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The distribution of phytophagous and predacious mites on apple leaves

INTRODUCTION

The distribution of prey and predator in their habitat may be of significance for the regulatory influence of the predator on the population development of the prey. A predator, which can not reach all the places where the prey occurs, will have a limited regulatory influence on the prey as continual reinfestation will occur from the uncovered areas. The distribution of phytophagous mites and predacious mites on fruit trees was studied by several authors (CHANT, 1959; CHANT and FLESCHNER, 1960; VAN DE VRIE, 1964).

The macroenvironment of the phytophagous mite *Panonychus ulmi* Koch (*Tetranychidae*) and one of its predators (*Typholodromus, Amblyseius*) *potent'llae* Garman (*Phytoseiidae*) is the fruit tree. Each tree consists of a number of branches, twigs and spurs while the twigs and the spurs bear the leaves. As both mite species occur almost entirely on the leaves during the vegetation period of the host plant and they migrate from one leaf to another only by walking, their distribution should be studied on individual leaves. The distribution of both species on the leaves has not necessarily to be identical with their distribution on the tree as there are disturbing influences as overwintering places of the wintereggs of *P. ulmi* and the development of new shoots with leaves during the vegetation period. Numerical variations between prey and predator on individual leavas and the course of these variations during the summer months may reflect the interrelationships which exist between these components.

Boll. Zool. agr. Bachic., s. II, v. 7, 1965.
(Atti del 5° Simposio europeo d'Acarologia, Milano, 23-25.IX.1965)

Methods and materials

In our studies on the interrelations of *P. ulmi* and one of its predators *T.* (*A.*) *potentillae* a series of insectary trials were carried out under glasshouse conditions. In these trials *P. ulmi* was bred on potted rootstocks, EM II, which were placed in cabinets consisting of metal frames and glass, giving a good isolation. These trees were infested with females of both *P. ulmi* and *T. potentillae*; 10 females of *P. ulmi* + 3 females *T. potentillae* being placed on each tree at the beginning of the experiment. As a comparison another cabinet was infested with only 10 females of *P. ulmi* per tree. 20 trees were placed in each cabinet. At weekly intervals two trees, each having aproximately 30-35 leaves, were taken as a sample and were replaced by two new ones. The shape and the size of these trees facilitated free movement and uniform dispersion between the trees. Mites and eggs were counted on all the leaves of the sample trees, thus providing a record of the population development during the observation period and providing a continuous record on the numbers of prey and predators present on individual leaves.

Results

The population development of the two series is demonstrated in the figgs. 1 and 2. Fig. 1 shows that *P. ulmi* develops to high densities. At the beginning of August a single *T. tiliae* was found on these trees and therefore a new series was started. On this new series also a rapid increase to high densities could be observed. In fig. 2 the development of both prey and predator is shown. Under the influence of the activities of the predator *P. ulmi* reaches a lower density as in fig. 1.

From the results of the weekly countings on the numbers of prey and predators correlation diagrams were made; the diagrams of the period July 6th to August 13th are given in fig. 3 A - F, as in this period the most important events took place.

Fig. 3 A shows that a high density of *P. ulmi* is present, with only five leaves having one, and two leaves having two predators. Fig. 3 B indicates that the density of *P. ulmi* is decreasing; now there are ten leaves with one predator each, but no leaves with more than one predator. Fig. 3 C shows that the density of *P. ulmi* is still decreasing, the density of the predator increasing at the same time; now there are

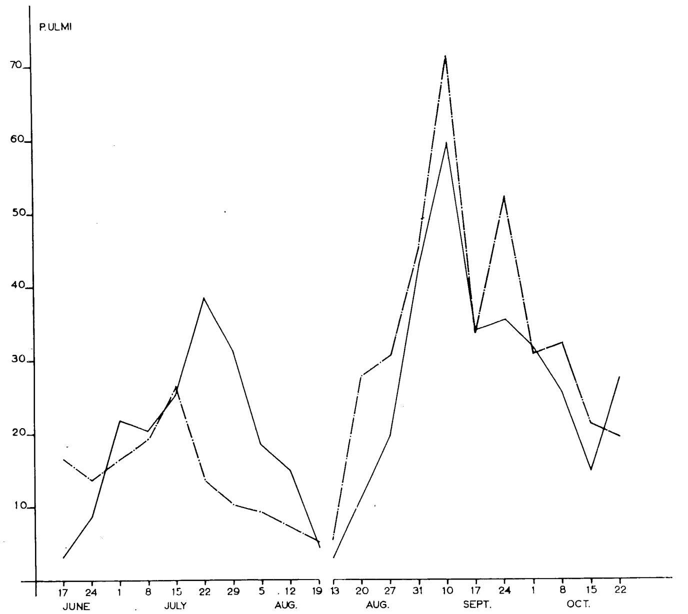

Fig. 1 - Population development of *P. ulmi* and *T.* (*A.*) *potentillae* in cabinets under glasshouse conditions: development of *P. ulmi* without predators.

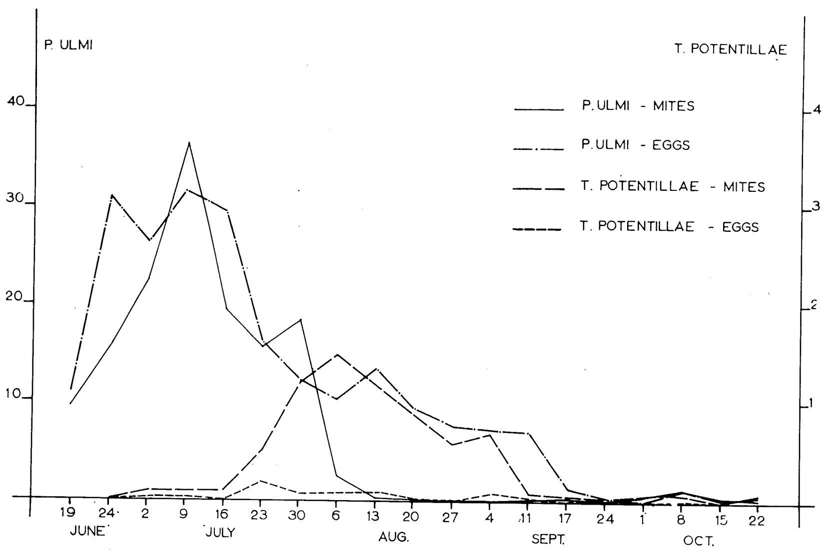

Fig. 2 - Population development of *P. ulmi* and *T.* (*A.*) *potentillae* in cabinets under glasshouse condition: 10 *P. ulmi* + 3 *T.* (*A.*) *potentillae* at the beginning of the experiment.

28 leaves with one, 4 leaves with two, 1 leaf with three and 1 leaf with four predators. Fig. 3 D gives an almost identical picture as fig. 3 C; in fig. 3 E the density of the *P. ulmi* as declined to rather low densities while the number of predators is decreasing also. However, there are still 23 leaves with three or more predators. Fig. 3 F shows that the density of *P. ulmi* as declined to very low values while also the predator is declining. After August 13th the situation remained almost stable as can be expected from the results in fig. 2.

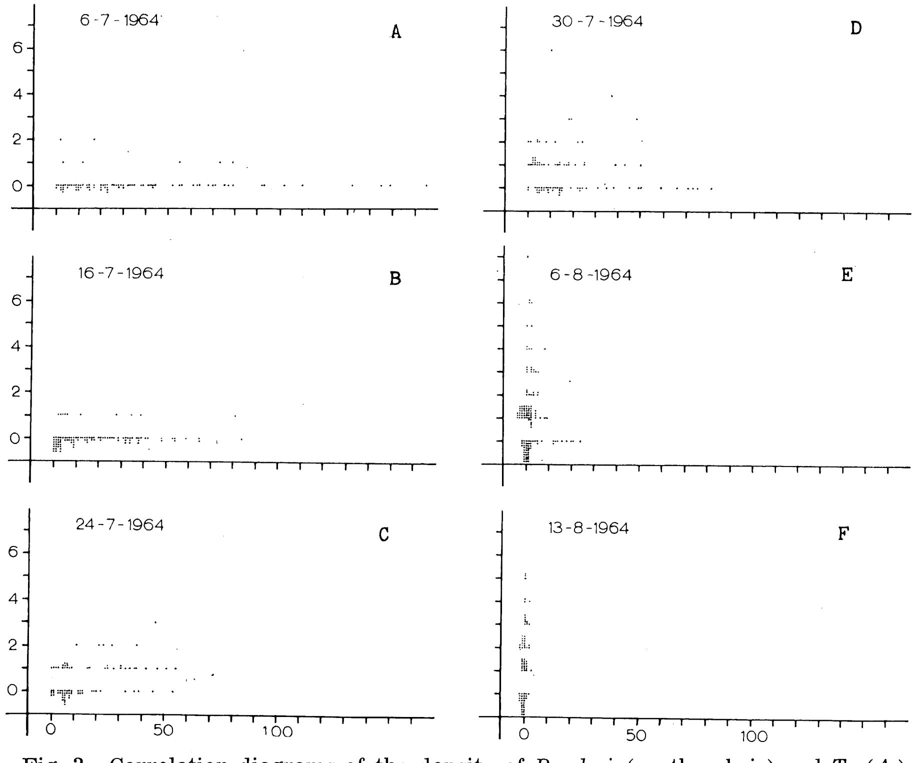

Fig. 3 - Correlation diagrams of the density of *P. ulmi* (on the abcis) and *T. (A.) potentillae* (on the ordinate) on corresponding leaves. For explanation see text.

Discussion

In the fig. 3 A - F it is remarkeble that the predatory mites almost occur on leaves with a low or medium density of the prey. This can only be explained by assuming that the predators have a deminishing effect on the prey; if the distribution of the prey was at random over the leaves an independency of the prey could be assumed.

As the density of *T. potentillae* increases, at the same time the density of *P. ulmi* decreases, while in the control series the density of *P. ulmi* increases to higher values. This decrease of *P. ulmi* is due to the predacious actions of *T. potentillae*; it was often observed that they fed upon the larvae and chrysalis I of *P. ulmi.*

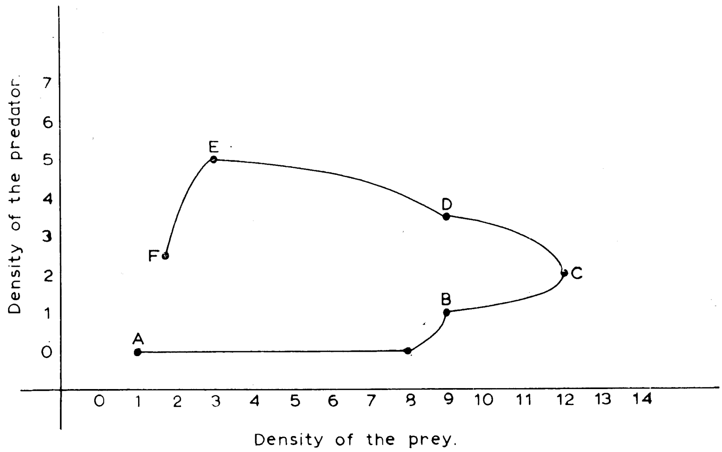

Fig. 4 - Theoretical explanation of the numbers of prey (*P. ulmi*) and the number of predator (*T.* (*A.*) *potentillae*) found on corresponding apple leaves. For explanation see text.

It is not known how *T. potentillae* detects the presence of its prey. It is likely to assume that when a predator has reached a leaf with a suitable amount of prey it will stay, feed and reproduce on this leaf. Predation by its offspring then reduces the numbers of the prey while at the same time the number of the predator increases. This leads to the theoretical explanation of the observed phenomena which is demonstrated in fig. 4. In A a leaf is infested with phytophagous mites which reproduce untill at B this leaf is infested with one predator. At this moment reproduction of the prey is continued and reproduction of the predator is started, reaching C. At D the activity of the predator has outnumbered the reproduction of the prey; by continuing this process E is reached. After this moment the prey is becoming in a minimum and most of the predators migrate to other leaves, thus reaching F. Some of the predators remain present with a low number of their prey. This is the situation which is normally found on unsprayed trees: both prey and predators here mostly occur in low numbers. In the field, however, the situation is more complicated as other predators and other prey may occur on corresponding leaves simultaneously; the interrelations of other prey and predators up till now are not well understood.

This theoretical explanation at the same time shows why it is seldom found that high numbers of both prey and predators occur simultaneous on the same leaves. If this was found it should show that the predatory mites have almost no regulatory influence on the population density of their prey.

It was tried to follow the process as shown in fig. 4 during a longer period on the leaves without taking them from the trees. It was impossible however, due to the habit of the predatory mites to hide along the midribs and the main veins, to make accurate countings of the mites in the field.

The data suggest that the regulation of *P. ulmi* by predatory mites takes place at low densities of both species. If this is true, the possibillities for an integrated spray programme, in which pesticides which are harmless to the predatory mites are used, look promising.

SUMMARY

The distribution of *P. ulmi* and *T. (A.) potentillae* on identical apple leaves was studied during the population development of both species. Correlation diagrams of the numbers of mites of both species per leaf showed that there is not a positive correlation between the density of the prey and the predator. The cause and the importance of the negative correlation are discussed.

RIASSUNTO

L'A. ha studiato la distribuzione di *P. ulmi* e di *T. (A) potentillae* durante lo sviluppo delle loro popolazioni su foglie di melo ed ha rilevato che non esiste correlazione positiva fra la densità della preda e quella del predatore sulla medesima foglia.

Della correlazione negativa vengono discusse causa ed importanza.

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