cumbed readily to sulfur dust. The eggs appeared to be unaffected, but larvae hatching from dusted eggs were killed.

Bliss and Lindgren (*14*) found that applications of a sulfur dust containing 3.41 percent of ferric dimethyl dithiocarbamate, put on primarily for disease control, caused infestations of the date mite to disappear.

Datebug

The datebug (*Asarcopus palmarum* Horv.) (fig. 7), was described as a new genus and species in 1921 by Horvath (*40*). American literature includes brief mention of it by Essig (*32*), Nixon (*51*), and Stickney (*61*). It is undoubtedly an introduced species, but the time of its establishment in date plantings in the Southwest is not known. The datebug was first noticed in 1922, and since that year it has been

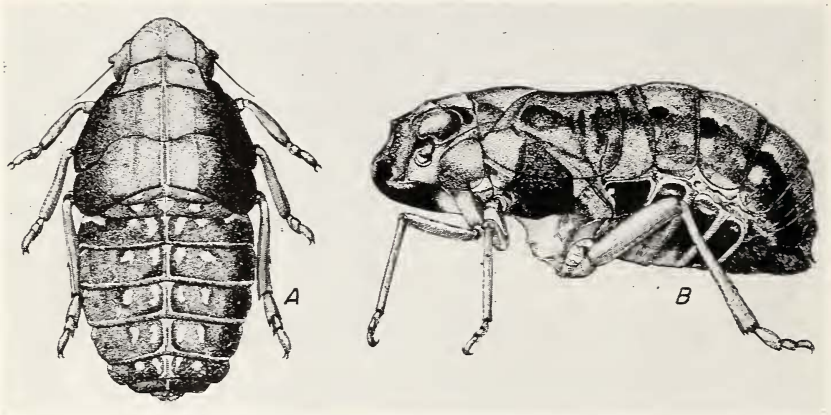

Figure 7.—Datebugs: *A,* Nymph; *B,* adult.

occasionally reported as causing serious damage to date palms. The insect is a member of the family Fulgoridae, the lanternflies, which includes few members that have any economic importance. Some of the closer insect relatives of the lanternflies are the cicadas, treehoppers, spittlebugs, and leafhoppers.

NATURE OF INJURY

The datebug concentrates on the white tissue behind the fiber, between unexpanded parts of terminal leaves, and within the spathes on the white tissue of the current season's fruit stalks (fig. 8). In these places it is protected and is not readily observed. Few datebugs are found elsewhere on date palms. Those that infest the white tissue behind the fiber do not penetrate so deeply as do the scale insects.

Where the datebug feeds, the host tissue turns brown and the affected parts take on a bruised appearance. The injured places are typically quite variable in size and outline. They seldom cover an extensive area of host tissue, chiefly because the insect moves around freely and usually does not occur in large masses. However, as many as 330 datebugs in all stages have been collected from the basal parts of the

Figure 8.—Datebugs on new growth of date palm.

terminal leaves of an offshoot weighing only 2 pounds. Healthy palms are so little affected by datebug infestation that damage is seldom obvious, largely owing to the rapid production of new terminal leaves and to the compactness of the parts where the datebug prefers to congregate. Small, weak palms may be so injured that the

terminal leaves droop because of heavy infestation on their slender, loosely growing bases.

The datebug secretes a clear, sticky, sweet substance in the form of droplets which frequently run together, producing a smeared appearance. On leaf bases these exudations, which collect much dust and dirt, are exposed by the growth of the leaves.

DESCRIPTION

The oval, flattened datebug nymphs, which hatch from pearly white eggs, are $\frac{1}{33}$ inch long by $\frac{1}{50}$ inch wide. Mature female nymphs are $\frac{1}{8}$ inch long by $\frac{1}{15}$ inch wide. In all stages nymphs are at first pale yellow or light brown, each succeeding stage deepening in color. Those of the last nymphal stage are dark brown. The lines between the body segments of nymphs of all instars are pinkish or reddish, the color being most pronounced on the back and on the sides of the abdomen.

The adult female of the datebug is elongate-oval, $\frac{1}{7}$ inch long by $\frac{1}{17}$ inch wide, of various shades of brown with a broad, light-brown band extending the length of the back, and darker brown markings along the sides of the band and on the under surface of the body. There is a dorsal hump on the abdomen. The adult male is elongate-oval, slightly smaller than the female, the brown of the body being broken into light and dark areas on all surfaces. There are white markings on the back, on the sides of the body, and on the under surface of the abdomen.

All stages of both sexes of the datebug have red eyes. Long hind legs equip them for jumping. They are without wings, but the adults of both sexes possess short pale-brown wing pads. Both sexes pass through five stages before becoming adult.

LIFE HISTORY AND HABITS

The datebug is active in all stages throughout the year. Eggs are deposited during the coldest as well as the hottest months. Although activity is appreciably reduced in winter, the population does not decline during that season.

The datebugs are rather phlegmatic. The females can be gently touched without exciting them, but such treatment causes adult males to crawl away rapidly. Individuals of all stages jump when stimulated by jarring.

Infestations of this species usually are attended by various kinds of ants, which apparently are attracted to the honeydew produced by the datebugs.

Most of the datebug population is composed of nymphal stages. This is true even though adult females, during their most active period, live for a month or more after egg deposition begins. Adult males live about as long as the females.

In the colder part of the year the insect is seldom seen away from the protection afforded by the basal parts of the terminal leaves and fruit stalks. In the warmer season some individuals, chiefly adults, scatter out on the foliage. There the females deposit their eggs, singly and distributed widely, even near the tips of long leaves 6 or 7

feet away from the place where the insects congregate. Eggs are deposited usually on the inner surface of the pinnae. Nymphs seldom are seen very far out on the foliage, and, on hatching, they promptly seek the protection of the basal parts, which, however, harbor but few eggs.

To illustrate a typical occurrence of the datebug on foliage, 13, 45, and 48 eggs, and 1, 4, and 5 adult females were found scattered over the inner surface of the pinnae on 3 leaves of a small palm on April 18. Some of the eggs had already hatched, and the others were in various stages of incubation, but no nymphs or adult males were present. No eggs were found on the outer surfaces of the pinnae, nor in the area occupied by the principal datebug infestation.

Records obtained from individuals kept on small seedling palms in an insectary showed the egg period to be about 14 days, beginning on May 26; 9 days at various times in July; 37 days, beginning on October 29; and 79 days, beginning on November 15. During the same season the lengths of the periods from egg deposition to emergence of adults, beginning on the dates given, were as follows: May 26, 60 days; July 30, 35 days; and November 1, 133 days.

The maximum number of eggs produced by a single female was not definitely determined, but the average number per individual for one lot of 10 females observed over an egg-producing period of 30 days, beginning on July 11, was 124. Another group of 4 females observed over an egg-producing period of 80 days, beginning on October 29, laid an average of 121 eggs. The average number of eggs produced daily per individual during the summer ranged from less than 1 to 10 and during the fall and winter from less than 1 to 4.

FOOD PLANTS AND DISTRIBUTION

The date palm, a closely related species, *Phoenix roebelini* O'Brien, and hybrid palms produced by crossing the date palm and the Canary Island palm, are hosts of the datebug. Forty-four varieties of the date palm, including all the more common ones, have been found to be infested. The California fan palm is a host but not a favored one.

The datebug is well distributed on date palms throughout the Coachella Valley and is present in the Imperial Valley. It is common in the Yuma District, Ariz., and is reported from the Salt River Valley district, including the Gila River Valley. In 1934 the datebug was apparently absent in the Palo Verde Valley, Calif. It has been found near Laredo, Tex. Lepesme (*41*) stated that it occurs in the environs of Cairo, Egypt.

CONTROL

Tests of various dusts and sprays have been made against the datebug during June and July, when high temperatures promote maximum activity of the insect and the highest efficiency of insecticides containing nicotine or sulfur. The dusts were calcium cyanide, black gas sulfur, flowers of sulfur, two nicotine dusts (one containing 2 percent and the other 3.5 percent of nicotine), and a nicotine-sulfur dust containing 3.5 percent of nicotine. The sprays were 40-percent nicotine sulfate in strengths of 1 to 500, 1 to 800, and 1 to 1,000; a plain soap solution at the rate of 4 pounds of soap to 100 gallons of water, and

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a 1.5-percent stable oil emulsion. To each of the nicotine sprays soap was added at the rate of 4 pounds to 100 gallons of water. Both light and heavy applications were tried.

Caution.—Many of the chemicals used for insect control are poisonous to man or irritating to the respiratory tract. Poisonous materials should be stored and handled with care. They should be kept in tightly closed, plainly labeled containers in places where they cannot contaminate food or be mistaken for flour or other food materials or medicines, and where children, pets, or livestock will not have access to them. Persons handling or applying insecticides should use proper precautions to prevent breathing or ingesting the spray or dust. Where there is undue exposure to dusts or sprays, a full-face respirator should be worn. Kerosene and sulfur are inflammable and in certain mixtures with air are explosive. All necessary precautions against fires and explosions should be taken. Dusting machinery used for applying sulfur should be grounded to carry off static electricity.

Of the dusts used, only a heavy application of the nicotine-sulfur combination was lastingly effective in ridding the palms of all datebugs and attending ants. The palms remained free of these insects for at least 12 weeks and control was satisfactory for an entire season. Even a light application, however, greatly reduced the datebug and ant populations. Black gas sulfur and flowers of sulfur were comparatively slow acting, but in time heavy applications of these materials considerably reduced the insects' numbers. Nicotine dust at both strengths and calcium cyanide dust were effective and rapid in their action against datebugs and ants, but their effectiveness did not last long. Ants returned to well-dusted surfaces within 18 hours.

A thorough application of 40-percent nicotine sulfate, 1 part to 500 parts of water, was the most effective spray. All datebugs and ants were eliminated 40 hours after treatment. Nicotine sulfate at a 1 to 800 dilution was effective as an immediate control, and at 1 to 1,000 reduced somewhat the datebug and ant populations up to 40 hours. The oil emulsion and the soap solution gave partial kills. An inspection 12 weeks after treatment showed that infestations of datebugs and ants were about as heavy on all sprayed palms as on the untreated checks.

The palms treated with dusts and sprays were in an infested block, and were exposed continuously to reinfestation. Best results were obtained by opening up the basal parts of the leaves where the datebugs were concentrated in order to direct the flow of the insecticide to the hiding places of the insects. It was not necessary to treat the whole tree, since only a small proportion of the population was out in the open.

Bees, Hornets, and Wasps

Although no study has been made of the kinds of bees, hornets, and wasps that feed on ripe dates, it is known that species of this group sometimes do a good deal of damage. Honeybees, in particular, may be harmful, especially to varieties of soft dates. Hornets and social wasps feed on fresh fruits, and it is probable that several species get food from dates.

In the fall of 1935 losses from these insects in a date garden near Phoenix led to the experimental use of shade-cloth extensions on paper rain covers as possible protection against them. Fifteen hundred special covers were made (fig. 9).

The shade cloth on the covers was of the type used to cover fields of wrapper tobacco, asters, and chrysanthemums. Because the population of bees, hornets, and wasps in the date garden where the experi-

Figure 9.—Paper rain covers with shade-cloth extensions. When in use the covers and extensions were closed by means of spring clothespins.

mental covers were tried was much lower during the harvest of 1936 than it had been the previous year, no test of protection against these insects was obtained. Neither were there enough western leaf-footed bugs, discussed on page 5, to make possible a conclusion on the effectiveness of the cloth extensions for excluding these insects. It was reported by the owner, however, that the fig beetle, described in the section that follows, was able to force its way through the cloth.

The grower mentioned that there was no trouble from the humidity being too high inside these covers, and he added that movement of the cloth in the breeze kept birds away.

The covers shown in figure 9 are not recommended, but they illustrate an experimental model which may suggest improvements in design and materials. Similar covers were tried at Indio in 1934. A general-purpose cover should shed rain, exclude nitidulid beetles and larger insects, be easily opened and closed for picking the crop, and have enough ventilation to prevent the humidity from being too high in the bunches.

Fig Beetle

The fig beetle (*Cotinis texana* Casey), a member of the large family Scarabaeidae, or June beetles, is a pest of dates in the Salt River Valley. Essig (*32*) stated that it is a Central American and Mexican species, the range of which extends into Texas, New Mexico, and Arizona. According to Quayle (*55*) fig beetles were found at Riverside and San Bernardino, Calif. H. H. Keifer, of the California Department of Agriculture, in correspondence, added Tustin (in Orange County) and Loma Linda (in San Bernardino County) to the distribution of the species in California.

The most detailed account of the fig beetle is that given by Nichol (*50*). He described the eggs as being pearly white and called attention to the fact that they increase in size, through absorption of water from the soil cell in which each is separately enclosed, until they are about double their original size. There are three larval stages. Larvae move about by creeping on their backs with the help of rows of bristles, their legs pointing upward.

The yellow pupae are enclosed in earthen cells an inch or more in length, the soil particles being bound together by a mucilaginous fluid secreted by the insect.

Adult fig beetles are robust, velvety green on their backs and shiny green on the head, with a band of yellow around the wing covers. The smallest males are about ⅝ inch long and the largest females about 1⅝ inches.

Most of the fig beetles in Arizona develop in corrals and haystack bottoms. The females lay their eggs from 2½ to 5 inches below the surface layer of organic litter. From 50 to 211 eggs have been laid by 1 female, and egg laying may extend over periods of 4 to 41 days, from early August to late October. Emergence of adults begins about the middle of the following July and continues through October. There is 1 generation a year.

Before casting their first skin the larvae are found just below the surface layer of organic litter, upon which they feed. After the first molt the grubs make permanent tunnels 4 to 12 inches deep. They feed under the litter and return to their burrows after each feeding period. In the last larval stage, after the second molt, the burrows may be 32 inches deep, but most of them are 12 to 24 inches deep. At the lower end of the burrow is a chamber where the grub rests between feedings.

With the first soaking showers of the midsummer rainy season the adults emerge from the pupal cases, which are 2 to 5 inches below

the surface. When the adults first take wing they fly at once to a fruit tree. Fermenting fruit is preferred, and ripe fruit is next in attractiveness. Injured fruits are often attacked, and uninjured fruits are not fed upon until after the beetle has punctured the skin by using the horn on the fore part of its head. Most of the feeding is done from 10 in the morning until sundown.

Figs, peaches, and grapes are favorites, although serious damage may be done to dates. Pears, apples, cracked melons, cactus fruits, damaged late sweet corn, various pollens, and plant gums are fed upon. Much fruit is spoiled by the beetles' excrement.

Larvae may be controlled by cleaning up corrals, manure piles, and haystack bottoms in February, March, and April. Flooding infested areas for 48 hours kills the eggs and young grubs. Satisfactory control measures against the adults have not been reported.

Nitidulid Beetles

Small beetles of the family Nitidulidae, a name based on a Latin word meaning "shiny," have increased greatly in date plantings in recent years, as the quantity of waste fruits available during the season has increased. Members of this group of beetles and their larvae feed on soft fruits that are ripe, partly dried, or in early stages of decay, and on some waste vegetables that contain enough sugar to support fermentation. Fruits and vegetables that are dry or in which rotting is far advanced are not attractive to these beetles or to their larvae.

The most important of the nitidulids in date gardens are the pineapple beetle (*Urophorus humeralis* (F.)), the dried-fruit beetle (*Carpophilus hemipterus* (L.)), the corn sap beetle (*Carpophilus dimidiatus* (F.)), and the yellowish nitidulid (*Haptoncus luteolus* (Er.)).

This group of small beetles, also commonly called sour bugs, are the most destructive insects with which date growers have to contend. Although the "sour" part of this common name is appropriate, "sour beetles" would be a better name since they are not true bugs.

In the warmer parts of the country, much waste ripe fruit falls to the ground, often on damp soil, where it usually squashes or cracks open. The surface that touches the soil becomes soft and very favorable for nitidulid beetles. The adults feed and the larvae develop in a moist, dark environment of yeasty and often moldy pulp. The larvae, feeding for 2 weeks or more, usually go into the soil beneath their host food to transform into the pupal stage. At Fresno nitidulid larvae and pupae have been found as deep as 2 feet in dry soil in a fig orchard.

The supply of food for nitidulid beetles is varied when tree fruits and certain vegetables are ripening. Almost anything that contains enough sugar to support yeast fermentation will do. Figs on the trees are very attractive, as are also soft ones on the ground. Mushy citrus fruits, rotting apples, broken watermelons, decaying sweet corn, and similar materials serve as food and breeding places for many of the beetles. The beetles feed frequently on decomposing tomatoes, but do not breed in them to any extent.

The four species of nitidulids most commonly found in infested dates are illustrated in order of their size in figure 10. The individual species will be discussed briefly.

PINEAPPLE BEETLE

The pineapple beetle is the largest nitidulid commonly found in dates in the Coachella Valley. Schmidt (*57*) named it the pineapple beetle because of its dominance among the six species of nitidulids in pineapple fields in the Hawaiian Islands. There the high sugar content of the stumps and leaves that remain after harvest (15 to 20 tons per acre) favors fermentation and produces food attractive to the beetles. There is no loss from attacks on pineapple fruits. However, the beetles are a nuisance in the canneries. Schmidt stated that the pineapple beetle has been found in India, Africa, Mauritius, Madagascar, the East Indies, and China.

The pineapple beetle (fig. 10, *A*) is a shiny black insect nearly $^{3}/_{16}$ inch long with a faint brown area at the base of each wing cover. As with many other nitidulids, the wing covers do not cover the abdomen.

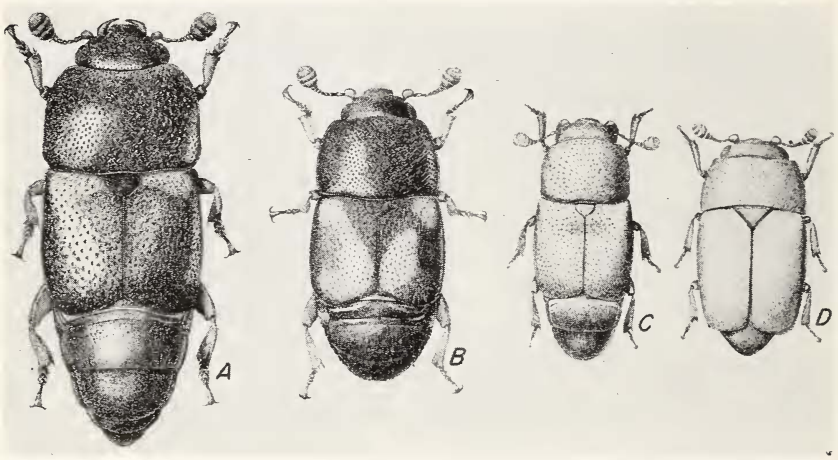

Figure 10.—Nitidulid beetles commonly found in infested dates: *A,* Pineapple beetle; *B,* dried-fruit beetle; *C,* corn sap beetle; and *D,* yellowish nitidulid.

Females, which Schmidt (*57*) kept in glass dishes containing squares of pineapple stump, laid eggs beneath the food. Twenty-five females averaged 882 eggs; the most prolific individual produced 1,466 eggs and averaged almost 15 a day for 100 days. These females lived from 23 to 113 days, the average longevity being 89 days. Egg-laying extended over an average period of 76 days.

Although this beetle occurs in dates, in 1946 it was much more abundant in waste grapefruit in the region around Indio.

Pemberton and Williams (*52*) reported that after developing in pineapple stumps the pineapple beetles fly to sugarcane fields, where their enormous numbers make them a nuisance to the laborers. In the fields the beetles develop on souring cane trash and congregate underground on the cut ends of planted seed pieces, promoting fermentation and interfering with germination.

On Guam this species is found in sugarcane, rotten breadfruit, and decaying cucumbers, according to Swezey (*64*).