

Insects of the Garden Bean in Hawaii*

BY F. G. HOLDAWAY† AND WILLIAM C. LOOK‡

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INTRODUCTION

When, in 1937, an Entomology Department was reestablished in the Hawaii Agricultural Experiment Station, it was found that the crops of diversified agriculture in which the Station and the community were interested were different from those which came within the field of work of the Entomology Department which had existed in the Station over 20 years before. Moreover, it was also found that many of the insects which occurred on these crops had been recorded in Hawaii only a comparatively few years before and little was known of them from the standpoints of abundance and crop injury. In order to secure perspective regarding the crop insects, surveys have been made of those of the more important crops.

This paper is the first of a series in which will be recorded a census of the insects known to date on crops, other than sugarcane and pineapple, in Hawaii. Where possible, information will be given on relative importance, distribution and seasonal incidence. The insects will be discussed under the headings of major pests, sub-major pests, minor pests, beneficial insects, and incidental insects. It will not be surprising if, as additional information is secured, or as crop abundance, or relative crop abundance changes, some modification of the grouping given here will be necessary. Already one change, that of whiteflies from a minor pest to a

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† Entomologist, Hawaii Agricultural Experiment Station and Associate Professor of Zoology, University of Hawaii.

‡ Associate in Entomology, Hawaii Agricultural Experiment Station.

major pest, has been necessitated by records secured since the main observations on which this paper is based, were made. Moreover it cannot be considered that the census is complete. It is merely as complete as it has been possible to make it in the time allotted for securing information sufficient for prosecuting work on the applied entomology of the respective crops. Records of additional insects on the crops will undoubtedly be secured.

The major insects will be classified on an ecological basis in a manner somewhat similar to that so well developed by Graham^{1*} for Forest Insects. Modifications of the system developed by Graham have been necessary to meet the special needs of truck and field crops. A general outline of the system which will be used in this series of papers follows.

A. Foliage insects

- (i) Foliage-consuming insects
- (ii) Leaf-mining insects
- (iii) Sap-sucking insects (including mites)

B. Insects attacking the meristem of terminal parts

C. Stem insects

- (i) Sap-sucking insects (including mites)
- (ii) Stem-boring insects

D. Insects of the reproductive organs

- (i) Flower insects or insects of the inflorescence
- (ii) Fruit insects
- (iii) Seed insects

E. Root and tuber insects

F. Soil insects

The common names used are those adopted recently by the Hawaiian Entomological Society following a report submitted by a committee appointed by the Society to bring up to date the list of names for common and economically important insects in Hawaii.

* * *

The garden or green string bean, *Phaseolus vulgaris*, with an annual production of more than one and one half million pounds, is one of the most important vegetable crops grown in the Territory. For the fiscal year 1937-38³ the crop was valued at \$121,481. In 1940⁴ the Territory was 100 per cent self-sufficient in the production of green beans. The main production occurs on the island of Oahu, where most of the observations on which the present article is based have been made. "Pole" beans have been the most popular type grown, and so most of the observations have been made on pole varieties.

The most important pests are a foliage-feeding beetle, a leaf-

* Reference is made by number to Literature Cited.

hopper, a plant-bug, an aphid, mites, a whitefly, and a pod-boring caterpillar. Eight major pests, three sub-major pests, twenty-three minor pests, and twenty-two species of beneficial insects are recorded here. Thirty-two additional species are recorded as incidental. The incidence of the respective pests varies with season and place; never are they all present on a crop at the same time. The differences in climate associated with elevation and windward and lee locations are comparatively marked in short distances. Thus it is not surprising to find the insect picture differing markedly in localities a few miles, or even a fraction of a mile, apart. Most of the observations recorded here were made during the years 1938-40 inclusive.

MAJOR PESTS

Foliage Insects

Foliage-consuming insects

Adoretus sinicus Burmeister, Chinese rose beetle—Coleoptera, Scarabaeidae

This beetle was introduced from the Orient, as an immigrant, some time prior to 1896¹³. At night, the adults devour the leaves, and may also attack the buds. During the day they may be found in the soil, or hidden among dried leaves, beneath the plants being attacked. When the beetle is abundant, bean plants may be skeletonized. No quantitative data are available on the geographic and seasonal abundance of the beetle. General observations, however, suggest that it has been particularly abundant at Waipahu, Heeia and Honolulu. Sections of Honolulu at a greater elevation and having a higher rainfall experience little injury at times when sections at a lower elevation with less rainfall are experiencing severe injury. Though the beetle is present at Lualualei, Waialua and Kaaawa, the damage at these places is relatively negligible. While our data are perhaps still too scanty for generalization, our observations suggest that attack is least in the very dry and the relatively moist sections, and is more marked in regions of intermediate rainfall. In general, it appears that in those localities in which the insect occurs, attack on beans is most severe during the summer months, but it may be quite serious during the winter months in periods of prolonged dry weather.* Chinese cabbage, corn, taro, grape, eggplant, okra and roses are other economic plants which are commonly attacked severely.

* In Hawaii the mean monthly temperature of the hottest month differs by only a few degrees from the mean monthly temperature of the coldest month. For Honolulu the difference is 7.6° F. The average for nineteen stations on Oahu is 7.4° F; the difference for Hawaii is 5.2° F. and that for Kauai 7.9° F. It seems probable, therefore, that the differences in moisture conditions between summer and winter which are commonly quite marked are more important factors determining seasonal activity than are differences in temperature.

*Sap-sucking Insects****Empoasca solana* DeLong, Bean leafhopper—Hemiptera, Jassidae**

This small, green, leafhopper was first found on amaranth in 1918¹⁵. Today it is one of the most serious enemies of the garden bean. The nymph may be recognized by its pale yellowish-green color and by the sidewise movements it makes. Adults and nymphs feed on the undersurface of the leaves, sucking the sap and producing "hopperburn." *Empoasca solana* is rather widespread on Oahu. It is especially abundant on beans at Lualualei where as many as 28 hoppers per leaflet have been recorded. It is also comparatively abundant on bush beans at Waialua. At Waipahu as many as 11 hoppers per leaflet have been recorded. Though fairly abundant on castor beans at Kahuku, this insect is found only occasionally on beans growing in this locality. It is present in small numbers at Kaneohe and Kaaawa. Blackeye cowpea, beet, Swiss chard, peanut, lima bean, lettuce, celuce, Irish potato, summer squash, celery and eggplant are other hosts. Blackeye cowpea is particularly susceptible. On this crop the insect breeds rapidly and causes serious puckering, distortion and yellowing of the leaves.

***Pycnoderes quadrimaculatus* Guérin, Bean Capsid—Hemiptera, Capsidae**

This mottled, black, grey and white capsid was first found in Hawaii, feeding on purslane, on December 11, 1929⁸. It was recorded on squash on May 30, 1932⁹. Both of these records were for Oahu. It probably arrived here from California where it is very injurious to cucurbits. It became increasingly abundant in 1933 and in 1934 was recorded on Kauai¹⁰. It is particularly abundant on beans in hot, dry sections, such as Lualualei, where as many as 45 individuals per leaflet have been recorded on plants two months old. The black excrement of the bugs is commonly seen on the undersurface of leaves which carry a large number of bugs and gives a characteristic appearance to heavy infestations. Leaf damage by this bug at Waialua is, to a certain extent, comparable to that at Lualualei. At the Waipahu school gardens and Kaaawa, the number is very small, seldom exceeding three to four bugs per row of 50 feet. The plants are injured by the depletion of sap due to the constant sucking of the bugs, which are commonly found on the undersurface of the leaves. Injury shows as a light stippling on the upper surface of the leaves and is not unlike the injury caused by red spider. Cucurbits, white mustard cabbage, and sweetpotato are also severely attacked by this bug in the hot, dry regions in which it is abundant. Okra is also a host.

A parasitic fungus *Entomophthora sphaerosperma* Fresenius* has been recorded attacking individuals on pumpkins, white cabbage, dishcloth gourd, and wild spiny cucumber at Lualualei¹¹ but has not yet been observed on bugs feeding on bean plants.

Aphis medicaginis Koch, Cowpea aphid—Homoptera, Aphididae

The cowpea aphid, which has been in Hawaii for more than 30 years, was probably introduced from California¹³. The adults are shiny black while the nymphs are dull grayish in color. Large colonies often infest the leaves, stems, and pods of plants of all ages and cause the plants to wither and die. This aphid is an important economic pest of a number of legumes, and is at times abundant also on *Portulaca oleracea* and other weeds from which it often migrates to young bean plants. Today its presence will be noticed on beans, at some time of the year, in almost every region of Oahu. It is particularly injurious to beans of the cowpea group. It is seldom abundant on non-legume crops but has been recorded also on asparagus and tomato.

Trialeurodes vaporariorum (Westwood), † Greenhouse whitefly—Homoptera, Aleyrodidae

At the time most of the observations recorded here were made, whitefly was regarded as a minor pest. Since the winter of 1940-41, however, this insect has been so numerous in the hot, dry sections of Waianae, Lualualei, Nanakuli and Maili that it must henceforth be regarded as a major pest. During the period January to June 1942, infestations have been heavy in these sections. In March and April, infestations were so heavy that serious crop losses occurred until a means of combating the insect was secured. On heavily infested leaves there is not a square centimeter free from eggs, nymphs or adults. The foliage becomes wet with the sticky secretions of the whiteflies and finally becomes dry and brown, assuming a scorched appearance.

Tetranychus sp.? near **T. bimaculatus** Harv. ‡ “Red spider” mite—Acarina, Tetranychidae

Hemitarsonemus latus (Banks), § White or “Broad mite”—Acarina, Tarsonemidae

There are at least two species of mites on garden beans—the “red spider” mite **Tetranychus** sp., possibly a new species, and a “white” mite *Hemitarsonemus latus*. These two mites are among the most injurious pests on the foliage of the garden bean. Infes-

* Identification by Prof. Wm. H. Weston, Harvard University.

† Provisional identification.

‡ Identification by E. A. McGregor.

§ Identification by H. E. Ewing.

tations of both species are especially high during the hot, dry seasons and in the arid sections of Oahu. They produce different symptoms on the leaves.

The "red spider" is commonly found on the lower surface of the leaves associated with a web of fine silky thread. The older leaves are often attacked and stippled with whitish spots which are evident on the upper surface. Heavily infested leaves usually turn yellow and drop off.

Unlike the "red spider" which is larger and orange to orange red in color, the "white" mite is pearly white and can be seen only with difficulty with the naked eye. It generally attacks the young growing leaves. Infested leaves are distorted, crinkled, and underdeveloped; the undersurface commonly has a rusty color. Growth of the plant ceases when the infestation is great and uncontrolled. The red spider undoubtedly has a large number of hosts, but until identity of the species on bean is established beyond doubt little can be said about other hosts. In Hawaii *Hemitarsonemus latus* has been recorded on papaya, ⁷ Swiss chard and sweetpotato. Injury resembling that of *Hemitarsonemus latus* has been observed on pepper, beet, tomato, Irish potato, eggplant, watercress and Jimson weed.

Stem Insects

Sap-sucking insects (including mites)

Aphis medicaginis which feeds on the undersurface of the foliage infests also the stems—and at times the pods, too. The mite *Hemitarsonemus latus* which occurs on the undersurface of the foliage is found also on the young stems.

Stem-boring insects

The pod borer, *Maruca testulalis*, discussed at greater length under the heading of pod insects does some injury by boring into the stems.

Pod-attacking Insects

Maruca testulalis (Geyer), Bean pod borer—Lepidoptera, Pyralidae

The bean pod borer, an insect which occurs in the East Indies and other tropical and sub-tropical places, first came to notice on green peas and later on lima beans in 1922 ¹³. Unlike the bean butterfly, which is commonly seen flying about the bean fields during day, the adults of the pod borer are seldom seen. The moths which are white and brown are mainly nocturnal; they are commonly found hidden among the lower leaves of the bean plants but may be seen on the wing in the daytime during dull weather. The larvae are cream-colored with brown spots. Young larvae may feed on any of the floral parts and on the foliage but are most commonly

found boring in the pods. Pods damaged early may be shed or may become deformed and unmarketable. Larger pods, when attacked, are rendered unfit for market by the unsightly holes and the mass of wet excrement. Up to the present, severe damage has been observed only at Mokapu, Waipahu, and Waialua. However, this pod borer must be considered as one of the most destructive insects of beans in Hawaii. Much of the damage attributed to bean butterfly in the past should undoubtedly be credited to *Maruca testulalis*⁵. Lima beans and hyacinth beans may also be heavily attacked by *M. testulalis*. Lima beans are more commonly attacked than are green beans.

SUB-MAJOR PESTS

There are three insects which are here recorded as sub-major pests of green bean. They are thus designated because, while they are not in general major pests, they are, at certain times and in certain places, more prominent than the insects recorded as minor pests and more important even than some of the insects recorded here as major pests. They are a leaf-feeding caterpillar and two pod-attacking insects.

Autographa chalcites (Esper.), Garden looper—Lepidoptera, Phalaenidae

The green looping caterpillar of this insect has been a pest in Hawaii for more than 30 years¹⁴. It feeds on the foliage of a large number of plants, including garden vegetables and ornamentals. It is generally found on the undersurface of the bean leaf, riddling the leaf with holes, but it does not skeletonize the plant as does *Adoretus sinicus*. Though the damage by this pest may be great, the insect was not very abundant on beans during the period of the observations recorded here. At Waipahu and Kaneohe it was more abundant during the winter than at other seasons. It has also been found on tomato, potato, Chinese pea, head cabbage*, and eggplant.

Cosmolyce boetica (Linné), Bean butterfly—Lepidoptera, Lycaenidae

The bean butterfly probably arrived from the Orient some years prior to 1882¹³. The method of attack is similar to that of *Maruca testulalis*. The larvae destroy the flowers as well as the pods of leguminous plants. In localities where the infestation is high and uncontrolled, damage may result in a complete loss of the bean crop. Fortunately, although the butterflies are usually present in bean fields, damage by the larvae is rarely seen. Commonly eggs are

* Most of the green looping caterpillars on cabbage and related plants are now known to be the cabbage looper *Autographa brassicae* which has been recorded on four of the islands of the Territory¹². However, *A. chalcites* is also found on cabbage.

abundant on and near the floral parts, but seldom does injury result. Swezey (Proc. Haw. Ent. Soc., 7, p. 287, 1929) has recorded *Trichogramma minutum* as a parasite of the egg. Other economic hosts are broad bean, lima bean, hyacinth bean and pigeonpea.

Dacus cucurbitae Coquillett, Melonfly—Diptera, Trypaneidae

The melonfly was introduced from the Orient, as an immigrant, about 47 years ago and became established in the Territory¹³. This relatively large yellow and brown fly attacks the fruits of cucurbits, tomato, and some of the legume family. It damages the pods of beans by laying eggs beneath the surface. The maggots, on hatching from the eggs, feed and develop in the pod, making it unsalable. Although this insect was reported to have been very destructive to beans about 9 or 10 years ago at Lualualei, observations made during the past few years have brought to light damage at Koko Head and Waialua only. Observations made at Koko Head suggest that the presence of a high population of flies and the absence of more attractive hosts are important factors in damage to beans⁶.

MINOR PESTS

There are several insects commonly found on garden beans which are at the present time considered as minor pests. Some of them may, at times, produce somewhat more damage than is ordinarily associated with minor pests. Should they increase in numbers it may be necessary later to rank them as major pests. The corn earworm, three-cornered alfalfa hopper, thrips, mealy bugs, certain species of aphid, grasshoppers, flea beetles, a cutworm, an ant, bean weevils and a leaf miner are here considered to be minor pests. They are as follows:

Orthoptera, Acrididae: *Atractomorpha ambigua* Bolivar

Orthoptera, Tettigoniidae: *Elimaea punctifera* (Walker)

Thysanoptera, Thripidae: *Thrips hawaiiensis* (Morgan); *Thrips tabaci* Lindeman

Homoptera, Aphididae: *Aphis gossypii* Glover; *Aphis sacchari* Zehntner; *Myzus persicae* Sulzer; *Rhopalosiphum nymphi* (Linné)

Homoptera, Coccidae: *Phenacoccus gossypii* Townsend and Cockerell; *Pseudococcus kraunhiae* (Kuwana)

Homoptera, Membracidae: *Stictocephala festina* (Say)

(This last mentioned species, the three-cornered alfalfa hopper, was probably introduced accidentally into Hawaii from California, on hay, about 17 years ago². Adults and nymphs have been found comparatively abundant on beans at Waipahu and Waialua. It is present also at Kailua, Kahuku, Koko Head, Kaneohe, Honolulu, and Lualualei. Although it may be abundant at times, it is considered to be a minor pest.)

Coleoptera, Bruchidae: *Bruchus chinensis* (Linné); *Acanthoscelides* (*Bruchus*) *obtectus* (Say); *Bruchus pruininus* Horn

Coleoptera, Anthribidae: *Araecerus fasciculatus* (De Geer); *Araecerus vieillardii* (Montrouzier)

Coleoptera, Chrysomelidae: *Diachus auratus* (Fabricius); *Epitrix parvula* (Fabricius)

(Seeds and dry pods of beans in storehouses are often attacked and destroyed by several species of weevil. Though not as abundant and injurious in the field as in storage, these weevils may become of great importance when pods are left to ripen and dry on the plant.)

Lepidoptera, Phalaenidae: *Heliothis armigera* (Hubner)

(At the present time, *H. armigera* is not considered to be a major pest of beans in Hawaii although it caused serious damage to bean pods at Waimea, Hawaii, in October, 1939. It would appear that a high population of the corn earworm moths and paucity of corn or other hosts more attractive than beans are factors in the attack of this insect on beans. Until further evidence is secured to the contrary, *H. armigera* is therefore designated a minor pest of beans.)

Lepidoptera, Phalaenidae: *Agrotis ypsilon* (Rottemburg) (Bean plants recently germinated are often cut off just above ground level by this cutworm)

Lepidoptera, Tortricidae: *Amorbia emigratella* Busck (The larva has been found attacking bean leaves)

Diptera, Agromyzidae: *Agromyza* sp. probably *pusilla* Meigen

Hymenoptera, Formicidae: *Solenopsis geminata* Fabricius race *rufa* (Jerdon) (The ants chew roots and stems at or about ground level).

BENEFICIAL INSECTS

Although many of the insect pests of Hawaii have been brought under control by biological means, most of the enemies of the garden bean are not attacked to any great extent by beneficial insects. Ladybird beetles are the commonest found. Of the seven species collected on beans, *Coelophora inaequalis* (Fabricius) is the most abundant and undoubtedly the most efficient enemy of aphids and mealy bugs. Several species of wasp have been observed attacking larvae of *Maruca testulalis* and other caterpillars. The number of wasps working at one time is usually small. While they must exert some control, and, at times an appreciable control, they cannot at the present time be regarded as a major factor in controlling the borer. Predaceous bugs are invariably present on bean plants. Aphids are no doubt commonly attacked. *Zelus renardii* Kolenati

was particularly abundant at Lualualei where it has been seen preying on adults and nymphs of *Pycnoderes quadrimaculatus*.

The following species of beneficial insects have been recorded:

Orthoptera, Tettigoniidae: *Conocephalus saltator* (Saussure);
Xiphidiopsis lita Hebard (Both these species have been reported by Swezey¹⁶ to prefer an insect to a vegetable diet)

Neuroptera, Hemerobiidae: *Eumicromus navigatorum* (Brauer)

Hemiptera, Anthocoridae: *Triphleps persequens* White

Hemiptera, Nabidae: *Nabis capsiformis* Germar

Hemiptera, Reduviidae: *Zelus renardii* Kolenati

Coleoptera, Coccinellidae: *Coelophora inaequalis* (Fabricius); *Coelophora pupillata* (Schön); *Cryptolaemus montrouzieri* Mulsant; *Dionus notescens* (Blackburn); *Platyomus lividigaster* Mulsant; *Rodolia cardinalis* Mulsant; *Pullus loewii* Mulsant.

Diptera, Dolichopodidae: *Chrysosoma fraternum* Van Duzee

Hymenoptera, Vespidae: *Polistes fuscatus* (Fabricius); var. *aurifer* (Saussure); *Polistes hebraeus* (Fabricius); *Polistes macaensis* (Fabricius)

Hymenoptera, Eumenidae: *Pachodynerus nasidens* (Latreille) (Adults attack larvae of *Maruca testulalis*)

Hymenoptera, Braconidae: *Chelonus blackburni* Cameron; *Ischiogonus palliatus* Cameron

Hymenoptera, Ichneumonidae: *Cremastus flavo-orbitalis* (Parasite of *Maruca testulalis*)

Hymenoptera, Encyrtidae: *Litomastrix floridana* (Ashm.) (Parasite of *Autographa chalcites*)

INCIDENTAL INSECTS

The following additional insects have been recorded on the garden bean. Some of them no doubt feed on the bean plant. Some, especially the sap-sucking insects and particularly the aphids, are potential vectors of virus diseases. The role of others is unknown. Some are possibly casual insects present on the bean plant merely because of proximity of their common hosts. Further observations would no doubt reveal the true relation of many of these insects to the plant.

Homoptera, Aphididae: *Macrosiphum gei* Koch; *Micromyzus formosanus* (Takahashi); *Aphis maidis* Fitch

Homoptera, Cixiidae: *Oliarus discrepans* Giffard

Homoptera, Delphacidae: *Aloha* sp.

Homoptera, Flatidae: *Siphanta acuta* (Walker)

Heteroptera, Lygaeidae: *Geocoris punctipes* (Say); *Nysius terrestris* Usinger; *Nysius nigriscutellatus* Usinger

Heteroptera, Capsidae: *Cyrtopeltis varians* (Distant); *Leucopoeila albofasciata* Reuter

- Heteroptera, Tingidae: *Teleonemia scrupulosa* Stål.
 Coleoptera, Cerambycidae: *Cyllene crimicornis* (Chevrolat); *Sybra alternans* Wiedemann
 Coleoptera, Cucujidae: *Cryptamorpha desjardinsi* (Guérin); *Psammoechus insularis* (Sharp)
 Coleoptera, Curculionidae: *Anthonomus eugenii* Cano; *Pantomorus godmani* (Crotch)
 Coleoptera, Scarabaeidae: *Anomala orientalis* (Waterhouse)
 Coleoptera, Elateridae: *Conoderus exsul* (Sharp)
 Coleoptera, Nitidulidae: *Carpophilus dimidiatus* (Fabricius); *C. hemipterus* (Linné); *Urophorus humeralis* (Fabricius)
 Coleoptera, Cleridae: *Tillus notatus* Klug
 Coleoptera, Anthribidae: *Phloeobius gigas horaeus* Jordan
 Lepidoptera, Phalaenidae: *Laphygma exempta* (Walker)
 Lepidoptera, Tineidae: *Ereunetis simulans* (Butler); *Opogona aurisquamosa* (Butler); *O. purpuriella* Swezey
 Lepidoptera, Tortricidae: *Argyroplote illepidata* (Butler)
 Diptera, Anthomyiidae: *Atherigona excisa trilineata* Stein (Probably a scavenger breeding in injured pods or other injured plant parts).
 Diptera, Drosophilidae: *Drosophila melanogaster* Meigen

SUMMARY

This is the first article in a series which will be devoted to the insects of crops, other than sugarcane and pineapples, in Hawaii. In it are recorded the results of a survey of the insects of garden bean. Most of the observations were made on the island of Oahu where most of the beans are produced. The relative importance of the insects has been recorded and the major pests determined. Eight major pests, three sub-major pests, twenty-three minor pests and twenty-two species of beneficial insects are recorded. The major pests have been classified on an ecological basis. They are a foliage-consuming beetle, *Adoretus sinicus* (the Chinese rose beetle), six sap-sucking insects including mites, *Empoasca solana* (the bean leafhopper), *Pycnoderes quadrimaculatus* (the bean capsid), *Aphis medicaginis* (the cowpea aphid), *Trialeurodes vaporariorum* (Westwood) (greenhouse whitefly), *Tetranychus* sp. (a red spider mite), and *Hemitarsonemus latus* (the broad mite), and a pod-attacking insect *Maruca testulalis* (the bean pod-borer). Sub-major pests include *Autographa chalcites* (the garden looper), *Cosmolyce boetica* (bean butterfly) and *Dacus cucurbitae* (the melonfly).

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