References to *Heliothis armigera* (Hübner), the corn earworm, or supposed synonyms of it, have long been present in Hawaiian literature. In 1880, Butler first listed the species from Hawaii as *Heliothis conferta* Walker, from specimens collected by Blackburn ("Bred from larvae found very rarely in company with that of *Vanessa Huntera*, on flowers of a species of 'everlasting' on Maui."; Butler, 1880:8). Although the species was long known as a notorious pest of corn and cotton in America, it was not reported as a pest of those crops in Hawaii. In 1922 (Proc. Haw. Ent. Soc. 5(2):185, 1923) Swezey reported that "The caterpillars of this moth are known as the cotton boll worm and corn ear worm in the Southern States, but in Hawaii they have not been recorded as injurious to those plants." However, by forced feeding in the laboratory, Swezey found that the caterpillars "voraciously" fed upon green sweet corn, and he stated that "It is not understood why corn in the field has not been reported attacked by these caterpillars." In 1930 corn was apparently suddenly attacked in Hawaiian fields, and subsequently corn earworms have been major pests of corn in Hawaii, and chemicals have had to be used to control them. In February, 1930, Swezey (Proc. Haw. Ent. Soc. 7(3):369, 1931) reported finding larvae in corn: "This is the first time that he had found larvae of this species attacking corn..." In November, 1930, Ehrhorn (Proc. Haw. Ent. Soc. 7(3):389, 1931) reported upon the prevalence of the caterpillars on corn, and it was stated that "it had hardly been known as a corn pest here heretofore." Within the next few years, infestation became general, and at times hardly an ear of corn could be found uninfested.

This apparently unusual behaviour raised the question of whether the records for the moth in Hawaii before about 1930 were based upon correct identifications or whether the moth had suddenly changed its habits. Investigations at that time did not reveal any apparent differences of specific nature between specimens collected long before 1930 and those found damaging corn after 1930, and the differences that were observed were considered to be only individual variations in a species well known for its extreme

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1 This research was completed during the tenure of a grant from the National Science Foundation, and this paper is an extract from the project INSECTS OF HAWAII, published at this time because of the economic importance of the species involved.
variability. It was also considered that there might be two strains present in Hawaii: one, an early immigrant which was a non-corn-eating strain, and the other, introduced about 1930, a corn-eating strain.

It is now possible to report that a careful re-examination of Hawaiian specimens in the light of more experience with comparative studies of the genitalia and stimulated by the work of recent authors, has revealed that not only is *Heliothis armigera* not present in Hawaii, but that two other species are involved. One of these was named "*Heliothis obsoleta variety hawaiensis*" by Quaintance and Brues in 1905, "*Chloridea obsoleta subspecies signata*" by Warren in 1912, and "*Chloridea armigera ab. hawaiensis*" by Strand in 1916, but these names escaped the notice of Hawaiian entomologists. This is the species which has long been present in Hawaii but which is not a pest of corn or cotton. The second species, which evidently gained entrance to Hawaii shortly before 1930, is *Heliothis zea* (Boddie), described from the United States in an obscure journal rarely used for entomological reports in taxonomy, and the name *zea* has also escaped general notice. These discoveries place the apparent anomaly in Hawaii in very different light, and, of course, supply the answers to the hostplant problem.

*Heliothis* is a complex containing many similar forms which are often difficult to separate by external characters. The two forms found in Hawaii, and others apparently allied to them or resembling them, are most easily distinguished by characters of the aedeagus. We are not able to report useful characters in the female genitalia at this time, and the genital valves of the males of the two species evidently differ only in degree rather than in major structure or shape.

The following key will facilitate the identification of the two species established in Hawaii, but it must be borne in mind that the color pattern is subject to much variation. Not all examples of either species have the color pattern as described in the key and specimens of either species may overlap the other in some of the color pattern characters, but the species can be determined by using a combination of the characters.

**Key to the Species of Heliothis in Hawaii**

1. Upper side of hind wing with the dark terminal band interrupted by a usually prominent pale patch at about middle, as illustrated; lower side of hind wing with the dark terminal band obsolete and usually with only a dark spot at apex of vein Cu2, as in figure 1; aedeagus without a subapical, thorn-like tooth, and with two clusters of long, mostly individually well-defined spines (cornuti), as in figure 3. .................. *zea* (Boddie)

Upper side of hind wing with the broad, dark, terminal band usually entire and without a prominent pale patch, as illustrated; lower side of hind wing with the terminal dark band usually much more
extensive than in *zea* and usually as in figure 1 or more so; aedeagus with a well-defined, subapical, thorn-like tooth, and with a long, continuous band of more numerous, smaller, more slender spines (cornuti), as in figure 3. **hawaiiensis** Quaintance and Brues

The hostplant records for *Heliothis* in Hawaii must now be extensively revised, because it is impossible to tell from many of the Hawaiian reports after about 1930 which of the two species has been the object of the reports. Zimmerman has the following hostplant records in his manuscript for *Insects of Hawaii*:


The parasites *Eucelatoria armigera* (Coquillet) (Diptera), *Frontina archippivora* (Williston) (Diptera) and *Trichogramma minutum* Riley (Hymenoptera) have been reported as being very effective, but we do not know whether they attack both species equally. The larvae of the moths are preyed upon by the wasp *Pachodynerus nasidens* (Latreille).

**Heliothis zea** (Boddie) (figs. 1–3)

*Phalaena zea* Boddie, 1850:132.

*Heliothis armigera*, as a misidentification.

*Chloridea armigera*, as a misidentification.

*Heliothis obsoleta*, as a misidentification.

*Chloridea obsoleta*, as a misidentification.

Immigrant to Hawaii. Not recorded under the name *zea* in Hawaii heretofore, but confused under other names in Hawaiian literature from 1931 onward. Accidentally introduced from North America, and evidently first established in Hawaii shortly before 1930.

Hostplants: corn, cotton, tomato and probably a large number of other hosts which have not yet been accurately determined in Hawaii.

**Heliothis hawaiiensis** Quaintance and Brues, new status (figs. 1–3)

*Chloridea armigera* "Ab. 1" Hampson, 1903:45 (described from a dark, boldly marked individual from Kona, Hawaii, 4,000 feet, July 2, 1892, Perkins).

*Heliothis obsoleta* variety *hawaiiensis* Quaintance and Brues, 1905:12.

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Fig. 1. Top row, *Heliothis zea* (Boddie), male, expanse 39 mm. Bottom row, *Heliothis hawaiiensis* Quaintance and Brues, expanse 34 mm.
Chloridea obsoleta subspecies signata Warren, 1912:308 (new name for "ab. 1" of Hampson).
Chloridea armigera "ab. hawaiensis" Strand, 1916:143 (Hampson's "Ab. 1," named without being seen by Strand).
Chloridea obsoleta, as a misidentification.
Heliothis obsoleta, as a misidentification.
Heliothis armigera, as a misidentification.
Heliothis conferta, as a misidentification.

Immigrant to Hawaii. It is not known when this species first became established in Hawaii. It is possible that it is a natural immigrant. We have not been able to find any specimens of the species from any region other than Hawaii, and whence it has come is not known. Judging from the evidence now at hand, it appears that the aedeagus most closely resembles that of Heliothis gelotopoeon (Dyar), 1921, from South America, but there may be other American species unknown to us to which it will be found more closely allied if not identical. The spines on the legs are not the same as in gelotopoeon, however. In the examples of that species before us, the spines are more numerous and heavy, and the outer side of the fore tibia has a comb of stout, conspicuous spines from near the base to apex which is lacking in hawaiensis (the number of spines may be variable, however). Also, the valves of the male genitalia are differently shaped and longer in proportion to the aedeagus in gelotopoeon. Externally, hawaiensis is quite similar to zea, and it may often be difficult to separate single examples of hawaiensis from zea. The same comments may apply also to armigera which is evidently widely distributed in Eurasia and Africa. The variation in color and pattern is so extreme that an attempt to describe the coloration from the examples at hand would be incomplete and possibly misleading. Examples may be found which externally closely resemble zea, others gelotopoeon, others armigera or other species. It is the aedeagus which offers the decisive characters. Our illustrations will serve to establish the diagnostic features of the species as we now recognize them. Todd (1955) has also figured the genitalia of zea and gelotopoeon, and Common (1953) has figured other species.

Blackburn collected this species in Hawaii in 1880. We have been able to find three Blackburn examples in the British Museum collection. One of these was determined as "H. conferta," presumably by Butler. It bears the number "4." Butler (1880:8), when recording this species from the Blackburn collection, stated that the material he examined was numbered "4," and the note from Blackburn appears to indicate that the specimen was from Maui. However, the specimen bears another label reading "Hawaii, Oahu, T. Blackburn 80-31." Perhaps this example is the specimen sent by Blackburn to Butler for determination, and the note regarding the rearing of the moth from a species of "everlasting" refers to other specimens taken by Blackburn.
but not sent to Butler. The other two Blackburn examples are labeled Heliothis armigera ♂ and Heliothis armigera ♀; the male bears the number "141," the female "154." Evidently Blackburn placed small tickets bearing numbers on the specimens he sent for determination so that the names of the species could be returned by number, thus making the return of the specimens unnecessary.

Hostplants: a polyphagous species whose hostplants have not been accurately determined because of some confusion with zea, but which include a large number of the plants listed above.

In addition to the foregoing two species, Heliothis inflata (Wallengren) (Anthoecia inflata Wallengren, Lepid. Mitt. 4(6):172, 1860) has incorrectly been listed as a Hawaiian species. We have examined the type in the Riks-museum, Stockholm; it is labeled in error as having been taken in Honolulu by Kinberg. It is the same as Anthoecia onca Wallengren and Anthoecia
cystiphora Wallengren, and is a species of Central and South America and the Galapagos.

REFERENCES

BODDIE, J. W. 1850. Insect physiology—the boll worm. SOUTHERN CULTIVATOR 8(9):132. (See Todd, 1955:602, for discussion of this publication.)


