

Preliminary observations on the choice of host plants by
adults of the citrus psylla, *Trioza erytreae* (Del Guercio)
(Homoptera: Psyllidae).

by

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SUMMARY

Preliminary observations have been made on the choice of host plants by adults of the citrus psylla, *Trioza erytreae* (Del Guercio). This oligophagous insect was given the choice between leaves of *Citrus limon* (rough lemon) and four indigenous host plants, namely, *Vepris undulata*, *Clausena anisata*, *Fagara capensis* and *Calodendrum capense*. Of these hosts, *Ci. limon* was significantly more attractive to adults of *T. erytreae* as a feeding and oviposition site, and this preference was consistent even when the test psyllids had been reared for at least two generations on either *V. undulata* or *Cl. anisata*. In all cases, of the indigenous host plants tested, *V. undulata* was the most attractive to adults of *T. erytreae* for feeding and oviposition and the other indigenous plants were much less attractive. The implications of these findings are discussed.

INTRODUCTION

The development of the immature stages of the citrus psylla *Trioza erytreae* (Del Guercio) on different host plants (Moran, 1968) has indicated that, of the indigenous hosts of this oligophagous insect, *Vepris undulata* and *Clausena anisata* are the most suitable. Both these plants were found to be more favourable for the development of the immature stages of the psyllid than the exotic rough lemon, *Citrus limon*. This paper includes preliminary observations on the choice of host plants by adults of *T. erytreae*, and is a contribution to an understanding of why *T. erytreae* has been attracted to commercial citrus from its indigenous hosts and thus become a pest.

MATERIAL AND METHODS

A culture of *T. erytreae* was maintained on potted seedlings in an environment room under controlled conditions of fluctuating temperature, humidity and light, as described by Moran & Blowers (1967). All the data contained in this investigation were derived from experiments conducted in the environment room at a temperature regime of four hour degrees Centigrade per day above 20°C and 38 hour degrees Centigrade per day below 20°C.

The rough lemon, *Citrus limon* (L.) Burm. f., and four species of indigenous plants in the family Rutaceae were chosen for testing the responses of *T. erytreae* adults. The species chosen were *Vepris undulata* (Th.) Verdoorn et Sm., *Clausena anisata* (Willd.) Hook. f. ex Benth., *Fagara capensis* Thunb., and *Calodendrum capense* (L. f.) Thunb. The reason for this choice has already been given (Moran, 1968).

Simple choice chambers were used to test the responses of adult *T. erytreae* to the five different host plants. Five small water-filled flasks were used to hold the test leaves. The mouths of the flasks were covered with thin polythene and the stem of the test leaf pushed through the polythene into the water beneath. The leaves in these containers kept fresh and turgid for at least five days. The flasks containing the test leaves were arranged randomly in a row in a glass trough, the roof of which was covered with thin perforated polythene. The perforated roof retained the psyllids in the trough and prevented water condensation on the sides of the vessel and on the leaves. Adult psyllids were introduced into the experimental vessel and counts of the numbers of insects feeding on each of the five test leaves were made at irregular intervals. Experiments were started in the late afternoon because experience had shown that the psyllids were strongly positively phototactic and the majority remained on the roof of the trough during light periods. Most of the psyllids settled on the leaves during the hours of darkness and, once they had settled, the numbers feeding on each of the leaves remained almost constant until the end of the experiment. At the conclusion of each experiment, a count was made of the number of eggs laid on each of the leaves.

RESULTS

Initially, several control experiments, in which adults of *T. erytreae* were given a choice between five leaves of *Ci. limon*, were conducted. These experiments illustrated some deficiencies in the experimental design. In the first place, it was learnt that the number of psyllids feeding on each of the leaves could be correlated with surface area of the leaves. This was particularly pronounced with some of the larger leaves which touched the sides of the experimental vessel; the insects in their wanderings around the trough came into chance contact with these leaves and proceeded to feed. Secondly, it was seen that the youngest and smallest leaves were always chosen as oviposition sites and often preferentially chosen as feeding sites. In all subsequent experiments, therefore, special care was taken to choose young, tender leaves of approximately the same age and surface area.

A subsequent control experiment was conducted incorporating these precautions. In this experiment adults of *T. erytreae*, which had been reared on *Ci. limon*, for at least two generations, were given a choice of five leaves of *Ci. limon*. The numbers of insects feeding on each of the leaves, and a record of the numbers of eggs laid on each leaf, are contained in Table 1. In Table 1, and in all the following tables, adjusted chi-square values are given (using Yates' correction for small numbers) for the average number of psyllids feeding. Throughout, comments on the significance of the data are derived from the chi-square values.

TABLE 1. — The average numbers of adults feeding, and the numbers of eggs laid by *T. erytreae* on five leaves from *Citrus limon*. (Adjusted chi-square values are for the average number of adults feeding.) These data are based on 16 observations over 47 hours, using 35 females and 2 male psyllids.

	<i>Citrus limon</i>	<i>Citrus limon</i>	<i>Citrus limon</i>	<i>Citrus limon</i>	<i>Citrus limon</i>
Average No. feeding	6.0	6.6	4.3	4.7	4.3
Adjusted chi-square values. . .	0.02	0.16	0.03	0.04	0.03
Number of eggs	19	7	18	40	4

Table 1 shows that adults, of *T. erytrae* given a choice of five leaves from *Ci. limon*, fed on each of the leaves with equal frequency (none of the adjusted chi-square values is significant). This experiment was replicated twice with similar results in each case. Table 1 shows, also, that all the leaves were used as oviposition sites although equal numbers of eggs were not laid on each of the leaves. This disparity may probably be explained by Clark's (1963) observations on the attractiveness of *Eucalyptus* foliage for oviposition by the psyllid *Cardiaspina albitextura* Taylor. Clark summarizes his observations as follows; "Field observations and experiments show that, when *Eucalyptus blakelyi* is heavily infested by *Cardiaspina albitextura*, the attractiveness of leaves for oviposition is affected greatly by the psyllid itself.

It appears that the attractiveness of leaves depends not only on such factors as leaf age and position on the growing shoot but also on the quantity of favourable food available in them. Heavy feeding either by nymphal or adult psyllids greatly reduces the attractiveness of leaves as oviposition sites. On the other hand, the presence of eggs increases the attractiveness of leaves in proportion to the number laid on them."

In subsequent experiments, adults of *T. erytrae* were given a choice between leaves of the five different host plants, namely, *Ci. limon*, *V. undulata*, *Cl. anisata*, *F. capensis* and *Ca. capense*. In the first of these choice experiments, adults which had been reared on *Ci. limon* for at least two generations, were given a choice between the leaves of the five host plants. The results are contained in Table 2.

TABLE 2. — The average numbers of adults feeding, and the numbers of eggs laid by *T. erytrae* on five leaves from different host plants. The psyllids had been reared for at least two generations on *Citrus limon*. The data are based on 14 observations over 65 hours, using 36 female psyllids. Adjusted chi-square values are given for the average numbers of adults feeding;
* — $p < 0.05$ but > 0.01 .

	<i>Citrus limon</i>	<i>Vepris undulata</i>	<i>Clausena anisata</i>	<i>Fagara capensis</i>	<i>Caloden- drum capense</i>
Average No. feeding	8.4	3.9	0.6	2.6	3.1
Adjusted chi-square values . .	4.69*	0.009	1.84	0.10	0.004
Number of eggs	118	41	0	14	0

The data in Table 2 show that adults of *T. erytrae* reared on *Ci. limon* seedlings had a significant preference for leaves of *Ci. limon* both as feeding and oviposition sites. *V. undulata* was chosen less frequently than *Ci. limon* but was more attractive than either of the other three hosts. This experiment was repeated twice with very similar results; in each case the leaves were rearranged randomly in the trough.

It is possible that the choice of hosts by the adults of *T. erytrae* may depend upon the species of host plant on which the immature stages were reared. This might explain the significant preference for *Ci. limon* leaves shown by the adult psyllids, when the nymphs were reared on this species of host plant (Table 2). This possibility was tested by giving groups of adults a choice between the five different hosts, as before,

except that the one group of insects was reared for at least two generations on *V. undulata*, and the other group for at least two generations on *Cl. anisata*. The results of these experiments are shown in Tables 3 and 4.

TABLE 3. — The average numbers of adults feeding, and the numbers of eggs laid by *T. erytreae* on five leaves from different host plants. The psyllids had been reared for at least two generations on *V. undulata*. The data are based on 14 observations over 65 hours, using 20 virgin female psyllids. Adjusted chi-square values are given for the average numbers of adults feeding; * — $p < 0.001$.

	<i>Citrus limon</i>	<i>Vepris undulata</i>	<i>Clausena anisata</i>	<i>Fagara capensis</i>	<i>Calodendrum capense</i>
Average No. feeding	10.4	3.0	0.5	0.5	1.1
Adjusted chi-square values . . .	14.92*	0.003	1.42	1.42	0.73
Number of eggs	4	0	0	1	0

TABLE 4. — The average numbers of adults feeding, and the numbers of eggs laid by *T. erytreae* on five leaves from different host plants. The psyllids had been reared for at least two generations on *Clausena anisata*. The data are based on 10 observations over 23 hours, using 40 female and 3 male psyllids. Adjusted chi-square values are given for the average numbers of adults feeding; * — $p < 0.001$ but > 0.001 .

	<i>Citrus limon</i>	<i>Vepris undulata</i>	<i>Clausena anisata</i>	<i>Fagara capensis</i>	<i>Calodendrum capense</i>
Average No. feeding	11.6	7.4	1.7	0.6	4.7
Adjusted chi-square values . . .	6.69*	0.56	1.73	3.23	0.05
Number of eggs	241	191	0	21	34

The data contained in Tables 3 and 4 shows that statistically significant numbers of *T. erytreae* adults chose *Ci. limon* as a host for feeding and oviposition in preference to the indigenous hosts tested. This response to *Ci. limon* was consistent throughout, irrespective of the host plant on which the psyllids had been reared. *V. undulata* was the most attractive of the indigenous hosts. Of the remaining indigenous hosts, *Ca. capense* was most attractive whereas, *Cl. anisata* and *F. capensis* were only slightly attractive to *T. erytreae* and were rarely used as oviposition sites. These experiments were each replicated twice with very similar results; in each case the leaves were rearranged randomly in the trough.

DISCUSSION

The observations, in this preliminary study, indicate that the rough lemon, *Ci. limon*, is highly attractive to adults of the psyllid *T. erytrae* and is far more attractive, both as a feeding and oviposition site, than any of the indigenous host plants tested. Of the indigenous host plants, *V. undulata* was the most attractive to the citrus psylla. The strong preference for *Ci. limon* was found to be consistent even when the psyllids used in the tests had been reared for at least two generations on host plants other than *Ci. limon*. The responses of the adult psyllids seems to be at variance with the nutritional needs of the immature stages because evidence has been presented to suggest (Moran, 1968) that, using relative development of the nymphs as a criterion of host plant suitability, the indigenous host plants *V. undulata* and *Cl. anisata* are more suitable than *Ci. limon*. Kennedy's comments (1953) are particularly relevant in this respect; "The implication of all this work (work by numerous authors on the relation between nutritional requirements and host selection in phytophagous insects) is that insects are equipped with means of sensory discrimination serving their host-specificity requirements, but with none directly serving their nutritional requirements, . . .". This might also explain why leaves of *Ca. capense* were so much more attractive to *T. erytrae* adults than those of *Cl. anisata*, although, *Ca. capense* was totally unsuitable as a host for the development of the psyllid (Moran, 1968). In any event, the present observations, on the responses of adult *T. erytrae*, would account for the invasion of commercial citrus from populations of *T. erytrae* which must have been present on the indigenous host plants, when citrus was introduced to this country.

Although feeding, nutrition and the chemotactic basis for host plant selection have been extensively investigated in a closely related family, the Aphididae, (Kennedy & Booth, 1951; Kennedy, 1958; Alikhan, 1960; Auclair, 1963; Mittler & Dadd, 1963; Dadd, 1967) nothing is known about host choice in the Psyllidae. Clark (1962) has shown that, although *Eucalyptus blakelyi* is the preferred host of the psyllid *Cardiaspina albilexura*, not all individuals of this plant are equally attractive. Clark has not investigated the sensory bases for these preferences. The sensory basis for host plant selection in *T. erytrae* also remains unknown although many attempts were made during the present investigation to isolate and test the attractive or phagostimulant principle from the leaves of *Ci. limon*. Several different types of olfactometer (see discussion by Thorsteinson, 1960) were used in these tests but without success. The lack of response of the psyllids to chemical extracts may be an indication that nutritive factors in the leaves play a role in host plant selection (Schoonhoven, 1968) in this species.

The present study, and that by Moran (1968), does emphasize, however, that the indigenous host plant *V. undulata* and perhaps also *Cl. anisata*, may be important in a consideration of control measures against *T. erytrae* on commercial citrus in South Africa. The approximate distribution of *V. undulata* and *Cl. anisata* and the location of the main citrus growing areas in the Republic of South Africa, are shown in fig. 1.

Fig. 1 indicates that, in some of the more important citrus growing areas of South Africa, a population reservoir of *T. erytrae* could be expected in the indigenous bush surrounding the citrus orchards. In these areas, this indigenous reservoir of *T. erytrae* may be the source of reinfestation of citrus even where rigorous chemical control methods are applied to the crop. The indigenous population of psyllids may also be responsible for maintaining an infection of the virus disease, "greening", on citrus (McClellan & Oberholzer, 1965 a,b; Schwarz, 1964, 1967) although no attempts have ever been made to isolate the "greening" virus from indigenous rutaceous plants.

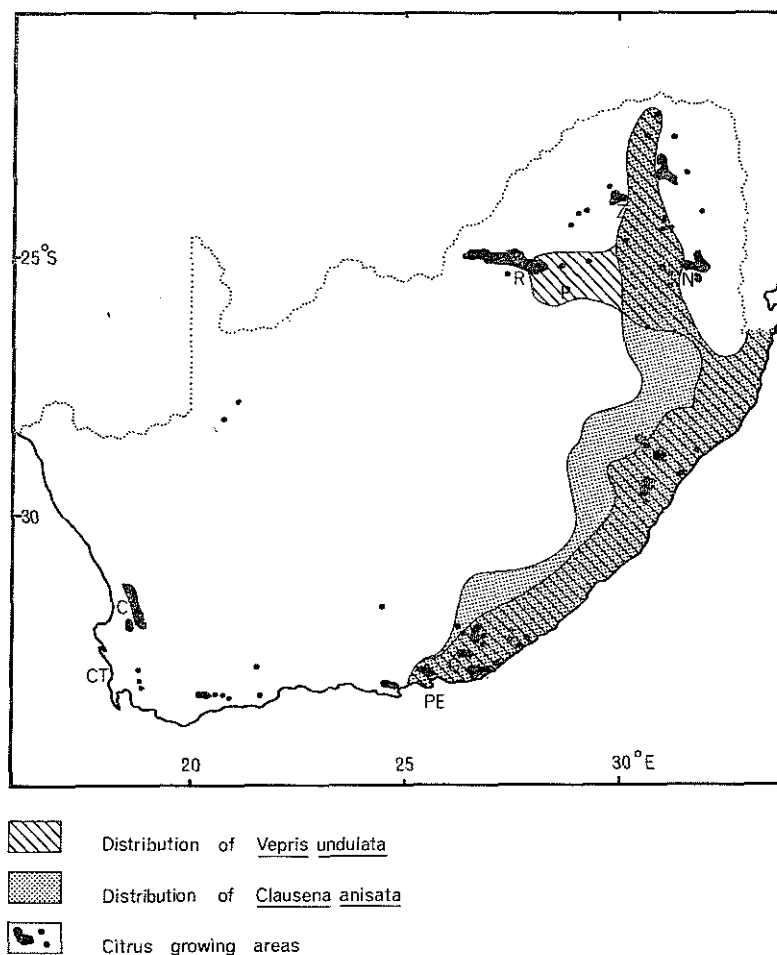


Fig. 1. The approximate distribution of *Vepris undulata* and *Clausena anisata*, and the location of the main citrus growing areas in South Africa. This figure is derived from data which were supplied by the Botanical Research Institute, Pretoria. C-Citrusdal; CT-Cape Town; PE-Port Elizabeth; G-Grahamstown; N-Nelspruit; Z-Zebediela; P-Pretoria; R-Rustenburg.

Van der Merwe (1941) has stated that, "The most recommended (control method against *T. erythrae*) is the removal of native food-plants from the vicinity of the orchard, the precaution being taken to destroy the shoots that may be thrown up again from the stump". Although the removal of indigenous host plants of *T. erythrae*, from citrus growing areas where psylla infestations are high, may help in controlling this pest, this step might reduce the reservoir of parasites which could aggravate the situation.

Also, there is no evidence to suggest that the indigenous hosts mentioned in this investigation are the only hosts of *T. erytrae*; it seems likely that other Rutaceae may also harbour *T. erytrae*. Further, it is suggested that permanent control of the citrus psylla and "greening" in South Africa will ultimately depend on cultural methods in which *T. erytrae* populations are limited by restricting citrus growing areas to the hot, low-lying regions of the country. Moran & Blowers (1967) have mentioned the adverse effects of high temperatures on populations of *T. erytrae* in the laboratory, and these findings have been supported by field observations on this species (Catling, 1967). The distribution of *T. erytrae* in the field is directly correlated with temperature (Moran, 1967), and McClean (1967) has evidence to suggest that the "greening" virus is also adversely affected by high temperatures.

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