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A reconsideration of the role of predacious mites in the control of the european red spider mite in orchards (*)

The ability of *Typhlodromus*-mites, occurring in orchards (of which *T. pyri* Scheuten is the best known) to regulate the numbers of the European Red Spider Mite (*Panonychus ulmi* Koch) still forms a matter of controversy in acarological literature. The reactions of these predators seem to be, indeed, far from evident.

Post (1962) was confronted with this problem in her work in experimental orchards over many years. She observed that in the unsprayed plots of the orchards, in which soil cultivation, fertilization, and pruning were applied, predation of mites and insects were insufficient to reduce the increased development of *P. ulmi*. On the other hand, an increase in the population density of the European Red Spider Mite also was observed after the application of chemical control only in the neglected orchard, but, as she stated, it could be seen clearly that the effect of chemical control on the excessive increase of *P. ulmi* was less important than that of cultivation, fertilization and pruning.

The work of Post made clear, therefore, that the difference in reactions found in « neglected » and « well kept » orchards only partly can be ascribed to the use of sprays. We recognize here an intriguing problem in the field of population dynamics. The rate of reproduction of *P. ulmi* is higher on the leaves from pruned, fertilized and cultivated trees (Post l.c.) which leads to an increase in numbers, but the predators evidently appear to lack their regulatory capacity under certain conditions.

It is easily understood that these complex interactions gave rise to different opinions among the research workers. Chant (1959)

(*) Prof. J. D. Lattin was so kind as to check the English text of this paper.

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concluded, as a result of laboratory experiments and a field experiment, that *Typhlodromus pyri* is of little value for controlling orchard-inhabiting phytophagous mites in England. On the other hand, based on their field or semi-field experiments, COLLYER (1964) and DOSSE (1962) consider the phytoseiid mites, notably *T. pyri*, as effective predators of the European Red Mite in orchards.

Both views may be right within certain limits.

If we are interested in a predator as a controlling factor, we must try and obtain information about its regulating capacities. Regulation means that these predacious mites are able to work as a feed-back mechanism, e.g. the higher the prey-density, the higher the mortality of the prey caused by the mites.

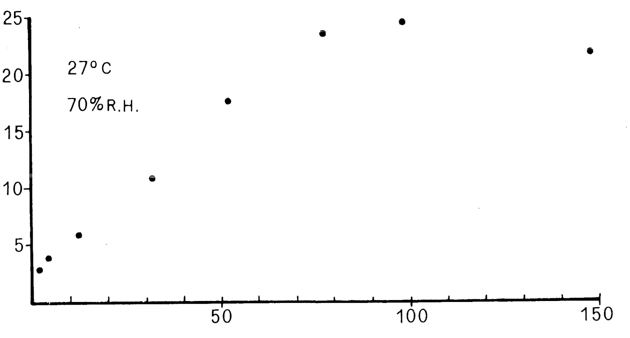

Fig. 1 - Functional response of single, isolated, fertilized females of *Typhlodromus longipilus* Nesbitt consuming the eggs of the Two Spotted Spider Mite on discs of bean leaf (24 mm diameter) during their oviposition period under stable conditions of temperature, relative humidity and light.
One point represents the mean of 10 replicates.
Abscissa: number of eggs per disc.
Ordinate: daily prey consumed during the oviposition period.

If the individual predator meets, per unit time, a certain number of their prey, it consumes all prey or a certain proportion of it. This consumption per animal per unit time, called functional response, by SOLOMON (1949), is among others, dependent on prey density. Fig. 1 shows the relation between consumption and prey-density, established by us for *T. longipilus* under laboratory conditions. Similar relationships were obtained by CHANT (1961) for *T. occidentalis* and by BRAVENBOR and DOSSE (1962) for *Phytoseiulus persimilis* Athias-Henricot. Fig. 2 is based on the data of BRAVENBOER and DOSSE. From the experiments of HERBERT (1961) with adults of *T. pyri*, we know something of the relation between larvae consumed and the density of the latter. She did not investigate, however, the reactions of the predators at higher prey-densities. We do not know, therefore, whether their reaction with increasing larva-density after having reached the

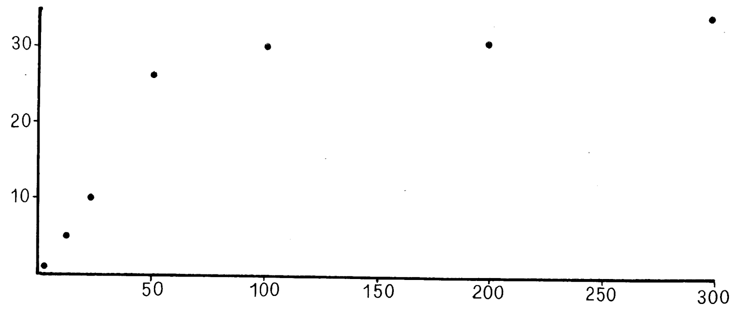

Fig. 2 - Functional response of single, isolated combined males and females of *Phytoseiulus persimilis* Athias-Henricot (after data of BRAVENBOER and DOSSE, 1962).
Abscissa: prey density (eggs) in experimental cages.
Ordinate: daily prey consumed per predator.

saturation point remains independent of prey-density, as in the case of *T. longipilus* and *P. persimilis* preying on spider mite eggs, or whether there is a decline in the response at higher densities.

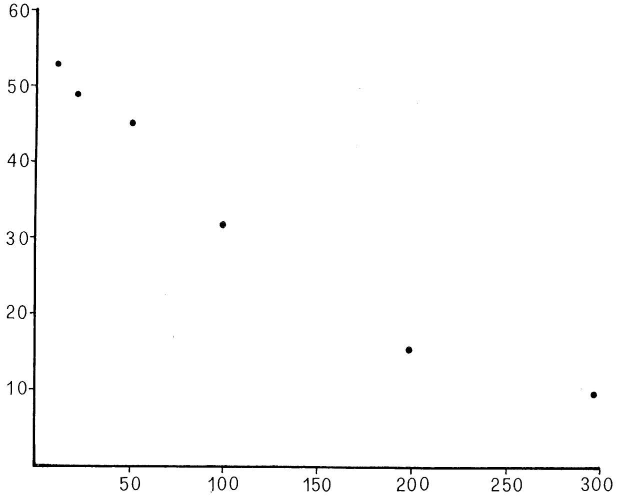

Fig. 3 - The data, used in Fig. 2, converted into a predation percentage, which would be obtained if predator numbers did not change.
Abscissa: prey density.
Ordinate: % predation.

Should the number of predators not change, predacious mites would not be able to regulate their prey, since predation would decrease with increasing prey-density (fig. 3). *Thyphlodromus* mites react, however, in many cases numerically on changes in prey-density. There is some information on the number of predacious mites, occurring in orchards, as a function of the density of *P. ulmi*. COLLYER (1958) concluded from field experiments that *T. pyri* showed only a numerical

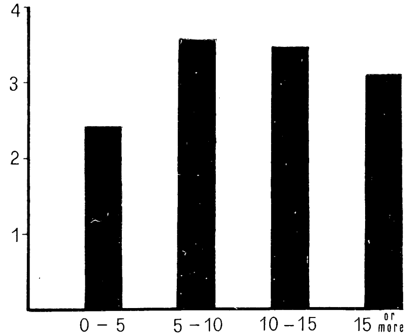

Fig. 4 - A numerical response of *Typhlodromus* spp. in the field. The data are after a figure of VAN DE VRIE (1964) and were collected in an apple orchard in the Netherlands. Prey: *Panonychus ulmi* (Koch); predator: *Typhlodromus* sp. mainly *pyri* Scheuten, at 24.7.1961.
Abscissa: number of prey per leaf.
Ordinate: number of predator per leaf.

response at low densities of the Red Spider Mite. This statement agrees with the data obtained from a figure of VAN DE VRIE (1964); these data were collected in a neglected orchard in the Netherlands on one day, other predators and *Bryobia rubrioculus* Scheuten occurring only in small numbers (fig. 4). Further experiments and field work must show whether the *Typhodromus* mites preying on the spider mites show inverse numerical responses at very high densities of their prey, as has been observed in *T. longipilus* (KUCHLEIN in press).

It is very likely that the phytoseiid mites in the orchard show a functional response curve of the type established for *Phytoseiulus persimilis* and *T. longipilus*, consuming the eggs of the Two Spotted Spider Mite, or a domed curve. A combination of the functional and numerical responses, as was done by HOLLING (1959) for two species of small mammals, produces a peaked or a declining curve for the percentage predation (if we accept the assumption that the two responses are immediate).

With relatively little information, only some presumptions can be made now:

1) If these phytoseiid mites in the orchard should be able to regulate, this can only be the case in a range of the lowest prey-densities.

2) In the well-kept orchard the predacious mites do not regulate the numbers of *P. ulmi*.

As HOLLING (1959) showed for small predacious mammals, the presence of more than one species of predator, each with peaked predation curves (if not showing the same picture), extends the range of prey-densities over which predation was high. There are indications that a similar situation may occur in the orchard. KUENEN (1947) and DOSSE (1962) argued that some of the insect predators need high densities of *P. ulmi* to acheive their development. COLLYER (1964) stated that the predator *Blepharidopterus angulatus* (Fall.) (*Heteroptera*, *Miridae*) is effective only at relatively high densities of the Red Spider Mite.

More thorough investigations of the *Typhlodromus* mites and the predacious insects as well would help us to elucidate the problem of predation in the orchard.

SUMMARY

In well-kept orchards the rate of reproduction of the Red Spider Mite (*Panonychus ulmi* Koch) is increased by the changed physiological condition of their food plant as a result of:

1. soil cultivation, fertilization and pruning;
2. the use of pesticides.

In neglected orchards the population-density of the Red Spider Mite remains low; in the well-kept orchards, however, the mite is one of the most important pests.

Based on data in the literature and our own experiments it is presumed that the predacious *Typhlodromus* mites would be able to regulate the numbers of their prey only in a range of the lowest prey-densities, if at all.

RIASSUNTO

Nei frutteti tenuti con cura la moltiplicazione del *Panonychus ulmi* Koch viene incrementata con il mutare delle condizioni fisiologiche della pianta ospite, ciò che risulta da:

1) lavori colturali, concimazioni e potature;
2) impiego di antiparassitari.

In questi frutteti, tuttavia, l'Acaro rappresenta uno dei più importanti fitofagi mentre nei frutteti trascurati la densità delle popolazioni del Ragno rosso delle piante da frutto rimane bassa.

Sulla scorta di riferimenti bibliografici e di esperimenti diretti si può presumere che i Tiflodromidi predatori hanno la possibilità di regolare il numero delle loro prede soltanto in regime di bassa densità delle prede.

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DISCUSSION

MELTZER: I should like to know, whether you have an explanation for the fact that with increasing of the prey density, the predator density is decreasing.

KUCHLEIN: We analysed this intriguing phenomen in the predacious mite *Typhlodromus longipilus* Nesbitt in the laboratory and we observed a high mortality and lower fecundity at higher prey-densities (if all developmental stages of the spider mites were present). Also the causes of this change in fecundity and mortality were analysed by us in the laboratory.