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The influence of predatory mites on the population development of *Panonychus ulmi* (Koch) on apple

INTRODUCTION

A potential pest in Dutch apple growing is the Fruit Tree Red Spider Mite, *Panonychus ulmi* (Koch) (= *Metatetranychus ulmi* Koch) (1). As this mite species has developed resistence against many acaricides (VAN DE VRIE 1963), attention was paid to the possibillities of including the use of predators in the commercial control of this pest. COLLYER (1958), DOSSE (1960), MATHYS (1958) and VAN DE VRIE (1965) have shown that under their local conditions, predatory mites can have an important influence on the population development of phytophagous mites. Therefore studies were conducted in the Netherlands to study the interrelationships between *P. ulmi* and two species of predatory mites, *Typhlodromus* (*A.*) *potentillae* Garman and *T. tiliae* Oudms (= *pyri* Scheuten) (*Phytoseiidae*). These two species are widely distributed on apple in the Netherlands. The studies were carried out under glasshouse and field conditions during 1964 and 1965.

MATERIALS AND METHODS

In the glasshouse experiments potted rootstocks, EM II, were grown in cabinets (fig. 1), which were placed in a semi air-conditioned glasshouse. 20 potted rootstocks were placed in each cabinet and infested with females of P. *ulmi* and *T. potentillae* at the following densities: 10 *P. ulmi* + 0 *T. potentillae;* 10 *P. ulmi* + 1 *T. potentillae;*

(1) During the meeting of the European Acarologists on their 5th Acarological Symposium at Milano, September 1965, it was approved that the name *Panonychus* has priority, consequently this name has to be used.

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10 *P. ulmi* + 3 *T. potentillae* per tree. At weekly intervals 2 potted rootstocks were taken as samples and replaced by two new ones.

All the mites and eggs present on the leaves were counted by using a binocular microscope. As the rootstocks had such a size that the leaves and the branches of the individual trees touched each other, migration and dispersion over all the trees was facilitated.

Fig. 1 - Cabinet for breeding *P. ulmi* and *T.* (*A.*) *potentillae* under glasshouse conditions.

In the field trial 5-year old unsprayed trees, variety Ellinson's Orange on EM II, which had a low density of *P. ulmi* and *T. potentillae*, were used. According to the experiment the trees were infested with different numbers of *P. ulmi* and *T. potentillae*. From these trees samples were taken at weekly intervals, each sample consisted of 30 leaves taken at three different regions: centre, middle and peripherie of the tree.

For the infestation of the cabinets and the trees in the field trial *P. ulmi* from our experimental garden was used; *T. potentillae* was collected in a lightly sprayed orchard.

Results

A. The glasshouse experiments

The population development of *P. ulmi* and *T. potentillae* in the cabinets is shown in the figgs. 2, 3, and 4.

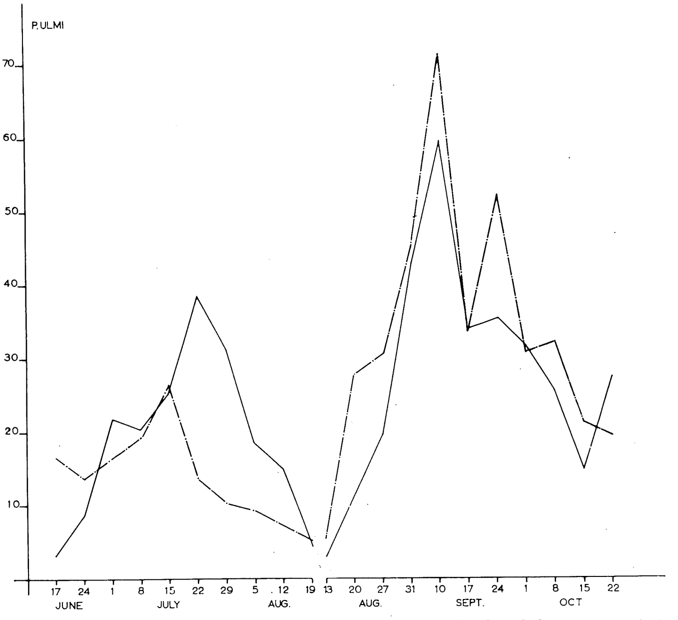

Fig. 2 - The population development of *P. ulmi* without predators.

In the cabinet with only *P. ulmi* a rapid increase took place (fig. 2). During the middle of August a single *T. tiliae* was found on these trees. Therefore a new series was started at the same densities of the original one. Here again a rapid development was found, reaching a density of approximately 60 mites per leaf during the first part of September. The decline after the middle of September is due to the oviposition of winter eggs.

The development of prey and predator with the original density of 10 *P. ulmi* + 1 *T. potentillae* is shown in fig. 3. During June and July a maximum of 25 mites per leaf is found. The number of predatory mites during this period is remarkeble low. During the month of September again a rather high density of *P. ulmi* is found, however the number of mites per leaf is lower than in the cabinet without predators. The development of *T. potentillae* apparently is responsible for the lower density of *P. ulmi*. The rapid decline in density of *P. ulmi* after the middle of September is partly due to the activities of the predatory mites and partly due to the oviposition of winter eggs.

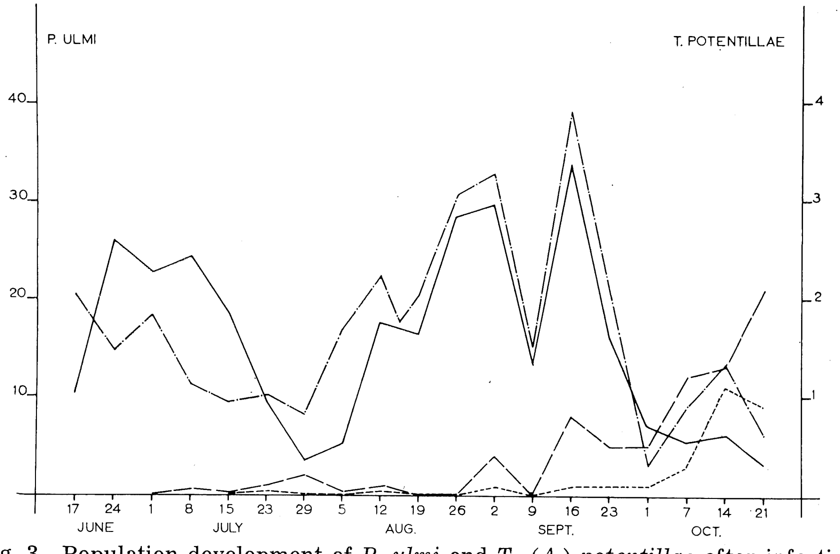

Fig. 3 - Population development of *P. ulmi* and *T. (A.) potentillae* after infection with 10 ♀♀ of *P. ulmi* + 1 ♀ *T. (A.) potentillae* per tree.

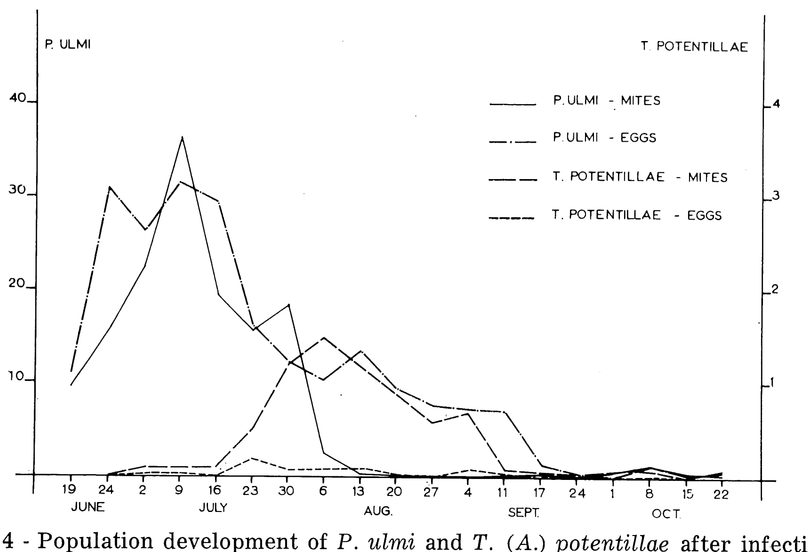

Fig. 4 - Population development of *P. ulmi* and *T. (A.) potentillae* after infection with 10 ♀♀ of *P. ulmi* + 3 ♀ *T. (A.) potentillae* per tree.

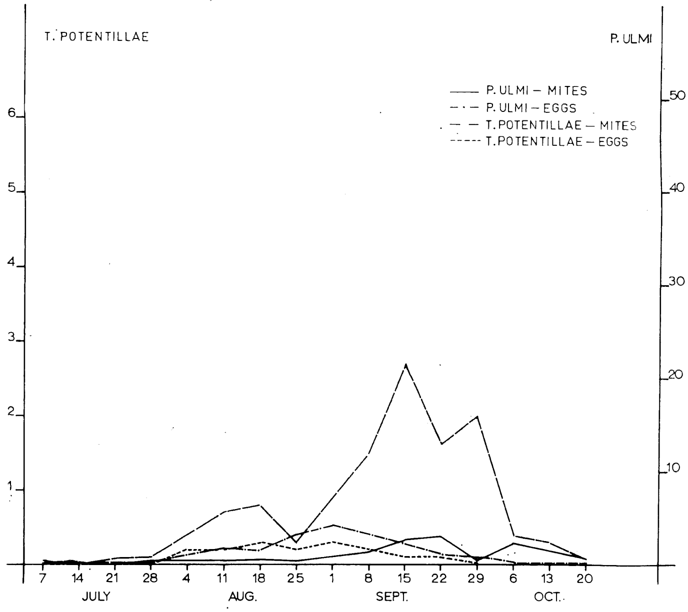

Fig. 5 - Population development of *P. ulmi* and *T. (A.) potentillae* under field conditions. *P. ulmi* low + *T. (A.) potentillae* low.

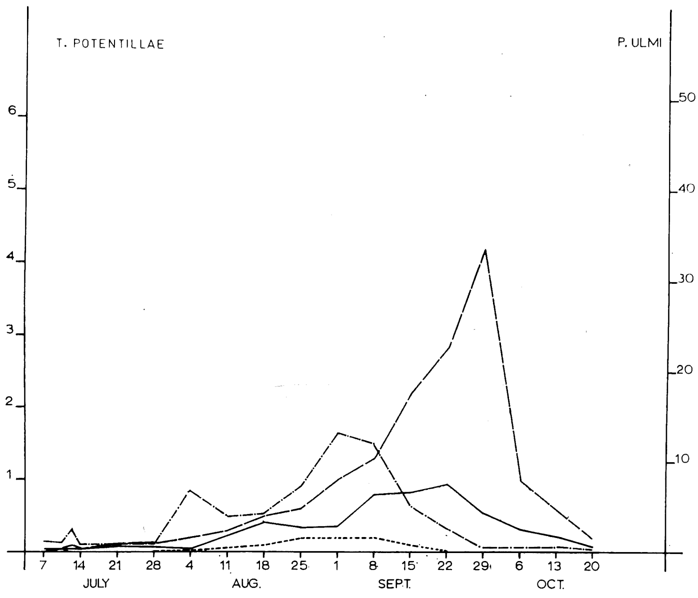

Fig. 6 - Population development of *P. ulmi* and *T. (A.) potentillae* under field conditions. *P. ulmi* high + *T. (A.) potentillae* low.

The population development in the cabinet with the original density of 10 *P. ulmi* + 3 *T. potentillae* is shown in fig. 4. During the end of June and the beginning of July a rapid development of *P. ulmi* is found, reaching a maximum of 35 mites per leaf. The higher rate of infection with *T. potentillae* results in a faster build up of this mite; at the end of July-beginning of August a density of more than 1 mite per leaf is found. The activity of the predatory mite prevents the further development of *P. ulmi*. It is remarkeble that the high number of summer eggs, present during June and July do not give rise to a further development of *P. ulmi;* the reasons herefore will be discussed later.

B. The field experiments

In the field trials the trees which had originally a low density of *P. ulmi* and *T. potentillae,* were infested with prey and predators according to the following scheme:

Treatment no:	*P. ulmi:*		*T. potentillae:*	
1	low	(0-1 mites per leaf)	low	(0-2 mites per 100 leaves)
2	low	(» » »)	high	(10 mites per 100 leaves)
3	moderate	(1-3 mites per leaf)	low	(0-2 mites per 100 leaves)
4	moderate	(» » »)	high	(10 mites per 100 leaves)
5	high	(3-6 mites per leaf)	low	(0-2 mites per 100 leaves)
6	high	(» » »)	high	(10 mites per 100 leaves)

Infestation was carried out by hand and took place on July 7th 1964. The trees were not isolated as the experimental plot was situated in a well sheltered part of the experimental garden. The treatments 2, 4 and 6 were carried out in duplicate; the treatments 1, 3 and 5 were conducted on single trees. As the trees had low numbers of *Vasates schlechtendali* Nal. before the trial was started, the trees were sprayed with endosulfan two weeks before the infection; this controlled this species effectively. Other mite species were not observed during the period of investigations.

In fig. 5 it is shown that during the whole period of observations a low density of prey and predator was present on the uninfested trees; this is normally found on unsprayed trees.

In fig. 6, low density of *P. ulmi* but with additional predatory mites, a somewhat higher density of *P. ulmi* was found especially during

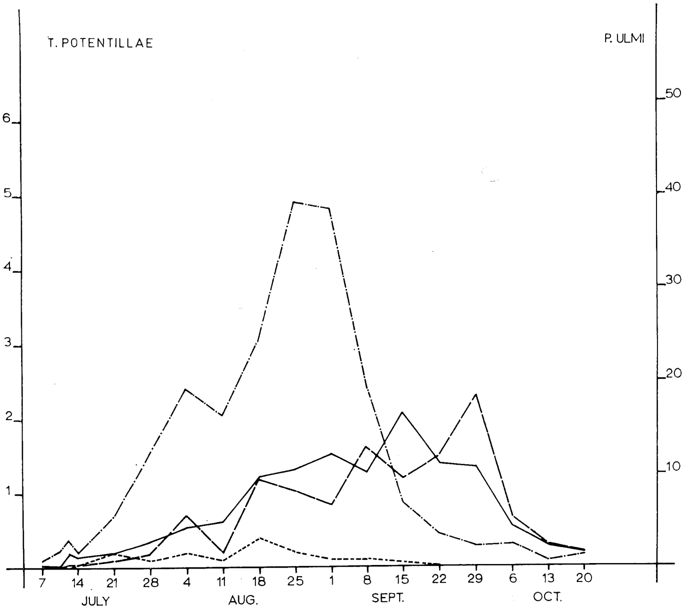

Fig. 7 - Population development of *P. ulmi* and *T.* (*A.*) *potentillae* under field conditions. *P. ulmi* moderate + *T.* (*A.*) *potentillae* low.

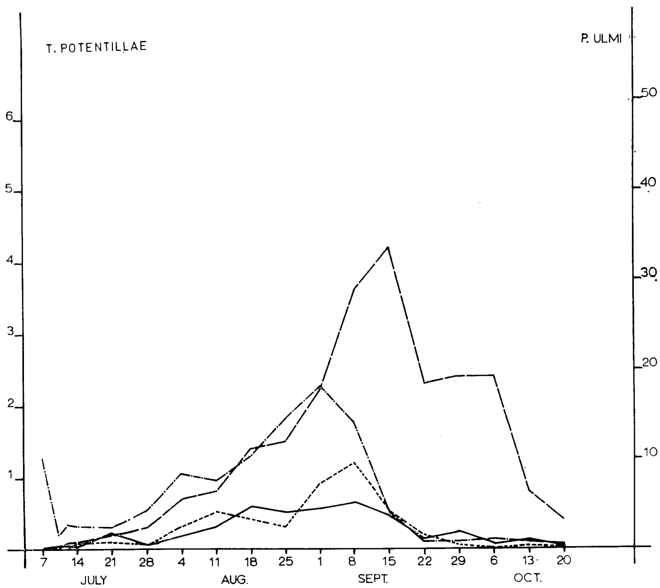

Fig. 8 - Population development of *P. ulmi* and *T.* (*A.*) *potentillae* under field conditions. *P. ulmi* moderate + *T.* (*A.*) *potentillae* high.

September. This higher density can not be explained, but apparently this higher density is not of much importance. As the result of the artificial infection with *T. potentillae,* the density of this species is somewhat higher at the end of the season than in the foregoing series.

In fig. 7 the development of a moderate density of *P. ulmi* with the original low density of the predator is shown. *P. ulmi* increases steadily untill the middle of September reaching than a maximum of 18 mites per leaf. It is noteworthy that the number of summer eggs is rather high, but this peak of eggs is not followed by a peak of mites. The causes and consequences of this phenomenon will be dicussed later. As a result of the presence of prey the predator population develops steadily untill the end of the season.

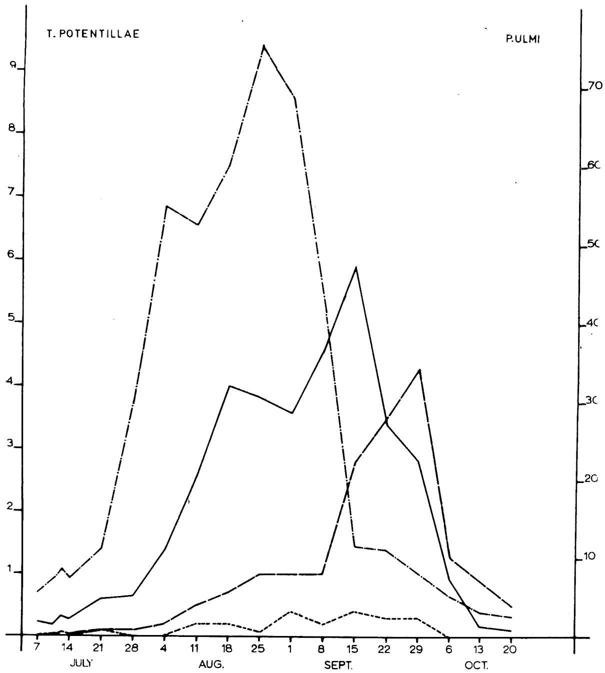

Fig. 9 - Population development of *P. ulmi* and *T. (A.) potentillae* under field conditions. *P. ulmi* high + *T. (A.) potentillae* low.

In fig. 8 the development of the moderate density of *P. ulmi* under the influence of a high density of *T. potentillae* is shown. *P. ulmi* reaches its maximum density between mid-August and mid-September; however, this density never increases higher than 5 mites per leaf.

Due to the low number of mites, the number of summer eggs is lower than in fig. 7. The artificial infection with *T. potentillae* results in a higher density of this mite; the activity of this mite species prevents a higher build up of the *P. ulmi* population.

The development of the high density of *P. ulmi* in the presence of the original low density of *T. potentillae* is demonstrated in fig. 9. Here *P. ulmi* increases to high densities during the months of August and September with a maximum of 48 mites per leaf on September 15th. Also *T. potentillae* reaches a high density, probably because food is abundantly present.

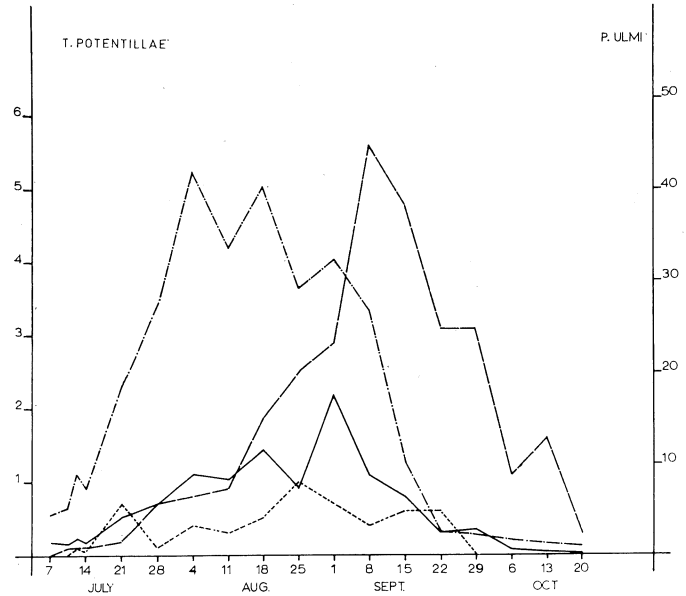

Fig. 10 - Population development of *P. ulmi* and *T. (A.) potentillae* under field conditions. *P. ulmi* high + *T. (A.) potentillae* high.

The development of the high density of *P. ulmi* in the presence of a high density of *T. potentillae*, both artificially infested, is shown in fig. 10. Comparison of the figgs. 9 and 10 shows that *P. ulmi* reaches a lower density in fig. 10. However, the numbers of summer eggs until the end of July are almost identical in both series. These summer eggs in fig. 10 do not give rise to a further development of *P. ulmi*; the causes herefore will be discussed later. As a consequence of the artificial infection with *T. potentillae* this predator increases to higher densities while the maximum is reached earlier in September than in fig. 9.

Observations on the amount of winter eggs during the winter after the above discussed trial was carried out, revealed that the highest number of eggs could be found on the trees no 3 and 5; the other trees all had relatively low numbers. This reflects the high numbers of females present during the period in which the winter eggs were laid. Further observations during the following spring showed that the trees 3 and 5 had the highest density of *P. ulmi* during the first generation; due to the activity of the predatory mites the following generations did not differ any more in density. During July and August all the trees had almost identical low populations of prey and predator.

Preference of *T. potentillae* for different stages of *P. ulmi*

In the above described trials it was frequently found that the presence of a high number of summer eggs of *P. ulmi* in combination with the presence of *T. potentillae* mostly did not result in an increase of the *P. ulmi* densities. Laboratory trials showed that neither *T. potentillae* nor *T. tiliae* preyed upon the summer eggs. The predatory mites never produced eggs and mostly died within one week when only summer eggs of *P. ulmi* were provided as food. Larvae were readily accepted; some of the laboratory investigations are given in table 1.

Table I. - *Preference of* T. tiliae *Oudms for different stages of* P. ulmi *Koch in laboratory trials*

Number and stages of *P. ulmi* offered	Number and stages of *P. ulmi* consumed	Number of females *T. tiliae*
100 females + 100 larvae	5 females + 98 larvae	10
20 females + 180 larvae	1 female + 176 larvae	10
180 females + 20 larvae	10 females + 20 larvae	10

From these figures it is clear that larvae are preferred above the females. The causes for this preference are not fully known; the larvae move slower and probably are easier attacked than the females. Another explanation might be that the larvae are much smaller so that the predators have to attack more of them to reach their required amount of food. Other laboratory trials revealed that *T. potentillae* has an identical preference for the larval stages of *P. ulmi*.

This preference for the larval stages of *P. ulmi* explains why the high numbers of summer eggs in the above mentioned trials often does not result in a further development of *P. ulmi*.

Discussion

Glasshouse and field experiments showed that the development of high densities of *P. ulmi* on apple trees could be prevented by *T. potentillae*. Glasshouse and field work with *T. tiliae* revealed identical results.

Under field conditions it was impossible to include a series with only *P. ulmi* on the leaves, as the predatory mites for this purpose had to be removed by hand. As the mites mostly hide along the midrib and the main veins of the leaves it is almost impossible to find and to remove them in the field.

As is shown in the figgs. 3 and 4 *T. potentillae* prevents the build of *P. ulmi* populations more or less strongly according to the original densities of both species. The same holds true for the field trial. It is premature to conclude from these figures which numbers of both species have to present on the leaves to maintain an equilibrium between prey and predator.

The results from the laboratory trials, by which is shown that the predatory mites have preference for the larval stages of the prey, provide an insight into one of the causes of such an equilibrium; the prey females are rarely attacked and provide by their offspring a source of food for the predatory mites.

All trials end with a low density of both prey and predator. This is in accordance with what is normally found in undisturbed mite populations on apple trees; here also mostly low numbers of phytophagous and predacious mites can be found. Mostly more species are present here, as there were in our trials, the importance of other food resources for the predatory mites is not yet known.

SUMMARY

The influence of the predatory mites *Typhlodromus (A.) potentillae* Garman on the development of populations of the phytophagous mite *Panonychus* (= *Metatetranychus*) *ulmi* (Koch) was studied in glasshouse and field trials. This species could prevent a build up of *P. ulmi* to damaging levels as well as under glasshouse conditions as under field conditions. The effect of the predatory mites is attributed to their preference for the juvenile stages of the prey.

RIASSUNTO

Mediante esperimenti in serra e in campo, è stata studiata l'influenza dell'acaro predatore *Typhlodromus* (A.) *potentillae* sullo sviluppo delle popolazioni di *Panonychus* (= *Metatetranychus*) *ulmi*. Il predotore sarebbe in grado di impedire che il fitofago si attesti a livelli dannosi, in entrambi gli ambienti osservati. La sua azione viene attribuita alla preferenza dimostrata per gli stadi giovanili della vittima.

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