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PAPAYA FRUIT FLY EGGS AND LARVAE (DIPTERA: TEPHRITIDAE) IN FIELD-COLLECTED PAPAYA FRUIT

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The papaya fruit fly, Toxotrypana curvicauda Gerstaecker, is a major pest of papaya, Carica papaya L., throughout much of the American tropics and subtropics. Although a series of studies was recently completed on adult behavior and life history (Landolt and Hendrichs 1983, Landolt 1984, 1985, Landolt et al. 1985, Sharp and Landolt 1984), little published information exists on the immature stages or the infestability of papaya fruit by papaya fruit flies. In support of an effort to establish a laboratory colony of papaya fruit flies on papaya fruit, an observational study of flies in field-collected fruit was conducted to determine what stages and sizes of papaya fruit were infested. Information also was gathered on the location and numbers of eggs and larvae in fruit to contribute to a more comprehensive life history of the papaya fruit fly.

Infested papaya fruit were obtained from commercial papaya groves in Dade County, Florida and from papaya trees on the grounds of the Subtropical Horticulture Research Station, Miami, Florida. Fruit of all sizes (1.9 to 15 cm diam) were randomly selected, picked, and transported to the laboratory for analysis. Damaged fruit and fruit with holes of any size were excluded from analysis, as were ripe fruit that may have been host to other species of fly larvae.

In the laboratory, fruit were first cut in half, fruit diameter and pulp thickness were measured, and fruit condition and any abnormalities were recorded. Fruit were then thoroughly dissected and searched for papaya fruit fly eggs and larvae. Fruit remnants were soaked in water overnight to drive any remaining small larvae from the pulp so they could be collected. Records were made of the location of eggs and larvae within the fruit, feeding and burrowing activity of larvae and sizes and numbers of larvae and eggs in each fruit. Identifications and measurements of eggs and larvae were made under a binocular dissecting microscope with the aid of an
ocular micrometer. All measurements were made at 10X magnification while specimens were immersed in 80% ethanol.

Of 205 infested fruit analyzed, 44 contained papaya fruit fly eggs. Eggs appeared as described by Knab and Yothers (1914), but were often linked end-to-end in strings (13/44 fruit) or in clumps (14/44 fruit) as reported by Mason (1922). The number of eggs per string or clump, indicative of a single oviposition bout by a female, ranged from 2 to 30. Numbers of eggs per fruit ranged from 1 to 30 ($\bar{X} \pm S.E. = 10.1 \pm 8.7, n = 44$). In 28 fruit with eggs, from 1 to 42 larvae were present also. Larvae in such fruit ranged from newly hatched to mature (from 0.65 to 12.3 mm long). The greatest number of eggs and larvae found together was 51. Eggs were found only within the seed cavity, either between or on immature seeds. Eggs were found in papaya fruit ranging from 1.9 to 10.9 cm (4.6 ± 1.7, n = 44) diam with pulp thicknesses (from the skin to the wall of the seed cavity) of 0.3 to 1.8 cm.

Papaya fruit fly larvae were found in 187 of the 205 infested fruit. From 1 to 56 were found per fruit, with an average of 15.1 (S.E. = 10.9) per fruit. Infested fruit ranged in size from 1.9 to 12.8 cm diam with pulp thicknesses of 0.2 to 2.0 cm. The complete range of sizes of fruit sampled was 1.9 to 15 cm diam with 0.2 to 2.5 cm thick pulp. Sixteen of 187 fruit infested were beginning to ripen, as indicated by yellow areas on the fruit exterior. Average length of larvae in this fruit (11.5 cm) was significantly greater than that of larvae in green fruit (7.7 cm) (1% level by Student's t-test). No eggs were found in fruit beginning to ripen. As reported by Mason (1922) and Knab and Yothers (1914), young larvae were found feeding on the seeds, usually within a small area of browned seed embryos; mature larvae were found tunnelling within the pulp, often near the exterior surface of the fruit.

Observations reported here indicate that the infestability of papaya fruit by papaya fruit flies may be limited by the depth of the fruit pulp. Fresh ovipositories in green fruit are outwardly visible as hardened mounds of sap on the surface (Landolt and Hendrichs 1983). In dissected fruit, the piercing of the pulp by the fruit fly ovipositor was often visible as a browning of the tissue within 2 mm of the path of the ovipositor through the pulp and by mounds of solidified sap exuded from the wound into the seed cavity. Similar wounds that did not run completely through the fruit pulp were often observed; possible evidence of an unsuccessful oviposition attempt. The absence of eggs in fruit with pulp greater than 1.8 cm in thickness suggests this may be a limiting function. Also, ovipositors of 10 field-collected female papaya fruit flies had an average length of 1.68 cm (S.E. = .09) and a maximum length of 1.85 cm, corresponding to the maximum pulp depth through which eggs were deposited.

This observed coincidence of a certain pulp thickness, presence or absence of eggs, and the length of the ovipositor indicates that female papaya fruit flies do not successfully infest fruit if they cannot get through the pulp to place eggs in the seed cavity. It is not known if this is caused by a failure to deposit eggs under those conditions, or if the eggs do not survive when placed in the pulp of the papaya fruit. Knab and Yothers (1914) found that “thick-meatged” fruit were not infested and suggested a link between this and groves of particular varieties that appeared to be free from infestation. However, as pointed out by Wolfen-
barger (1962), fruit of all varieties are thin-fleshed when young and are thus susceptible to infestation. Because fruit that escape infestation will grow to full size and maturity, harvested fruit of these larger varieties would tend to be uninfested. Since infested fruits often ripen prematurely and fall from the tree, an infestation could exist in such groves but remain undetected.

Although Mason (1922) stated that "usually an adult fly will not oviposit in a fruit with eggs or larvae," field-infested fruit was collected that contained both eggs and larvae (28), indicating otherwise. These were undoubtedly separate, temporally spaced ovipositions in the same fruit.

It appears then, that unripe papaya fruit can be infested with papaya fruit flies if the female can completely penetrate the pulp with her ovipositor, regardless of the presence or absence of other eggs or even larvae already in the fruit. Since no evidence of cannibalism by larvae was observed, it is not known what regulates numbers of larvae in papaya fruit.

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