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PESTS OF THE AVOCADO

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The first commercial avocado plantings in California were relatively free of pests except for sporadic attacks of omnivorous native insects that occasionally swarmed into cultivated areas and fed on the avocado foliage along with that of citrus and deciduous trees and a wide variety of other plants. These insects, among them the June beetles, cucumber beetles, flea beetles, darkling ground beetles, false chinch bugs, harlequin bugs, and cutworms, are still with us today and are causing similar localized and sporadic damage. Their attacks are confined to the foliage and they are therefore of principal concern while the trees are small, when defoliation, including the destruction of newly-inserted buds or scions, is far more injurious to the tree than later in its life.

The sporadic pests mentioned above are relatively unimportant to the avocado industry as a whole, compared with other pests that have become permanently established on the avocado during the last two or three decades. Among these are mites, certain caterpillars, the greenhouse thrips and the latania scale. Some of these are becoming more abundant on the avocado or are changing their feeding habits so as to cause damage to fruit as well as foliage. On the other hand, one species, the latania scale, appears to have declined in importance.

New pests are continually being found infesting the avocado and more can be expected as the avocado industry, which is relatively young in this state, becomes older and more widely established. New pests may "work over" to the avocado from other fruit crops or from native vegetation, or they may be accidentally introduced from other avocado-growing areas. Avocado pests, however, have not yet attained the same relative importance as the principal pests of other subtropical fruit crops, such as citrus, walnuts and grapes, despite serious sporadic and localized attacks on certain varieties. This fortunate situation is believed to be due to the fact that the principal avocado pests are hindered by adverse climatic conditions, or by effective biological control, from attaining their maximum potentialities as pests.

Natural enemies (parasites and predators) play an important role in limiting the seriousness of insect and mite infestations on the avocado, and these are destroyed by insecticides. Therefore it behooves the grower to refrain from insecticide treatments unless it is obvious that the economic loss from the pest far outweighs any possible advantages from maintaining the optimum "natural balance" of the pests and their natural

enemies. In making this decision it should be borne in mind that treatment one year may so upset the "natural balance" that treatment the following year may be necessary whereas otherwise the natural enemies might have increased sufficiently, according to the usual cyclic nature of such phenomena, to again bring about a satisfactory degree of biological (natural) control.

The purpose of this article is to give the avocado grower an up-to-date list of the insects, mites and other pests attacking the avocado, as well as a brief account of their appearance, life history and artificial control.

MITES

The mites, sometimes called spider mites or red spiders, are not insects; they are more closely related to the spiders. The adults have eight legs rather than the six legs found on insects, and are very small, usually about the size of a period on this page. They feed by extracting the plant sap and chlorophyll by means of their piercing-sucking mouthparts. Despite their small size, they can cause great damage because of their large numbers and possibly also because of the ability of some species to inject a toxic substance into the plant tissue.

Avocado Brown Mite

The avocado brown mite, *Paratetranychus coiti,* was named after the well known horticulturist Dr. J. E. Coit, who found the mite in the Carlsbad area in 1929. It is now so widely distributed in coastal areas that it is the best known of the avocado mites. A similar species attacks the avocado in Florida.

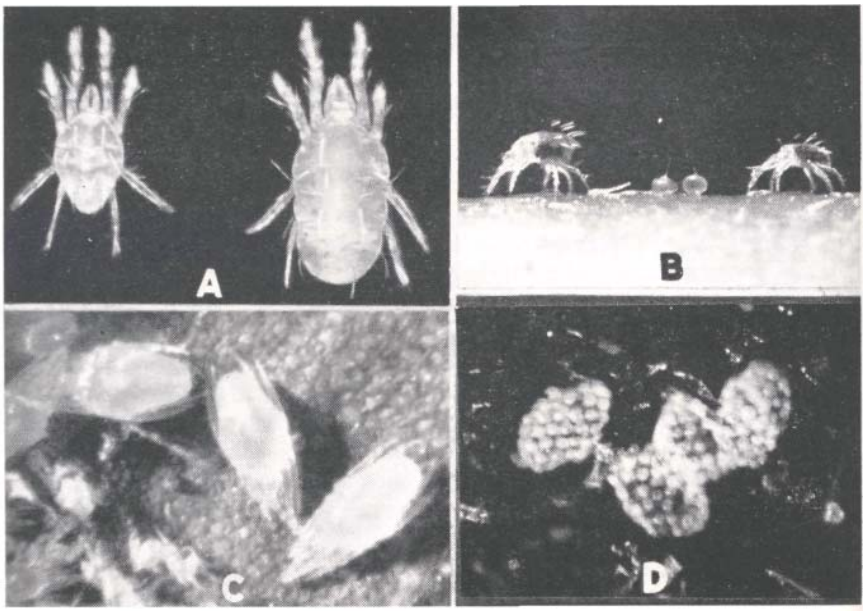

Fig. 1. *Mites attacking the avocado. A, six-spotted mite: male, left; female, right. B, avocado brown mite: female, left; male, right; two eggs in center. C, pallid mite. D, four eggs of the broad mite.*

Appearance. The avocado brown-mite lays its tiny, globular, amber-colored, stalked eggs (fig. 1B, center) along the midrib of the upper surface of the leaf, and, as the infestation increases, quite generally over the upper surfaces.

The newly-hatched larva is globular, light yellow, and possesses 6 legs and conspicuous reddish eyes. After molting it possesses another pair of legs and the body color deepens still further. After the second molt it is not only larger, but more elongate, with a greater resemblance to the adult. The adult female (fig. 1B, left) is oval in shape and is pinkish in color over the front portion of the body and the legs, but the abdomen has many blotches of purplish or blackish brown and may become solidly blackish brown on older individuals. The male (fig. 1B, right) is smaller than the female and the abdomen tapers to a point behind. It is somewhat paler than the female.

A generation requires only about two weeks under summer outdoor conditions.

Injury. The mites are primarily on the upper surface of the leaf, first along the midrib and later along the veins and eventually entirely over the upper leaf surface. Their location on the leaf is evidenced by the brownish discoloration, which may eventually cover the entire upper surface of the leaf. Myriads of whitish hatched eggs and cast skins of the mites also characterize an infestation. The heaviest infestations are found along the road, where the increased amount of dust on the trees appears to favor a heavy infestation. The mites must be very abundant to cause defoliation, and control measures are usually not employed unless the infestation is extremely severe.

Control. Sulfur dust, from ¼ to ½ pound per tree, will result in control of this species. Sulfur is effective only at temperature above 70° F. A spray of wettable sulfur at 2 pounds to 100 gallons is sometimes used, but may cause injury to foliage at temperatures around 85° F. or higher.

Six-spotted Mite

Less well-known than the previous species is the six-spotted mite, *Eotetranychus sexmaculatus,* for it has been a pest of importance only since the spring of 1950. It has long been known as a pest of citrus within a few miles of the coast. In the same narrow coastal strip it has recently become a pest of the avocado.

Appearance. The adult mites (fig. 1A) are oval in shape and generally lemon yellow in color except that the majority have blackish spots, usually grouped or coalesced into as many as six areas on the back and sides of the abdomen although there may be fewer of the blackish areas and some individuals may have none.

The tiny, globular, pearly eggs are found in areas where mites are feeding and may be laid on the surface or attached to the delicate webbing with which the mites cover such areas. The females may lay 25 to 40 eggs in a period of 10 to 20 days. These require from 5 days to 3 weeks to hatch, depending on the temperature. The developmental stages are similar to those of the previously described species. The mites reach maturity in 8 to 12 days during the summer months.

Injury. The six-spotted mite is first found along the midrib of the leaf and later along the veins and other areas, but, unlike the avocado brown mite, it attacks only the lower surface of the leaf. The presence of the mite is generally first indicated by the discoloration along the midrib caused by the early phases of feeding, or by an unseasonal

drop of green leaves.

Unlike the avocado brown mite, the six-spotted mite is injurious even when in surprisingly small numbers and there may be much defoliation before the grower is aware of the presence of the mite in the orchard. To detect the earliest infestations of the mite, the most susceptible varieties, such as the Nabal, Anaheim, Hass, Wurtz and Carlsbad should be watched for unseasonal leaf drop or the brownish or purplish discoloration along the midrib of the lower surfaces of the leaves. Prompt treatment may then he necessary to avoid severe defoliation.

Control. The acaricides (mite killers) that may be used in the control of the six-spotted mite, and their recommended concentrations, are as follows: (1) fifteen per cent Aramite wettable powder at 2 pounds, or 25 per cent wettable powder at 1¼ pounds, or 25 per cent emulsifiable solution at 1¼ pounds, to 100 gallons; (2) 50 per cent Ovotran wettable powder at 1 pound, or 25 per cent emulsifiable solution at 2 pints, to 100 gallons; or (3) 40 per cent Sulphenone wettable powder at 2 pounds, or 25 per cent emulsifiable solution at 3 pints to 100 gallons.

Among the acaricides used experimentally, a new compound known as No. 338[1] showed great promise in the control of the six-spotted mite. A "systematic" compound known as Systox[2] was found to be highly effective against the six-spotted mite in limited trials. It was used as a spray at 1½ pints of a 32 per cent solution to 100 gallons, or the same concentrated solution was painted on the trunks of the trees, using from 2 to 4 ounces per tree, depending on the size of the trees. The two methods of application appeared to be about equally successful. When painted on the trunk, the compound reaches the mites through the sap stream as they feed on the foliage. It also controls greenhouse thrips in this manner. It has the advantage of leaving no poisonous residue on the *surface* of the tree and consequently has no adverse effect on natural enemies. *Possible toxic hazards have not been fully evaluated and consequently the use of Systox should be confined to non-bearing trees or nursery stock.*

Since the six-spotted mite occurs only on the lower surfaces of the leaves, special effort should be made to wet these surfaces. This can be accomplished by (1) spraying from inside the tree and (2) directing the spray from the outside at an angle so that the leaves will be turned over by the spray stream. Sufficient spreader must be used to insure the complete wetting of the lower surfaces of the leaves. It is not possible to drive a spray rig into the orchards with large, interlacing trees, so several lengths of hose must be used to reach all parts of the orchard from the street or from picking drives.

Other Mites

A species of mite not previously recorded from avocado has recently been found by Dr. C. A. Fleschner of the Citrus Experiment Station to be rather widely distributed on the avocado in southern California. It is known as *Paratetranychus platani* and is similar to the avocado brown mite in appearance and in the nature of the injury it causes. It has not yet been found in large numbers on the avocado to date, but should be regarded as a potential pest. It is reported as a pest of the loquat in the San Francisco Bay area and also

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[1] Supplied by the Geigy Company, Inc., New York

[2] Supplied by Pittsburgh Agricultural Chemical Company, San Francisco

feeds on a number of other hosts.

Another species, *Tydeus californicus* (fig. 1C), a little larger than the six-spotted mite and whitish in appearance, has become abundant in some avocado orchards in recent years. Sometimes hundreds of these mites may be found on the lower surface on a single leaf, but even where the mites are very abundant, no outward evidence of injury has been noticed. Investigations are being made in cooperation with Dr. C. A. Fleschner, to determine the possibility of an insidious type of injury to the tree, such as a gradual reduction in vigor, that might not be initially evident from the appearance of the foliage.

The broad mite, *Hemitarsonemus latus,* has been found attacking the tips of avocado seedlings in greenhouses, causing a characteristic crinkling and dwarfing of the terminal foliage. This mite can be controlled by repeated dustings with sulfur. The strongly reticulated eggs of this species (fig. 1D) are more conspicuous than the mite itself.

A bud mite, *Epitrimerus myersi,* may be found under the "buttons" of the fruits, but appears to do no damage.

Natural Enemies of Mites

The insect predators normally found attacking mites on avocado trees include the brown and green lacewings, the lady beetles and a staphylinid beetle *(Somatium oviformis),* a thrips *(Scolothrips sexmaculatus),* a dusty wing *(Parasemidalis hageni),* and a fly *(Arthrocnodox occidentalis).* The latter appears to be the most important of the insect predators of the six-spotted mite on avocados. There are also a number of predatory mites that are very important as natural enemies.

Many insecticides destroy the natural enemies without destroying the mite pests, and therefore tend to accentuate the damage caused by the latter. Acaricides may advantageously be used with the insecticides, particularly in coastal areas, where the six-spotted mite can be a serious pest, and when spraying varieties on which this mite is especially serious.

The Argentine ant interferes with the work of natural enemies and its control would appear to be a sound practice from this standpoint as well as from the standpoint of eliminating it as a nuisance to pickers and others working in avocado trees. A slurry, made by mixing 2 pounds of chlordane 50 per cent wettable powder in a gallon of water may be painted on the trunks of the trees to keep off the ants, provided that the tips of low lying branches be prevented from touching the ground or that any point of contact of the branches with the ground be dusted or sprayed with chlordane.

THRIPS

The greenhouse thrips, *Heliothrips haemorrhoidalis,* is known throughout the world as a pest in greenhouses, but in southern California it can survive outdoors in the mild climate of coastal areas and can be found attacking such subtropical fruit plants as the avocado, citrus, grape, mango, sapote, cherimoya and guava, as well as bush berries. Among ornamental plants the carissa, rose arbutus, viburnum, statis, mandevilla, fuchsia, eugenia, myrtle, azalea, euonymus, hibbertia, cypress, eucalyptus and mesymbryanthemum are hosts. If these plants, as well as non-commercial varieties of the

avocado, such as the Northrup, Puebla and various seedlings, are found infested with thrips, they should be removed or sprayed. Although a sluggish insect and seldom seen in flight, the greenhouse thrips can fly, and an infestation can spread by that means on a warm day.

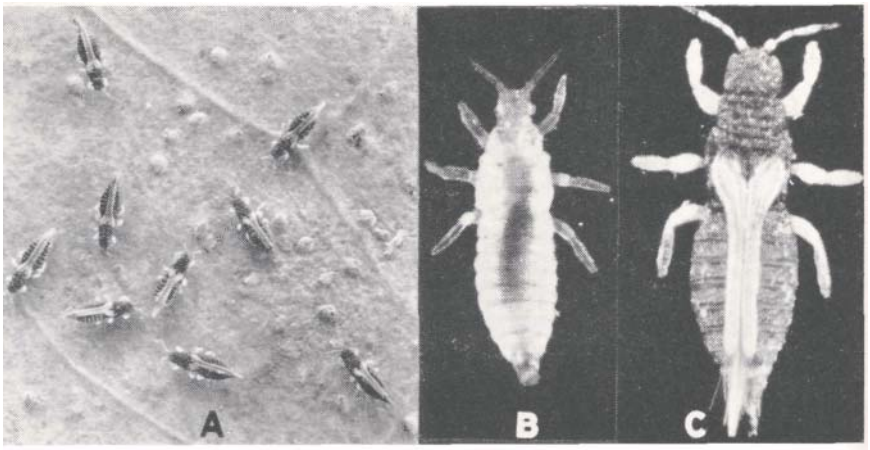

Fig. 2. *The greenhouse thrips. A, adults and egg blisters; B, second-instar nymph; C, adult, greatly enlarged.*

The Anaheim and Nabal, coastal avocado varieties that are especially susceptible to infestations of the six-spotted mite, are among the least susceptible to the greenhouse thrips. The Fuerte and Dickinson are also relatively resistant when compared to such highly susceptible varieties as the Hass, Queen, Wurtz, Itzamna, Carlsbad, Benik, Panchoy, and Millie-C.

Appearance. The adult greenhouse thrips (fig. 2C) is about 1/25 inch long, brown to black in color, with slender pale wings bearing a fringe of hairs, and with stout, pale legs. There appear to be no males. The females insert their eggs under the epidermis of the leaf or fruit and small "blisters" (fig. 2A) can be seen where the eggs are inserted. In figure 2A, small holes can be seen in the egg blisters, showing where egg parasites *(Megaphragma mymaripenne}* have emerged from the eggs.

There are two nymphal stages and a prepupal and pupal stage, all these being pale to yellowish in color. They may be seen (together with the adults (fig. 2A)), predominantly on the upper surfaces of the leaves, but sometimes on the lower surfaces, as well as on the fruits. The nymphs carry a globule of liquid fasces on the tip of the last abdominal segment, where it is supported by six hairs. When these globules reach a certain size they fall off and form the black "specks" that characterize a greenhouse thrips infestation. There are 5 or 6 generations of greenhouse thrips per year on the avocado, depending on the locality.

Injury. Avocado trees lose much of their foliage during the flowering season and most of the overwintering thrips fall to the ground and perish. Usually the thrips do not reappear in numbers sufficient to cause injury until fall. The first indication of thrips injury are small, whitish, silvery, or ashy-gray patches on the upper surfaces of the leaves or on the bottoms of the more mature fruits. These discolorations are caused by the extraction of chlorophyll by the thrips. Later the injured areas become larger and turn brown and

leathery. The fruit becomes discolored and scarred, and the skin may crack when infestations are severe. The quality of the fruit is not reduced, but the fruit is culled because of its inferior appearance.

Control. The present recommendation is to spray with 2 pounds of 50 per cent wettable DDT powder to 100 gallons plus a suitable spreader. An acaricide should be used along with the DDT in order to control mites. DDT does not control mites, but destroys their natural enemies and has the effect of increasing the mite population. A properly applied DDT spray should control the greenhouse thrips for an entire year. Dusts are generally not effective.

Dieldrin, parathion, and dilan are much more effective than DDT. Dieldrin has repeatedly controlled greenhouse thrips for an entire year when applied as a 1 per cent dust. Although the above insecticides have been used in many orchards experimentally, they have not yet been released for commercial application, pending further studies on the public health aspects of the problem.

MOTHS

Injury to foliage from the larvae or caterpillars of a number of moths (fig. 3) can be seen on practically any avocado tree. These larvae consume large quantities of foliage and if they are abundant they may nearly defoliate a tree. The species to be discussed in this section are severely attacked by parasites and disease (fungi and viruses) and usually a buildup of larvae, in an orchard is followed by a rapid decline due to these natural causes. Sometimes it is difficult to find a live caterpillar in an orchard a month or two after a severe infestation.

Omnivorous looper

The most important of the moths is the omnivorous looper, *Sabulodes caberata.* The larvae are called loopers, measuring worms, spanworms, or geometers because of their looping method of locomotion. The larva; have the usual three pairs of legs at the fore end of the body and two pairs of fleshy protuberances called "false legs" or "prolegs" at the extreme rear end. The larvae must draw these up close to the true legs, located at the front end, thus looping their bodies (fig. 3A). The prolegs are then firmly attached to the leaf and the fore end of the body is thrust forward.

Appearance. The adults are dull brown or yellow moths, nearly white beneath, with two irregular darker transverse median bands across the upper surface (fig. 3B). They have a wing expanse of about 2 inches, but are seldom seen during the day because they cling to the undersides of the leaves and fly about only at night. The female lays from 200 to 300 eggs, in clusters numbering up to 80, on the underside of the leaf. The eggs are first metallic green, but in two days turn to a chocolate brown.

There are five larval instars, the last instar being 1½ to 2 inches long. The larvae are yellow to pale green or pink, with yellow, brown, or green stripes on the sides and back, besides a number of black markings.

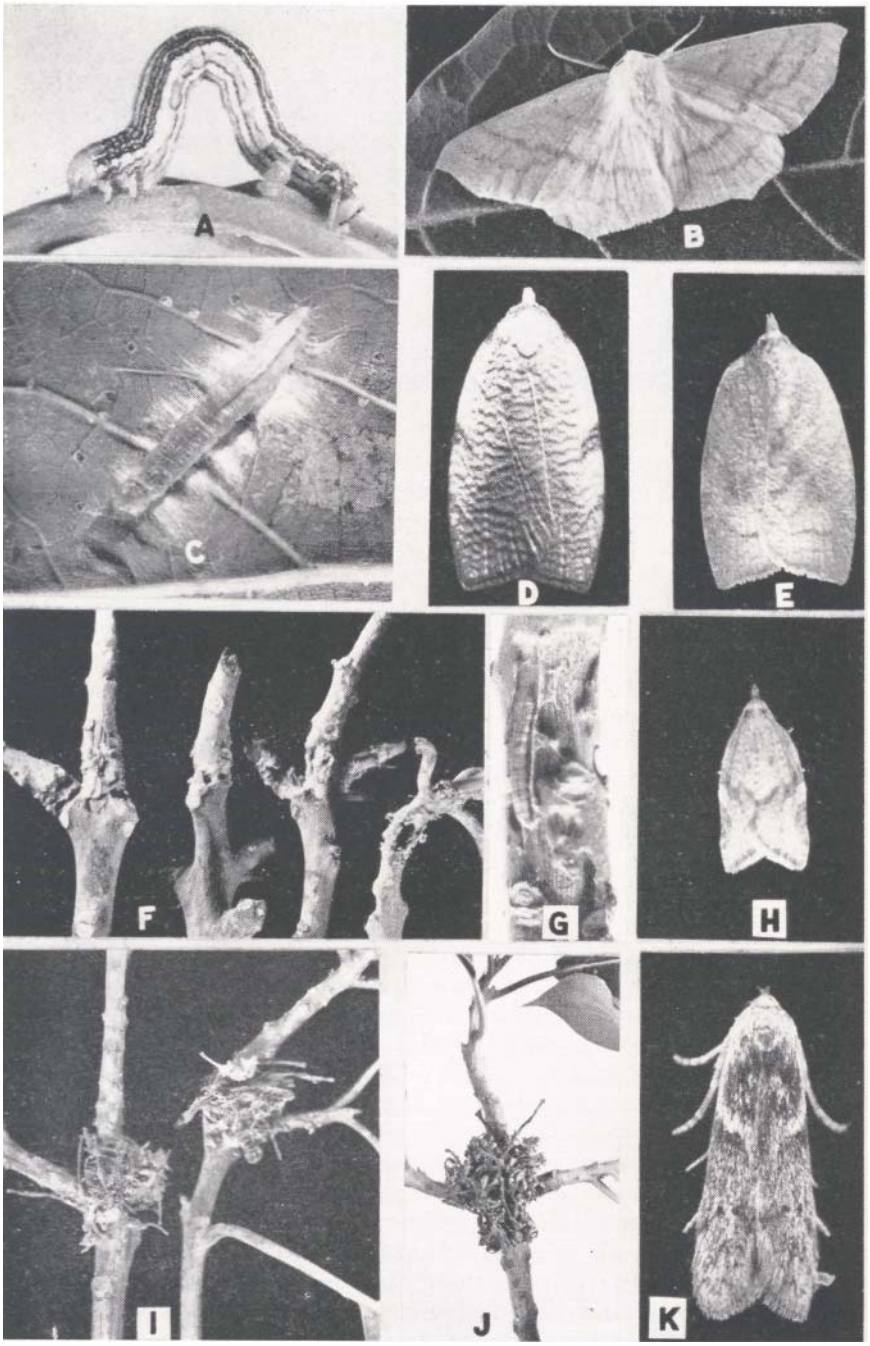

Fig. 3. *Moths. A. larva and B, adult of the omnivorous looper; C, larva of amorbia, with covering leaf torn away to reveal webbing; D, male and E, female of the amorbia; F, injury to twigs from larvae of the orange tortrix; G, larva of orange tortrix* in situ *and injury to green bark of a twig; H, adult orange tortrix; I, "nests" of orange tortrix; J, "nest" of holcocera; K, adult holcocera.*

Larvae of the first two instars drop from the tree on silken threads when they are disturbed and remain suspended for some time. Those of the later instars web themselves into a fold of a leaf, or between two or more leaves, and remain hidden there during the day. They crawl about and feed at night. The pupae may also be found webbed between

leaves. They are at first white, but become a dark brown before the adult moths emerge.

There may be five or six generations a year, but the looper population generally decreases sharply during the fall and remains low until spring.

Injury. The omnivorous looper has long been known as a defoliator, but only in recent years has it begun to cause extensive damage by feeding on the fruit. The larvae begin feeding on the smallest fruits, just after they are set, and cause many to drop. The grower may be unaware of this type of damage. The first instars cause shallow grooves in the fruit (fig. 4C) but the larger larvae can gouge deep holes in the fruit, causing damage similar to that done by snails. It is not uncommon for the loopers to cull or destroy from 25 per cent to 50 per cent of the crop. It is the damage to the fruit, rather than defoliation, that makes the omnivorous looper one of the most serious of avocado pests.

Control. Excellent control of the omnivorous looper can be obtained by spraying with 50 per cent wettable DDT powder at one pound to 100 gallons. An acaricide should be added for mite control in coastal areas. Although the larva; are protected from the spray by the webbed leaves in which they hide during the day, they succumb to the insecticide by crawling over it at night. Parathion has been used experimentally with good success.

Amorbia

The amorbia, *Amorbia essigana,* is one of the tortricids or "leaf rollers" and was first recorded as occurring in California in 1922. It is usually not as abundant as the omnivorous looper and its relative importance is further reduced by the fact that it can feed on fruit only when it is able to web a leaf against the fruit and feed under cover, or where two or more fruits are in contact.

Appearance. The reddish-brown adults have a wing expanse of about one inch and have the characteristic bell shape of the tortricids when at rest (fig. 3D and E). Like the omnivorous looper they are nocturnal and rest on the undersides of the leaves during the day. They lay their eggs on the upper surface of the leaf in flat, greenish masses of from 5 to 100 and a single moth may lay 400 to 500 eggs.

There may be as many as 7 larval instars, but pupation may take place in the fifth or sixth instar. The larvae (fig. 3C) are greenish in color and reach a length of ¾ to 1⅛ inches.

The larvae spend the day in leaf rolls or webbed between two or more leaves. They actively wiggle away when the leaves are parted. The pupa may also be found in such locations. They are ½ to ¾ inch long, at first pale green and later brown. The cocoon of the tachinid fly (a parasite) may often be found alongside the empty pupal case of the amorbia.

Injury. The larva; often web together the terminal leaves of a young twig, feeding within the protection thus afforded, and may thus prevent the twig from continuing its growth. Otherwise their injury to foliage and fruit is similar to that of the omnivorous looper, previously described. Figure 3A shows a fruit with the leaf removed that had covered the amorbia larva while it was feeding on the peel.

Amorbia larva; may sometimes be found under the budding tape of newly budded seedlings and can destroy the bud.

Control. Control is seldom required. DDT as recommended for the omnivorous looper is

effective.

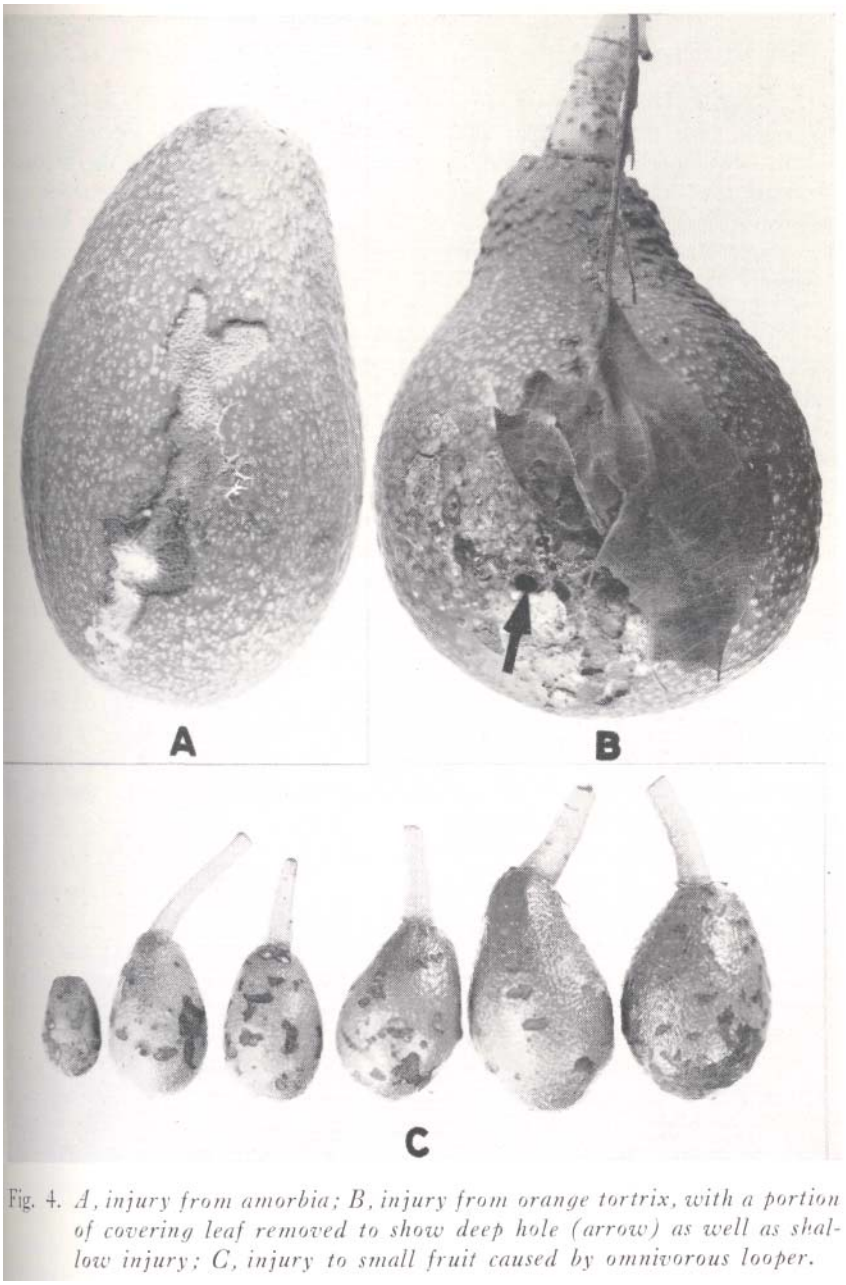

Fig. 4. *A, injury from amorbia; B, injury from orange tortrix, with a portion of covering leaf removed to show deep hole (arrow) as well as shallow injury; C, injury to small fruit caused by omnivorous looper.*

Orange Tortrix

The orange tortrix, *Argyrotaenia citrana,* is also a tortricid (leaf roller). Long a pest of oranges, it has been found since 1949 in increasingly larger numbers in avocado orchards. This insect may possibly become one of the major avocado pests.

Appearance. The buff-colored moths have a wing spread of about 2/3 inch. When at rest they are bell-shaped and each wing has a dark diagonal band (fig. 3H). The pale-green or cream-colored eggs are laid in masses, the eggs overlapping one another like those of the amorbia. There may be 5 to 7 larval instars, the full-grown larvae (fig. 3G) being about a half inch long and greenish or straw-colored. When exposed, they wiggle away actively

like the larva; of the amorbia. The brownish pups are about a third of an inch long and suspend themselves by means of small booklets at the narrow hind end of the body. There are probably about three generations a year in coastal areas.

Injury. The most conspicuous evidence of the presence of orange tortrix larvas are the crude nests of plant debris (fig. 3I) with which they cover themselves and under which they feed. They most frequently feed on the green bark of terminal twiglets (fig. 3F) and these are sometimes girdled. However, the bases of larger twigs may be girdled at the point of attachment to branches. In either case the injured tissue usually exudes a white sugar known as "dulcitol."

The larvae may also be found inside the avocado flowers, during the blooming period, where they feed on the developing embryo or the calyx. Later they may feed on the long stems of the flower clusters, keeping themselves covered with "nests" of flower parts.

Like the amorbia, the orange tortrix may destroy the terminal buds of rapidly-growing twigs, after folding the terminal leaves, or may feed under the budding tape of newly budded seedlings.

Orange tortrix larva; can feed on the fruit, where they find protection from an adjoining leaf (fig. 4B) or where several fruits come in contact. Their injury consists of shallow grooves like those caused by the amorbia, but in addition they may occasionally make a deep hole into the fruit (fig. 4B) as they are also known to do on oranges. As many as 5 per cent of the fruits have been scarred by tortrix larvae in a few isolated instances.

Control. A spray of two pounds of 50 per cent wettable DDD (TDE, Rhothane) powder to 100 gallons is effective in controlling not only the orange tortrix, but also the omnivorous looper and the amorbia.

Holcocera

A small, slender, grayish moth, about ⅓ inch long, known as *Holcocera iceryaella* (fig. 3K) and at least one other closely related species are primarily scavengers, but occasionally feed in the green bark of the avocado. To date they have been of no economic importance and are of interest primarily because their nests (fig. 3J) are similar in appearance to those of the orange tortrix except that they are generally larger and more carefully formed. They also occasionally build their nests on leaves.

Cutworms

The larvae of the grayish-brown night-flying moths often called "millers" have been known to attack young avocado trees, particularly near large uncultivated areas. The variegated cutworm, *Peridroma margaritosa,* has been identified among the species taken from avocado. Poisoned bait, scattered about under the trees just before dusk, will control cutworms, as well as snails.

Leaf Miner

The small, reddish larvae of tiny moths *(Marmara salictella)* occasionally bore beneath the epidermis, leaving a narrow, light-colored, serpentine pattern on the green twigs, leaves, or fruit of the avocado. The "mines" of the leaf miner are most apt to be found near willows, which are the native host of this species, but no important injury has ever been reported.

BEETLES

The beetles attacking the avocado all feed, in the adult stage, on foliage. They are principally pests of nursery trees or newly-planted trees, for the smaller the amount of foliage per tree, the greater the percentage of defoliation from a given number of beetles. One species, the bronze willow flea beetle, feeds on the fruit as well as foliage.

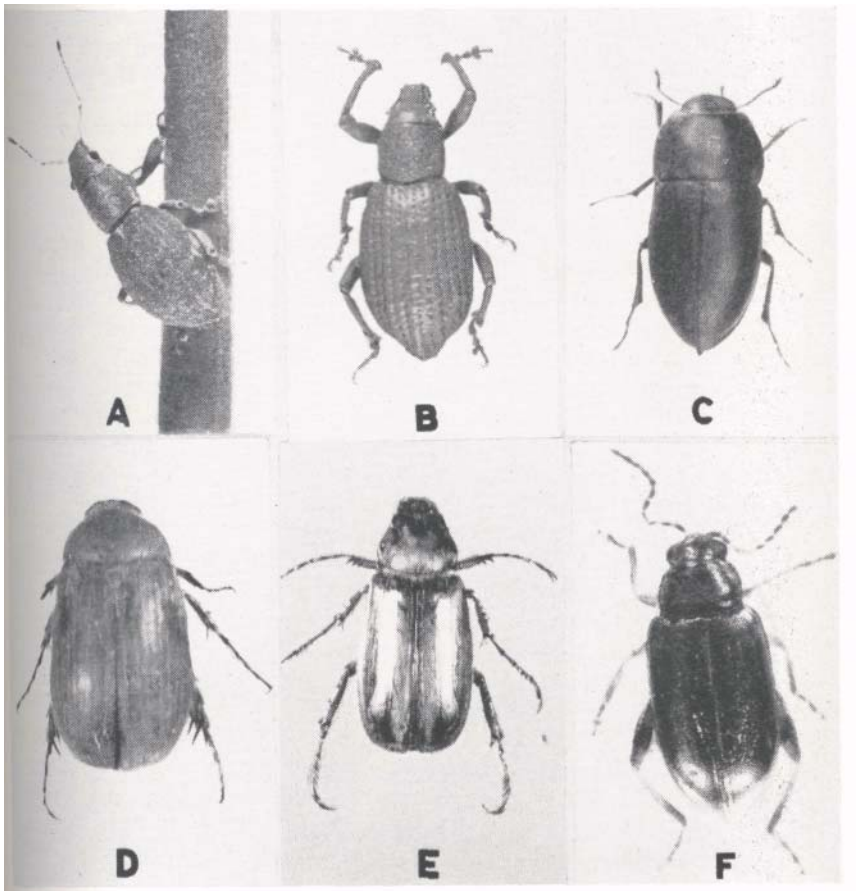

Fig. 5. *Beetles. A, Fuller rose beetle; B, adaleres beetle; C, darkling ground beetle; D, June beetle* (Serica); *E, June beetle* (Coenonycha); *F, banded flea beetle.*

June Beetles

Two species of the well known June beetles, *Serica fimbriata* and *S. alternata,* are about a half inch in length and colored brown (fig. 5D). These beetles fly in from their breeding places in unfilled fields and brush land and eat the foliage on the trees at night, beginning in May or June. During the day they burrow into the first ½ to 2 inches of soil under the tree, reappearing again the following evening.

The species *Coenonycha testacea* (fig. 5E) is smaller and distinctly narrower than the above species, being about ⅓ inch long and 1/7 inch wide. It is shiny yellowish-brown in color. This species has caused considerable injury to young trees in the Fallbrook area since 1946. It begins to fly and feed much earlier than the *Serica* June beetles, beginning about the first of February.

Control. Dusting the trees with 5 per cent DDT results in good control of all species of June beetles. It is important to watch the orchard carefully at the season of the year when June beetles injury is to be expected and apply the dust (or spray) at the first signs of injury, for the beetles can do severe damage within a few nights.

Fuller Rose Beetle

The Fuller rose beetle, *Pantomorus godmani,* is a pale brown beetle about ⅜ inch long (fig. 5A). It causes the very ragged appearance of leaves on the lower branches of large trees, and small trees may be completely defoliated. The legless white larvae live in the soil and pupate there. The adults are unable to fly, so a sticky banding material applied to the trunks will prevent them from climbing the tree. Five per cent chlordane dust applied to the foliage results in good control.

Adaleres Weevil

The adaleres weevil, *Adaleres humeralis,* is light to dark brown, with a grayish mottling on the wing covers of some individuals, and about a half inch long (fig. 5B). The adults may move into avocado orchards from adjacent brush land and cause great damage to young trees, feeding on foliage and terminal buds. They remain in an orchard for many months, and if they are not controlled, they may not give the trees a chance to recover from the initial defoliation. Since these weevils do not fly, they may be kept off the trees by means of a sticky banding material.

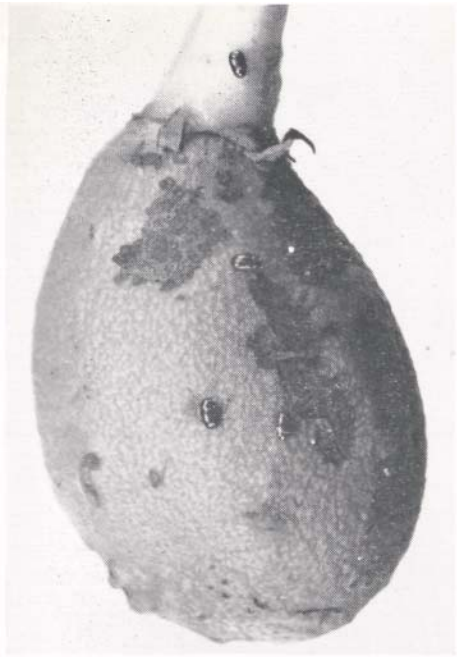

Fig. 6. *Bronze willow flea beetles and their injury to a small avocado.*

Darkling Ground Beetle

A shining black or brown beetle about ⅓ inch long and belonging; to a group known as darkling ground beetles, may sometimes fly into the cultivated areas from the surrounding

hills in enormous numbers. The species shown in figure 5C is *Coniontis subpubescens.* This species was found climbing on shingles protecting newly planted trees and feeding on foliage coming in contact with the shingles. The beetles did not appear to be climbing up the trunks of the trees. They were controlled by spreading poison bran mash on the ground around the trees.

Flea Beetles

The flea beetles are so called because the femora of the hind legs are much thickened and fitted with muscles for jumping. Two species have been found attacking the avocado: the banded flea beetle. *Systena taeniata,* (fig. 5F) feeding on the leaves of newly-planted trees, and the bronze willow flea beetle, *Diachus auratus,* feeding on foliage and fruit (fig. 6). The former is a yellowish or brownish insect with reddish head and 2 lateral black stripes on each wing cover and is 1/8 to 1/5 inch long. *Diachus auratus* is smaller, being about 1/12 inch long and metallic bronze in color. It is common on willow. Both species have been well controlled by a spray of 2 pounds of 50 per cent DDT wettable powder to 100 gallons.

Fig. 7. *Broad-nosed grain weevil injury to avocado seeds in nursery seed bed.*

Branch and Twig Borer

The adult branch and twig borer, *Polycaon confertus,* is black with brown wing covers, cylindrical, and ¼ to ⅝ inch long. The adults and larvae burrow into the twigs and branches, causing the exudation of dulcitol. Infested branches should be pruned off and burned and native or cultivated trees in surrounding areas should be examined for possible sources of reinfestation.

Seed Weevils

The broad-nosed grain weevil, *Caulophilus latinasus,* may be found in avocado seeds in California, but only after the fruit has fallen to the ground. It should not be confused with the avocado seed weevils of Latin America, which attack the fruit on the tree. The broad-nosed grain weevil is blackish-brown, ⅛ inch long, slender, and has the typical prolonged snout of the weevils. This weevil has in a few instances destroyed avocado seeds planted in nursery beds or devitalized the seed sufficiently to affect the vigor of the resulting seedling (fig. 7).

Ambrosia Beetles

Weakened trees are subject to the attacks of a wide variety of bark beetles. Their presence is indicated by many small round holes in the bark. Two species of ambrosia beetles, *Xyleborus xylographus* and *Monarthrum* sp., found by the writers attacking the trunk and lower sections of the larger limbs of avocado trees, were controlled by painting the infested bark surfaces with a 5 per cent kerosene solution.

BUGS, SCALES AND RELATED INSECTS

The insects to be discussed under this heading are commonly considered as members of the same order (Hemiptera). They have sucking mouthparts, and the species attacking the avocado are primarily important because they suck sap from leaves and green twigs.

Long-Tailed Mealybug

The long-tailed mealybug, *Pseudococcus adonidum,* is a soft, oval, flattened insect, covered with a white, mealy wax with waxy marginal filaments and very long anal filaments (fig. 8A). The young emerge as active insects and remain for a while under a thinly-woven, cottony network of waxy threads that the female weaves about her body. An average of about six weeks is required for the mealybugs to reach maturity. Like other mealybug species, they are strictly coastal in distribution.

Injury from the long-tailed mealybug is nearly entirely confined to the scions of grafted trees while they are still under the protecting paper bags. Unless they are controlled they usually destroy the scions by feeding on the small tender foliage. Natural enemies do not find them soon enough to prevent damage. They may be controlled by painting the trunk or limb on which the scion is inserted with a thick chlordane slurry. This may be prepared by stirring 2 pounds of 50 per cent chlordane wettable powder in a gallon of water. The slurry may be applied, by means of a brush, over the upper six inches of the sawed-off trunk or limb on which the scions are inserted. This should be done immediately after grafting, for apparently the success of the treatment depends on keeping ants off the scions.

When the graft cleft is cracked, it is the practice to reseal the cleft, and any insecticide applied before the second application of sealing substance is thereby covered over. The chlordane should be reapplied immediately after the resealing of any graft clefts. Honey bees occasionally remove the sealing substance around the scion in their search for dulcitol and it is to be expected that they might be responsible for the removal of sufficient

insecticide in the area surrounding the graft cleft to reopen safe avenues of approach for ants.

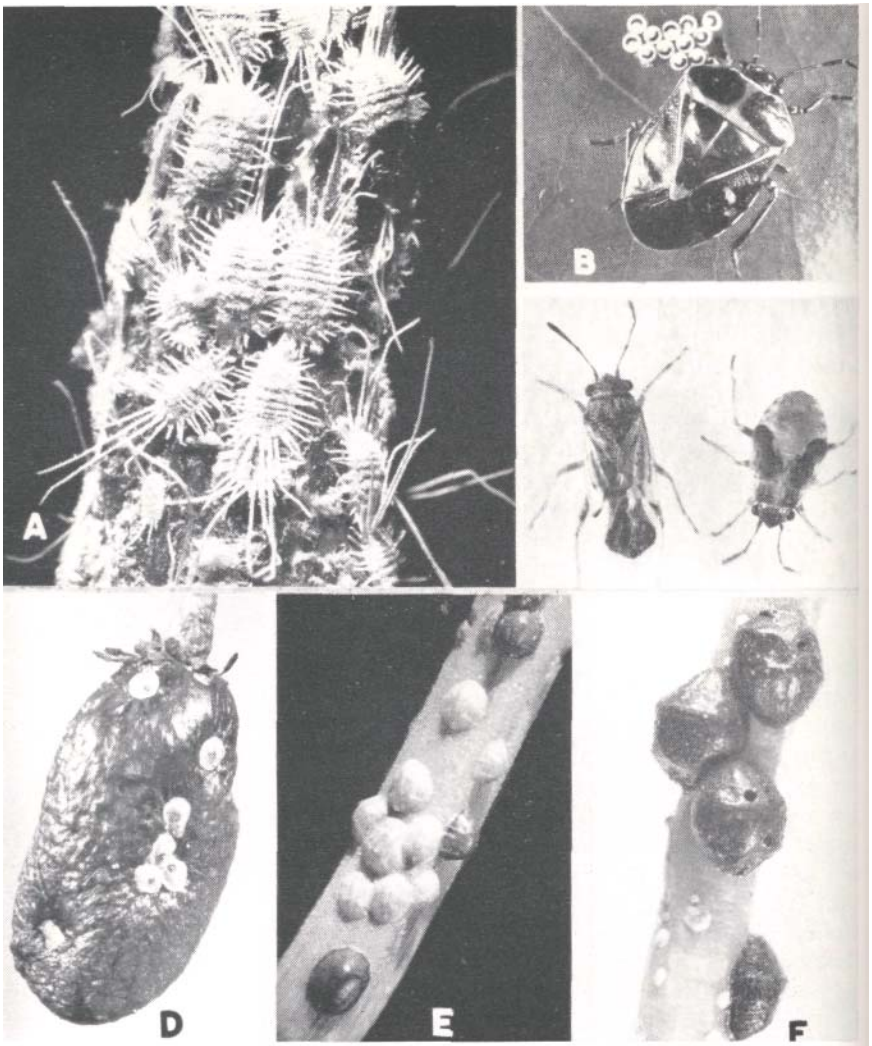

Fig. 8. *A, Long-tailed mealybugs on a twig; B, harlequin bug and eggs; C, false chinch bug, adult and nymph; D, latania scale on small avocado; E, hemispherical scale, mature and immature stages; F, adult black scale with exit holes of parasites.*

Aphids

Aphids may become abundant on avocado trees where they are growing close to aphid-infested citrus trees. The species involved are those ordinarily found on citrus, mainly the spirea aphid, *Aphis spiraecola,* and the melon aphid, *Aphis gossypii.* At considerable distances from citrus, the only species the writers have found on avocado trees is the dock aphid, *Aphis fabae,* and the melon aphid but only on an occasional succulent twig terminal. Nicotine sulfate, oil-rotenone, or tetraethylpyrophosphate (TEPP) preparations are currently being used for the control of aphids on citrus.

Greenhouse Whitefly

The greenhouse whitefly, *Trialeurodes vaporariorum,* (fig. 9) is occasionally found in

sufficient numbers on nursery trees or young avocado trees in the orchard to cause some injury to the tree. Their presence is indicated, as in the case of aphids, mealybugs and unarmored scales, by the black sooty mold fungus, covering the foliage, which lives on the honeydew secreted by the insects. Spray oil with nicotine, pyrethrum, or DDT has been used against the greenhouse whitefly with success. Parathion spray is very effective, but it must be borne in mind that *parathion is a very toxic material and must be handled and applied with proper safeguards.*

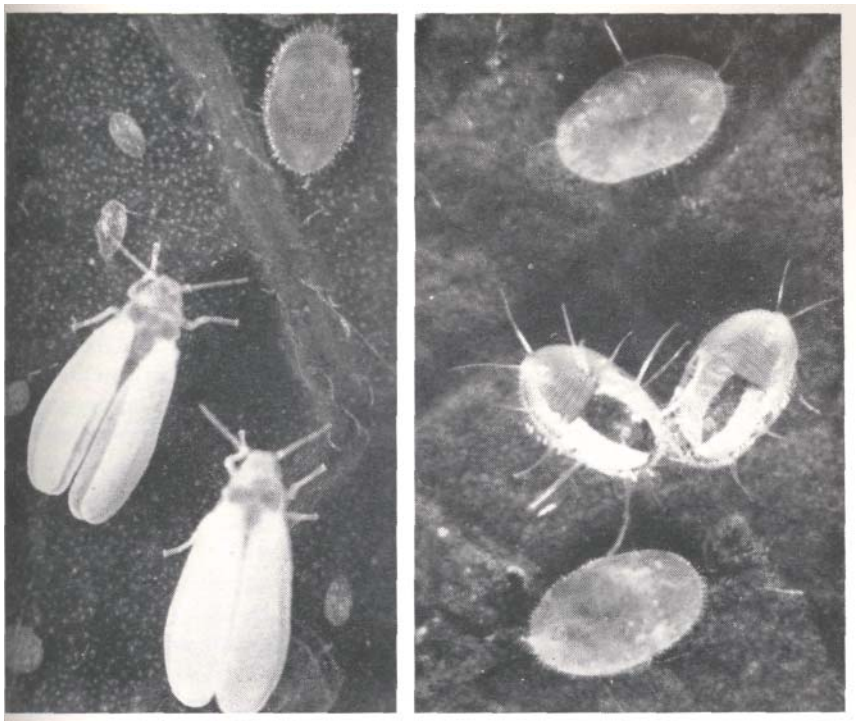

Fig. 9. *Greenhouse whitefly. Above, prepupae and pupae with adult emergence ruptures; below, adults and nymphs. The adults are 1/16 inch long.*

Unarmored Scales

The hemispherical scale, *Saissetia hemisphaerica,* (fig. 8E) the black scale. *Saissetia oleae,* (fig. 8F), the soft scale, *Coccus hesperidum,* and the European fruit lecanium (brown apricot scale), *Lecanium corni,* are unarmored scales that are all rather effectively controlled by parasites. Consequently they increase in large numbers in a very localized section of a tree, where their presence is evidenced by the honey dew, sooty mold fungus, and the omnipresent Argentine ant, but seldom have a chance to spread over an appreciable portion of the tree before the parasites find and effectively control them. If artificial control were needed, it could be accomplished by repeated sprayings with 2 per cent light medium oil emulsion.

Latania Scale

The latania scale, *Hemiberlesia lataniae,* once considered the most important of the avocado pests, is now generally so well controlled by natural enemies that it seldom requires artificial treatment. Growers have been advised to allow a considerable

infestation, rather than treat, in order to avoid the disruption of the natural balance of the pest and its natural enemies.

Appearance. The latania is one of the armored scales, that is, the soft body of the insect is covered with a "scale" or "armor" consisting of wax secreted by the insect plus the cast skins of the various molts. In the case of the female latania scale (fig. 8, D) the armor is circular, 1/16 to 1/12 inch in diameter, and rather strongly convex when compared with certain other species, such as the oleander scale and the greedy scale, which occur in limited numbers on the avocado and with which the latania scale might be confused. If the grayish armor of the insect is lifted, the soft yellowish body may be seen. Likewise the tiny yellow eggs, or the sulfur-yellow active young "crawlers" that hatch there from, are sometimes seen.

The crawlers settle near the parent within a half day after hatching and start secreting the wax that forms the armor. The insect undergoes two molts and then enters the adult stage. In summer about two months are required for the life cycle. Males have not been found in California.

Injury. The latania scale is often very abundant on the larger branches and twigs, but close examination will reveal that the majority of the individuals are dead and represent an accumulation of many generations. In heavy infestations the scales appear on green twigs, leaves and fruit. Small twigs may be killed. Generally the most serious consequence of an infestation, however, is the culling of the infested fruit, although the quality of the fruit is not affected. On the Fuerte variety, and possibly other thin-skinned varieties, the beak of the scale appears to cause an irritation in the flesh, as indicated by nodules adhering to the inside of the peel when it is removed. Corresponding depressions occur on the flesh of the ripe fruit. The Anaheim variety appears to be the most susceptible to infestation.

Natural enemies. It appears that the most important predator of the latania scale is the twice-stabbed lady beetle, *Chilocorus stigma,* so called because it has a bright red spot on the middle of each wing cover, which is otherwise shining black. The larvae and adults feed on the latania scale. In addition, the adults carry about, usually under their wing covers, the "traveling form" of a parasitic mite, *Hemisarcoptes malus,* which drops off when the beetles reach the scales. They then crawl beneath the armor of the latania scale, feed on the scale and lay eggs under the armor. Predaceous mites, *Cheletomimus berlesei* and *Neophyllobius* spp., feed on latania scale crawlers.

Other predators are Blaisdell's lady beetle, *Lindorus lopanthae,* the blood red lady beetle, *Cycloneda rubripennis,* the larvae of green lacewing flies, and a predaceous thrips, *Watsoniella flavipes.*

Among the parasites are *Aphytis dispidis, Aspidiotiphagus citrinus* and *Thysanus* sp.

Control. At one time HCN fumigation was employed, using light tents and generating the gas by sprinkling calcium cyanide dust on the ground under the tent. Light medium spray oils, emulsives at 1¾ per cent and emulsion at 2 per cent, have also been used, sometimes resulting in defoliation and reduction in the crop of the following year.

Fifty per cent parathion wettable powder, at 2 pounds to 100 gallons, as used for red scale on citrus, has been successfully used, experimentally, on avocados. The sprayed fruit

was picked one month after treatment. Parathion also controls the greenhouse thrips, omnivorous looper, amorbia, mealybugs and beetles. *Because of the particular hazard attending the use of parathion, it is recommended that in the few cases in which it is apt to be used experimentally in the control of certain avocado pests it should be applied by an experienced commercial operator.*

Other Armored Scales

The greedy and oleander scales, somewhat similar in appearance to the latania scales, have already been mentioned. The California red scale, *Aonidiilla aurantii,* the most important citrus pest, is occasionally found on avocado, but only in rare instances is it a pest. Somewhat similar in appearance is the dictyospermum scale, *Chrysomphalus dictyospermi,* except that the armor has a more yellowish-brown or brownish tinge. It can be removed from the body of the fully mature female, and this is not possible in the case of the California red scale. The dictyospermum scale is a common greenhouse pest in California, and in the Whittier district and in limited areas in Ventura County it has been found in considerable numbers on avocado trees. Whenever it has been found, attempts have been made to exterminate it.

False Chinch Bug

The adult false chinch bug, *Nysius ericae,* is a small, light or dark gray bug, about 1/8 inch long (fig. 8C, left). The nymph (fig. 8C, right) is pale gray with reddish brown abdomen. The chinch bugs swarm into avocado orchards from adjacent grasslands when they begin to dry and may cause severe injury by feeding on the foliage. They may be controlled with 5 per cent chlordane dust.

Harlequin Bug

Less frequently reported on avocado than the false chinch bug, but equally injurious, is the harlequin bug, *Murgantia histrionica.* This is an attractive black bug with bright red markings on its back. It is about ⅜ inch in length. The cylindrical, white eggs have conspicuous black rings and a single black spot. As seen from above, they are shown in figure 8B, along with the adult. The nymphs are black with white, yellow, orange and red markings. There are two generations a year.

These bugs are most likely to be found in avocado orchards near uncultivated fields containing mustard or other crucifers, on which they breed. On avocado they cause a waiting and yellowing of the foliage. They may be controlled by dusting the infested trees with 0.75 per cent rotenone dust or 10 per cent sabadilla dust. Removal of the bugs by handpicking may be practical on small trees.

FIRE ANT

The fire ant, *Solenopsis geminata,* is 1/25 inch long and pale yellowish or reddish, with black abdomen. This species may girdle and kill young avocado trees. It may be controlled by dusting with 5 per cent chlordane dust applied to the trunk and the soil about the base of the tree.

EUROPEAN BROWN SNAIL

The European brown snail, *Helix aspersa,* is a pest of citrus and avocados in the relatively humid and cool coastal areas. The shells are of a grayish-yellow and brown color, have 5 or 4½ whorls, and are an inch or more in diameter when mature (fig. 10).

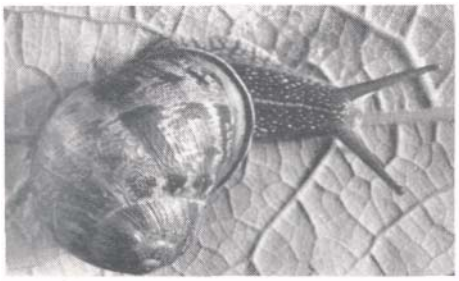

Fig. 10. *European brown snail on a section of avocado leaf.*

The brown snail sometimes occurs on avocado trees in large numbers and feeds on the foliage and to some extent on the blossoms and very young fruit. It may cause extensive damage if not controlled. Control may be accomplished by scattering poison bran mash under the trees, about a pound to an average sized tree. Ducks and geese allowed to run about in the orchard eat large numbers of snails and may result in control.

RATS

Three rats that feed on avocado fruits in the orchard are the roof rat, *Rattus rattus alexandrinus,* the black rat, *Rattus rattus rattus,* and the Norway rat, *Rattus norvegicus.* They all climb trees.

Appearance. The roof rat (fig. 11) attains an overall length of 15 inches, with a tail measuring 8.5 to 10 inches, and seldom exceeds 8 ounces in weight. It has a gray-brown back and sides and the belly is white or nearly white. The black rat resembles the roof rat except for its almost solidly black color. It is not apt to be found as far inland.

The Norway rat is a larger species with a shorter tail. Full-grown adults are about 16 inches long, with a 7½ inch tail and weigh 10 or 12 ounces, but occasionally a rat may weigh as much as 24 ounces. The hair is coarse and brown, with scattered black hairs, and is darkest along the middle of the back. The under parts are pale gray to yellowish white.

Control. An effort should be made to reduce the number of nesting and breeding places to a minimum. Since soil tillage is not practiced in avocado orchards, there is a tendency to pile broken avocado limbs in various places throughout the orchard. These afford ideal nesting places and should be removed. Garbage and scraps of edible material should be kept in closed cans or destroyed promptly.

Fig. 11. *The roof rat about to feed on an avocado.*

Trapping is an effective control measure, using the ordinary spring snap trap, and almost any human food for bait. However, since the advent of warfarin as a poison, trapping has largely given way to poisoning as a control measure. Warfarin does not require "prebaiting" and is not as poisonous to humans as some of the baits previously used. Grains or any human food may be used as bait. The poisoned bait is placed in "bait boxes" in locations in which rats are known to occur. These are left out several days and the poisoned bait is renewed until feeding ceases.

OTHER RODENTS

The native wood rat, *Neotoma fuscipes,* which inhabits the foothills and b known for its habit of building large conical nests of sticks and litter on the ground or in trees, will sometimes make forays into avocado orchards and teed on the fruit or the bark, sometimes killing branches. It can be readily caught in spring rat traps, using rolled oats, peanut butter, raisins, prunes, etc. for bait.

The red fox squirrel, *Sciurus niger rufiventer,* was accidentally introduced and now occurs in northern Los Angeles County and Ventura County. It feeds on avocados, oranges and walnuts. It may be trapped with an extra large type of rat trap placed in trees.

Meadow mice or voles *(Microtus)* gnaw on the bark and roots of avocado and citrus trees and may be found in orchards in which the trees are surrounded by grass and weeds. Baited mousetraps may be placed in the runways, or the mice may be poisoned, using strychnine on alfalfa leaves or rolled barley or *zinc* phosphide on rolled barley or oats.

Pocket gophers *(Thomomys* spp.) can rapidly kill young avocado trees and their control demands constant vigilance on the part of the grower. They may be controlled by trapping or poisoning after their presence is indicated by a series of fresh surface mounds which they push up when digging in their burrows.