Status of Insect Pests of Sugarcane in the Southwestern Islands of Japan

YOSHIAKI ITÔ

Okinawa Prefectural Agricultural Experiment Station

Since the introduction of sugarcane into the Southwestern Islands (Okinawa Prefecture and southern islands of Kagoshima Prefecture) about 300 years ago, some insects living on gramineous crops and weeds have adapted to attack this new crop, and others which were originally restricted in southern areas (especially Taiwan) have been introduced into these islands with sugarcane seedlings.

Following two features can be recognized of the insect pests of sugarcane in the Southwestern Island: (1) many of important pest species are suspected to be introduced pests, and (2) gradation-type outbreaks of soil-inhabiting insect pests have recently been noted in many parts of this area.

Introduced pests

Among nine species of important pests of sugarcane, which were described in 'Standard of Control Practice of Insect Pests for 1975 (Okinawa Ken),' the oriental chinch bug, *Cavelerius saccarivorus*, is known to be introduced from Taiwan in or some years before 1915. This species is now found on all parts of the Southwestern Islands. This is an only case where year of introduction was approximately estimated, but sugarcane leafhopper, *Perkinsiella saccharicida*, is also considered to be introduced from Taiwan in the biginning of this century. This species did not become a serious pest of sugarcane in Southwestern Islands as well as in Taiwan, probably due to effective parasites. Although direct evidence is lacking, there is a possibility that some other species such as a moth-borer, *Eucosma schistaceana*, sugarcane mealybug, *Saccharicoccus sacchari*, and wooly aphid, *Ceratovacuna lanigera* are also introduced pests. *Eucosma schistaceana* is found in the Southwestern Islands, Taiwan, The Philippines, Indonesia and some distant localities where sugarcane is growing. Sugarcane is an only host plant so far known for this species[1]. *Saccharicoccus sacchari* is also found in most of sugarcane growing areas, possibly due to introduction with cane seedlings.

Special remark must be made on a diaspine scale, *Aulacaspis takarai*, which is a serious pest of sugarcane in Miyako Jima (Miyako Is.) and adjuscent islets since 1960's. This species was discovered in Miyako Jima in 1961 being confused with another important pest of sugarcane in southern areas, *Aulacaspis tegalensis*. but described in 1965 as a new species. Takagi[10] described this species also from a bamboo, *Plioblastus linearis*, of Okinawa Hontô (the Island of Okinawa) but there is no report to date on the infestation of this species on sugarcane of Okinawa Hontô. As Azuma, Oshiro and Nema[2] failed to transplant this population to sugarcane despite more than ten thousand individuals were tested, it is highly possible that *A. takarai* of Okinawa Hontô is a distinct race from that of Miyako Jima. The author cannot deny a possibility that *A. takarai* (sugarcane race) was accidentally introduced from a southern area (e.g. Indonesia) into Miyako just after the War II, because Indonesia is the mother country of other two important *Aulacaspis* species which attack sugarcane; *A. tegalensis* and *A. madjunensis*, and there were frequent

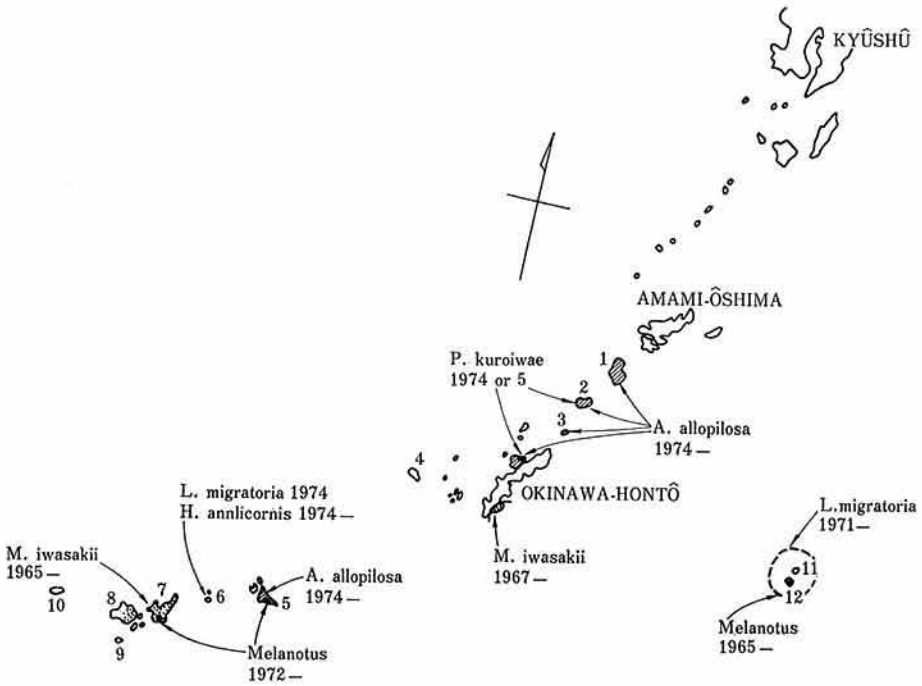


Fig. 1. Outbreaks of soil-inhabiting insect pests of sugarcane in Southwestern Islands.
1: Tokunoshima, 2: Oki-erabu Jima, 3: Yorontô, 4: Kume Jima. 5: Miyako Jima, 6: Tarama Jima, 7: Isigaki Jima, 8: Iriomote Jima, 9: Hateruma Jima, 10: Yonaguni Jima, 11: Kita-Daitô Jima, 12: Minami-Daitô Jima

immigrations of peoples from southern area to Miyako just after the war.

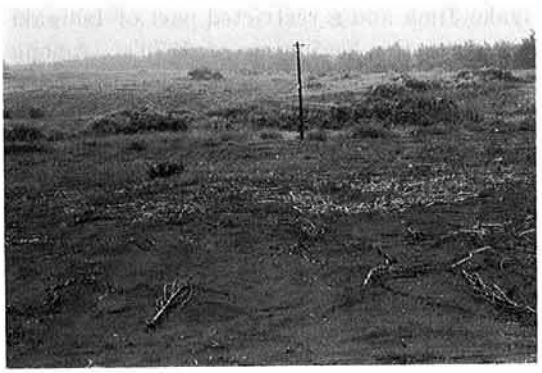
Gradation of soil-inhabiting insects

One of the notable features recently seen in sugarcane insect pests in the Southwestern Islands is the gradation-type outbreak of soil-inhabiting insect pests.

As shown in Fig. 1, outbreaks or severe injury of soil-inhabiting species have been known for 6 species and, at least, on 9 islands, when we include locust and grasshoppers to the soil-inhabiting insects as they lay eggs into soil. It is notable that, for all the species, when the population density once reached a high level, the high density has been maintained for a long time. The situation resembles to the 'Gradation' (a German ecological term) in forest defoliators, and then we call these the 'gradation-type outbreak.'

Population density of a wireworm, *Melanotus* sp. (*tamsyuensis*?) (Plate 1A) increased to a high level in the southern part of Minami-Daitô Jima (Southern Daitô Is.) since 1965. In the outbroken area, all the buds of sugarcane ratoons or seedlings were eaten and the sugarcane field became a barren land (see Plate 1B). This wireworm was known to be a pest of sugarcane in Okinawa Prefecture before the War II, but such a severe damage was not known so far. The outbreak is continuing till the present time and outbroken area is gradually expanding year by year. It must be noted that this outbreak began in 1965, before the prohibition of heptachlor use in 1972. Heptachlor was an effective control measure of this wireworm and a large amount of this had been used in Minami Daitô Jima. The author believe that this population became resistant to the heptachlor. Similar outbreak has also been known in the southern part of

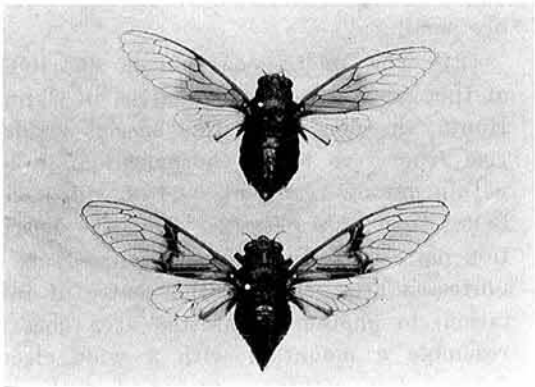
A



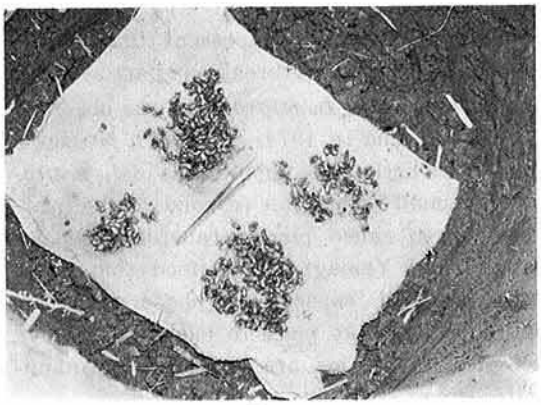
B

C

D



E



F

Plate 1. A: A larva of *Melanotus* sp. attacking sugarcane. B: Abandoned sugarcane fields due to severe damage by *Melanotus* sp. (1973, Minami-Daitô Jima). C: Group of 1st instar nymphs of *Locusta migratoria* phase *transiens* (June 1973, Minami-Daitô Jima). D: Mass-flight of *Locusta migratoria* phase *transiens* (December 1974, Kita-Daitô Jima). E: A male (top) and a female (bottom) of *Mogannia iwasakii*. F: Nymphs of *Mogannia iwasakii* found under a single stool of sugarcane (1973, Isigaki Jima).

Miyako Jima and a restricted part of Ishigaki Jima since the beginning of 1970's. Among chemicals we can use now, only DD and EDB were effective to control this species.

The locust, *Locusta migratoria*, several times invaded into the Southwestern Islands from the Philippines, but there was no case where the phase transformation took place in these islands before 1971. Solitary phase of this species is always seen in the Southwestern Islands but the density never reaches to such a level that leads serious injury. An unusual rise in the density of this locust was first noted in Minami-Daitô Jima (a small, flat, islet where sugarcane occupies more than 60% of land) in 1971. Marching of black-coloured nymphs (Plate 1C) and gregarious oviposition, both of which are features of the transient and gregarious phases, were observed in 1972 and 1973[8]. Swarming of a number of adults (possibly more than one hundred thousands) was observed in Kita-Daitô Jima (northern Daitô Is.) in December, 1974 (Plate 1D). Morphometric analysis confirmed the idea that the phase transformation from solitary phase to transient phase has taken place in Minami-Daitô Jima[6]. Epidemic status of *L. migratoria* in Minami- and Kita-Daitô Jima is continuing till the present time (1975). In addition, another outbreak and partial phase transformation of *L. migratoria* was observed in Tarama Jima in 1974. Although Uvarov[12] wondered whether the populations of *L. migratoria* in small island can respond to the overcrowding to cause phase transformation or not, Itô and Yamagishi[6] claimed that other outbreaks and consequent phase transformation should take place in islands, of which ecological situations are similar to Minami-Daitô Jima.

In Tarama Jima, a grasshopper, *Hieroglyphus annulicornis*, which was previously not so common in the Southwestern Islands, has also reached an epidemic level in recent years.

Outbreaks of a white grub, *Anomala allopilosa*, have been reported on five separated islands in 1974; Tokunoshima, Oki-erabu Jima, Yoron-tô, Motobu Peninsula of Okinawa Hontô, and Miyako Jima. The number of adult beetles caught by light traps in Miyako in 1974 and 1975 was ten times as many as those in 1970 to 1974, and the damage was so severe that even ratoon canes died almost completely in the centre of outbreak.

A biologically interesting phenomenon is the gradation of a cicada, *Mogannia iwasakii*, in sugarcane fields of Isigaki Jima, Miyako Jima and a restricted part of Okinawa Hontô (Plate 1E, F). Since the first discovery in 1907, this endemic cicada was known to inhabit *Miscanthus* grassland and nobody recognized this as a pest of sugarcane. But heavy infestation of this species to sugarcane was reported in Isigaki Jima since 1965 (Fig. 2F) and in Okinawa Hontô since 1967. The density of cicada is tremendously high, 200 to 400 adults emerge per 1 m^2, leaving more than 50,000 eggs.

Based on their ecological studies, Itô and Nagamine[4),5)] and Nagamine and Itô[9)] pointed out three features of the outbreak of this cicada:

(1) In this species, having once reached an epidemic situation, the unusually high density has lasted semi-permanently and the amplitude of population fluctuation is remarkably small.

(2) The micro-geographical distribution of this species is unique, that is, in Okinawa Hontô, the density of this species suddenly rise from zero to an enormously high level within narrow transient zone of which width is less than 1 km (Fig. 2). Thus the distribution pattern of density along a line from one unifested area, through the centre of infestation, to another uninfested area does not resemble a mountain with a wide circumference but rather a trapezoid with sides nearly vertical.

(3) Life table study showed that more than 95% of individuals are killed just after the egg hatch, mainly due to predation by ants. We considered that in the outbreak area, when the density once exceeded a threshold level, the population of this species could escape from any pressure of natural enemies,

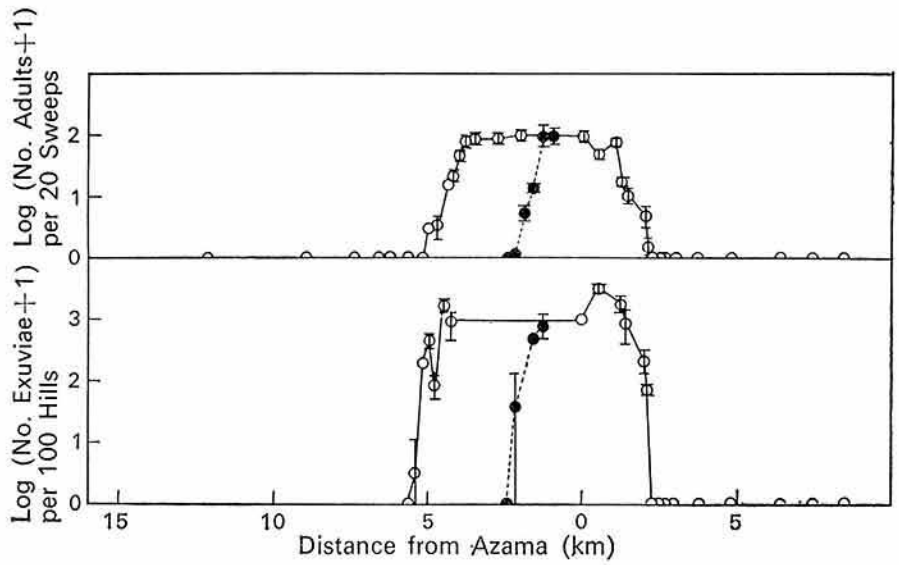


Fig. 2. Distribution of the numbers of adults and exuviae of *Mogannia iwasakii* along a sea-side road through the outbreak centre. Broken lines indicate a route other than the sea-side road. Vertical bars attached to the circles indicate the range of values (From Itô & Nagamine, 1974)

and, this resulted in a long-continued outbreak.

It is a curious fact that the population density of cicadas, which for a long time were unknown as sugarcane pests, has recently reached epidemic levels in sugarcane fields of several different localities. These are, *Yanga guttulata* in Madagascar (since 1962), *Cicadetta (Melampsarta) puer* (since 1962) and *Parnkalla muelleri* (since 1964) in Queensland, and *Mogannia hebets* in Taiwan (since 1962).

In 1975, we saw a number of adults of other cicada, *Platypleura kuroiwae* in sugarcane fields of Motobu Peninsula of Okinawa Hontô, Oki-erabu Jima and Tokunoshima. As *P. kuroiwae* is an inhabitant of pine wood, this outbreak which is believed to begin in 1974, is of course a strange phenomenon.

Destruction of natural enemies (especially of ants) due to over-use of organochlorine insecticides was considered to be a cause of the outbreak in Queensland[14] and Madagascar[3]. Dubois[3] also remarked that the increase of the number of ratooning is an important cause of the population increase, because ploughing results in 90 to 95% mortality of nymphs.

Cumulative amount of the organochlorine insecticides used in sugarcane fields of Okinawa Prefecture exceeded 730 kg/ha till 1972 when use of these chemicals was prohibited. This over-use might result in decrease of natural enemies, especially ants. The number of ratooning increased since the introduction of a new variety NCo 310 and sometimes reached more than 8 times. Nagamine and Itô[9] considered that either or both of these factors should be responsible for the outbreak of cicadas.

It is highly possible that these two factors should also be a major cause of outbreaks of other soil-inhabiting species. Having once reached an epidemic level, escape from the pressure of natural enemies may be responsible for the maintenance of the high population level for a long time.

The organochlorine insecticides are still being used in sugarcane fields of many countries, because there is no other effective insecticides to control soil insects and only a trace of these insecticides could be detected

in sugar. But this policy may not only result in further contamination of ecosystem but also lead danger to human health when the bagasse becomes to be used as a food of livestock. Other control measures such as the sex pheromone of wireworm[10] and pathogenes of cicada and wireworms[12], and the method to combine these with insecticides should be explored to control soil-inhabiting insects.

Island ecology

According to MacArthur and Wilson's[7] theoretical discussions on the relative simplicity and unstableness of island fauna, the richness of fauna is determined by the probability of immigration and extinction; the both being, in turn, functions of (1) area of island, (2) distance from the mainland, and (3) time. The younger, smaller, and/or farther the isalnd is, more simple fauna can be seen. This is the case of islands such as, Minami- and Kita-Daitô Jima, Tarama Jima, Oki-erabu Jima and Miyako Jima. It has been pointed out that there may be empty niches in such an island, which enable introduced animals to establish more easily than continent, to expand their habitat, and increase their numbers to an enourmously high level. This may be one of the causes of some of the strange phenomena reviewed in the previous sections.

The above mentioned features of the island fauna offer, on the other hand, good conditions for the biological control of insect pests by introduction of natural enemies. In this respect, it is notabe that the introduction of Japanese weasel, *Mustela itatsi*, to control rats and mice in sugarcane fields succeeded only in small islets, such as Minami-Daitô Jima and Hateruma Jima, but failed in a larger island such as Isigaki Jima.

Cavelerius saccharivorus is attacked by two parasites, *Phanurus blissae* and *Phanurus* sp., in Taiwan where the density is low, but the latter parasite is not found in the Southwestern Islands. *Ceratovacuna lanigera* has some parasites in Indonesia but no parasite is so far found in this area. Introduction of parasites of these two species is worth to be attempted. Introduction of parasites or predators against *Aulacaspis takarai* is also worth to be attempted, because this species is suspected to be an introduced pest. In addition, there is a possibility that some islands lack some of natural enemies of sugarcane pests which are seen in other islands. In this case, exchange of natural enemies within Southwestern Islands is promissing. Detailed survey on the natural enemy fauna in all the islands where sugarcane is growing is needed.

References

1) Azuma, S. & Oshiro, A.: Studies on the insect pests of sugarcane in the Ryukyu Islands. (5) On the gray sugar cane borer, *Tetramoera schistaceana* Smelen. *Bull. Ryukyu Agric. Exp. Sta.*, No. 5, 51–74 (1969) [In Japanese].
2) Azuma, S., Oshiro, A. & Nema, T.: Studies on the insect pests of sugarcane in the Ryukyu Islands. (7) On the sugar cane white scale, *Aulacaspis takarai* Takagi. *Bull. Ryukyu Agr. Exp. Sta.* No. 6, 29–41 (1971) [In Japanese].
3) Dubois, J:. Influence de certaines modifications récentes dans la culture de la canne a sucre sur l'évolution des populations de la cigale *Yanga guttulata Sign. L'Agronomie Tropicale*, Nos. 6–7, 786-821.
4) Itô, Y. & Nagamine, M.: Distribution of infestations of a sugar cane cicada, *Mogannia iwasakii* Matsumura (Hemiptera: Cicadidae) in Okinawa Island with a discussion on the cause of outbreak. *Appl. Ent. Zool.*, 9, 58–64 1974).
5) Itô, Y. & Nagamine, M.: Population dynamics of a sugarcane cicada *Mogannia iwasakii* Matsumura in Okinawa Island. Proc. XV Congr. Int. Soc. Sugarcane Technol., 1, 468–474 (1974).
6) Itô, Y. & Yamagishi, M.: Outbreaks and partial phase transformation of *Locusta migratoria* in sugarcane fields of Minami- and Kita-Daito Zima, Okinawa. *Acrida* (In press).
7) MacArthur, R. H. & Wilson, E. O.: The Theory of Island Biogeography. Princeton Univ. Press, 203 pp.
8) Nakamori, H. & Itô, Y.: Occurrence of *Locusta migratoria* phase *transiens* in Minami-Daito Island. *Jap. J. appl. Ent. Zool.*, 18, 5–8 (1974) [In Japanese with English

summary].
9) Nagamine, M. & Itô, Y.: A life table of *Mogannia iwasakii* (Homoptera: Cicadiidae) in sugarcane field of Okinawa. *Res. Popul. Ecol.* 17, 99–110 (1975).
10) Onsager, J. A., McDonough, L. M. & George, D. A.: A sex pheromone in the Pacific coast wireworm. *J. Econ. Ent.*, **61**, 691–693 (1968).
11) Takagi, S.: On the scale insects of genus *Aulacaspis* from Ryukyu (Homoptera: Coccoidea). *Kontyu*, **33**, 39–41 (1965).
12) Uvarov, B. P.: Grasshoppers and Locusts: A Handbook of General Acridology. I. 481 pp. Cambridge Univ. Press, London (1966).
13) Wang, Z. N. & Leu, L. S.: Entomogenous fungi on sugarcane pests in Taiwan. *Proc. XV Congr. Int. Soc. Sugarcane Technol.*, 1, 428–433.
14) Wilson, G.: Cicadas as pest of sugarcane in Queensland. Proc. XIII Congr. Int. Soc. Sugarcane Technol., 1410–1415 (1969).