Arrival Rates of the Oriental Fruit Fly, *Dacus dorsalis* Hendel (Diptera: Tephritidae), to Methyl Eugenol[1]

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ABSTRACT

Rates at which oriental fruit fly, *Dacus dorsalis* Hendel, males arrived at the site of the lure, methyl eugenol, were determined in the field. Arrival rate curves varied and were classified by shape into three types: Type A, a rapid initial arrival followed by a rapid decline with time; Type B, a delayed initial arrival followed by a rapid increase; and Type C, a relatively steady arrival but in low numbers. The implications of these three curves with respect to the distribution and abundance of *D. dorsalis* males are discussed.

KEY WORDS: Oriental fruit fly, methyl eugenol, arrival rates.

Methyl eugenol is the most effective and commonly used lure for attracting male oriental fruit flies, *Dacus dorsalis* Hendel (Howlett 1915, Steiner 1952, Steiner et al. 1965). In Hawaii, indices of population abundance are based on the number of flies captured per week or month in traps baited with methyl eugenol (+ toxicant) (Steiner 1957, Vargas et al. 1983). Nishida (unpublished) used methyl eugenol to monitor *D. dorsalis* populations in mango, *Mangifera indica* L., and guava, *Psidium guajava* L., orchards. Instead of using traps, he placed a drop of methyl eugenol on a leaf and recorded the time of arrival of the first fly as well as the total numbers that arrived in 5 min. The same method was used to capture males for studying the crop content (Nishida 1980). In both studies arrival rates varied greatly. On the methyl eugenol-baited leaves of certain trees *D. dorsalis* males arrived in seconds; on others, initial arrival took as long as 5 min. Total numbers that arrived per 5 min ranged from 2 to 25 flies. The present paper reports studies on the arrival rates of *D. dorsalis* males to methyl eugenol immediately after placement in the field. It attempts to explain variation observed in arrival rates.

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MATERIALS AND METHODS

Arrival Rate Determination. A simple piece of equipment was constructed to determine arrival rates of *D. dorsalis* to methyl eugenol. The device (Fig. 1), a copper sphere (7.6 cm in diam.) suspended above a 60.6 cm square sheet of hardware cloth (8 meshes per linear 2.54 cm), was hung on the branches of each test tree 1-2 m above the ground. Approximately 0.2 cc of methyl eugenol (+ .02 cc naled) was painted with a fine brush in three circles (0.5 cm in diam.) at equidistant points along the equator of the sphere. Males attracted to the lure ingested it immediately and within 10-16 sec, dropped dead on the horizontal hardware cloth under the copper ball. Dead flies were removed and counted every 5 min for 75 min. Studies were conducted on mango and guava trees. Only guava trees were fruiting at the time of the study. Studies were conducted from June to November 1981 on the island of Oahu, between 9:00 AM and 12:00 PM. Temperature at sample sites ranged from 24 to 27°C. The number of determinations in the respective localities were: Waimanalo, 30; Pearl City and Aiea, 10 each; and Waianae and Nanakuli, 5 each; for a total of 60. Because test trees were not grown commercially the distance among them varied from 15-25 m.

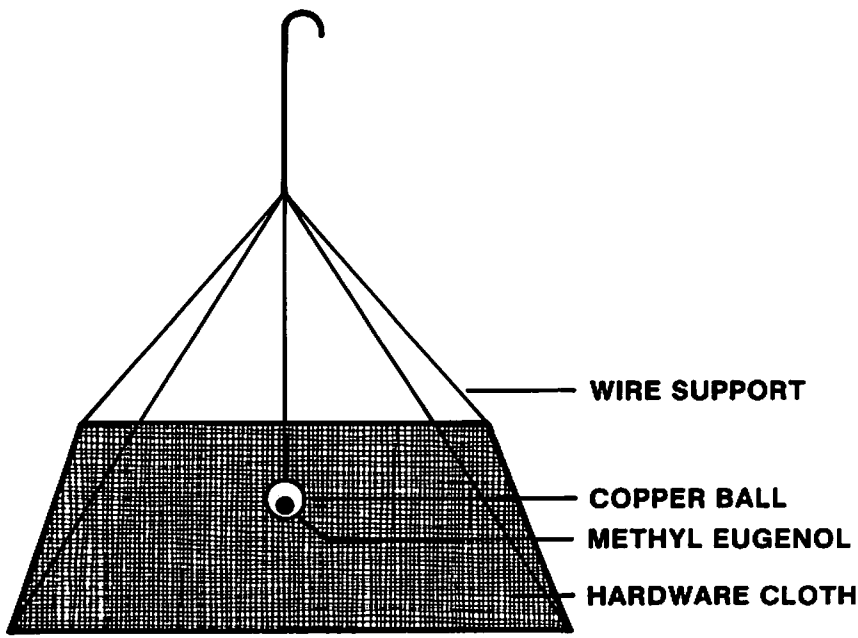

FIGURE 1. Diagram of the equipment used to determine the arrival rates of *D. dorsalis* males to methyl eugenol lure.

Alteration of Arrival Rate. A study was conducted in a mango orchard at Waimanalo to determine whether arrival rates could be altered by preluring. Twenty-four hours before determining the arrival rate using the method already described, a 5-cm-long dental wick impregnated with 2 cc of nonpoisoned methyl eugenol was suspended in test trees. To prevent ingestion of the methyl eugenol, the dental wick with the lure was encased in a cylindrical cage (5.0 cm in diameter and 8.0 cm long) constructed of hardware cloth (8 meshes per linear 2.5 cm). After 2 days the dental wick was removed and the arrival rates determined by use of the equipment described previously. There were three pre-lured trees (treated) and three non-pre-lured (control) trees.

RESULTS

Arrival Rates. A total of 60 arrival rate curves was obtained from field data. Curves were grouped according to shape into the following (Fig. 2): Type A, high initial arrival with a rapid decline with time; Type B, low initial arrival with high arrival later; and Type C, low initial arrival with minor fluctuations with time. In general, Type A and B curves were common in the humid high population areas, and Type C in the dry low population areas. The average number of flies recorded per 75 min for Type A, B, and C curves was 115, 250, and 13, respectively.

Alteration of Arrival Rate. Pre-luring altered only the initial arrival rate; it had no effect on the subsequent arrival rates (Fig. 3). Surprisingly, the alteration was not as great as anticipated considering the potency of the lure used. Evidently, males satiated with methyl eugenol vapor either did not respond to the poisoned methyl eugenol or they did not remain in the immediate vicinity. Curves shown in Fig. 3 resemble the Type A curve because trials were made in trees where Type A arrival rates occurred.

Explanation of Data. Before proceeding with the discussion it is helpful to understand certain aspects of the population behavior of *D. dorsalis* adults. Both sexes are present on trees such as mango and guava during fruiting and nonfruiting periods. Often, there are higher populations after fruiting than during fruiting. There is also much tree to tree variation in the abundance of adults, even among trees of the same species. This may be due either to inherent aggregative behavior, or to variation in the physical conditions of the micro-habitat as well as in the abundance of food in the form of honeydew and nectar. A lek behavior similar to that reported by Prokopy and Hendricks (1979) among males of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), may also be involved in the aggregation of *D. dorsalis*.

The data obtained in this study are explained on the basis of the position of the lure in relation to its distance from trees harboring various numbers of males. Obviously, those nearest to the lure will arrive earlier than those far away. The various situations (A, B, C, and D) in which the lure could be placed and the resultant arrival rates, are shown diagrammatically in Fig. 4.

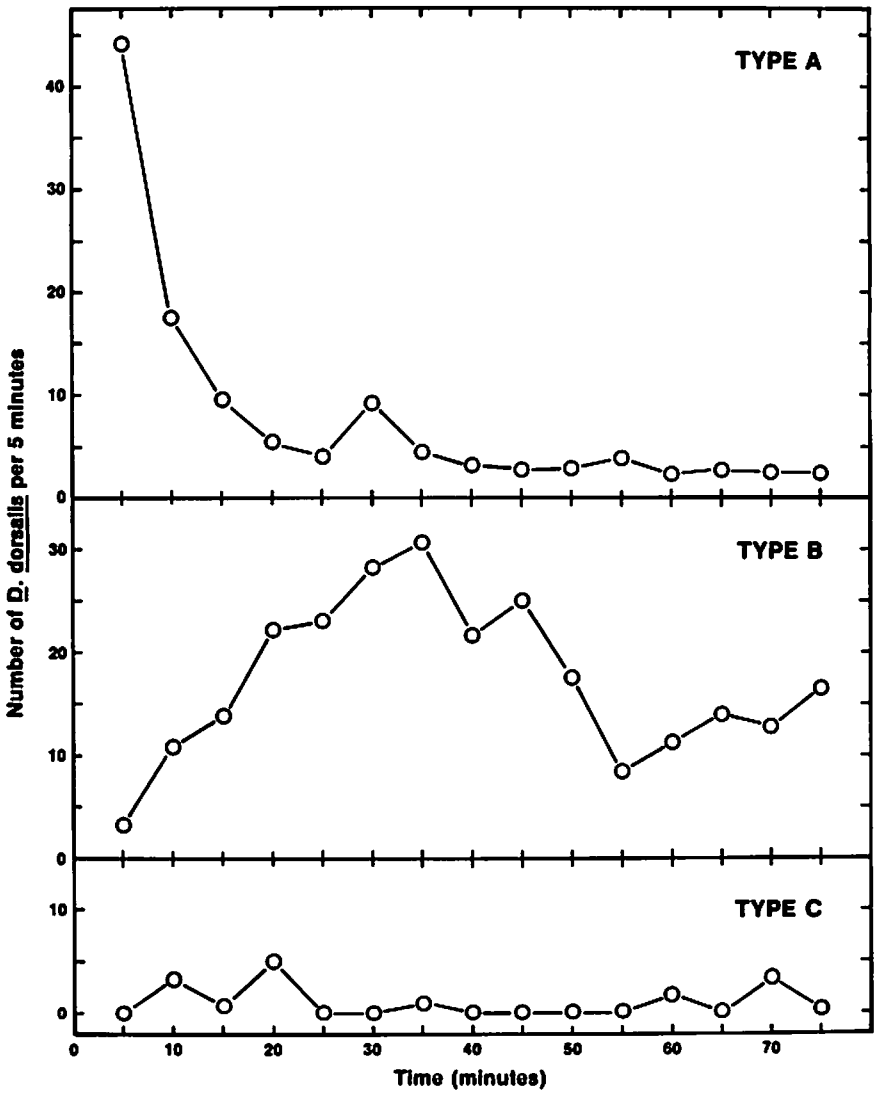

FIGURE 2. The three types of arrival rate curves of *D. dorsalis* males to methyl eugenol lure.

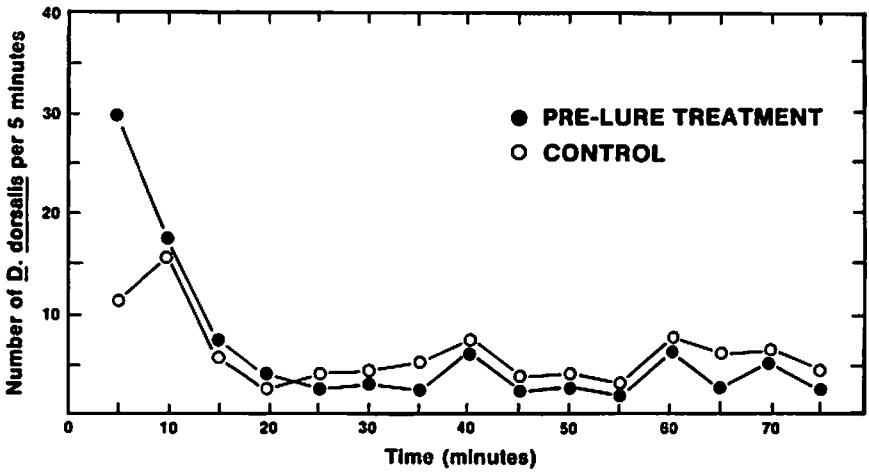

FIGURE 3. Alteration of arrival rates of *D. dorsalis* to methyl eugenol lure by pre-luring mango trees with nonpoisoned methyl eugenol.

In Situation A, the lure and the high fly population happened to be on the same tree. Because the distance between the lure and the flies was short and there were no neighboring trees with flies, the arrival rate peaked fast and then declined to zero. Although this situation is possible, it was not observed in this study. In Situation B, the lure was on the tree with a high population of flies; however, there were also many flies in nearby trees. Hence, the arrival rate peaked rapidly but didn't decline to zero because of the influx of flies from other trees. In Situation B, two groups of flies were involved; one that resided on the methyl eugenol-baited tree and the other attracted from nearby trees. Being close to the lure, the former group arrived earlier than the latter. In Situation C, the lure happened to be on a tree with no flies; however, there were numerous flies on trees away from it. In this situation there was an initial delay in the arrival rate followed by a rapid increase later. Finally in Situation D, there were few flies on the tree on which the lure was placed as well as on nearby trees. Under such a condition there would be relatively low rates of arrival without high peaks. The curves shown in Situations B, C, and D in Fig. 4 correspond to Types A, B, and C in Fig. 2.

In trapping *D. dorsalis* we normally place traps on trees in a more or less random manner without consideration of the presence or absence of flies. Therefore, some traps may be situated in favorable trees while others may be in less favorable ones. In view of the above discussion, a great variation in the arrival rates should be expected when traps are placed on trees at random.

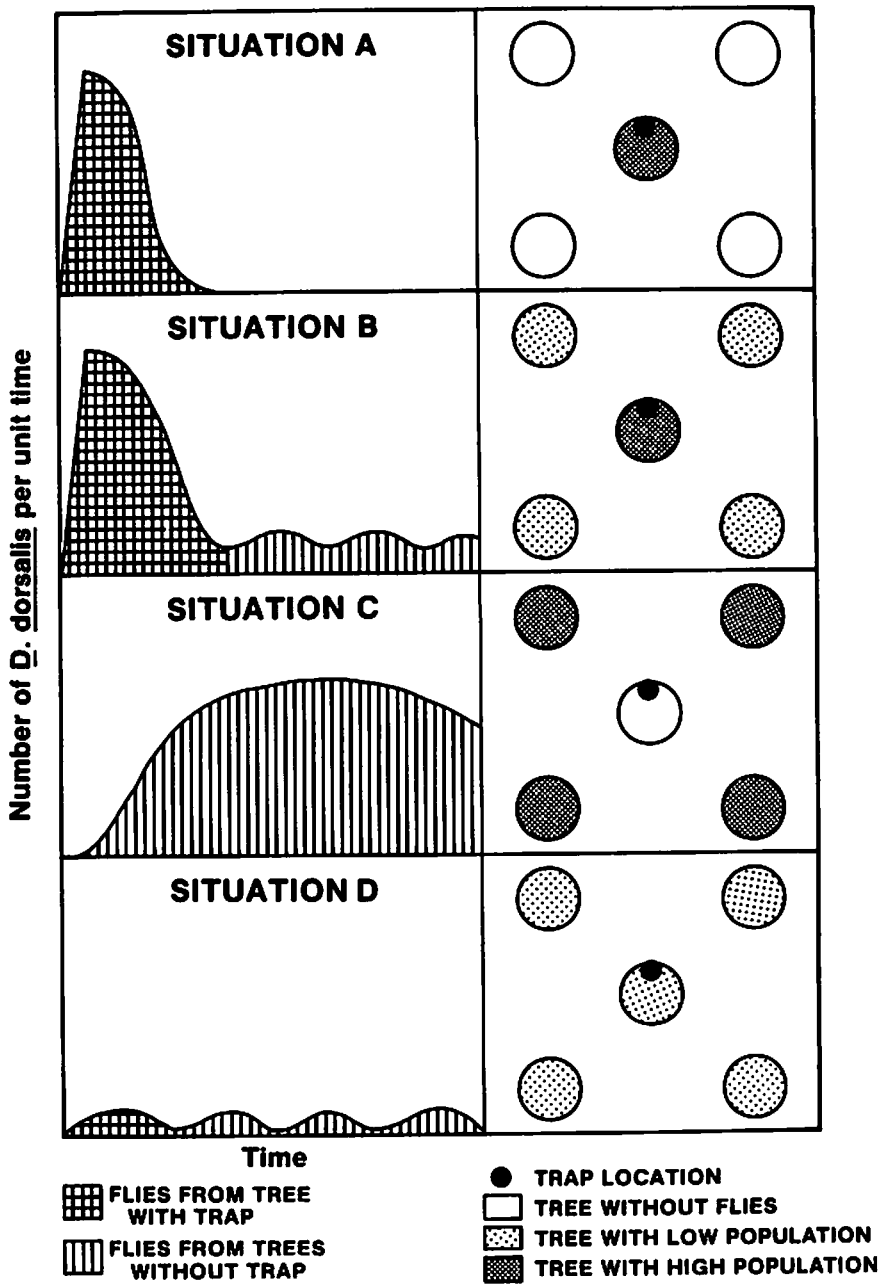

FIGURE 4. Diagram showing the types of arrival rate curves that could result from the position of methyl eugenol lure in relation to the location of the population of *D. dorsalis*.

DISCUSSION

Research of the kind reported in this paper involves two dynamic systems: 1) the behavior of the methyl eugenol molecules which is influenced by physical factors; and 2) the behavior of *D. dorsalis* males which is influenced by both physical and biological factors. Although no measurements of these factors were taken, the data presented represent the behavior of both the methyl eugenol molecules and the fly under conditions typical of habitats in Hawaii. In other habitats the arrival rates may be different.

To simplify the explanation on the variation of the shape of the arrival curves, it was assumed that methyl eugenol vapor diffused into trees with flies that were not in flight. Actually, adults remain motionless at night, but during the day there are individuals that fly from tree to tree. It is possible that some of these individuals did detect the methyl eugenol stimulus in flight and orient towards the source of the lure.

Arrival rate curves may give information on the proximity of the fly population to the lure. For example, if data fit a Type A curve, we can be reasonably sure that the bulk of the flies are nearby. On trees with the Type A curve, the arrival rate is at times so fast that *D. dorsalis* males can be seen flying around the methyl eugenol bottle soon after it is opened and before the lure is placed in the trap. If data fit a Type B curve we would know that there are no flies nearby, but there is a large population some distance away. Finally, a Type C curve will tell us that there are few flies in the vicinity of the lure as well as some distance away.

The arrival of *D. dorsalis* to methyl eugenol lure placed on mango trees is similar to that of flies arriving on individually fruiting trees to be sprayed for the control of this pest. If the tree is in Situation A, Fig. 4, effective control may be obtained by spraying it. However, in other situations, B, C, and D, control would be difficult because of the continuous arrival of flies from other trees. The various situations presented in this paper should be considered before spraying trees especially in backyard situations where there are only few trees.

The pre-luring trapping procedures discussed here may be used in developing rapid methods of monitoring the populations of *D. dorsalis*. Trees on which traps are to be placed may be pre-lured to concentrate the flies before placing the traps. By this procedure the probability of traps catching *D. dorsalis* males can be increased. This procedure should be useful in areas of sparse populations.

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