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THE AVOCADO BROWN MITE IN RELATION TO ITS NATURAL ENEMIES

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The avocado brown mite, **Oligonychus punicae** (Hirst), infests California avocado orchards in many areas every season. The presence of these mites is usually first noted when a characteristic brownish coloration, caused by mite feeding, appears on the upper surfaces of the leaves beginning along the midrib and main veins. The undersides of the leaves remain undamaged unless the infestation is unusually severe. Although occasionally some leaves become damaged to such an extent that they drop from the tree, brown mite populations normally decline to low levels before serious injury occurs.

Natural enemies play an important part in controlling the avocado brown mite, as was demonstrated by Fleschner, et al. (1). When all mite predators were removed by hand from an experimental limb of an avocado tree for an extended period of time, severe mite damage occurred on the leaves. On another limb, where mite predators were not removed, leaf injury never became extensive.

The most important predators of the avocado brown mite are: **Stethorus picipes** Casey, a small black coccinellid or lady beetle; and two species of predaceous mites, **Typhlodromus (Amblyseius) hibisci** Chant, and **T. (A.) limonicus** (Garman and McGregor). Adult **Stethorus** beetles are shiny black and about 1/16 inch in length, while the larvae have a dark brown coloration and reach a length of about 1/8 inch when full grown. Both adults and larvae feed on mites, and can be readily found on the upper surfaces of the leaves when brown mites are present in relatively large numbers. The **Typhlodromus** mites spend much time on the undersides of the leaves so that they are not easily seen, although they readily move to the upper surface to attack and consume brown mites. The adult **Typhlodromus** mite is only slightly larger than an adult avocado brown mite. They are basically colorless and opaque, but, after consuming mites, portions of their bodies take on a coloration similar to that of the mite prey. These predators are extremely fast-moving, and run rapidly when disturbed. Other mite predators, such as **Oligota oviformis** (Casey), a small black staphylinid beetle, and several species of "dustywings" or coniopterigids, sometimes become abundant, but are usually of lesser importance on avocados compared with the other predators

mentioned.

In order better to understand the interrelationships between the avocado brown mite and its natural enemies in various areas, populations of mites and predators were closely observed in several avocado orchards during the 1961 season. The information accumulated should be useful in more effective utilization of natural enemies in the control of mites. The purpose of the data here presented is to illustrate some of the characteristic interactions between the avocado brown mite and its major natural enemies.

METHODS

Four avocado orchards were selected for study during the year 1961: the L. Bailard orchard in Carpinteria, Santa Barbara County; the McAdam orchard in Encinitas, San Diego County; the Beck orchard in Fallbrook, San Diego County; and the Thille orchard in Santa Paula, Ventura County. The first two localities are near the ocean and are characterized by mild summers and winters, while the last two are somewhat intermediate between coastal and interior climatic areas, having warmer summers and somewhat cooler winters. Avocado brown mite and predator populations were sampled from four trees selected in each grove. Brown mites and predaceous **Typhlodromus** mite densities were measured as follows: ten leaves were picked from around the periphery of each sample tree and the mites on these leaves were counted in the laboratory. All **Typhlodromus** mites, except eggs, were recorded but only adult female brown mites were included in the data given here. Relative densities of insect predators which feed on mites were estimated by counting all predators seen during a walk around each sample tree for a period of five minutes. Data illustrating numbers of mites and predators consist of averages of the four sample trees in each grove. Inasmuch as **Stethorus** and **Typhlodromus** were the only abundant predaceous species which fed on brown mites in this investigation, others were not considered in the preparation of this report. The sample trees consisted of the following varieties: Bailard and Beck orchards—Hass; McAdam orchard—Wurtz; Thille orchard—two Hass and two MacArthur trees.

RESULTS

1. BAILARD ORCHARD:—Population trends of avocado brown mites and major predators are shown in Fig. 1. Brown mite populations remained low until June, when they began building up rather rapidly and

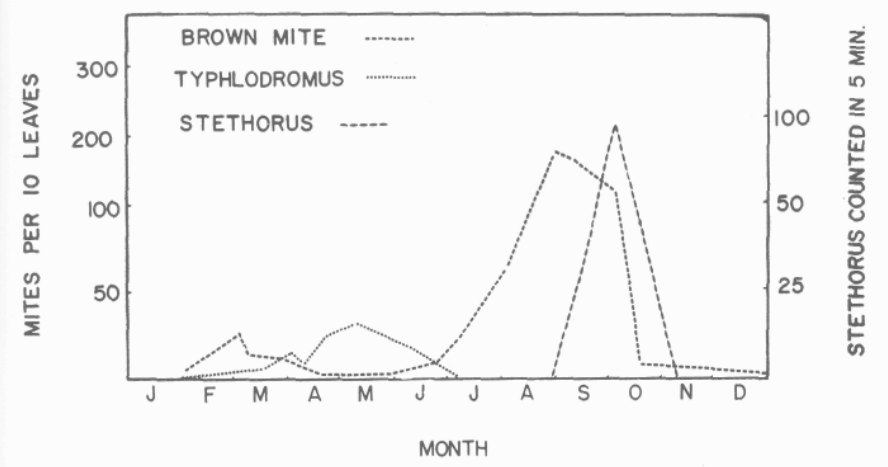

FIGURE 1. Avocado brown mite and predator population trends in the Bailard Orchard, 1961.

2. McADAM ORCHARD:—Brown mite and predator population levels are illustrated in Fig. 2. The brown mites began increasing quite early in reached a peak early in August. **Stethorus** beetles and predaceous **Typhlodromus** mites reproduced rapidly as the brown mite populations became heavy, and reached peak numbers as the brown mites were beginning to decline. This "lag" between the peaks of prey and predator populations is a characteristic phenomenon. It should be pointed out that the population densities of **Stethorus** and **Typhlodromus** are illustrated only in relative numbers, since the two species could not be sampled by the same method. In absolute numbers **Typhlodromus** mites considerably outnumbered **Stethorus.** However, an individual **Stethorus** is able to consume many times more mite prey than a **Typhlodromus** mite, so that the impact of **Stethorus** on a dense mite population is great. Obviously both of these predators were important in causing the rapid decline in the brown mite population. The mites in this orchard were brought under control before severe damage occurred.

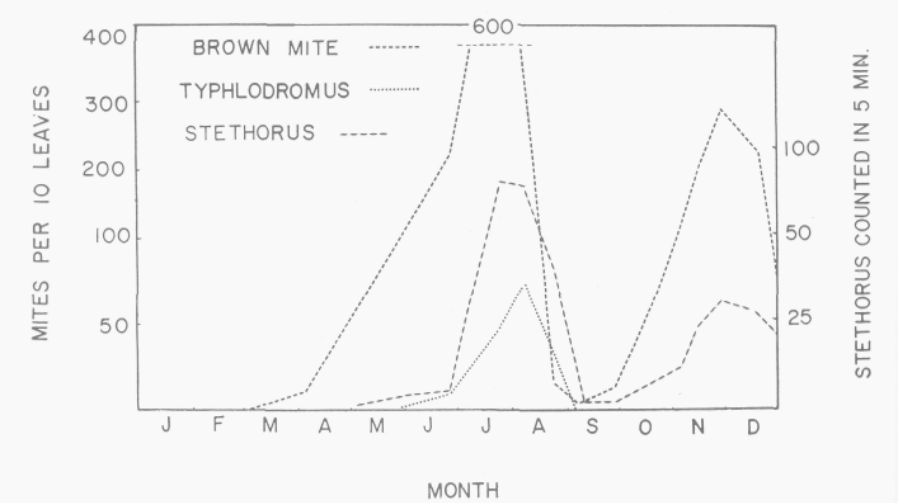

FIGURE 2. Avocado brown mite and predator population trends in the McAdam Orchard, 1961.

2. McADAM ORCHARD:---Brown mite and predator population levels are illustrated in Fig. 2. The brown mites began increasing quite early the season at this location, and reached their highest level toward the end of July. **Stethorus** rapidly increased as the brown mites approached peak densities, and appeared to be mainly responsible for bringing about the brown mite decline.

The **Typhlodromus** mites were rather slow to appear in this grove; they did not become numerous until the brown mite infestation reached its peak level and then began receding. At this time it was noted that many of the predaceous mites could be found on newly matured leaves, where brown mites were very low in numbers, as well as on older leaves which had heavy mite populations. Nearly all of the predaceous mites on this newer growth contained a brown coloration in their intestines, indicating that they were feeding on brown mites. It is probable that they were responsible for destroying the brown mites before they were able to colonize the younger leaves, which never became damaged. The **Stethorus**, on the other hand, were found almost entirely on the older leaves which contain higher mite populations.

After the predators essentially disappeared as a result of lack of prey, brown mites were again able to increase during October and November. The weather was warm enough at this location to allow the mites to reproduce late in the year. **Stethorus** then began increasing in response to the resurging mite population. **Typhlodromus** did not reappear, and therefore **Stethorus** was virtually the only predator feeding on the mites at this time.

Quite a number of trees in this orchard showed considerable browning on the upper surfaces of their leaves, but the infestation did not appear to have any serious effects.

3. BECK ORCHARD:—Fig. 3 shows that the only significant avocado brown mite activity occurred with a period of about two months during the summer. Both the upsurge and decline in mite population were abrupt. After the peak of 470 adult brown mites per 10 leaves on August 21, the population "crashed" to a level of 3 per 10 leaves

within the eshort interval of two weeks. Both **Stethorus** and **Typhlodromus** reproduced rapidly as the brown mites became abundant and reduced their prey to very low numbers. During the remainder of the season, conditions did not again become favorable for brown mite activity. The infestation was suppressed by natural agencies before reaching dangerous levels.

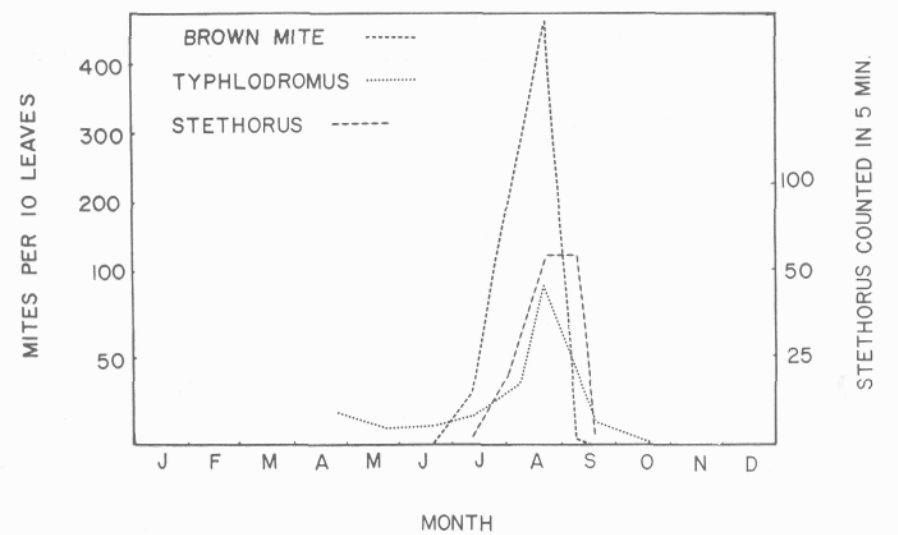

FIGURE 3. Avocado brown mite and predator population trends in the Beck Orchard, 1961.

4. THILLE ORCHARD:—As seen in Fig. 4, the avocado brown mite population showed no decided tendency to increase until July and did not reach a peak until late August. In September, **Stethorus** rapidly built up to large numbers and reduced the mites to low levels.

It is notable that **Typhlodromus** populations clearly outnumbered brown mite during the spring. Since there were no plant-feeding mites present in appreciable numbers at this time, there is strong indication that these predators are able to utilize sources of food other than mites under some conditions. In some samples, one or more of the **Typhlodromus** counted showed evidence of feeding on brown mites; however, most of the predators must have been finding other types of food in order to be sustained in such large numbers. By the beginning of July the **Typhlodromus** population declined and remained low. It was not until this time that brown mites began to increase significantly.

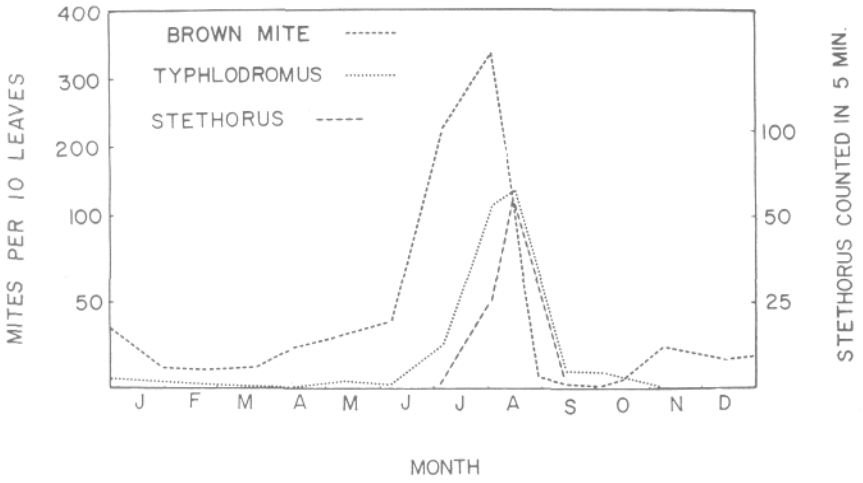

FIGURE 4. Avocado brown mite and predator population trends in the Thille Orchard, 1961.

DISCUSSION

Generally, the avocado brown mite population trends during a season are such that a single high peak is attained in the summer, followed by a rapid decline or "crash." Sometimes a resurgence may occur in the fall or winter, as was the case in the McAdam orchard during 1961. This seems to occur mainly in coastal areas at times when late-season temperatures remain mild. It is believed that natural enemies were the major cause of the rapid population declines of brown mite which occurred during the summer. Two other factors which sometimes may be attributed to mite population decline are decrease in susceptibility of the leaves to mite feeding, and adverse weather conditions. When mites are present in extremely high numbers, leaves can become injured to the extent that they are no longer suitable for feeding and reproduction. However, it seemed obvious that leaf damage was not severe enough for this to be a major factor in the decline in mite numbers in the four orchards studied. Previous observations revealed that where the natural balance has been upset, brown mites have been able to reach numbers of nearly 2,000 adults per ten leaves whereas the highest count in this study was only about 600 per ten leaves. Climatic factors are not considered to be responsible for the summer population "crashes," since these occurred during periods when the weather was favorable for mite reproduction.

Strethorus is considered to be the most important predator in bringing about the rapid decline in brown mite numbers in the summer, after a high peak has been reached. As mite prey became abundant, **Strethorus** begins to develop and reproduce very rapidly, and apparently eventually overtakes and reverses the upward trend of the mite populations. This action by **Stethorus** is usually quite predictable under circumstances where no upsets in the natural balance of mites and predators have occurred. But the population level of brown mite reached before this decline takes place is variable, so that occasionally mite numbers may reach dangerous levels before they are brought under control by natural enemies.

The role of the **Typhlodromus** mites is somewhat more difficult to interpret. Under most circumstances it appears that they would not be able to control a rapidly increasing brown mite population by themselves, though when present in large numbers along with **Stethorus** they undoubtedly contribute a significant part. These predaceous mites appear to be important, also, after the brown mite population is in the declining stage, because they remain on the trees and tend to encounter and consume all remaining mites. **Typhlodromus** mites are very efficient in seeking out mite prey, and consequently can sustain themselves at low prey densities. Also, if they have become abundant early in the season before the mites have begun to increase rapidly, it is possible that they tend to maintain the mites at low levels until late in the summer. This may have occurred in the Thille orchard, where the **Typhlodromus** mites were abundant early in the year. Studies are in progress to evaluate more thoroughly the importance of this species and to investigate, also, possible alternate food sources on which they are able to subsist under certain circumstances.

It was apparent that any attempt to control avocado brown mite with chemical sprays would not have been warranted in the cases discussed here. Although it cannot be said definitely what level of avocado brown mite constitutes an economic infestation, it appears that fairly high levels can be tolerated before there is a significant reduction in the yield or vigor of the tree. Consequently, chemical treatment should be considered only in emergency situations because of the danger that it could upset the existing balance between pests and their natural enemies, thus resulting in undesirable effects.

In many instances, when brown mite injury is first noticed, predators are already in the process of bringing them under control, and it may be only a matter of days before the mites are reduced to low levels. If this is taking place, a close examination of the infested leaves will reveal numerous **Stethorus** adult beetles and larvae on the upper surfaces of the leaves, and often many brown-colored predatory **Typhlodromus** mites on the undersides.

In an attempt to reduce further the potential threat of the avocado brown mite, the Department of Biological Control of the University of California, Riverside, is introducing, mass rearing, and colonizing new mite predators imported from other countries (2). It is hoped that this will result in the establishment of a predator complex capable of maintaining the avocado brown mite at lower levels.

LITERATURE CITED

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2. McMurtry, J. A. 1961. Current research on biological control of avocado insects and mite pests. California Avocado Society Yearbook 45: 104-106.