MARINUS VAN DE VRIE
Institute for Phytopathological Research, I.P.O., Wageningen,
Proefstation voor de Fruitteelt, Wilhelminadorp, the Netherlands

Problems and prospects in the integrated control of phytophagous mites

INTRODUCTION

The traditional approaches to control phytophagous mites have centered mostly on the development of methods which attempt to eliminate mite populations almost completely as they appear in considerable numbers in our crops. Generally speaking many of these techniques have proved to be very successful. The high performance of the fruit produced in modern commercial orchards, and the high yields and high quality of glass-house crops in flower and vegetable production give the convincing proof for the value of modern pest control techiniques. However, the accompaning and inherent limitations of these techniques become clearer and clearer year after year. Of these accompaning problems I only mention here the danger of contamination of the fruits by residues of the pesticides used, the development of strains of mites resistent to acaricides, the outbreaks of pests which were formerly of minor importance and the adverse effects on beneficial species. The arising of these problems has stimulated researches into the possibilities of developing an integrated spray programme. This integrated spray programme is applied pest control which combines and integrates chemical and biological measures into a unified pest control programme. As time is too limited to go into details of this integrated control concept, I will mention here the work of DE FLUITER (1961) and FRANZ (1961), which give a description of this concept and the terms used.

I would like to draw your attention to four topics which are, in my opinion, of much importance in our approach to this subject. They will be illustrated with some results of our work into the possibilities of integrated mite control in orchards in the Netherlands, but I think, in other countries identical situations will be present.

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

The 4 topics are:

1) The complexity of the biocoenosis of apple trees.
2) The complex influence on the biocoenosis by pesticides.
3) The evaluation of pest damage in terms of density of the pest.
4) The introduction of changes in the spray programme in practise.

THE COMPLEXITY OF THE BIOCOENOSIS OF APPLE TREES

By inventories of phytophagous, indifferent and predacious mite species on neglected trees, which we may call the natural environment of these species as they are not influenced by sprays or other measures, we can find the number of species listed in table I.

TABLE I. - *Mite species collected from unsprayed trees*

PHYTOPHAGOUS	PREDACIOUS
Bryobia rubrioculus Sch.	*Typhlodromus tiliae* Oudms
Czenspinskia lordi Nesb.	*T. tiliarum* Oudms
Panonychus ulmi Koch	*T. potentillae* German
Tetranychus urticae Koch	*T. soleiger* Ribaga
Eotetranychus pomi Sep.	*T. finlandicus* Oudms
Phyllocoptes schlechtendali Nal	*T. cucumeris* Oudms
Tenuipalpus oudemansi Geysk.	*T. masseei* Nesb.
Tarsonemus spec.	*T. aberrans* Oudms
Tydeus spc.	*Phytoseius macropilis* Banks
Oribatidae	*Mediolata mali* Ewing

Some of these species sometimes are numerous, others are rare species. It is remarkeble that during long periods of observations on the same trees little changes in the abundance of these species. This may indicate that there is some kind of a balance, the mechanisms which cause this balance are up till now not fully understood.

The mite population on well kept trees is much less complicated; the species found on this type of trees is given in table II.

TABLE II. - *Mite species collected from well kept trees*

PHYTOPHAGOUS	PREDACIOUS
Panonychus ulmi Koch	(*Typhlodromus tiliae* Oudms)
(*Tydeus* spec.)	(*T. tiliarum* Oudms)
(*Oribatidae*)	

Here we find almost entirely the phytophagous species *Panonychus ulmi* Koch and some *Tydeus* sp. and *Oribatidae* on the branches and trunks. In some orchards we may find the predacious species *T. tiliae* and *T. tiliarum*, but in most orchards these species are absent. Not only the number of species has changed, but also the numbers of mites per species. *P. ulmi* on this type of trees often occurs in high numbers and often reaches a pest status. Some reasons for these changes will be discussed later in this paper.

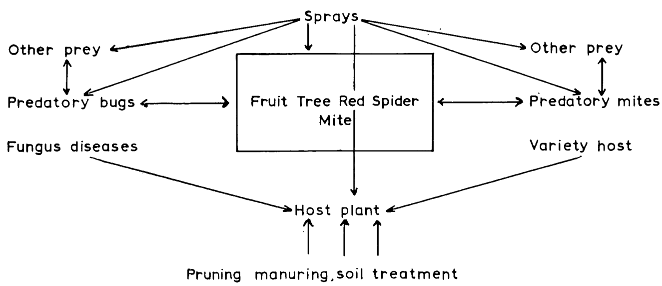

Fig. 1 - Relations of the Fruit Tree Red Spider Mite, *Panonychus ulmi* Koch with host plant, predators and cultural measures.

The complexity of the biocoenosis is demonstrated in fig. 1 where the relationships of the fruit tree red spider mite, *P. ulmi*, with its host plant, cultural measures and predators is shown. In this diagram we placed *P. ulmi* in the centre of a number of influence causing agents, but almost certainly an identical diagram could be made for other species which have reached a pest status. Post (1962) has shown that the condition of the host plant is of importance for the reproduction capacity of *P. ulmi*; Collyer (1958) and van de Vrie (1965) showed that the predatory mites have a reducing influence on the population development of this mite, Collyer (1952, 1953 a, b, c) demonstrated the importance of predatory bugs as a reducing factor. Predatory mites also feed upon other mite species beside of *P. ulmi*, while the polyphagous bugs as *Anthocoris nemorum* L., *A. nemoralis* L. and *Orius* sp. almost certainly have relations with other prey as aphids, young instars of caterpillars etc. The application of pesticides have, depending on their nature, influence on the quality of the host plant, and on the numbers of mites and insects, regardless whether these species are phytophagous or predacious.

As we are on this moment trying to trace the interrelations of *P. ulmi* with its principial predators, much has to be learned about the other relations and influences which certainly exist. In the Netherlands STORMS is studying the influences of the quality of the host plant in relation with the reproduction of *P. ulmi*; KUCHLEIN is studying the predator-prey relations of *Typhlodromus longipilus* Nesb. and *Tetranychus urticae* Koch. An almost unknown field is is food competition between phytophagous species.

In glasshouses the situation seems to be less complicated as fungus diseases are less numerous and the number of insect pests is also less than in the open. By this reason the number of pesticide applications is lower and fewer disturbances can be expected. However, the rapid changes in crops are in contrast to the situation in orchards, as this rapid changes give the beneficial species smaller changes to settle. It is remarkable that under these conditions predacious mites and insects can play an important role in the control of *T. urticae*, as is shown by BRAVENBOER (1959).

THE COMPLEX INFLUENCE ON THE BIOCOENOSIS BY PESTICIDES

The influence of some insecticides on the biocoenosis of neglected apple trees is shown in table III.

From this tabel it appears that parathion + DDT, chlorobenside and to some extend also carbaryl have a reducing influence on *Bryobia rubrioculus*, isolan and endosulfan have no influence. *Phyllocoptes schlechtendali* is reduced by all materials except by chlorobenside, while *Tydeus* sp. is reduced by all materials except by isolan and by carbaryl. *Czenspinskia lordi* is strongly reduced by endosulfan and carbaryl, much less influence is shown by the other materials. *Tarsonemus* sp. initially is strongly reduced by parathion + DDT but recovers during the following two months, while after the application of endosulfan a strong reduction and no recovery is found. The predatory mite *Typhlodromus tiliae* is strongly reduced by parathion and DDT, the other materials seem to have no harmful effects on the mites, however the number of eggs is lower than in the untreated series. This example shows that pesticides can differ very strongly in their influence on the biocoenosis. Identical results were obtained in trials with fungicides (VAN DE VRIE, 1964).

It must be considered that the figures given in table III were obtained after one application of the pesticides; some of these materials have to be applied rather frequently in commercial orchards.

TABLE III. - *Numbers of mites counted on samples of 100 leaves before* (16.VI) *and after treatment* (26.VI to 29.VIII) *with some insecticides*

Material and concentration	Counting dates	*Bryobia rubrioculus* *m*	*e*	*Typhlodromus tiliae* *m*	*e*	*Phyllocoptes schlechtendali* *m*	*Tydeus* sp. *m*	*Czenspinskia lordi* *m*	*Tarsonemus* sp. *m*
Untreated	16.VI	58	38	54	29	16	13	3	14
	26.VI	61	40	50	21	17	15	4	11
	6.VII	83	76	63	12	12	11	4	9
	19.VII	18	110	110	40	35	4	3	28
	29.VIII	21	13	84	4	2	9	29	52
Parathion 0.06 % + DDT 0.2 % . . .	16.VI	64	48	68	21	15	14	5	12
	26.VI	12	28	4	0	2	0	0	1
	6.VII	90	64	2	1	3	0	1	1
	19.VII	34	278	8	3	6	1	2	8
	29.VIII	397	95	79	9	44	1	30	100
Isolan 0.1 % . . .	16.VI	42	58	51	15	14	12	7	14
	26.VI	45	44	44	10	3	12	1	12
	6.VII	60	51	63	4	13	6	0	17
	19.VII	6	145	128	3	3	7	52	17
	29.VIII	29	12	93	10	3	12	10	25
Endosulfan 0.2 % .	16.VI	52	29	51	21	13	17	8	12
	26.VI	69	37	59	18	0	0	0	0
	6.VII	82	54	59	2	1	0	0	0
	19.VII	28	343	49	3	6	4	2	1
	29.VIII	112	50	69	4	1	0	5	3
Chlorobenside 0.2 %	16.VI	59	71	39	14	12	10	8	9
	26.VI	50	85	30	6	11	8	11	10
	6.VII	9	24	51	13	9	2	5	17
	19.VII	3	25	56	14	41	5	32	55
	29.VIII	11	6	129	8	2	6	78	43
Carbaryl 0.2 % . .	16.VI	48	15	38	27	14	2	7	5
	26.VI	1	23	35	21	0	2	0	6
	6.VII	14	17	42	9	0	6	1	5
	19.VII	6	19	59	5	2	3	0	5
	29.VIII	32	10	65	1	0	9	8	9

m = mites; *e* = eggs.

An important question is how the indirect influence of pesticides on mites is, first the indirect influence by altering the amount of food supply, secondly by influencing the reproduction capacity either direstly as shown by HUECK (1953), or indirectly by influencing the quality of the host plant. This last subject up till now, has gained little attention.

THE EVALUATION OF PEST DAMAGE IN TERMS OF DENSITY OF THE PEST

All discussions on integrated pest control presuppose the availability of biological control agents. This includes that, to some extend, also prey must be available for these predators and parasites. This means that some density of the insect or mite pest has to be allowed to remain present in the crops. And it is here that we meet great difficulties both from the scientific and from the practical approach as little is known about the densities at which insects and mites are becoming of economic importance. Some work has done in respect to the influence of mite damage to flower formation and yield of fruit trees (ASQUITH, 1959; CHAPMAN et al., 1952; VAN DE VRIE, 1956), but much remains to be done in other respects. The introduction of chemical thinning in fruit trees indicates that overproduction of flowerbuds often occurs and that some damage may be tolerated without having the risk of economic damage. In glasshouse cultures, I think, there are great differences in the evaluation of mite damage according to the crop grown. In flower production a low mite density can cause considerable damage to the quality and appearence of the crop, in contrast to the situation in cucumber growing where a low density of mites is of minor importance.

In my opinion, it would be of much help to have figures about the density of pest organisms in relation to the damage they cause, to provide a basis for the knowledge at which densities these organisms can be tolerated to keep parasites and predators alive in such quantities that they can be of help in controlling the pest organisms.

THE INTRODUCTION OF CHANGES IN THE SPRAY PROGRAMME IN PRACTISE

It has been said already that the availability of biological control agents presupposes the availability of prey. As most of our modern fruit growers, and I think the same applies to the glasshouse crop producers, have been educated and practised for many years pest control in a prophylactic way, it will be difficult for them to allow some pest insects or mites to be present in their crops. BRAVENBOER (personal communication) experienced this in introducing *Phytoseiulus riegeli* Dosse in cucumbergrowing; I think the same will happen in fruit growing if some biological control agent can be introduced in orchards.

It will be clear that a fixed spray schedule, or treatment based on the presence of phytophagous insects or mites, is not compatible with the idea of integrated control. The application of pesticides has to be based on the real need of controlling a population present; the numbers of predators and parasites have to be taken into account. This means that growers are placed in a position to make decisions about matters they never thought about before. It will be a task of advisory services and research workers to face this problem.

CONCLUSIONS

In closing, I like to state that many side effects and accompaning problems of the use of pesticides should not blind us to the many positive values they have. I think it is more real to seek solutions for the shortcomings pesticides accompany. In modern agriculture, chemicals, whether they are pesticides or fertilizers, are of essential value, and if they have shortcomings, it is our task to try to find a solution for whatever these shortcomings may be. In my opinion, integrated pest control can be a solution to overcome some of the shortcomings of pesticides. It is my opinion that the ecological approach to chemical pest control will provide a basis for a longer lasting effect of chemical control procedures and will give possibilities for avoiding unwanted accompaning side effects.

SUMMARY

The biocoenosis of apple trees is very complex and little is known about the interrelations of the occurring insect and mite species. The species present are influenced by various treatments viz. by manuring, pruning, application of pesticides and activities of parasites and predators. Furthermore there is a lack of knowledge about the level at which phytophagous species are of economic importance. Some of the interrelations of *P. ulmi* are discussed.

Under glasshouse conditions the situation is less complicated; the number of phytophagous species is limited while also fungus diseases are less numerous. The introduction of *P. riegeli* in cucumber growing seems to be promising; it is questionable whether this predator in flower growing can be of economic importance.

RIASSUNTO

La biocenosi del Melo è assai complessa e scarse sono le conoscenze sulle interrelazioni fra Insetti e Acari. Il rapporto fra le specie viene influenzato da vari fattori, quali le concimazioni, le potature, la somministrazione di antiparassitari e l'attività di parassiti e di predatori. Mancano inoltre precise conoscenze circa il punto oltre al quale le specie fitofaghe assumono importanza economica.

L'A. ha preso in considerazione alcune interrelazioni del *Panonychus ulmi*. Nelle serre la situazione appare meno complicata: inferiore è il numero sia delle specie fitofaghe che delle malattie crittogamiche. La diffusione del *Phytoseiulus riegeli* nelle colture di Cetriolo sembra essere promettente; è discutibile se questo predatore può avere importanza economica durante la fioritura.

LITERATURE CITED

ASQUITH D., 1959 - Mite injury sharply decreases apple tree yields. *Sci. Fmr*, 6, 6.

BRAVENBOER L., 1959 - De chemische en biologische bestrijding van de spintmijt *Tetranychus urticae* Koch. *Diss. Wageningen*, 85 pp.

CHAPMAN P. J et al., 1952 - Responses of apple trees to mite infestations. *J. econ. Ent.* 45, 815-821.

COLLYER E., 1952 - The biology of some predatory insects and mites associated with the fruit tree red spider mite (*Metatetranychus ulmi* (Koch) in south-eastern England. I. The biology of *Blepharidopterus angulatus* (Fall.) *Hemiptera-Heteroptera, Miridae. J. hort. Sci.* 27, 117-129.

COLLYER E., 1953 a - II. Some important predators of the mite. *J. hort. Sci.* 28, 85-97.

COLLYER E., 1953 b - III. Further predators of the mite. *J. hort. Sci.* 28, 98-113.

COLLYER E., 1953 c - IV. The predator-mite relationship. *J. hort. Sci.* 28, 246-259.

COLLYER E., 1958 - Some insectary experiments with predacious mites to determine their effect on the development of *Metatetranychus ulmi* (Koch) populations. *Entomologia exp. appl.* 1, 138-146.

FLUITER H. J. DE, 1961 - Die nützlingsschonende Schädlingsbekämpfung und ihre Beziehung zur Taxonomie der Nützlinge und Schädlinge. *Entomophaga* 6, 143-154.

FRANZ J., 1961 - Definitionen in der biologischen Schädlingsbekämpfung. *Z. Pfl-Krankh. PflPath. PflSchutz.* 68, 321-329.

HUECK H. J., 1953 - The population-dynamics of the fruit tree red spider mite (*Metatetranychus ulmi* Koch 1836, *Acari, Tetranychidae*). *Diss. Leiden*, 147 pp..

POST A., 1958 - Invloed van cultuurmaatregelen op de dierliike levensgemeenschap in boomgaarden. *Meded. Dir. Tunib.* 21, 612-621.

POST A., 1962 - Effect of cultural measures on the population density of the fruit tree red spider mite, *Metatetranychus ulmi* Koch. *Diss. Leiden*, 110 pp..

VRIE M. VAN DE, 1956 - Over de invloed van spintaantasting op de opbrengst en groei van vruchtbomen. *Tijdschr. PlZiekt.* 62, 243-257.

VRIE M. VAN DE, 1962 - The influence of spray chemicals on predatory- and phytophagous mites on apple trees in laboratory and field trials in the Netherlands. *Entomophaga* 7, 243-250.

VRIE M. VAN DE, 1965 - In the press.

DISCUSSION

CHABOUSSOU: Je remarque que le carbaryl — qui multiplie généralement *P. ulmi* — n'a pas entrainé de pullulation de *Bryobia*. Nous pensons qu'il faut voir là une conséquence des ripercussions biochimiques du produit sur la plante, et par contre-coup, sur la fécondité de l'Acarien: phénomène de trophobiose négatif. Il paraît en effet que *Bryobia*, dont le nourrissage est nocturne, présente des exsigences nutritionnelles passablement différentes de celles de *P. ulmi*.

DICKER: In my opinion the use of insecticides based only on the assessment of pest populations in relation to the risk of damage will present great difficuties. The threshold level for economic damage will depend on many variable factors such as climatic conditions and soil fertility. We should aim to develop selective insecticides which can be used regularly to protect the crop against the main pest species, rather than rely on annual populations trends which will vary between orchards and localities each year.

VAN DE VRIE: I fully agree with these remarks; however entirely selective insecticides are extremely rare. Our hope is that they will be available in the future.

KUCHLEIN: 1) I missed in your scheme, illustrating the interrelations between *ulmi* and its environment, the important influence of climate and weather.

2) Do you agree with my opinion, that Phytoseiid mites alone, even in the untreated orchard, are unable to regulate the density of the European Red Spider Mite?

VAN DE VRIE: 1) In the diagramme not all possibilities of influences on *P. ulmi* are given; the given diagramme is already rather complicated. There is no special reason for excluding the influence of climate.

2) We do not have enough evidence to say yes or no; they certainly have some influence. Further work must show the value of these predators.

CHABOUSSOU: Le terme « insecticides sélectifs » impliquait seulement la relative aptitude d'un produit à épargner les ennemis naturels, et de façon à épargner ce qu'il était convenu les « equilibres biologiques ». A la suite de la mise en évidence du phénomène de « trophobiose » (multi-pli-cation par modification du régime alimentaire par distorsion de la biochimie de la plante sous l'action du pesticide), il serait indiqué de trouver un vocable plus approprié pour désigner l'ensemble des pesticides sans danger pour la multiplication des Tetranyques.