

On the Extinction of the Asiatic Rice Borer *Chilo suppressalis* in Hawaii^{1, 2, 3}

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INTRODUCTION

The fate of newly arrived immigrant insects in a new area may be placed into 1 of 3 categories (1) no establishment, (2) temporary establishment or (3) permanent establishment. Entomologists are concerned with insects in categories 2 and 3 particularly if they are species of considerable economic importance. The Asiatic rice borer, *Chilo suppressalis* (Walker), an insect discovered in Hawaii in 1927, may be placed in the 2nd category. The purpose of this paper is to present the history of *C. suppressalis* and to put on record that this borer and some of its imported natural enemies are no longer present in Hawaii. This information will help clarify some of the recent literature citations which were true 35 years ago, but which are no longer applicable.

HISTORICAL BACKGROUND

According to the available records Mr. K. A. Ching, Pacific Chemical and Fertilizer Company, first noticed *C. suppressalis* in Hawaii during the fall of 1927 (Van Zwaluwenburg *et al.*, 1928). At that time the insect was known only on Oahu. Four years later Swezey and Van Zwaluwenburg found infestations in rice stubbles on Kauai at Waimea, Hanalei, Kapaa, Wailua, Nawiliwili, Huleia and Hanapepe. (Swezey and Van Zwaluwenburg, 1931). Aside from Oahu and Kauai this borer has never been reported from other islands. Judging from its distribution and extent of damage during 1927-1931 the establishment of *C. suppressalis* in Hawaii was not merely an incidental one. According to Van Zwaluwenburg *et al.* the damage was so great that some of the farmers on Oahu stopped growing rice (Van Zwaluwenburg *et al.*, 1928). It was also reported that in some of the areas of Honouliuli, Oahu the damage was so great that no rice was harvested.

The mode of entry of the borer into Hawaii is not known. It seems likely that this borer reached Hawaii in rice straw that was being used

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TABLE 1. *A list of parasites of C. suppressalis in Hawaii*

Species reported	Names in current use	Reference
<i>Apanteles</i> sp.	<i>Apanteles chilonis</i> (Munakata)	Van Zwaluwenburg <i>et al.</i> , 1928
<i>Amyosoma chilonis</i> Viereck	<i>Bracon chinensis</i> Szepligetii	" " " "
<i>Amyosoma</i> sp.	unknown	Williams, 1931
<i>Cremastus hymeniae</i> Viereck	<i>Trathala flavo-orbitalis</i> (Cameron)	Van Zwaluwenburg <i>et al.</i> , 1928
<i>Cremastus</i> sp.	unknown	" " " "
<i>Cremastidea chinensis</i> Viereck	<i>Temelucha biguttulus</i> (Matsumura)	Williams, 1931
<i>Centeterus alternicoloratus</i> Cushman	no change	" "
<i>Diocles chilonis</i> Cushman	<i>Eriborus sinicus</i> (Holmgren)	Fullaway, 1931
<i>Neotrichogramma japonicum</i> Ashmead	<i>Trichogramma japonicum</i> Ashmead	Swezey, 1929
<i>Nesopimpla narangae</i> Ashmead	<i>Itoplectis narangae</i> (Ashmead)	Fullaway, 1931
<i>Phanurus beneficiens</i> (Zentner)	<i>Telenomus dignus</i> Gahan	Van Zwaluwenburg <i>et al.</i> , 1928
<i>Trichogramma japonicum</i> Ashmead	no change	" " " "
<i>T. minutum</i> Riley	no change	" " " "

as packing material for fragile merchandise shipped from the Orient. Fullaway reported that the larvae of *C. suppressalis* were found at Honolulu docks in rice straw that was used for packing (Fullaway, 1929). The larvae were also found in rice straw that was used as packing material for persimmons shipped from Japan to Hawaii by mail. (Whitney, 1931). Because the larvae of *C. suppressalis* may be in diapause for periods as long as 5 to 6 months in rice straw they could have easily survived the long ocean voyages between the Orient and Hawaii.

Host plants: The records of the host plants of *C. suppressalis* in Hawaii deserve comment. Besides rice, *Oryza sativa* L., Kuwana (1929) listed the following host plants from the Orient: *Coix lacryma-jobi* Linn., *Panicum mileaceum* L. and *Zizania aquatica* var. *latifolia* (Turecz.) Komar. In Hawaii at least 8 plants have been reported as hosts of *C. suppressalis*. (Van Zwaluwenburg *et al.*, 1928, Van Zwaluwenburg *et al.* 1929). In the family Gramineae the following were listed: barnyard grass, *Echinochloa crusgalli* var. *cruspavonis* (H. B. K.); rice grass, *E. stagnina* (Retz.) Beauv.; goose grass, *Eleusine indica* (L.); foxtail, *Choetochloa verticillata* (L.); panicum grass, *Panicum barbinode* Trin. and Hilo grass, *Paspalum conjugatum* (Berg.). Other plants listed were: *Eclipta alba* (Hassak), family Compositae; and *Phaseolus lathyroides* L., family Leguminosae.

The question that arises is whether or not these host plants listed from Hawaii were true hosts, i.e., those on which the eggs were laid and in which the larvae developed. The present authors believe that the above mentioned plants were not true hosts. It has been observed that in Japan and other countries the larvae of *C. suppressalis* often crawled out of the rice straw at harvest time in the autumn and migrated onto other plants. They have been observed to bore into various plants other than rice during this period. Apparently workers in Hawaii were not aware of this habit of the larvae, which is related to the movement into overwintering sites.

Parasites: Shortly after the discovery of *C. suppressalis* in Hawaii attempts were made to control this borer by the introduction of natural enemies from China, Japan, and neighboring areas. The parasites introduced are listed in Table 1. According to Dr. C. E. Pemberton (*Personal communication* 1967) these parasites were released only on Oahu and Kauai because this borer was found only on these 2 islands.

CURRENT INVESTIGATIONS

During 1963-66 field studies were conducted on *C. suppressalis* in Hawaii. The studies were made initially to locate parasites so that some of the promising species could be sent to Japan. During the course of these studies, observations were made on nearly all of the areas in which rice was currently and formerly grown. These areas are shown in Fig. 2.

Rice paddies: The rice industry in Hawaii, which began about 1853, lasted about 100 years. From the export and acreage data it appears that

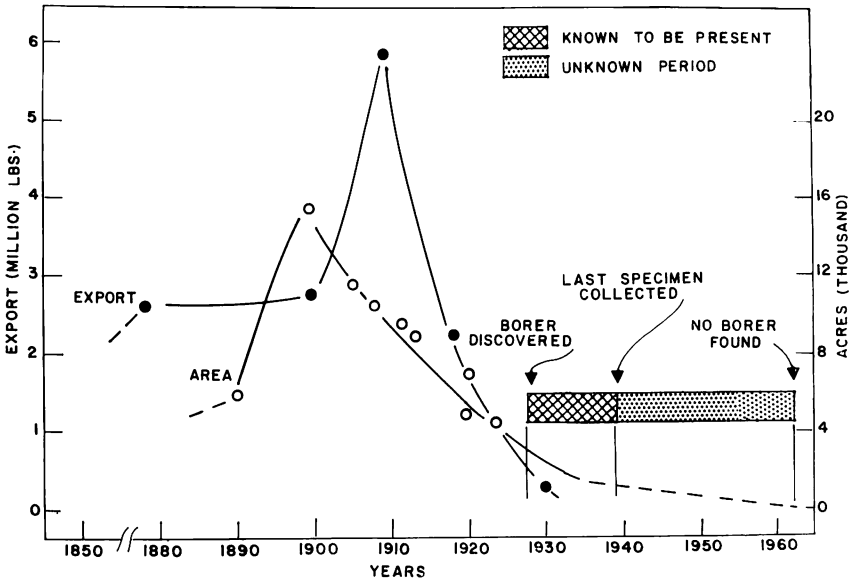


FIG. 1. The rise and fall of the Hawaiian rice industry and its relationship to *C. suppressalis* in Hawaii. Data on export from Thrum (1878); those on acreage, Iwai (1927).

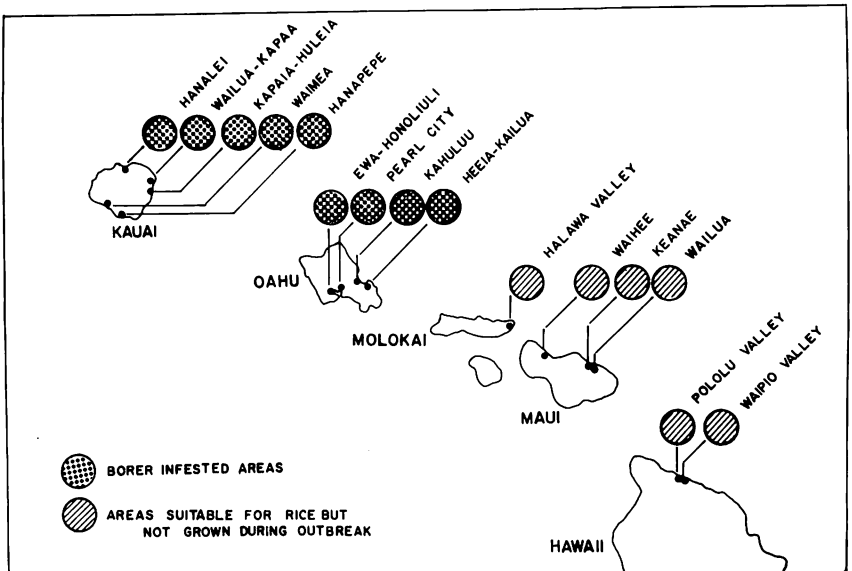


FIG. 2. Map of the Hawaiian Islands showing the rice areas where *C. suppressalis* was established. It also shows areas potentially suited for rice culture, but where rice was not grown on a large scale during the outbreak of *C. suppressalis*.

the industry reached its peak between 1900–1910. From then on there was a rapid decline. (Fig. 1). In 1962, the writers witnessed what might be considered the last rice paddy in Hawaii. This paddy was located at Waialua, Kauai where the Hawaii Agricultural Experiment Station, University of Hawaii, was growing a small area on an experimental basis. Since then the authors have not seen any rice grown in Hawaii.

Today only a few remnants of the paddies of the once flourishing rice industry remain; others have completely disappeared. The former rice lands are now variously utilized, viz., house lots, apartments, fruit orchards, vegetable farms and grazing paddocks. In some areas such as Ewa and Honouliuli, the former rice lands are used for sugar production. The poorly drained former rice lands in the remote valleys are not being utilized; they are covered by swamp vegetation.

Surveys on stem borer: Extensive surveys were conducted during 1963–66 to determine the present distribution of *C. suppressalis* in Hawaii. Sweepings by use of insect nets were made in the vegetation of former rice paddies. Light traps, commonly used in Japan, were also used as a means of determining the presence of *C. suppressalis*. We were not able to find any moths at all. The stems of rice and other grasses were carefully examined, but not a single larva was found.

The date of the discovery of *C. suppressalis* in Hawaii is known; however the time of its disappearance is not known. According to the insect collection at the Hawaiian Sugar Planters' Association and the State of Hawaii, Department of Agriculture, the last specimen of the moth was collected in 1939. There are no records of either collections or reports on *C. suppressalis* since 1939. Thus we know definitely that *C. suppressalis* was present in Hawaii during 1927–39. We also know that it disappeared sometime between 1939 and 1962.

Surveys on parasites: Simultaneously with the surveys on *C. suppressalis* efforts were made to determine whether or not the parasites introduced for the control of this borer were present in Hawaii. The areas surveyed were those areas in which *C. suppressalis* was known to be present as well as those areas that were suitable environments for rice culture. These areas are shown in Fig. 2.

During these surveys hymenopterous parasites of various Lepidoptera were obtained, however, not one of the parasites listed in Table 1 was observed. Some of the common parasites collected were *Chelonus texanus* (Cresson), *Apanteles trifasciatus* Muesebeck, *A. marginiventris* (Cresson), *Meteorus laphygmae* Viereck and *Opius fletcheri* Silvestri⁶. These were not parasites of *C. suppressalis*.

DISCUSSION

From the information obtained from the literature and field surveys

⁶Identifications by Professor C. Watanabe, Hokkaido University, Sapporo, Japan, are gratefully acknowledged.

it is possible to come to a few conclusions concerning *C. suppressalis* in Hawaii. It has been stated that *C. suppressalis* disappeared from Hawaii because of the cessation of rice culture. This statement is not true because rice was grown, albeit in small acreages, up to 1962. It has also been stated that *C. suppressalis* caused the downfall of the rice industry in Hawaii. This statement is also not true because, as shown in Fig. 1, *C. suppressalis* was discovered in Hawaii after the decline in rice production. What this insect did was perhaps hasten the death of the rice industry.

According to recent literature, *C. suppressalis* and its parasites are still present in Hawaii. The present authors conclude that while this statement was true thirty years ago, it is no longer true. It appears, however, that some of the parasites that were not specific to the borer may still be present. For example, Williams (1931) stated that *Nesopimpla narangae*, *Cremastus hymeniae* and *Trichogramma minutum* are also parasites of *Omioides blackburni* (Butl.) [= *Hedylepta blackburni* (Butler)] a moth whose larvae feed on the leaves of the coconut tree. Presumably these parasites are still present in Hawaii.

The cause of the extinction of *C. suppressalis* has not been established. It is speculated that this borer became extinct because it was not adapted to conditions of low rice production. It is known that during the years of high rice production in Hawaii 2 crops per year were grown. However, during the years of low production farmers tended to plant 1 crop per year. Under such conditions *C. suppressalis* was not able to perpetuate itself because the adults live for a few days, and the larvae do not undergo diapause under Hawaiian conditions. There was thus a break in its life cycle which caused the extinction of the borer.

The question of whether or not the plants reported in the literature were true hosts was mentioned in this paper. It was pointed out that the plants mentioned in the literature were not true hosts. If they were, *C. suppressalis* should still be Hawaii because these so called "host plants" are still in Hawaii.

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ADDENDUM

On October 31, 1968, almost a year after this manuscript was submitted for publication, Dr. F. Trujillo, Plant Pathologist, Kauai Branch Station, Hawaii Agricultural Experiment Station, noted rice infested with borers at Waialua, Kauai. Investigations made on the following day indicated that the borer was the Asiatic rice borer, *Chilo suppressalis* (Walker) The identification of the borer was subsequently confirmed by Drs. K. Yasumatsu and K. Yano, Kyushu University, Japan.

The discovery of this borer at this time raises some speculative questions. One of these is whether the current infestation resulted from the progeny of borers that were discovered in Kauai in 1929 or whether it resulted from the progeny of a new borer introduction. No definite answer is available; however, on the basis of the work reported in this paper and other observations, it appears that this is a new introduction.