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Department of Applied Entomology, Warsaw Agricultural University, Warsaw

Head: Prof. Dr. Jan Boczek

Zbigniew T. DĄBROWSKI

EFFECT OF PESTICIDES ON THE ASSOCIATIONS OF PREDATORY MITES IN APPLE ORCHARDS*

(Ekol. Pol. 18: 817–836). The author determined quantitative and qualitative variations in predatory mite associations in apple orchards treated with various pesticides. Attention was given in particular to the response of the association to the action of the pesticides.

It has been found that the application of pesticides in apple orchards causes: 1) a delay in the growth of predatory mite populations, as compared with orchards which have never been treated, 2) changes due to the presence or absence of a sufficient amount of animal food (phytophagous mites), 3) changes resulting from the variable pesticide-tolerance of individual species of Phytoseiidae, 4) changes due to the decreased density of predatory insects in the orchards, following the treatment with pesticides.

Few papers have so far been published concerning the effect of pesticides on predatory mites of the family *Phytoseiidae*, found in orchards. They usually deal with studies on the effect of specified pesticides on the density of *Phytoseiidae*, thus determining the degree of destruction to the predatory mite populations, caused by the treatment with pest-control chemicals. Only in a small number of papers was an analysis made of qualitative changes in the associa-

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tions of predatory mites, such as, for instance, the change of the dominating species among *Phytoseiidae*, as a result of treatment with pesticides. Among the papers concerned are the following: Clancy and Mc Alister (1956a, 1956b), Mac Phee and Sanford (1954, 1956, 1961), Collyer and Kirby (1955,1957), Mathys (1956), van de Vrie (1962), and those by Polish writers: Suski (1961), Niemczyk (1965), Niemczyk and Wiąckowski (1965), and Dąbrowski (1968, 1969a, 1969b, 1970c). The results obtained by these authors made it possible to classify the chemicals according to their toxic effects in relation to *Phytoseiidae*, and distinguish three groups of them specified as strongly-, medium-, or weakly-toxic:

– all organic phosphate insecticides, and under certain condions also lime-sulphur, Miltox and Dithane M–22 A appeared to possess a very high toxic effect;

– the medium-toxic group included: chlorinated hydrocarbon insecticides and carbamate insecticides, most acaricides, sulphur fungicides, Ferbam, Zineb, and copper oxichloride;

– among the insecticides with a low toxicity were the following: calcium arsenate, lead arsenate, nicotine sulphate soln., Thiodan; of acaricides: Mitox (chlorobenside), and of fungicides: Captan, Thiuram (TMTD), Bordeaux mixture.

The effect of pesticides on the species composition of predatory mites in the orchards was observed by Morgan and Anderson (1958). In their experiments, *Phytoseiidae* in an apple orchard appeared to have regained their previous numerical level within a year after a three times repeated spraying of the orchard in July. During the ensuing three years the density of the predatory mites was much higher than in the check orchard, not treated with the chemical concerned. The dominant species in the predatory mite association was *Typhlodromus occidentalis* Nesbitt, while in the adjacent orchards not treated with pesticides 90% of the *Phytoseiidae* associations was represented by *Typhlodromus rhenanus* (Oud.). *T. occidentalis* probably is fairly resistant to Parathion. The varying tolerance of the different species of *Phytoseiidae* with regard to the same chemicals was also stressed by: Huffaker and Kennett (1953), Mac Phee and Sanford (1954, 1956, 1961), and Dąbrowski (1969b).

The changing of dominant species among *Phytoseiidae* was observed also by Chant (1959), who maintains that in those orchards found in south-eastern England, which are not treated with pesticides *Typhlodromus pyri* Sche. only occurs in small numbers, though it appears to be the dominant species in pesticide-treated orchards. According to Chant (1959) the increase in numbers of this species in orchards not treated with chemicals is controlled by the population of another predatory mite, viz. *Typhlodromus finlandicus* (Oud.).

T. finlandicus ate eggs, larvae and nymphs of other species of *Phytoseiidae* including *T. pyri*.

In the literature concerned with this problem the view is held that in pesticide-treated orchards the abundance of predatory mites is always lower than in those which are not treated. After the preliminary observation which was carried out in orchards near Góra Kalwaria, Warka and Grójec the author of the present paper has found that considering the conditions prevailing in Poland the above view, which is a simplification of the problem, appears to ignore the changes caused by the various pesticides. Changes in the biocenoses of orchards as a result of the treatment with pesticides do not always lead to the elimination of predatory mites. In certain cases a significant increase in density of the predatory mites was seen in pesticide-treated orchards as compared with orchards which had never been treated with chemicals used for pest control.

The aim of the present study was to provide a more detailed description of the quantitative and qualitative changes in the association of predatory mites. Special attention was given to the reaction of the association to the action of pesticides used for pest control in orchards.

METHODS

In the years 1964–1968 in a number of selected commercial orchards near Góra Kalwaria, Warka and Grójec a regular observation of the abundance and species composition of *Phytoseiidae* was carried out. Field experiments were carried out during the years 1965–1967 in the orchards of the Agricultural Experimental Station at Krobów (orchards *K 1*, *K 4*, *K 5*).

The methods of sample taking, preparation of specimes for microscopy, elaboration of results, as well as the description of the fungicides, acaricides and insecticides have been presented in earlier papers (Dąbrowski 1968, 1969a, 1970).

Changes in numbers of the predatory and other groups of mites, that took place in the different combinations, are presented graphically. Variation in numbers of the following phytophagous mites was taken into account: *Tetranychidae*, *Tarsonemidae*, *Tydeiidae* and *Eriophyoidea*. Changes in abundance of the different predatory mite species, as estimated in the samples taken during the groving season, are illustrated by the graphs which show the species dominance of the associations of predatory mites. The dominance is expressed in terms of percentages of the different species in relation to the total number of individuals of Phytoseiidae.

The dominating developmental stage was also established by using the formula:

$$\frac{\text{number of eggs}}{\text{total number of living mites}}$$

The index value thus found expresses the number of eggs per each mite at the time the sample was being analysed. The values are written above the date of observation.

DISCUSSION OF RESULTS

The treatment of apple orchards causes a number of quantitative and qualitative changes in the associations of predatory mites living there. The changes, which proceed in many directions, are as follows:

1. A delayed increase of numbers of predacious mites in relation to the orchards not treated with pesticides.

2. Changes due to the presence or lack of sufficient and suitable food (phytophagous mites).

3. Changes resulting from different susceptibility of individual species of *Phytoseiidae* to pesticides.

4. Changes caused by the decrease in density of the predatory insects, following the treatment with pest-control chemicals.

1. Delayed increase of numbers of predacious mites in relation to the orchards not treated with pesticides

The delay in population growth of *Phytoseiidae* was caused by three factors (Fig. 1 and 2). As a result of the treatment a part of the mite population was killed and thereby their density, as expressed by the number of individuals per 100 leaves, decreased. The present paper does not include a detailed analysis of the effect of the different pesticides on the predatory mites since this was the subject of separate publications (Dąbrowski 1968, 1969a, 1969b). Some of the results are only dealt with in the review of literature.

Not all the applied pesticides killed phytoseiids, though in fact in the pesticide-treated trees a decrease of the number of predacious mites could be seen. The effect of some of the chlorinated hydrocarbons of contact action was that *Phytoseiidae* moved from the sprayed leaves on to the bark of the spurs and branches. These emigratrions greatly affected the numbers of the predacious mites on the leaves. A situation like this could be observed in orchard *GK* 1 near Góra Kalwaria in 1964, immediately after the termination of the treatment with pest-control chemicals (Fig. 3). In 1966 in the orchards of

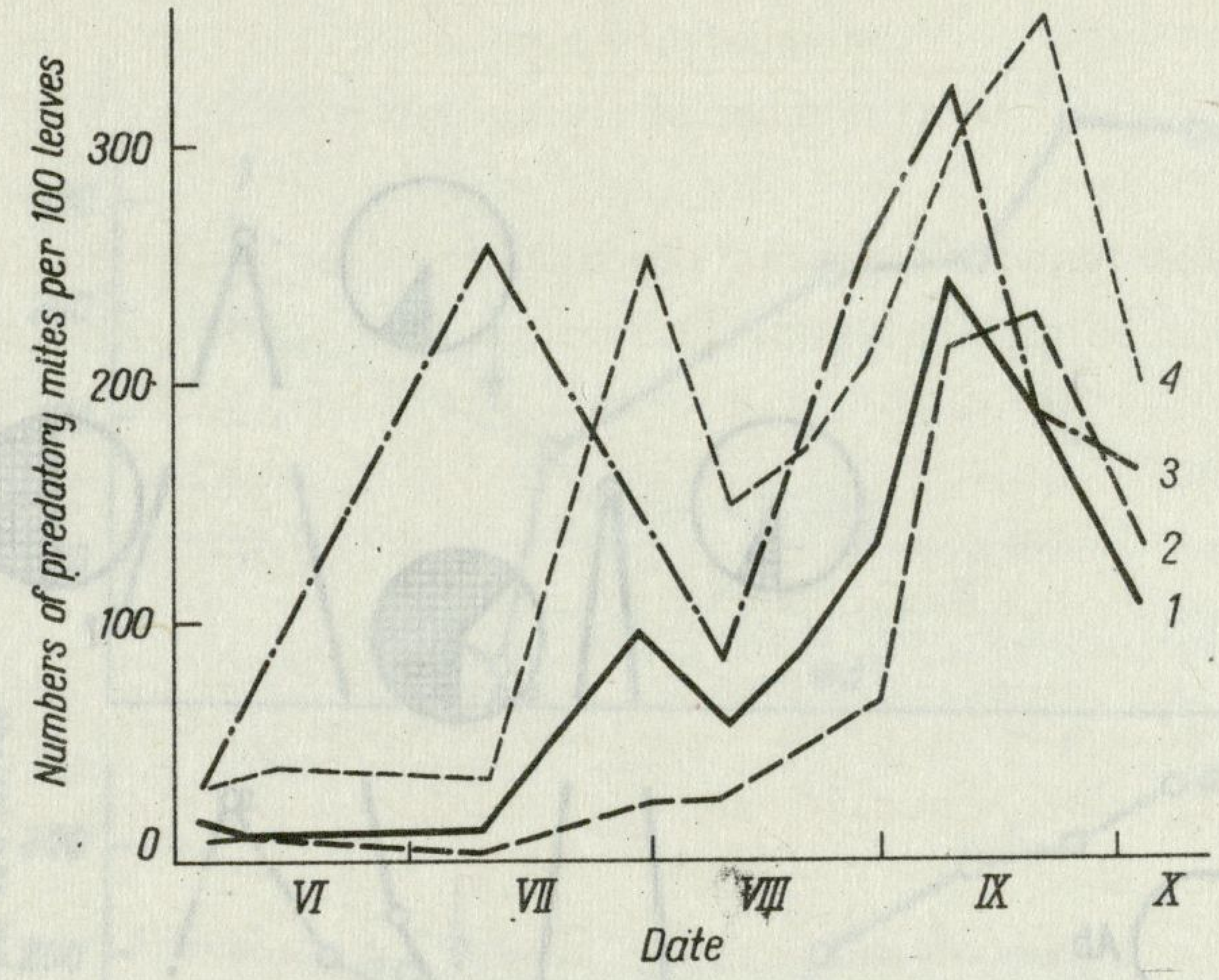

Fig. 1. Variation in numbers of predatory mites in 4 orchards not treated with pesticides, in 1964

1 – orchard *K 1*, *2* – orchard *K 2*, *3* – orchard *K 3*, *4* – orchard *K 4*

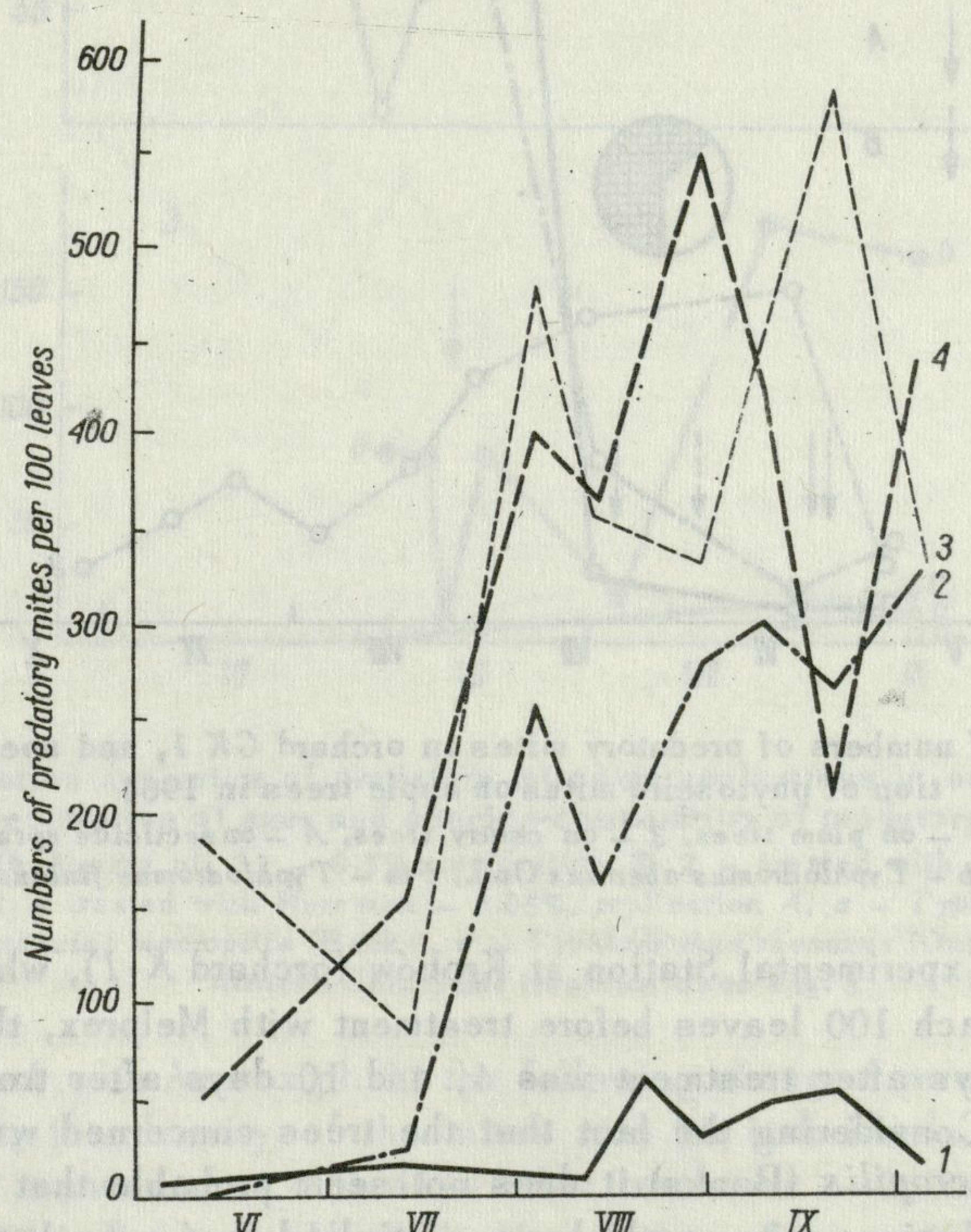

Fig. 2. Variation in numbers of predatory mites in 1964 in 4 orchards treated with pesticides

1 – orchard *KL*, *2* – orchard *G3*, *3* – orchard *G4*, *4* – orchard *G2*

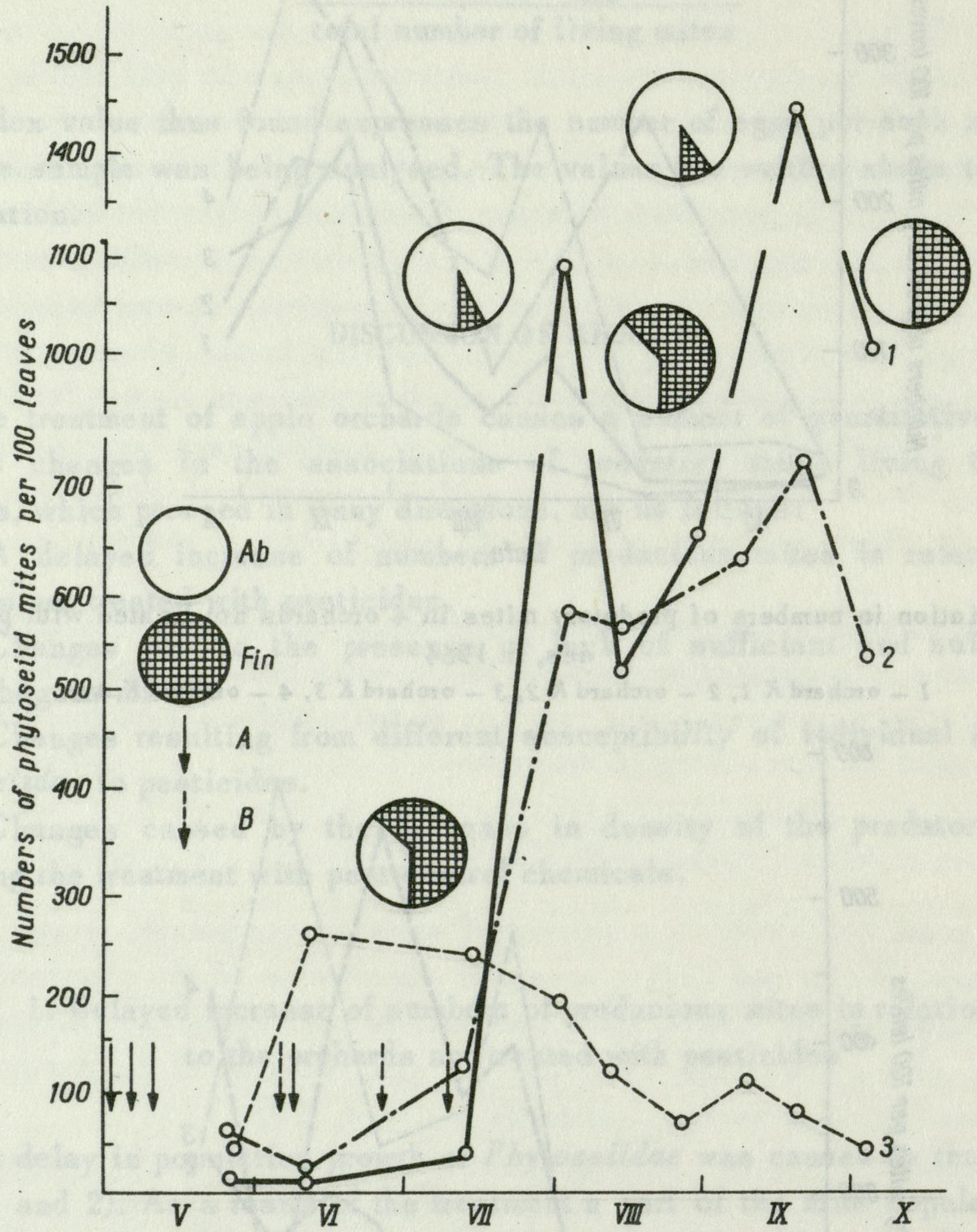

Fig. 3. Variation of numbers of predatory mites in orchard *GK 1*, and specific composition of phytoseiid mites on apple trees in 1964

1 — on apple trees, *2* — on plum trees, *3* — on cherry trees, *A* — on secticide spraying, *B* — fungicide spraying, *Ab* — *Typhlodromus aberrans* Oud., *Fin* — *Typhlodromus finlandicus* (Oud.)

the Agricultural Experimental Station at Krobów (orchard *K 1*), where 18 mites were found per each 100 leaves before treatment with Melprex, the number of mites found 5 days after treatment was 4, and 10 days after treatment — 67 per 100 leaves. Considering the fact that the trees concerned were inhabited by *Phytoseius macropilis* (Banks) it does not seem probable that the 4 individuals of this predacious mite would have multiplied fast enough to attain that level of abundance within as short a time as 5 days.

Similarly rapid variations in numbers in *Phytoseiidae* populations were seen in 1966 in a combination with Azotox pł. 33 and Acricid in orchard *K 5*.

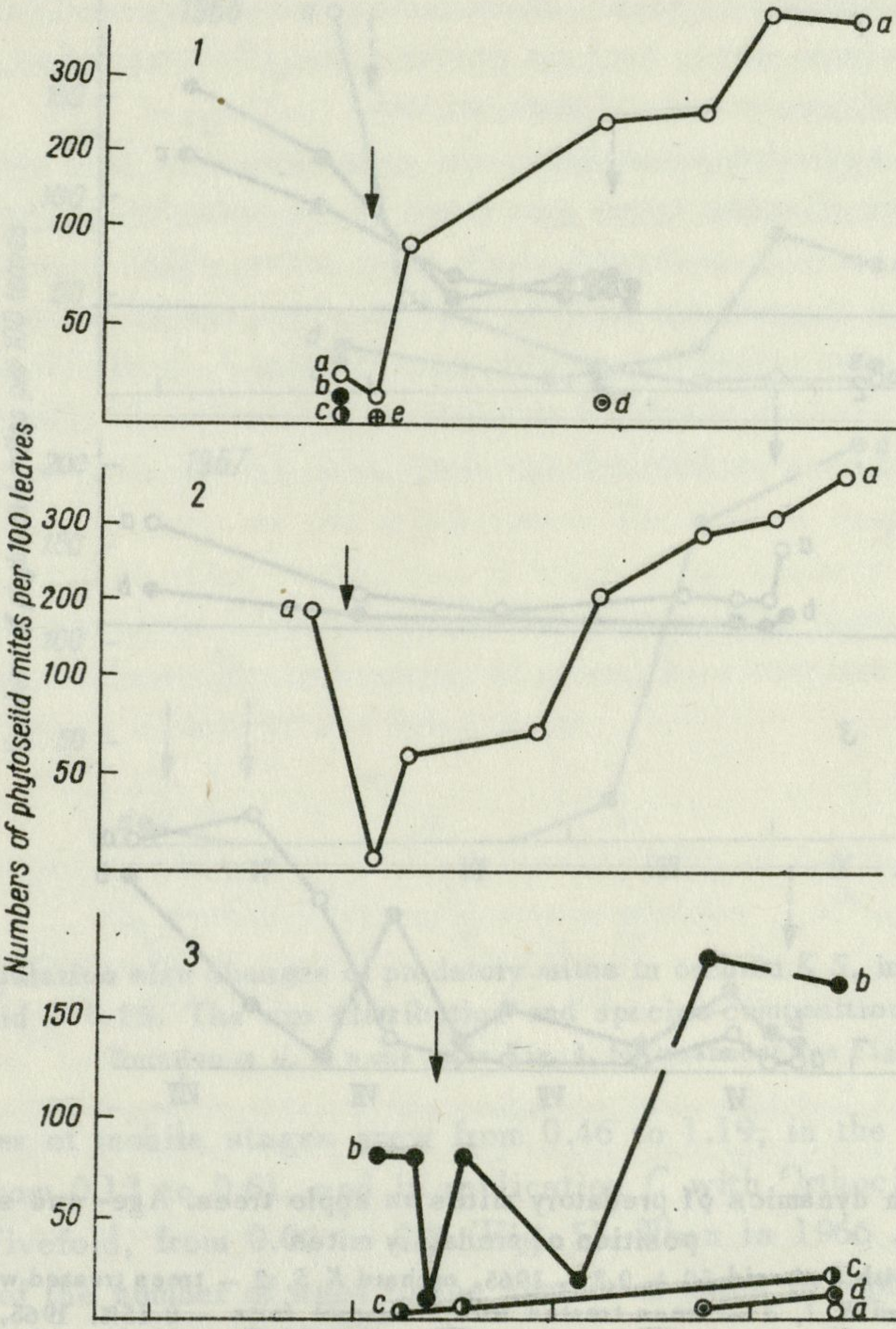

Fig. 4. Population dynamics of predatory mites on apple trees in orchard *K 5* in 1966. Description of age- and species-composition of predatory mites
1 – treated with Azotox pł. 33 – 0.3%, replication *B*, *2* – treated with Azotox pł. 33 – 0.3%, replication *C*, *3* – treated with Morestan – 0.05%, replication *A*, *a* – *Typhlodromus finlandicus* (Oud.), *b* – *Phytoseius macropilis* (Banks), *c* – *Typhlodromus rhenanus* (Oud.), *e* – *Typhlodromus tiliarum* Oud. Same treatment as on Fig. 3

In replication *A* with Azotox pł. 33 the following changes were observed: before the treatment, the density of the mites was 86 individuals per 100 leaves; 2 days after treatment – 6;5 days after treatment – 5; and 10 days after treatment – 67 individuals. In replication *B* the values were: 32, 2, 3 and 89, respectively, and in replication *C* – 215, 3, 2 and 48. A diagrammatic representation of these changes can be seen in Figure 4. The changes indicate that there occurs a temporary migration of the predacious mites from pesticide-

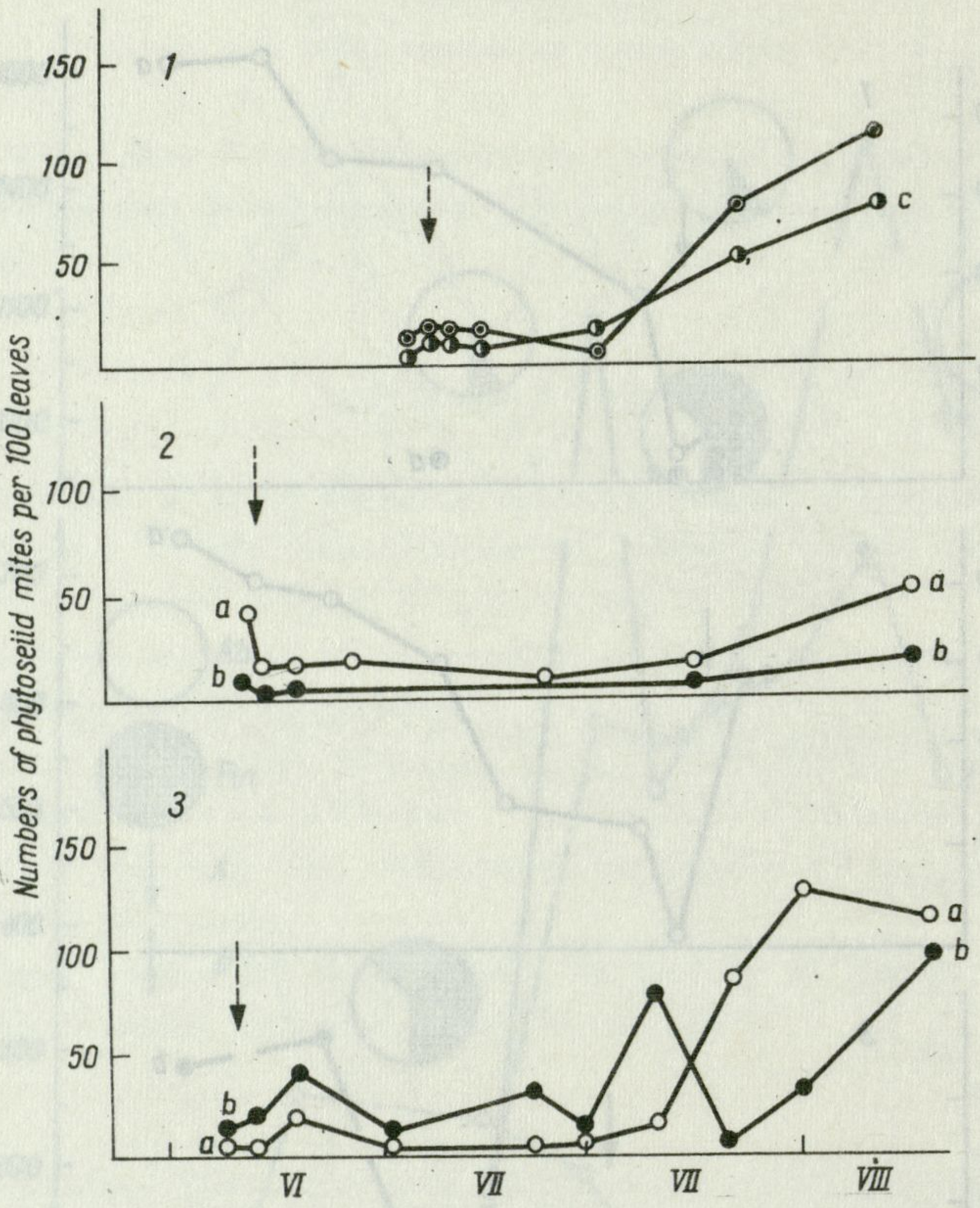

Fig. 5. Population dynamics of predatory mites on apple trees. Age- and species-composition of predatory mites

1 – trees treated with Orthocid 50 – 0.3%, 1965, orchard *K 5*, *2* – trees treated with Grzybol – 0.15%, 1965, orchard *K 1*, *3* – trees treated with Pomarsol forte – 0.15%, 1965, orchard *K 1*. Notation: *a*, *b*, *c*, *d* same as in Fig. 4, for treatment see Fig. 3

-treated leaves, caused by the presence of the residues of the chemicals used. These changes were not found to occur in check trees.

On the other hand the delay in the growth of numbers of *Phytoseiidae* was the result of changes in the age-structure of the populations of the different species of predacious mites. The use of a chemical caused changes in the percentages of individual developmental stages of *Phytoseiidae* in their associations. As a result of the decreased percentage of adult mites and the simultaneous increase of the percentage of eggs, larvae and nymphs, the size of individual population is determined by the number of individuals which survived the spraying. The number of eggs found during the 2–4 weeks following the spraying was comparatively small.

In trees treated with Grzybol, in 1965 the ratio of the number of eggs to

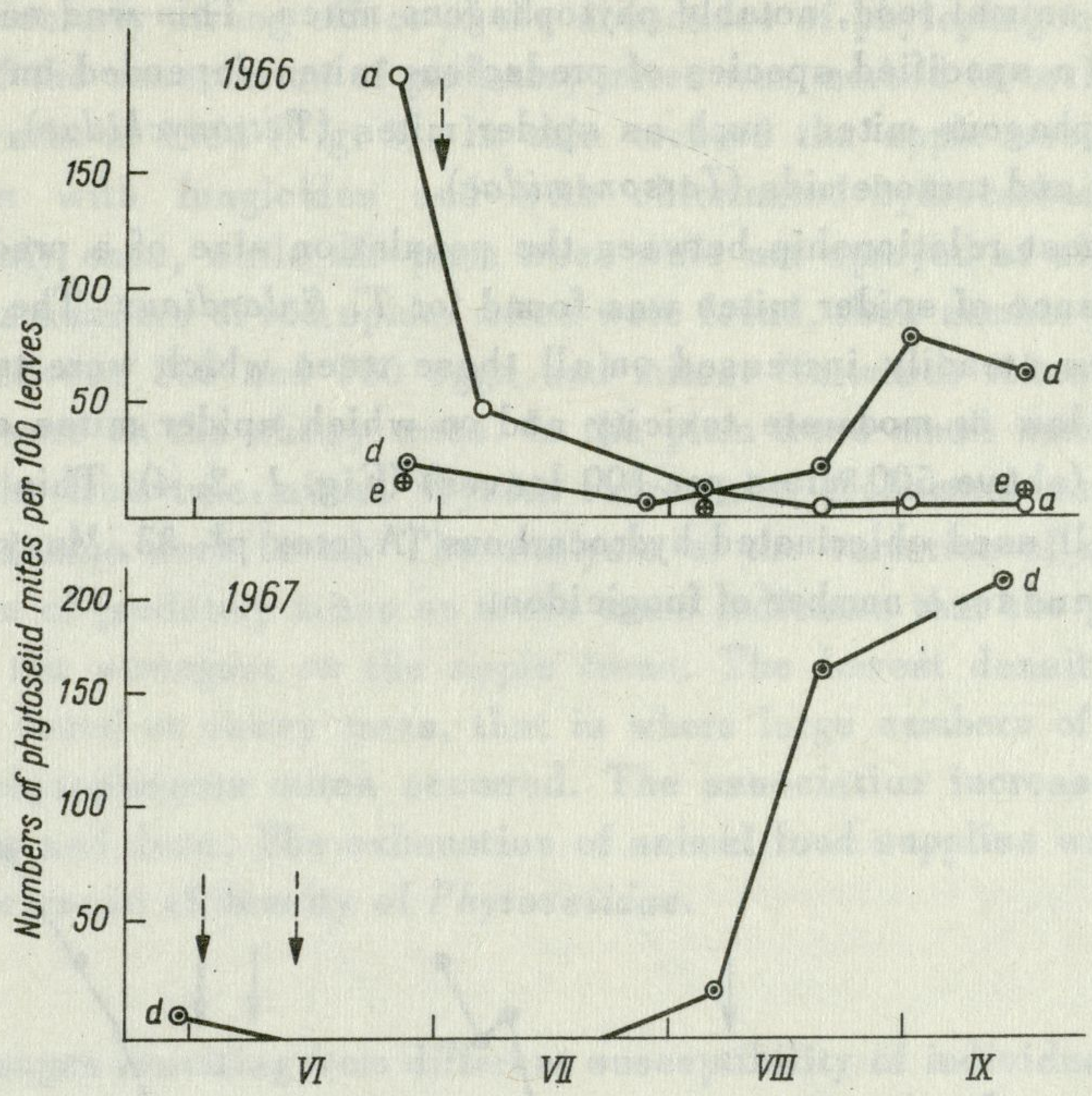

Fig. 6. Population size changes of predatory mites in orchard *K 5*, in apple trees treated with Acricid – 0.2%. The age distribution and species-composition of predatory mites

Notation *a, d, e*, same as in Fig. 4, for treatment see Fig. 3

the number of mobile stages grew from 0.46 to 1.19; in the case of Pomarsol forte – from 0.13 to 0.61, and in replication *C* with Orthocid 50 the ratio increased fivefold, from 0.06 to 0.3 (Fig. 5). When in 1966 Acricid was used, the ratio of the number of eggs to the number of mites in replication *C* increased sixfold, from 0.08 to 0.48 (Fig. 6).

The above changes did not occur in the case of treatment with acaricides of the group of summer ovicides. For instance in 1966 on trees treated with Roztoczol pł. 20 the numerical ratio of the eggs to the mobile stages on replication *A* decreased from 0.06 to 0.03, and in 1967 – from 0.12 to 0.07. The chemicals thus appeared to have been also destructive to the eggs of the predacious mites.

2. Changes due to the presence or lack of sufficient and suitable food (phytophagous mites)

Variations of the abundance and of the percentage of individual species in the associations of predacious mites to a large extent depended on the kind and amount of animal food, notably phytophagous mites. This was natural since the density of a specified species of predacious mites depended on the abundance of phytophagous mites, such as spider mites (*Tetranychidae*), gall mites (*Eriophyoidea*) and tarsonemids (*Tarsonemidae*).

The strongest relationship between the population size of a predatory mite and the abundance of spider mites was found for *T. finlandicus*. The population of this species steadily increased on all those trees which were treated with pesticides of low or moderate toxicity and on which spider mites occurred in large numbers (above 500 mites per 100 leaves) (Fig. *1*, *2*, *4*). This effect was observed for all used chlorinated hydrocarbons (Azotox pł. 33, Mszycol pł. 10, Metox pł. 30), and for a number of fungicides.

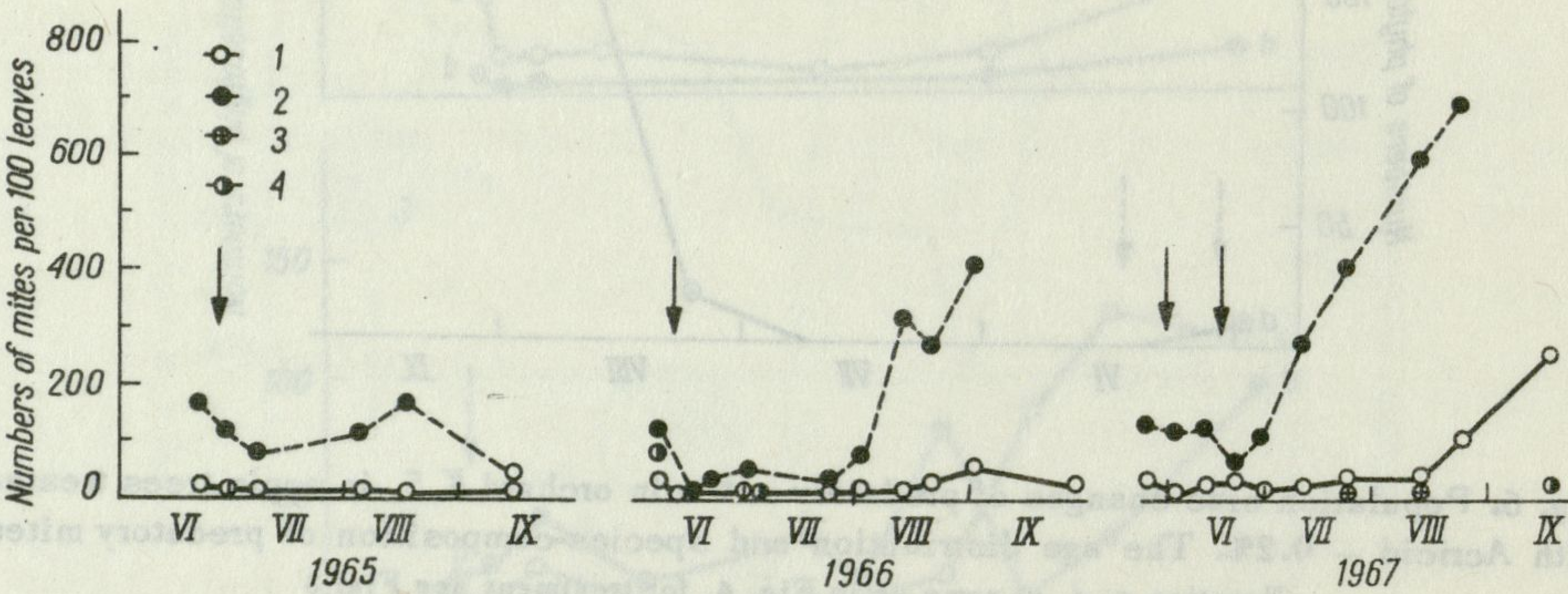

Fig. 7. Variations in numbers of phytophagous and predatory mites on trees treated with Elosal – 0.5%, in 1965, and with Thiovit – 0.2% in 1966 and 1967

1 – all stages of *Phytoseiidae*, 2 – all stages of *Tetranychidae*, 3 – all stages of *Tarsonemidae*, 4 – all stages of *Eriophyoidea* on 25 disks of Ø 1.5 cm. For treatment see Fig. 3

During the experiments continued for 3 years a steady growth in numbers of the spider mites was found in trees treated with Thiovit. In the first year of treatment with this fungicide the population size of spider mites and predatory mites was small. During the following year a rapid growth in numbers was recorded for the red spider mite. In 1967, i.e. the third year of treatment, a considerable increase of the abundance of *P. macropilis* was seen. The population of this species attained maximum growth about the middle of September when 231 individuals per 100 leaves were found (Fig. 7). However, this is one of the few cases when such a considerable growth in numbers of *P. macropilis* was seen, depending on the abundance of the red spider mite as its food. In a number of combinations a close relationship was found between the growth in numbers of *P. macropilis* and the presence and abundance of the apple rust mite, *Aculus schlechtendali* (Nal.).

A particularly strong effect of the abundance of phytophagous mites on the numbers of the association of predatory mites was marked in orchard *GK 1* near Góra Kalwaria in 1964 (Fig. 3). In this orchard the apple trees were sprayed four times with fungicides and with chlorinated hydrocarbon insecticides, cherries only once, while the plum trees were not sprayed at all. In the apple trees, large numbers of red spider mites were found, their number per 100 leaves varying between 500 and 780 eggs and mites. Numerous mites of the family *Tydeidae* were on the cherry trees. In the plum trees small numbers of individuals of the fruit tree mites, *Bryobia rubrioculus* (Scheuten) and mites of the family *Tydeidae* were found. The analysis of the variation of numbers in the association of predatory mites on these trees indicates that the growth in numbers was the strongest on the apple trees. The lowest density of predatory mites was found on cherry trees, that is where large numbers of *Tydeidae* and no other phytophagous mites occurred. The association increased in numbers only in May and June. The exhaustion of animal food supplies was followed by a steady decrease of density of *Phytoseiidae*.

3. Changes resulting from different susceptibility of individual species of *Phytoseiidae* to pesticides

Evidence concerning the changes caused by pesticides in predatory mite associations immediately after treatment could be obtained by analysing the changes in the species composition of samples collected 2, 5 and 10 days after treatment in relation to the analyses carried out one day before the treatment. It was assumed that a significant percentage-increase of the population of one species accompanied by a simultaneous significant decrease of the percentage of another species indicated that the former was being reduced at a slower rate than the latter. The other species was thus more susceptible to the given pesticide.

Generally, it could be seen that in all the combinations in which among other species also *P. macropilis*, *T. pyri*, *T. tiliarum* Oud. and *T. aberrans* Oud. had been found before the treatment the proportion of these species in the species composition, as determined from the samples collected, increased considerably after the treatment (Fig. 8). A typical example of this is orchards *GK 1* and *KL* in which immediately after spraying only *T. aberrans* and *T. pyri* Sche. occurred. *T. finlandicus* occurred in large numbers only after a month from the last treatment with insecticides. In the commercial orchards near Warka and Grójec predatory mites occurred in comparatively small numbers. Only the following species were present: *P. macropilis*, *T. tiliarum* and occasionaly *T. pyri*.

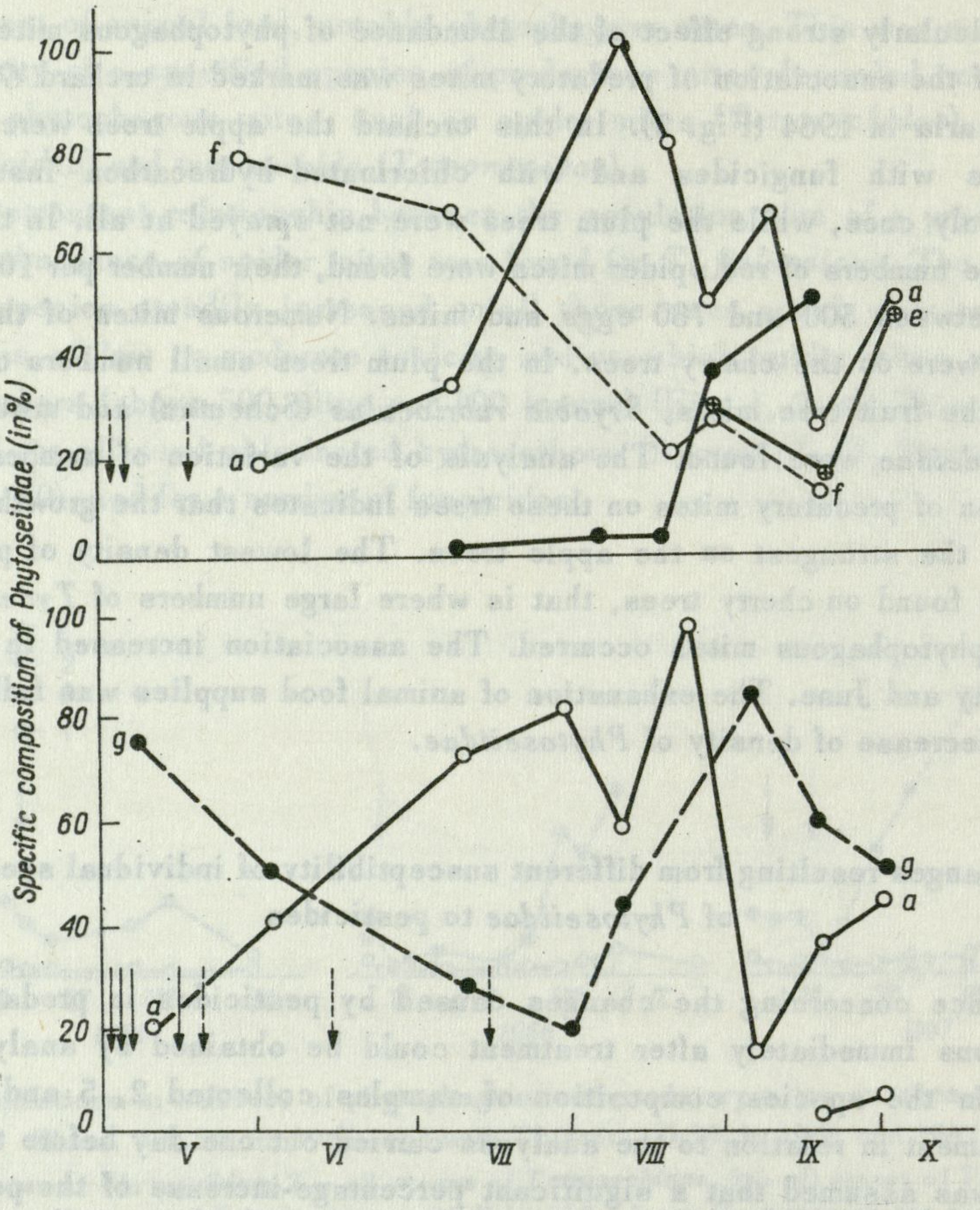

Fig. 8. Changes in the species-composition of predatory mites in orchards *KL* and *GK 1* in 1964

Notation *a, b, c* same as in Fig. 4 *f* – *Typhlofromus pyri* Sche., *g* – *Typhlodromus aberrans* Oud. For treatment see Fig. 3

In a number of pesticide-treated (but not with organic phosphate insecticides of systemic action) orchards a relatively high density of *T. aberrans* population was seen. In 1964, in a 6-times sprayed orchard near Góra Kalwaria (*GK 1*) the density of *Phytoseiidae* came up to 1450 individuals per 100 leaves (Fig. 3). In this orchard the following two species were abundant: *T. aberrans* and *T. finlandicus*.

In 1968 *T. aberrans* was found to dominate in several orchards in areas near Warka. These orchards were treated with fungicides and Metox pł. 30. In the preceding years organic phosphate insecticides of deep action were used. The density of *T. aberrans* came up to nearly 500 individuals per a 100-leaf sample

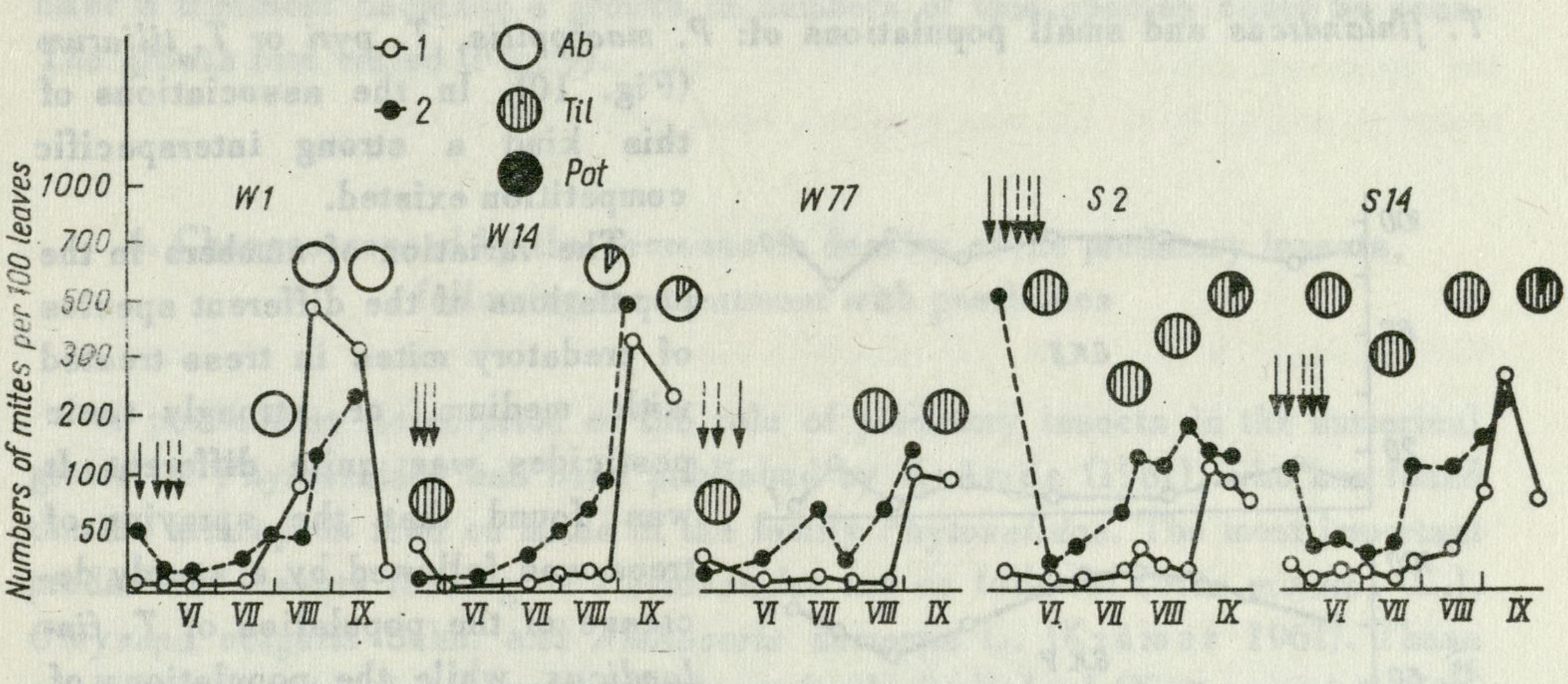

Fig. 9. Variations in numbers of spider mites and predatory mites in 5 apple orchards treated with pesticides in 1968. Species composition of predatory mites

1 – all stages of *Phytoseiidae*, *2* – all stages of *Tetranychidae*, *Ab* – *Typhlodromus aberrans* Oud., *Til* – *Typhlodromus tilliarum* Oud., *Pot* – *Typhlodromus potentillae* (Gar.), for treatment see Fig. 3

(Fig. 9). In all these orchards a rapid growth in numbers of this species could be seen. Its population sometimes increased several dozen times within a 10-days period.

It seems that the abundance of *T. aberrans* and *T. tiliarum* in pesticide-treated orchards first of all is not the result of their being physiologically resistant to pesticides, for in orchard *GK 1*, where an organic phosphate insecticide of systemic action (Metasystox ,,i") had been applied, *Phytoseiidae* appeared to have been eliminated completely. Simultaneously, the species were found to readily occupy bark crevices on the spurs, or remain beneath the scales of the European fruit lecanium, or of the oystershell scale. In the orchards considered, the coccids frequency of occurrence was 4–5 dead females per 20 cm of spur-length. It seems possible that *Phytoseiidae* developed beneath these scales and left them as soon as the action of the residues of the pesticides ceased. This is the only explanation for the fact that the number of adult individuals of *T. aberrans* increased from 40 to 152 per each 100-leaf samples within 10 days.

Similar temporary migrations of the predacious mites were seen in the orchard of the Agricultural Experimental Station at Krobów. Examples are given in part 1 of this paper.

Disturbances within the associations of predatory mites affected the growth conditions of the populations of various species throughout the vegetation season. In untreated orchards or in those treated occasionally with pesticides the predatory mite associations consisted mainly of an abundant population of *T. finlandicus* and small populations of: *P. macropilis*, *T. pyri* or *T. tiliarum* (Fig. 10). In the associations of this kind a strong interspecific competition existed.

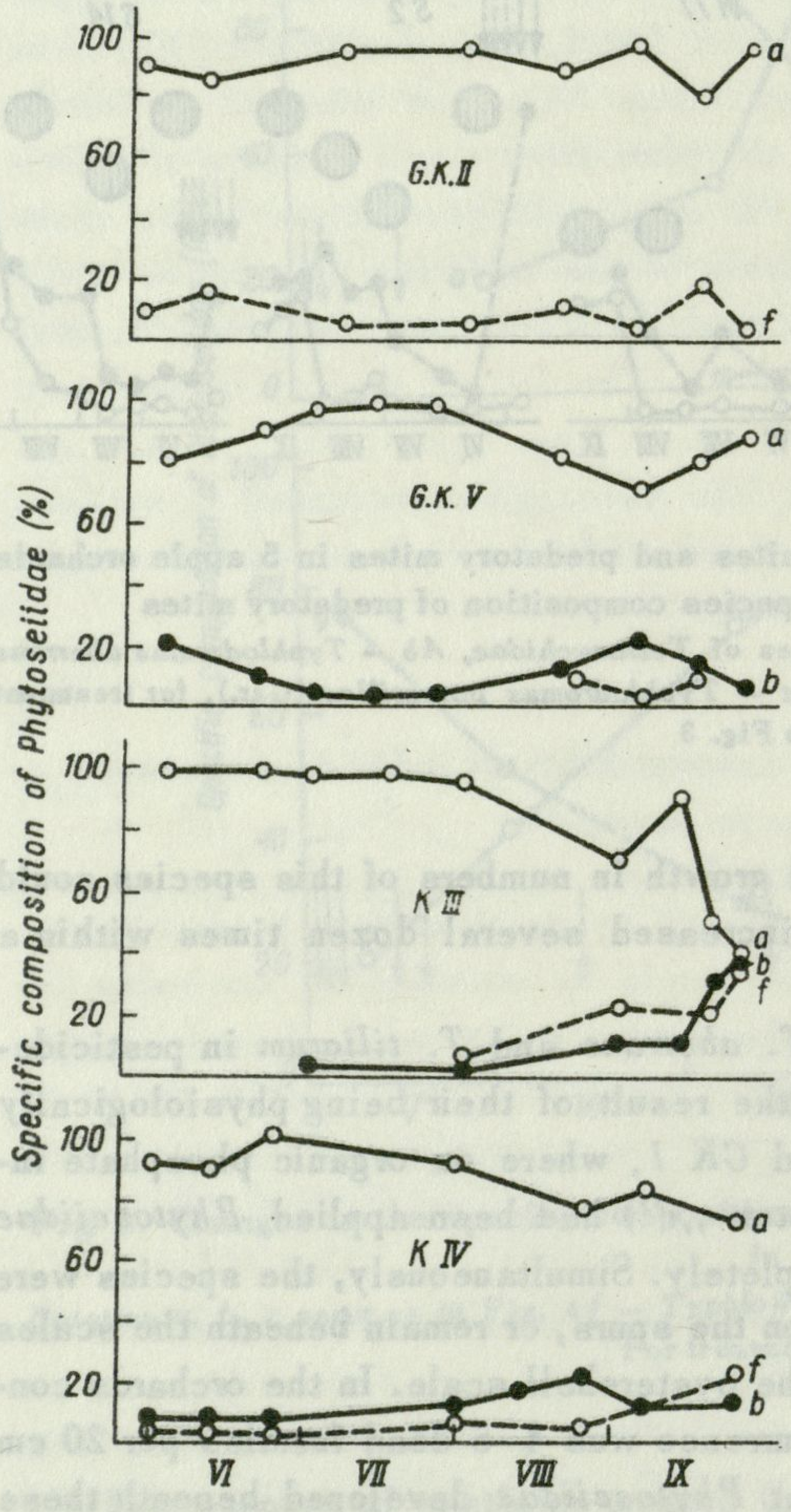

Fig. 10. Description of changes in species-composition of *Phytoseiidae* in 4 apple orchards in 1964

Notation *a*, *b*, *e*, *f* as in Fig. 4 and 8

The variation of numbers in the populations of the different species of predatory mites in tress treated with medium, or strongly toxic pesticides was quite different. It was found that the spraying of trees was followed by a steady decrease of the population of *T. finlandicus*, while the populations of other species of *Phytoseiidae* rapidly increased in size. A typical example was Acricid-treated trees on which as a result of the spraying the populations of the spider mites and *F. finlandicus* steadily decreased, while the population of *T. potentillae* increased to attain a density of 223 mites per 100 leaves in autumn. Changes in the density of the two populations are given in Figure 6.

Similar changes were seen in those associations in which *P. macropilis* was present. Being more resistant to pesticides than are other *Phytoseiidae* this species survived in the associations of predatory mites, while all other species died. Under these conditions the course of the development of *P. macropilis* population was quite different. It clearly grew in numbers, and the growth curve rose more or less rapidly (Fig. 7). The density of this species in Thiovit-treated trees was 231 individuals per 100 leaves during the third year of treatment.

The changes caused by the pesticides persisted only when the chemical used was strongly destructive to *T. finlandicus*. When the pesticides used were of medium or low toxicity in relation to the population of *T. finlandicus*, then after a transient decrease a growth in numbers of this species could be seen. The growth rate varied (Fig. 9).

4. Changes caused by the decrease in density of the predatory insects, following the treatment with pesticides

A preliminary description of the role of predatory insects in the numerical growth of *Phytoseiidae* has been published by Krämer (1961), who has found that 38 arthropods feed on mites of the family *Phytoseiidae*. The most important predacious insects feeding on *Phytoseiidae* are as follows: *Orius ,minutes* (L.), *Chrysopa vulgaris* Schn. and *Anthocoris nemorum* L. (Krämer 1961). These predatory insects also occur in apple orchards in Poland (Niemczyk 1963).

The analysis of the results obtained shows that the effect of predatory insects on *Phytoseiidae* proceeds in two directions. Predacious insects, notably bugs, feed on *Phytoseiidae* by sucking out their body fluids and soft tissues, therefore the relation existing between these two groups is that between a predator and prey. However, their food requirements in regard to phytophagous mites are the same, so they compete for food. The intensity of this competition depends on the density of spider mites, the lower the density, the stronger the competition. As has already been pointed out, in untreated orchards, in which the density of spider mites was low, the populations of predatory mites were also small. In such cases the most affected was the population of *T. finlandicus*. In the orchards considered predatory insects were often seen sucking out the body of *T. finlandicus* females.

T. finlandicus is characterized by a large body size as compared with the body size of other species of *Phytoseiidae*. It walks on the glabrous underside of the leaf. In the orchards under study there also occurred another predatory mite species, viz. *P. macropilis*. It differs from *T. finlandicus* in body size (being considerably smaller) and in the behaviour on the leaves. It usually remains hidden deep among the hairs in the leaf axils, rather seldom walking over the leaf blade. It avoids glabrous areas on the leaf. For this reason perhaps the species of big body size and moving over the whole leaf blade (e.g. *T. finlandicus* and *T. potentillae*) are the first to become the prey of predatory insects.

The above effect of predatory insects on predatory mites decreases in two cases. Insecticides of contact action, which are highly toxical to predacious insects cause a decrease in their density. This change creates more favourable conditions for the growth of the populations of predatory mites. It has been found that pesticides of contact action, e.g. the chlorinated hydrocarbon insecticides, are only medium or weakly toxic for *Phytoseiidae*. Those *Phytoseiidae* which have survived will thus develop in the environment from which the predatory effect of these insects as well as their competitive action with regard to animal food, i.e. spider mites, have been eliminated.

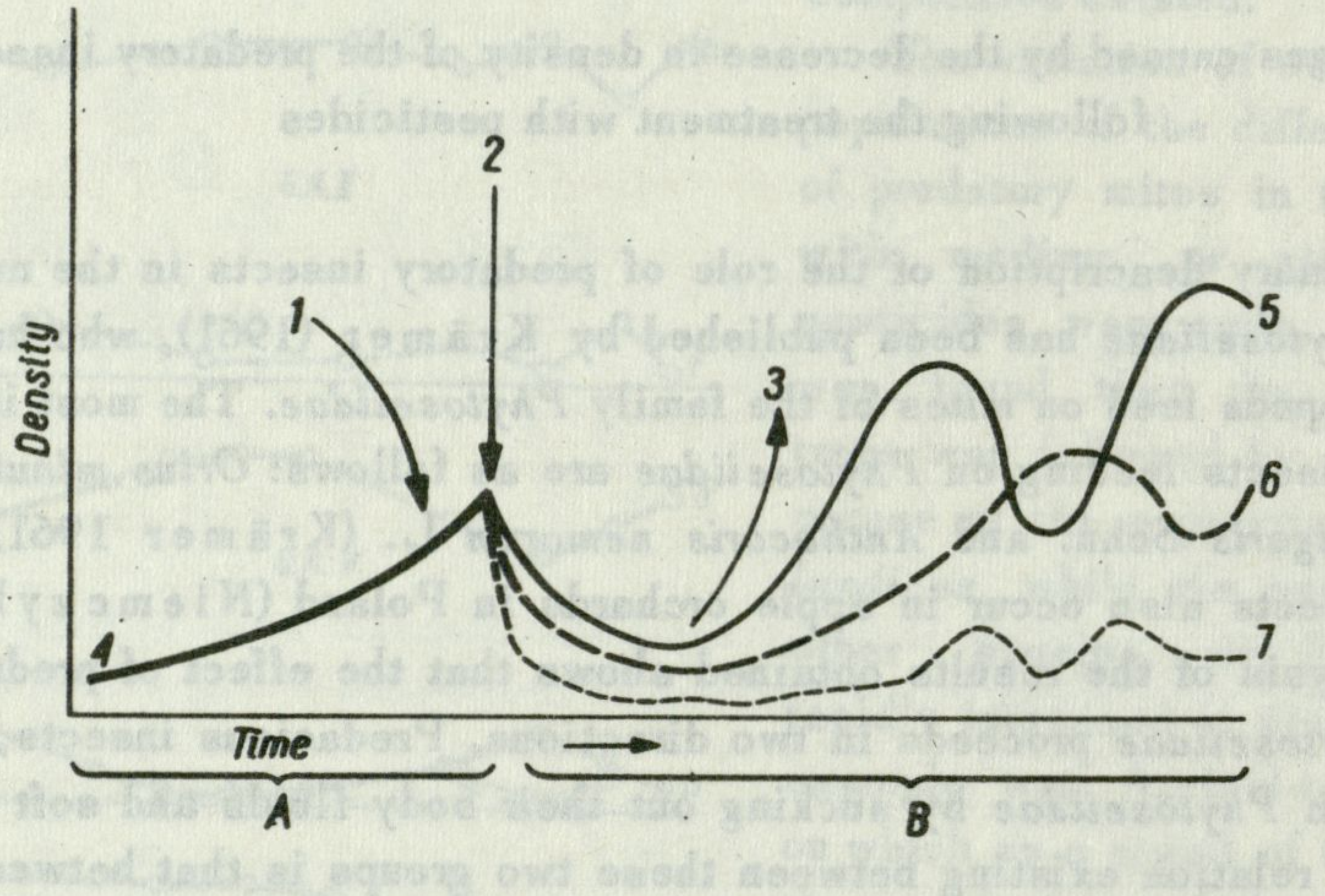

Fig. 11. Description of the effect of three groups of factors on the abundance of predatory mites in pesticide-treated and in untreated apple orchards

A – before treatment, *B* – after treatment *1* – Factors limiting the growth in numbers of *Phytoseiidae*, e.g. scarcity of animal food – phytophagous mites, interspecies competition among *Phytoseiidae*, predation by insects, *2* – treatment with three groups of pesticides of moderate, strong and very strong toxicity in relation to predatory mites, *3* – factors accelerating the growth in numbers of *Phytoseiidae*, e.g. low density of predacious insects, rapid increase in the amount of animal food – phytophagous mites, changes within the predatory mite association itself, *4* – population dynamics of predatory mites before treatment, *5* – changes in abundance of *Phytoseiidae* after the application of a medium-toxic pesticide, *6* – changes in abundance of *Phytoseiidae* following the application of a strongly toxic pesticide, *7* – changes in abundance of *Phytoseiidae* following the application of a very strongly toxic pesticide

On the other hand many pesticides, when used for the spraying of orchards, cause growth of the population of spider mites. In such orchards the competitive and predatory pressure of the predatory insects on *Phytoseiidae* decreases, for a spider mite is much more likely to be encountered by a predatory insect than is a predatory mite. In pesticide-treated orchards in which no regular spider mite control is applied the average density of these mites comes up to 1500–3000 individuals per 100 leaves, while the average density of predatory mites ranges from 150 to 400 individuals per 100 leaves. *Phytoseiidae* attain this level of abundance only in pesticide-treated orchards which are not treated with organo-phosphate insecticides strongly toxic to predatory mites, notably those of systemic action.

Changes of the factors affecting the growth of numbers of the particular species of predatory mites in pesticide-treated orchards are presented diagrammatically in Figure 11.

SUMMARY

The data presented in this paper indicate that the use of pesticides of medium or low toxicity to predatory mites caused an increase of their populations. This growth resulted from the fact that some of the pesticides used stimulated the growth of spider mites, which in turn favoured the growth of the populations of the different species of *Phytoseiidae*. The maximum abundance attained in such cases by the association of predatory mites was higher than in those orchards which had never been sprayed with pesticides. This becomes noticeable when data given in Figure 1, illustrating numerical variation of the predatory mite communities in 4 orchards never treated with pesticides, is compared with data in Figures 2 and 3. Only in one (*KL*) of the pesticide-treated orchards was the abundance of predatory mites 4 times lower than in orchards which were not treated with pesticides. The orchard concerned was treated with Malathion and with insecticides of the chlorinated hydrocarbons group. Malathion is a compound strongly toxic to *Phytoseiidae*. In all other pesticide-treated orchards the population of predatory mites was larger than in untreated orchards.

In view of the above data the opinion that in untreated orchards the abundance of the association of predatory mites is always much higher than in pesticide-treated orchards seems to be an oversimplification of the problem. The facts found have not been hitherto duly emphasized in the literature concerned. These are the most important arguments indicating that it is possible to work out a scheme of integrated control of spider mites, as conceived by A.D. Pickett, as a programme for controlling the populations of arthropods so that the population of pests can be kept below the economic tolerance by intensifying the resistance of the environment to prevent too high a rate of their multiplication, and replacing this resistance by the use of selective pesticides only in cases when it is likely that the economic injury level will be exceeded (Pickett, Mac Phee 1965).

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WPŁYW PESTYCYDÓW NA ZESPOŁY DRAPIEŻNYCH ROZTOCZY W SADACH JABŁONIOWYCH

Streszczenie

Praca miała na celu określenie zmian ilościowych i jakościowych w zespołach drapieżnych roztoczy w sadach jabłoniowych traktowanych różnymi pestycydami. Szczególną uwagę zwrócono na reakcje zespołu na niszczące działanie pestycydów.

Stwierdzono, że zmiany w zespołach drapieżnych roztoczy wywołane stosowaniem pestycydów są wielokierunkowe i dotyczą:

1. opóźnienia wzrostu liczebności drapieżnych roztoczy w stosunku do sadów nigdy nie traktowanych pestycydami,

2. zmian uwarunkowanych występowaniem lub brakiem dostatecznych ilości odpowiedniego pokarmu zwierzęcego (roztoczy roślinożernych, a przede wszystkim przędziorków),

3. zmian wywołanych różną wrażliwością poszczególnych gatunków *Phytoseiidae* na pestycydy,

4. zmian wywołanych spadkiem zagęszczenia drapieżnych owadów w sadach opryskiwanych pestycydami.

Zebrane dane świadczą, że stosowanie średnio toksycznych lub słabo toksycznych preparatów dla *Phytoseiidae* wywoływało wzrost liczebności drapieżnych roztoczy. Wzrost ten był wywołany dzięki temu, że stosowanie wielu pestycydów stymulowało rozwój przędziorków. Stwarzało to więc korzystniejsze warunki dla wzrostu populacji różnych gatunków drapieżnych roztoczy. Osiągana wtedy maksymalna liczebność *Phytoseiidae* była wyższa w stosunku do sadów nigdy nie opryskiwanych chemicznymi środkami ochrony roślin.

Po zabiegach pestycydami obserwowano istotne zmiany wpływu drapieżnych owadów na zespoły *Phytoseiidae*. Zastosowanie insektycydów o działaniu kontaktowym silnie niszczyło drapieżne owady. Zagęszczenie ich spadało. Stworzyło to z kolei korzystniejsze warunki dla wzrostu liczebności drapieżnych roztoczy, ponieważ szereg pestycydów o działaniu kontaktowym (na przykład z grupy chlorowanych węglowodorów) były słabo lub tylko średnio toksyczne dla *Phytoseiidae*. Pozostałe przy życiu drapieżne roztocze rozwijały się w środowisku, w którym został wyeliminowany wpływ drapieżnictwa tych owadów jak i konkurencyjność w zakresie pokarmu zwierzęcego, a więc przędziorków.

Z drugiej strony zastosowanie wielu pestycydów wywoływało wzrost liczebności przędziorków. W sadach takich zmniejszał się nacisk konkurencji i drapieżnictwa drapieżnych owadów na wzrost liczebności *Phytoseiidae*.

AUTHOR'S ADDRESS:
Dr Zbigniew T. Dąbrowski
Katedra Entomologii Stosowanej SGGW,
Warszawa, Ursynów — Pałac,
Poland.