Karnyothrips flavipes Jones

K. flavipes is a common predator and probably feeds on mealy bugs too, as Rivnay (1933) found it in large numbers between sepals and orange fruit where P. citri abounds. A more recent survey in the neighbourhood of Rehovot showed that eggs and larvae of these thrips were also found under sepals.

MARGARODIDAE

The Cottony-Cushion Scale Icerya purchasi Maskell

Icerya purchasi was introduced into Israel (then Palestine) towards the end of the first decade of this century. Its serious damage to citrus trees, such as described during its early days in California was first felt in the groves of Petach Tikvah and Jaffa. Twenty years later M. Apfelbaum (1931) described the grave situation of the citrus groves in the following words:

"There was a period when we were discouraged beyond measure, namely in 1910-11, when we had a serious attack of the parasite known as "Icerya purchasi"; this parasite attacked the orange groves in a most extraordinary virulence, the groves being entirely stripped of their fruit and leaves, the trees were in places white, where they were covered by this insect, and had the appearance, from a distance, of tufts of cotton (cottony scale). In other parts, the trees were black, covered with smut. All methods adopted to combat this parasite proved unsuccessful."

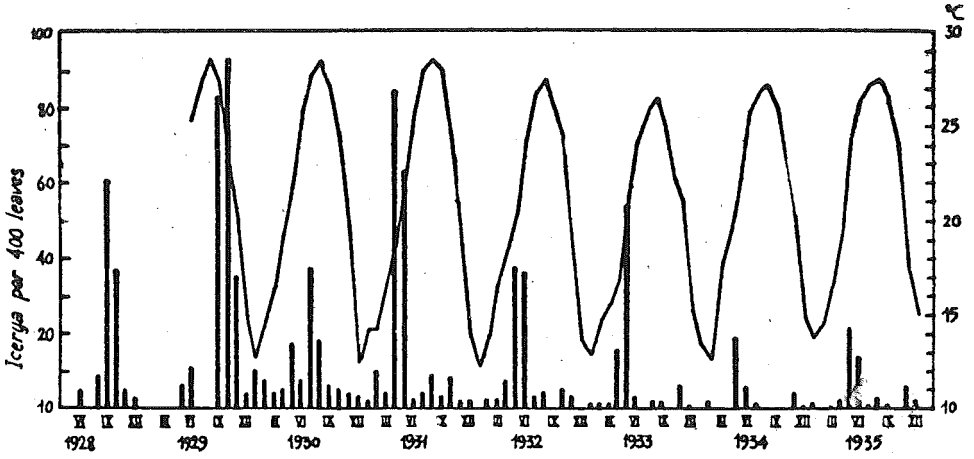
As mentioned in an earlier paragraph, there were no entomologists who could offer advice, and help was solicited from the Turkish Governor of Jaffa who summoned a meeting of notables. Details of the meeting were also recalled:

"All those interested were deeply concerned at the seriousness of the plague which raged particularly in the neighbourhood of Jaffa. A joint meeting held with the Governor of Jaffa and the principal orange growers, at which ways and means of combating the disease were discussed. It was then that the writer of this article recommended the introduction of the 'Coccinella' (Lady Bird) known as 'Novius cardinalis'. My recommendation was adopted and the insect brought into the country. Wonders were worked: What human power had not been able to do for years, this tiny creature accomplished in a very short space of time. This is how we were able to save the orange plantations" (Apfelbaum 1931).

It may be surmised that the job of handling this matter, writing and asking for the predators and taking care of them upon their arrival was placed upon the person who proposed it. Mr. Apfelbaum wrote to Italy where Rodolia (Novius) Cardinalis had been introduced and established since 1895. Details of events as they happened later were received now verbally from the octogenarian Mrs. Apfelbaum, the wife of the late agronomist: "Two shipments were received, each consisted of a match box containing about a dozen bettles. In the first they were all dead, the second had some beetles still living, and they were liberated in the groves. Wonders were accomplished by them and the trees were cleaned after a short period".

An equilibrium below economic level was attained, except on certain occasions when temporary outbreaks occurred which were soon subdued by the predator. One of these outbreaks, which took place at Hadera in 1929 and 1931 stimulated Bodenheimer (1932) to undertake a study on the pest-predator relationship, and the climatic factors which may disturb the favourable balance between host and predator.

Fig. 10 - Fluctuations of Icerya populations (Num/400 leaves) at Hadera, and of temperatures during 1929-1935. (after Bodenheimer)



The results of this study are presented in the chapter on Rodolia cardinalis. (see pp. 75-76).

Bodenheimer proposed a practical way for the control of the pest. Where centers of dense population of L. purchasi occur, its ovisacs should be collected and delivered to a breeding center. Thereby the pest population in the grove is decreased; the predator's egg and larvae in the host's ovisace should be bred to maturity in the breeding center and adults should be released in the groves again. This method proved to be satisfactory, he said.

The situation in 1966-67

The method proposed by Bodenheimer was practised for a few years, until it was noticed that a reduction of the pest occurred both in the groves where the method was practised and in other groves as well, this method was then abolished.

A change in the situation took place when cover sprays on a large scale were introduced into the groves against the Mediterranean fruit fly. In such groves the pest increased enormously. One of the insecticides used lavishly was methoxichlor, which we know now is one of the most toxic to Coccinellidae. The balance of L. purchasi and R. cardinalis improved soon after the abolishment of this method.

Biology of Rodolia cardinalis Muls.

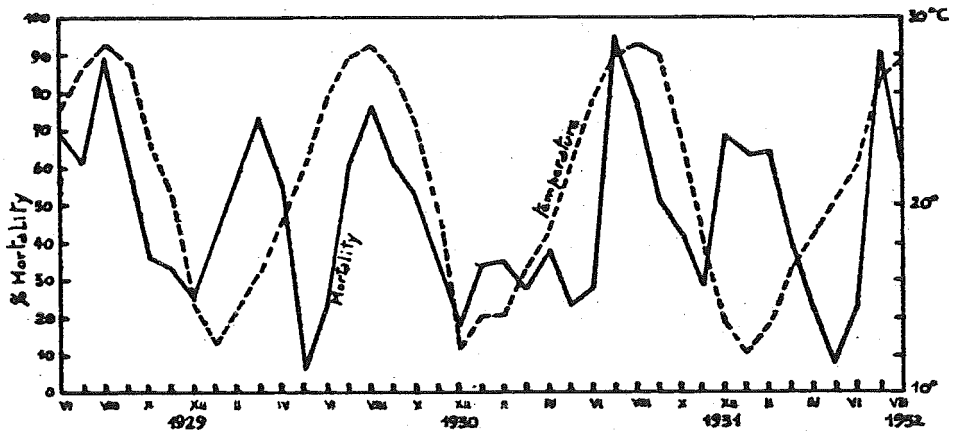
The following is the summary on the biology of R. cardinalis in Israel as studied by Bodenheimer (1932, Bodenheimer et al. 1933).

The quickest developing individuals may raise about twelve generations under climatic conditions of the coastal plain in Israel; actually there are about nine generations. Breedings having been carried out at various temperatures; it was possible to calculate with the aid of the hyperbola formula the development zero and the thermal constant. The former has been established as 9°C, while the latter as 662 day degrees Centrigrade.

The average number of eggs laid by one female varied with the temperature. The lowest oviposition took place in the early winter and the highest in the early summer, when over 500 eggs were laid by one individual, and on one occasion as many as 1037 eggs were oviposited. The annual average number per female was about 307 eggs. The average duration of the various stages in the coastal plain during the summer was as follows: egg - 8 days, larva about 10, pupa 7-9 days and preoviposition period about 4 days. The life span of the adult was about 80 days for females and 90 for males.

A detailed study of the mortality of the various stages showed that egg mortality ranged from 8-43%; on the average 23. 9% of the eggs died. Over 50% of the eggs survived to maturity. The lowest mortality of the individuals as a whole was in May (12%) at an average temperature of 22-23°C, and in November-December at an average temperature of 17-18°C; the highest during July-August (about 77%), at a temperature above 28°C, or in the winter at a temperature below 16°C.

Fig. 11 - Mortality of Rodolia and monthly average temperatures (after Bodenheimer 1933).



The opinion was expressed that the relative humidity played a minor role in bringing about this mortality since most stages were protected in the ovisac. Adults are more exposed to the climatic factors and are more susceptible to low humidity. Temperature is a more decisive factor in regulating the density of the population.

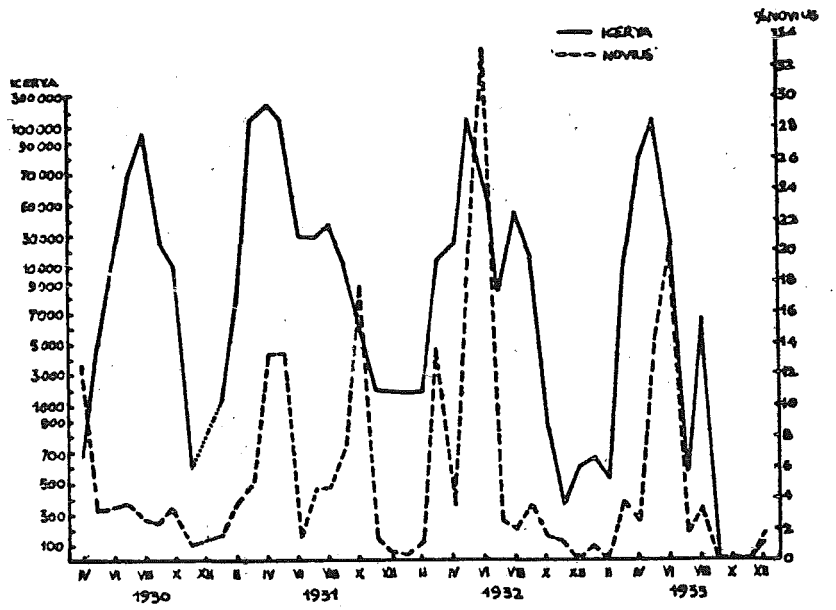
In the grove it was shown that the highest mortality coincided with the highest or lowest temperatures.

. Population dynamics of Host and Predator

A detailed study was made on the feeding capacity of this coccinelid. One R. cardinalis larva could devour as many as 8-15 I. purchasi larvae in twenty days during the spring, 13-18 during this period in the summer, and 28-33 in the autumn. Thus the autumn generation devours more I. purchasi larvae than does the summer generation. It was found that Spartium fed I. purchasi served as food for R. cardinalis, although it was not a desired one, as less larvae were devoured by R. cardinalis on Spartium than were on citrus; the development of the beetles on Spartium was slower. These differences, Bodenheimer thought, could be exploited in the efforts towards mass breeding of the beetle. The host was too quickly exterminated by its predator on citrus, whereas on Spartium a more stable mass breeding could be maintained. In Israel, R. cardinalis is restricted to Icerya purchasi only and it is the main predator upon this host, thus an evaluation of the reciprocal effects was not complicated. The number of generations raised annually by Rodolia cardinalis is higher than that of the host. In colder climates it may raise twice as many generations as does I. purchasi, and in the Mediterranean countries three and even four times more. On the other hand, I. purchasi is more tolerant to low temperatures than its predator; the threshold of development of the host being 0°C and that of the predator being 9°C. The latter was also more susceptible to high temperatures than its host. The optimal conditions of both species seem to be about 18-23°C and a relative humidity of about 70%. Rodolia cardinalis is said to become acclimatized to whatever locality its host had become established. Bodenheimer pointed out that this did not mean that the predator was capable of controlling it in any locality, but it could do so only in climates with no extremes of temperature which are capable of bringing the R. cardinalis population to zero, and in climates where the optimal conditions described above exist for a minimal sequence of months.

Four years' count of I. purchasi and R. cardinalis in citrus groves in Israel showed that as a rule the peak of the population of I. purchasi occurred in April-June (in 1930 it was in July-August). During this period of high density of the host population the percentage of R. cardinalis of all stages ranged from 13% to as high as 30%. A count of the number of predators of all stages in each ovisac of the host showed that the number of predator eggs ranged from one to over a dozen, but on the average they were 5. 10 eggs of R. cardinalis per ovisace of I. purchasi. The average number of larvae were 1. 23 per ovisac. This reduction of the number from egg to larvae was surely due to cannibalism as they all developed within the ovisac of the host, and as a rule only one larva completed its development in one ovisac.

Fig. 12 - Fluctuation of Icerya and Rodolia populations in the orange groves, at Atta (after Bodenheimer 1930-1933).



Other enemies of I. purchasi

Bodenheimer also studied the influence of other predators upon I. purchasi. Lithophilus marginatus Rtt. a local Coccinellid is not very common. Due to its high mortality, its small number of generations, and its low feeding index, this beetle is an unimportant factor in the regulation of the population density of the host. Occasionally larvae of the Noctuid Coccidophaga scitula Hbn. were found in I. purchasi colonies, as were some Neuroptera and mites. The fly Cryptocheatum grandicorne Rond was not associated with I. purchasi, but rather with Gueriniella serratulae F.

Matsucoccus josephi Bod. & Harp.

During the fourth decade of this century, an outbreak of the pine pest Matsucoccus josephi Bod & Harp. attracted the attention of foresters. This pest is endemic, and surveys carried out recently showed it to be present on old trees as well as young ones in various parts of the country, especially on Mt. Carmel. The reasons for the new outbreak were no doubt the increases in areas of Aleppo pines due to the afforestation enterprise by the Jewish National Fund. In these areas the trees were planted densely, thus creating favourable conditions for the outbreak of the pest which in some cases reached dense populations, causing injury to the trees and conern to the foresters.

On infested young trees, the needles and twigs dry up, the lower branches also die and the tree is weakened. In older trees, many females hide under the bark, resin flows from the stem and the trees are weakened. Such trees

shelter other organisms; Pathogenic fungi develop upon the stem, and the bark beetles Pityogenes calcaratus Eichhoff finds favourable conditions for its existence. All these factors may lead to the deterioration and finally to the destruction of the tree.

A study was undertaken by Bodenheimer and Neumark (1955) which among others included the biology of entomophagous insects associated with M. josephi. This part of the study aimed at finding the role and potentialities of the entomophagous insects.

Several predators were found to feed upon the pest. The most abundant and prevalent was Chrysopa carnia Stephens. It was found that this lace wing may be active throughout the year with no diapause, and may raise five to seven generations.

Another Neuropteron of lesser importance is Sympherobius pygmaeus Rbr. Although this species could raise ten generations during the year, the authors considered it of negligible importance in keeping the pest at low levels.

Four Coccinellidae were found on the pine trees, the main food of which consisted of aphids, but did not refuse Matsucoccus larvae or eggs when available - these were: Synharmonia conglobata, Adalia decempunctata L., Exochomus flavipies Thunb. and Chilocorus bipustulatus L.

The small Anthocoris nemorium was feeding on the larvae of Matsucoccus, and also the mite Anystis baccarum L., which during the short period of its activity diminished the population of the species.

In addition to all these, ants too carried away many Matscucoccus females, not as "milch cows", the authors believed, but for eventual food.

In conclusion, the authors were convinced that the Matsococcus population was greatly depressed by the combined effects of all the predators. This was demonstrated, by the rise of the population on a tree from which predators were excluded, having been covered with a tent. However, the real cause of the low Matsucoccus josephi population in the summer is the physiological state of the pine trees during the hot and dry spring and summer days. Precisely when the sucking insects are in urgent need of moisture and food on these dry Khamsene days, the osmotic pressure in the cell sap of the tree rises so much that the sucking insects are unable to extract water or food.

Biology of Sympherobius pygmaeus Rbr.

According to Bodenheimer and Neumark (1955), oviposition did not take place during December-February, but larvae and pupae continued to develop at slow rates. The development during the early spring lasted 58 days, the summer generations 30 days, whereas the late autumn about 80 days. The insect thus raised nine generations in the hills of Samaria

The development of the generation (until 50% of the eggs were laid) took

38 days at 25°C, 60 at 20°C and 138 days at 15°C. These data served to compute the threshold of development and it was set at 10.4°C while the thermal constant was found to be 550 day degree C.

The females are prolific. In the spring a female living about 50 days, laid on the average 970 eggs. In the cold season reproduction was reduced; 400 eggs were laid in the autumn and 43 eggs in the winter.

The summer is a critical time for the larvae, as mortality due to high temperatures was great, in addition, cannibalism caused a big reduction in its population.

SOFT SCALES - COCCIDAE (= LECANIIDAE)

In Israel there are several species of Coccidae, but only a few are of economic importance. They are Coccus hesperidum L., Saissetia olea Bern., and Ceroplastes floridensis Comst; Ceroplastes rusci L. may occasionally be injurious to fig trees.

All cause the same kind of injury, namely production of honey dew upon which black sooty mold develops, and the sucking of the sap from the leaves and branches. In severe outbreaks the population may be so dense as to cause incrustation upon the bark of the branches. This brings about the drying of the twigs, reduced crop and an increase in the number of the cull fruit.

On the other hand, more than any other scale insect, the soft scales are the subjects of attack by many parasites which as a rule keep the respective pests in control. The role of these parasites was not properly appreciated in Israel until they were exterminated in certain localities by lavish applications of synthetic insecticides.

Coccus hesperidum L

Coccus hesperidum is found on various hosts, the most important, from an economic point of view, being citrus trees. Ordinarily, this pest is kept below the economic level by several parasites, (Rivnay 1944). As soon as an outbreak starts, parasites check it, except in sites where parasites have been exterminated. On such occasions the outbreak may be severe, as happened in a grove at Benyamina in the early sixties. In that grove, the branches of the trees were encrusted with layers of the pest, and subsequently dried up, the crop was reduced to a third, and the remaining fruit was black with fumagine.

Rivany (1944) made a survey of the parasites to see which of them played the more important role. Twenty years later a survey was made again by Rosen (1962 and 1964). The parasites collected then are given in the Table 7

As will be noticed in that table, most of the parasites found by Rivnay were also found by Rosen, except for differences in the rating of some of them as far as their degree of parasitization is concerned. Rosen also found parasites and