayanan and Batra 1960, Weems and Heppner 2001
Orange	<i>Citrus sinensis</i>	Narayanan and Batra 1960, Weems and Heppner 2001
Fig	<i>Ficus carica</i>	Narayanan 1953, Narayanan and Batra 1960, Weems and Heppner 2001
Avocado	<i>Persea americana</i>	Narayanan 1953, Narayanan and Batra 1960
Sour soap	<i>Annona muricata</i>	Narayanan and Batra 1960
Custard apple	<i>Annona reticulata</i> , <i>A. squamosa</i>	Narayanan and Batra 1960
Apple	<i>Pyrus malus</i>	Narayanan and Batra 1960, Wen 1895
Litchi	<i>Litchi chinensis</i>	Wen 1985
Starfruit/carambolas	<i>Averrhoa carambolas</i>	Wen 1985, Armstrong et al. 1995
Chisese banana	<i>Musa</i> sp.	White and Elson-Harris 1994
Blue field banana	<i>Musa paradisiaca</i> , <i>M. sapientum</i>	McBride and Tanda 1949

In terms of the stages intercepted, most of the interceptions were immature stages (mostly larvae = 382 interceptions) and the rest adults (27 interceptions). Regarding the hosts, interceptions of this pest were associated with a total of 53 different hosts (most of them were fruits of various families) and 5 were hitchhikers either in containers with cargo or inside aircrafts.

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