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Symposium on

The Major Insect Pests of the Rice Plant

Proceedings of a Symposium at
The International Rice Research Institute
September, 1964

Published for THE INTERNATIONAL RICE RESEARCH INSTITUTE
By THE JOHNS HOPKINS PRESS, Baltimore, Maryland

Printed in the United States of America
Library of Congress Catalogue Card No. 65-27673

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Insect Pests of Rice in Malaysia[1]

Part I
Malayan Region

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In Malaya, 159 species of insects have been recorded on rice (Table 33–1). Of these, 12 are pests of considerable importance. A number of other insect species, such as grasshoppers, beetles, and flies also cause damage to the crop, but this usually is negligible compared with that caused by the three categories outlined below.

LEPIDOPTEROUS PADDY STEM BORERS

Five species occur in Malaya: (*a*) *Tryporyza incertulas* Walker, (*b*) *Tryporyza dodatellus* Walker, (*c*) *Chilotraea polychrysa* Meyrick, (*d*) *Chilo suppressalis* Walker, family *Pyralidae*, and (*e*) *Sesamia inferens* Walker, family *Noctuidae*. All except *S. dodatellus* are considered important.

The first species is the yellow stem borer *Tryporyza incertulas*, previously referred to either as *T. bipunctifer* or *T. incertellus* Walker. The eggs, covered with scales from the female moth body, are almost always laid on the upper leaf surface. The complete life cycle takes about six weeks, of which about three are spent in the larval stage. No alternative host plants have so far been recorded for this species.

The second economic species, *Chilotraea polychrysa*, was until recently referred to as *Proceras polychrysa* Meyrick, *Diatraea polychrysa* Meyrick, and *D. auricilia* Dudgeon, in that order. The caterpillar is a dark-headed striped borer with greyish-lilac stripes and is easily distinguishable from the pale-headed rice borer (*Chilo*) with brown stripes. *C. polychrysa* is one of the most serious rice pests in Malaya. Its larvae have been reared from the sedges *Scirpus grossus* and *Cyperus digitatus* and from grasses recorded by Pagden (1932), for example, *Oryza latifolia*, now called *O. minuta*, and *Setaria rubiginosa*, now *S. pallide-fusca*. It also was reared in 1930 from *Panicum amplexicaule*, or *Hymenachne myuros*, now *Hymenachne pseudointerrupta*.

The third pyralid, *Chilo suppressalis*, was previously recorded as *C. simplex* Hampson. This species was not separated for many years from *Chilotraea*, which it resembles.

The last rice stem borer species is the noctuid (subfamily *Agrotinae*) *Sesamia inferens*, a much more robust moth than any of the

[1] This review excludes Singapore, where no rice has ever been grown, and Sabah, where no detailed work on rice pests has, so far, been carried out.

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previously mentioned species. It is popularly called the violet stem borer. A characteristic blue powdering is present on the anterior end of the pupa. As in *Chilo*, the larva develops in about four weeks and the life cycle takes about seven weeks. Generally, it is not as important as the other rice stem borers, but it can cause serious damage. The injury is confined to the leaf sheaths and stems, so that white ear heads are seldom caused. *Sesamia* has a wide range of host plants. It is frequently found in sugar cane and maize, in the sedges *Scirpus grossus* and *Cyperus digitatus*, and in a large number of grasses.

In Malaya, unlike some other countries, there are no periodic emergences of moths from which outbreaks can be forecast, because all stages of borers are present simultaneously throughout the year.

LEAF-EATING CATERPILLARS

Included in this group are three species generally distributed throughout the rice-growing areas of the country: (*a*) *Spodoptera mauritia* Boisduval, (*b*) *Cnaphalocrocis* medinalis Guenée, and (*c*) *Nymphula depunctalis* Guenée.

These caterpillars injure plants either by direct consumption of the leaves, or, after cutting and folding or rolling the leaves, by eating the tissue.

Armyworms

Spodoptera mauritia Boisduval is the worst of the swarming caterpillars attacking paddy in the nursery. The species can cause severe damage as they migrate from field to field, and frequently they are not noticed in the early stages when the leaf tips are only scraped before the leaf blade is consumed. In the field it may be a pest of dry paddy.

S. mauritia has been bred from paddy, but the closely related *S. pecten* Guenée, which is a minor pest, occurs on *Paspalum scrobiculatum* and maize.

It is of interest that while the armyworm *Leucania unipuncta* Haworth (formerly *Cirphis*) can be a serious pest on *Pennisetum purpureum* and *Axonopus compressus* in Malaya, it has never been recorded here as a paddy pest.

Leaf-rolling and Leaf-tying Caterpillars

Damage to half-grown paddy is reported fairly regularly in the form of folded edges of leaves accompanied by a loss of tissue fed on by the larvae of *Cnaphalocrocis medinalis.* Damage may become severe if neglected. It can sometimes be checked early by hand picking the rolled leaves.

Another leaf-eating lepidopterous pest of paddy is the leaf-roller *Nymphula depunctalis.* This species crawls up the plant, cuts off portions of the leaves, and folds them into cases, in which it shelters itself while feeding. No parasites have been recorded.

SUCKING HEMIPTEROUS BUGS

Two main types occur: the larger, unequally winged *Heteroptera*, which feed either at the base of stems or on developing grains, and the much smaller, equally winged *Homoptera*, or planthoppers, which may occur in large numbers. The species are: (*a*) *Leptocorisa acuta* Thunberg, (*b*) *Scotinophara coarctata* Fabricius, *Heteroptera*; (*c*) *Sogata furcifera* Horvath, (*d*) *Nephotettix bipunctatus* Fabricius, *Homoptera.*

Heteroptera

Leptocorisa acuta is known locally as the green paddy bug. It migrates from various wild grasses to feed on paddy at the milk stage, resulting in empty or partly empty grains. Complete details concerning this insect appear in a bulletin by Corbett (1930).

Although four other species of *Leptocorisa* (*L. varicornis* Fabricius, *L. costalis* Herrich-Schaffer, *L. corbetti* China, and *L. lepida* Boisduval) occur in Malaya, practically all the damage is done by *L. acuta.*

The second species is the shield bug *Scotinophara coarctata*, the black paddy bug which feeds chiefly at the base of stems and severely injures the panicle. It causes stunted plant growth and the leaves turn reddish-brown. When present in large numbers, it sometimes kills the plants. During a drought, this species shelters itself in cracks in the soil. Details of its habits, as published by Corbett and Yusope (1924), show that its life cycle takes 32 days. The sedges *Scirpus grossus* and *Scleria sumatrensis* and the grass *Hymenachne pseudointerrupta* (formerly *Hymenachne myuros* or *Panicum amplexicaule*) are its other host plants.

Two other species, *S. bispinosa* Fabricius and *S. cinerea* Le Guillou, also occur on paddy, but cause only slight damage compared with *S. coarctata.*

Homoptera

The delphacid *Sogata furcifera*, formerly referred to as *S. pallescens* Distant, is a small, grey planthopper often present in enormous numbers on paddy plants. It sucks the sap from the stem just above water level. In the morning, it feeds on higher plant parts. Severe attack results in a well-defined yellowing of the leaves, not to be confused with the reddish coloring, a condition known locally as *penyakit merah* (red disease), which often occurs in the absence of planthoppers. This species also occurs on the grass *Digitaria didactyla. Sogata* has been reported to cause severe damage in areas where the water is stagnant. It has never been observed in dry areas (Miller and Pagden, 1930).

The jassid *Nephotettix bipunctatus* is a smaller planthopper with green wings tipped with black. It does not seem to depend as much on wet conditions as *Sogata.*

General

So far, insect pest infestation of rice in Malaya has seldom resulted in complete crop loss. However, substantial yield losses have occurred.

For example, in the Krian district of north Malaya, of which about 60,000 acres are under wet paddy annually, the rice stem borers caused "from 26–70 per cent loss of yield on experimental sites and probably a third of the over-all yield of Krian was lost due to their depredations" (Wyatt, 1957). The average yield per acre of wet paddy in Krian between 1951 and 1956 was 283 *gantangs*, or 1,776 kg/ha (Wilson, 1958). This means that the potential yield from an undamaged crop would be about 400 *gantangs* per acre, or 2,510 kg/ha, a yield comparable to 391 *gantangs* per acre (Wilson, 1958) over the same period for the state of Kedah, where the crop was relatively free from rice stem borer infestation. Assuming this order of crop loss, the total loss for the entire Krian district would be 18,000 tons of paddy annually.

This paper excludes detailed descriptions of the species listed above, because these are also found elsewhere in southeast Asia and are familiar to other entomologists.

WORK ON THE RICE STEM BORERS

The importance of the rice stem borer as a pest in Malaya has long been recognized. The earliest recorded work was by Pagden (1930), who studied three species of rice stem borers, namely, *Diatraea auricilia* Dudgeon (now *Chilotraea polychrysa*), *Tryporyza incertellus* Walker (now *T. incertulas*), and *Sesamia inferens* Walker. He described the life histories of the species, their alternative host plants, their natural enemies, and methods of controlling them.

Pagden recorded five parasites attacking *C. polychrysa*–three hymenoptera from the ovae, a braconid from the larvae, and a chalcidoid from the pupae. On *Tryporyza* species, two egg parasites were recorded, while no egg parasite was found on *Sesamia* species. *Trichogramma minutum* Riley was the most common of the rice stem borer parasites. Pagden (1930) considered biological control to be the only method likely to succeed, because paddy farmers in Malaya at that time would not readily adopt the cultural control methods advocated and carried out in other countries. In 1931–32, attempts were made to control rice stem borers by mass producing the egg parasite *Trichogramma minutum*. Although millions of the parasite were bred, and about 1.3 million parasites per acre were liberated, mass production of the egg parasites was not an economical or practical method (Pagden, 1932).

Besides paddy, the following alternative host plants of rice stem borers were recorded: *Echinochloa colona* Link., *Eleusine indica* Gaertn., *Eriochloa annulata* Kunth., *Hymenachne myuros* Beauv., *Ischaemum timorense* Kunth., *Oryza latifolia* Desv., *Panicum auritum* Presl., *Panicum repens* L., *Paspalum orbiculare* Forst., *Paspalum punctatum* Burm., *Saccharum officinarum* L., *Sacciolepis myosuroides* Ridley., *Scirpus grossus* L., *Setaria rubiginosa* Miq., *Vetiveria odorata* Virey., and *Zea mays* L.

Light traps were also used by Pagden (1932) to determine whether they would effectively control the pests and to get information on the fluctuations in adult borer populations.

The introduction of tachinid flies from South America, which was begun in 1939, was interrupted by World War II and was resumed only in 1951 when trial shipments of *Paratheresia claripalpis* van der Wulp pupae were started from Trinidad. It was then found possible to rear the maggots of this parasite on *Chilotraea polychrysa* and *Chilo suppressalis* larvae. Of the total puparia, 70 per cent, totalling 8,187 flies, were released in 1952. Small numbers of another Neotropical tachinid fly, *Metagonistylum minense* Townsend, had been sent in 1951, but this insect proved delicate and the experiment failed. A search of the double-cropping area in Province Wellesley, where the *Paratheresia* adults were released, failed to recover any tachinid flies (Lever, 1956).

The appearance of synthetic insecticides in Malaya in post-war years led to investigations on chemical pest control. Wyatt (1956, 1957) conducted experiments in pots as well as in the field. The pot experiments were designed to answer the following questions:

1. Can insecticides be used at economic rates to control rice stem borers under Malayan conditions?
2. Is there an optimum time for treatment?
3. Is there any advantage in more than one application?
4. Which is the most suitable insecticide?
5. Is it possible, by continuous insecticide protection of the plants, to produce borer-free paddy and thereby determine the economic losses caused by borers and the possible natural compensation for these losses by induced tillering?

Three insecticides—EPN 300, endrin, and dieldrin—were used in the experiment. The first two are restricted by law for general use in Malaya because of their high mammalian toxicity. All three insecticides were found to be about equally effective in reducing borer numbers, but dieldrin was preferred for its low toxicity to man and other vertebrates. The paddy variety used in the experiment was the short-term variety Pebifun, the maturity period of which is about 120 days.

Wyatt (1956) found the marked optimum spraying time to be about six weeks after transplanting. Spraying at seven weeks was almost as good; spraying at five weeks was distinctly less effective. At four weeks, the treatment was definitely too early, and the borers did considerable damage, because the residual effects of the insecticide disappeared before the paddy was sturdy enough to resist attack. Treatment at eight weeks was too late, for by this time, the borers had already attacked most of the tillers. It appeared that this heavy attack initiated late tillering, and since the treatment at eight weeks arrested the damage, the tillers were able to develop to produce new leaves and increase the number of late ears. In the control, however, where the borers suffered no setback, extra tillers were produced, only to be attacked immediately and prevented from earing.

Figure 33-1 shows the percentage of bored tillers at 10 weeks. It shows that spraying at 6 weeks produced the least percentage of bored tillers.

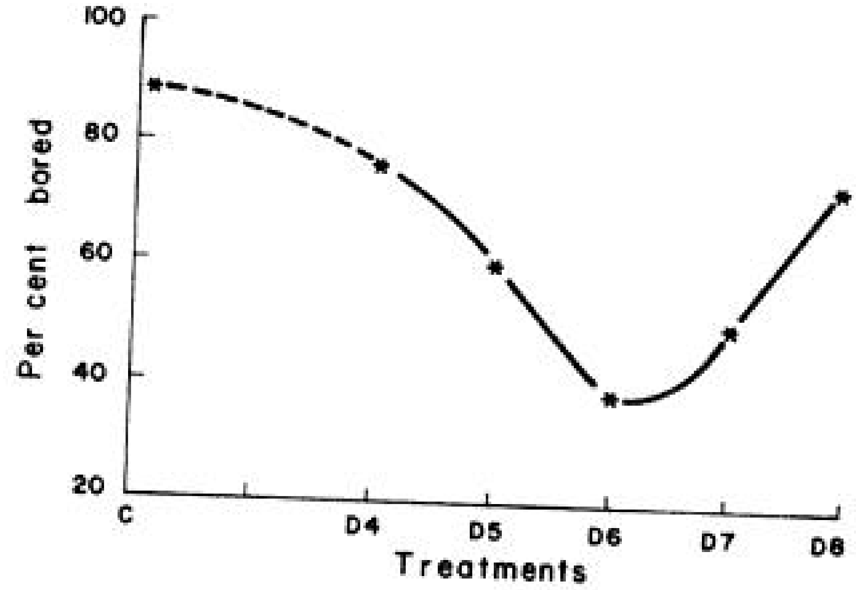


Fig. 33–1: Percentage of tillers bored at 10 weeks. Key: C, Control, not treated with insecticide; D4, Sprayed with dieldrin four weeks after transplanting; D5, Sprayed with dieldrin five weeks after transplanting; D6, Sprayed with dieldrin six weeks after transplanting; D7, Sprayed with dieldrin seven weeks after transplanting; D8, Sprayed with dieldrin eight weeks after transplanting.

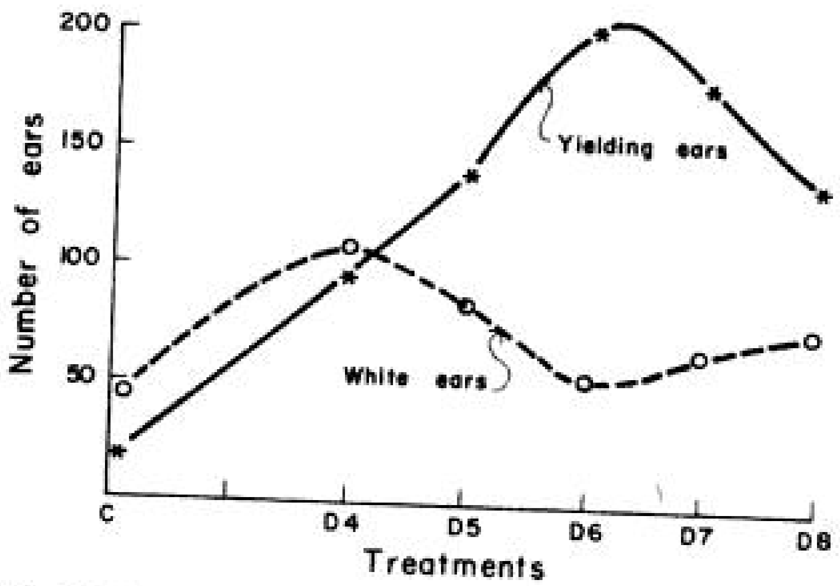


Fig. 33–2: Yield and white ears at harvest. (See key in Fig. 33–1.)

Figure 33–2 shows the number of yielding ears at harvest. The resulting curve is clearly an inversion of Figure 33–1, with D6 (treatment with dieldrin at six weeks after transplanting) again as the outstanding treatment.

The number of white ears appears to be directly related to the number of borers, except in the control, where earing was almost completely suppressed.

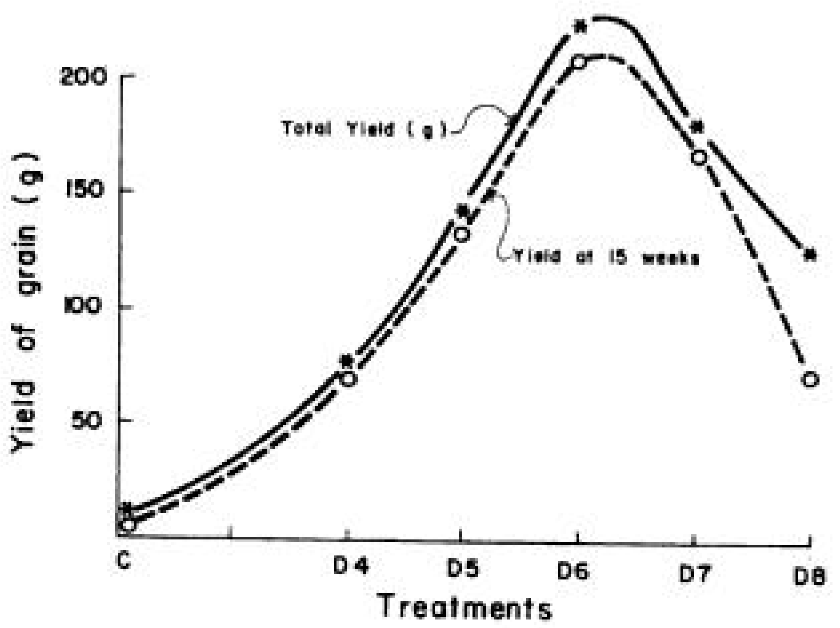
A curve similar to that in Figure 33–2 was obtained by plotting the total grain yield (Fig. 33–3). Here the peak is even more marked at six weeks, yields falling away rapidly if the plants were sprayed before or after that date. The graph also illustrates the recovery made by the paddy in D8 by its late production of ears.

Wyatt (1956) further found that the paddy plants were most vulnerable to borer attack just before ear emergence; only the unbored tillers at this time produced ears. Later attacks usually damaged the flowering stems directly and produced only white ears.

In field investigations, Wyatt (1957) sought answers to the following problems:

1. Can rice stem borers be controlled in the field with insecticides, and, as in the pot experiments, is there a marked optimum time for treatment?
2. Which is the most suitable insecticide?
3. What economic losses do rice stem borers cause and how is this loss related to intensity of attack?
4. Is there any appreciable compensation for loss due to induced tillering?
5. How do rice stem borers exist through the off season? Do they live in grasses, sedges, or volunteer paddy?
6. Are there enough rice stem borers persisting through the off season to start an initial high infestation in newly planted paddy, or does the population have to build up through the paddy season?
7. Is the distribution of borers in an area influenced by environmental conditions such as type of off-season growth, water depth, soil fertility, proximity to roads, canals, villages, and so on?

According to Wyatt (1957), rice stem borers caused crop loss by killing the tillers, preventing the emergence of ears, causing the production of empty ears, or reducing the size of ears. Greatest crop loss resulted when ear formation was prevented. Consequently, the period before flowering seemed the most crucial. Tillers bored at this stage generally failed to produce ears, and this resulted in yield loss. Rice stem borer attack after flowering also produced a small proportion of empty ears, but, apart from that, little harm seemed to result, although a high infestation built up by harvest time.



Wyatt (1957) suggested that insecticide treatments against rice stem borers be given at the most vulnerable stage of the paddy plant, that is, just before flowering, and not necessarily when the borers are most abundant. Since the larvae are protected within the stem for about three weeks, guarding against attack in the most crucial plant stage by spraying at least a month before flowering with an effective insecticide was considered essential. This suggestion was fully substantiated by the results of his investigations. In one experiment, spraying a month before flowering gave the best yield increases; in another, spraying seven weeks before flowering doubled the yield. One experiment failed completely because spraying was delayed too long.

If the applications are well timed, spraying with insecticides could provide economic returns, as shown by Wyatt (1957).

Calculated on the basis of the samples, the maximum possible yield in the absence of rice stem borers would have been about 773 *gantangs* per acre. The control plots, partly protected from infestation, being surrounded by treated plots, produced only 229 *gantangs* per acre. This indicated a loss due to borers of about 70 per cent of the yield. In the surrounding area, the loss was probably greater.

A single application of dieldrin at the rate of one-half pound per acre cost approximately $7 (U.S.) per acre, including an allowance for the sprayer. But it resulted in a yield of 450 *gantangs* per acre—an increase of 221 *gantangs*, valued at $111.50. Thus, the application of dieldrin doubled the crop and gave a sixteenfold return on the original investment.

Wyatt's (1957) work also revealed that during the off season, sufficient paddy continued to grow in the field to keep a small population of rice stem borers alive, and although a few borers might have been living in the larger grasses and sedges, these were considered relatively unimportant. Although the rice stem borer population at the time the main paddy crop was planted was small, it increased rapidly throughout the growing season until, by harvest, the majority of the paddy stems had been bored. Contrary to popular belief, Wyatt (1957) found that stem borers preferred more vigorously growing paddy in which they generally were unnoticed.

Koyama (1958–59) studied in detail the reproductive habits and the development of feeding habits, population fluctuations, and chemical control of *Chilotraea polychrysa* in the field. Some salient points on the reproductive habits and development of *C. polychrysa* are outlined below.

1. Mating usually takes place during the day when moths emerge from their pupal cases, and the female moth oviposits for one or two nights starting on the night of its emergence. She lays an average of 300 eggs in about four egg clusters during her lifetime.

2. Under Malayan climatic conditions, the incubation period is about five days, and maximum hatching takes place between 9 and 10 A.M. The newly hatched larvae crawl into the inner parts of the leaf sheaths, where they feed and remain for a few days. After growing into the third- or fourth-instar larvae, they proceed to their final feeding position. Altogether, there are six larval instars, and the larval period is between 20 and 30 days.

3. The pupation period is about a week.

The total life cycle is between 31 and 42 days. This suggests that between 8 and 12 generations of rice stem borers may occur each year. After harvest, the pest migrates to fresh tillers of volunteer paddy or to other host plants.

The seasonal fluctuation of the pest population in the field was determined with light traps. Five peaks occurred at about monthly intervals, from October to February, a period when the host plant was in the field. Larvae following the second peak (November) caused the most extensive damage to the crop. This period corresponded with the flowering stage of the host plant. Treatment with insecticide four weeks before this stage would, therefore, be appropriate. This agrees with the finding of Wyatt (1957).

Koyama (1958-59) stated that newly hatched larvae feed on the inner parts of the leaf sheaths. The second- or third-instar larvae start boring into the stems. The fourth-instar larvae feed on the center of the lower part of the stems, while mature larvae feed on the internodes, the inner parts of the stems, and the growing points.

In investigations on the chemical control of the pest, Koyama used three insecticides, BHC, dipterex, and dieldrin. The ovicidal effects of the three insecticides are as follows:

1. Dieldrin causes almost 100 per cent mortality in newly laid egg clusters and 16 per cent mortality in clusters up to two days old. Older clusters apparently are unaffected.
2. BHC causes about 56 per cent mortality in newly laid egg clusters and about 50 per cent mortality in eggs at different stages of incubation.
3. Dipterex causes about 53 per cent mortality in newly laid egg clusters and about 25 per cent mortality in older egg clusters.

Koyama (1958-59) concluded that BHC was superior as an ovicide against rice stem borers. In field trials, he found that treatment a month before flowering caused a high degree of larval mortality, whereas treatment at later stages caused less than 50 per cent mortality. In these trials, BHC and dieldrin proved superior to dipterex.

Kimura (1959-60) conducted further experiments on the chemical control of rice stem borers to determine (*a*) whether power sprayers are suitable for use in the chemical control of borers, (*b*) the optimum number of treatments necessary to control the pests, and (*c*) the expenses involved in controlling the pest by insecticides. Kimura used two types of sprayers, the power sprayer and the knapsack hand sprayer. He found that although the power sprayer gave a wide spray coverage, it merely deposited insecticides on the leaves and upper parts of the plant. The knapsack hand sprayer, on the other hand, had a narrow spray coverage, but with skillful maneuvering it could deposit insecticides on the entire plant. In field applications, however, the knapsack hand sprayer presented problems, because the planting distance was about 12 inches by 12 inches, and when half-grown or advanced in age, the crop was tall and bushy. These factors made the passage of the insecticide through the crop difficult.

In actual field applications, Kimura (1959-60) found that the two types of sprayers differed only slightly in effectiveness. They were equally effective in killing pests about 14 inches above the water level or higher. A single insecticide application was insufficient to control the pest and increase yield. Two applications, one applied three weeks before flowering and the other, two weeks before flowering, were effective and increased yield. Three treatments, applied three weeks before flowering, one week before flowering, and one week after flowering, significantly increased yield.

An increase in yield of 80 *gantangs* per acre was obtained in plots given two applications of dipterex 50 per cent emulsion at 400 g active ingredient per acre, using a power sprayer. The treatment (insecticides, labor, and so on) cost $25 (U.S.). Since the market price of paddy was 62 cents per *gantang*, $24.60 was saved.

Kawase (1960–62) further investigated the control of rice stem borers in Malaya. He conducted surveys of the pest population in the Krian district and reported that *Tryporyza incertulas* began to build up its population in early November, reaching its maximum population by mid-December. *Chilotraea polychrysa* reached its maximum population in mid-January, and *Sesamia inferens* showed an increase in population toward harvest time, in February or March. However, its number was comparatively insignificant when compared with that of the two other species.

Kawase (1960–62) used dipterex, folidol, endrin, BHC (of several formulations), sevin, rogor, lebaycid, and dieldrin in insecticide trials. Under Malayan climatic conditions, insecticides of the chlorinated hydrocarbon group were more persistent than those of the organophosphorus group. However, the results obtained by Kawase of the comparative merits of the insecticides in controlling the pest were inconclusive.

As mentioned earlier, studies in Malaya on the fluctuation of the rice stem borer population by means of light traps have been made since 1930 (Pagden, 1930). This work, however, has not been continuous. Since 1958, several traps have been in operation, and the results for one of the traps is given in Figure 33–4.

STUDIES ON INSECT PESTS OF RICE OTHER THAN THE STEM BORERS IN MALAYA

All the work done in Malaya on insect pests of rice other than the stem borers was conducted in the prewar years. Only a brief reference to it is made in this review.

Leptocorisa *Species*

The earliest work on *Leptocorisa* was conducted by Corbett (1923). It dealt with the insect's life cycle and its various host plants. Corbett (1930) later studied the bionomics of *L. acuta* and investigated methods of controlling this pest. This work describes the species in detail and provides excellent reference material.

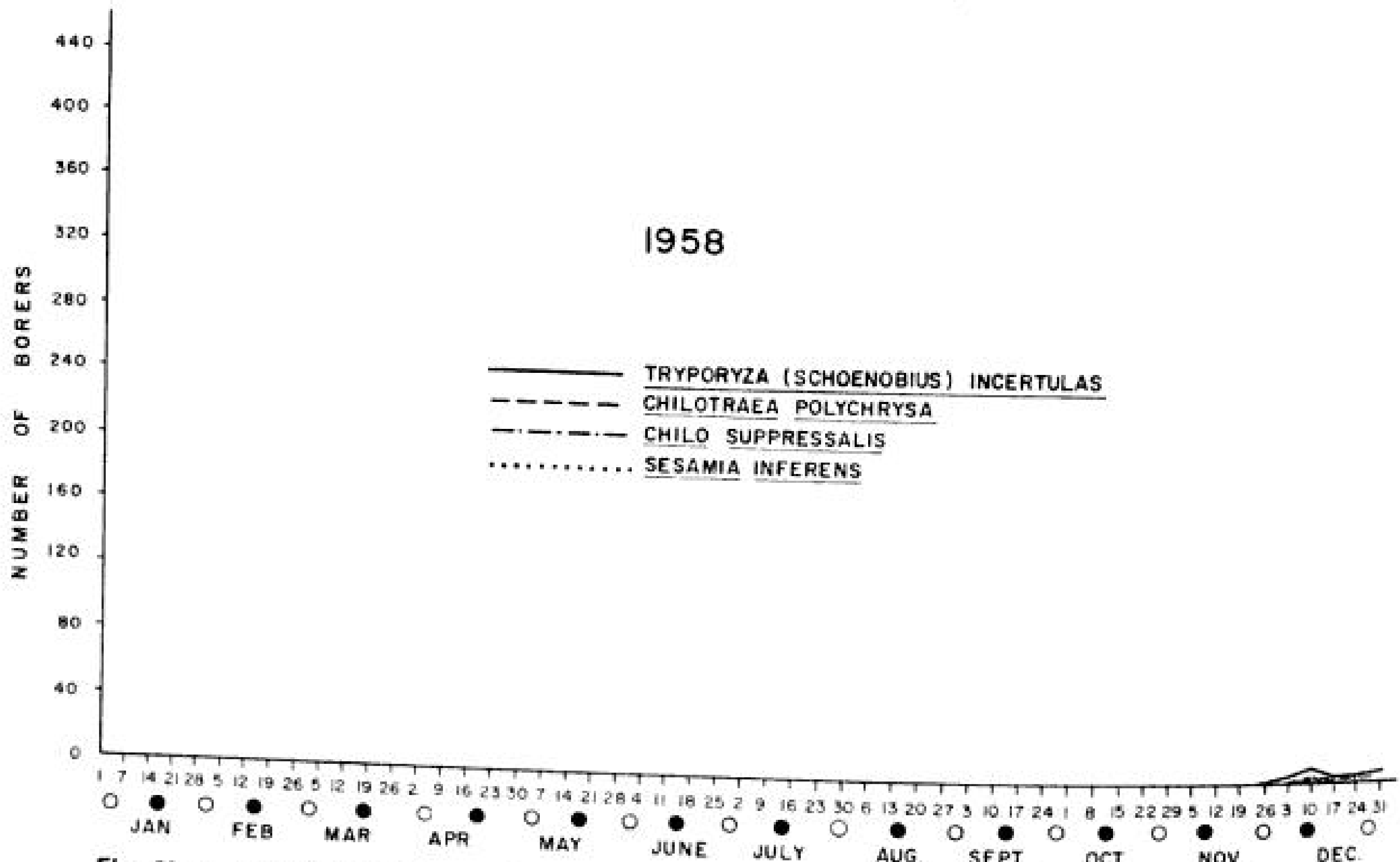
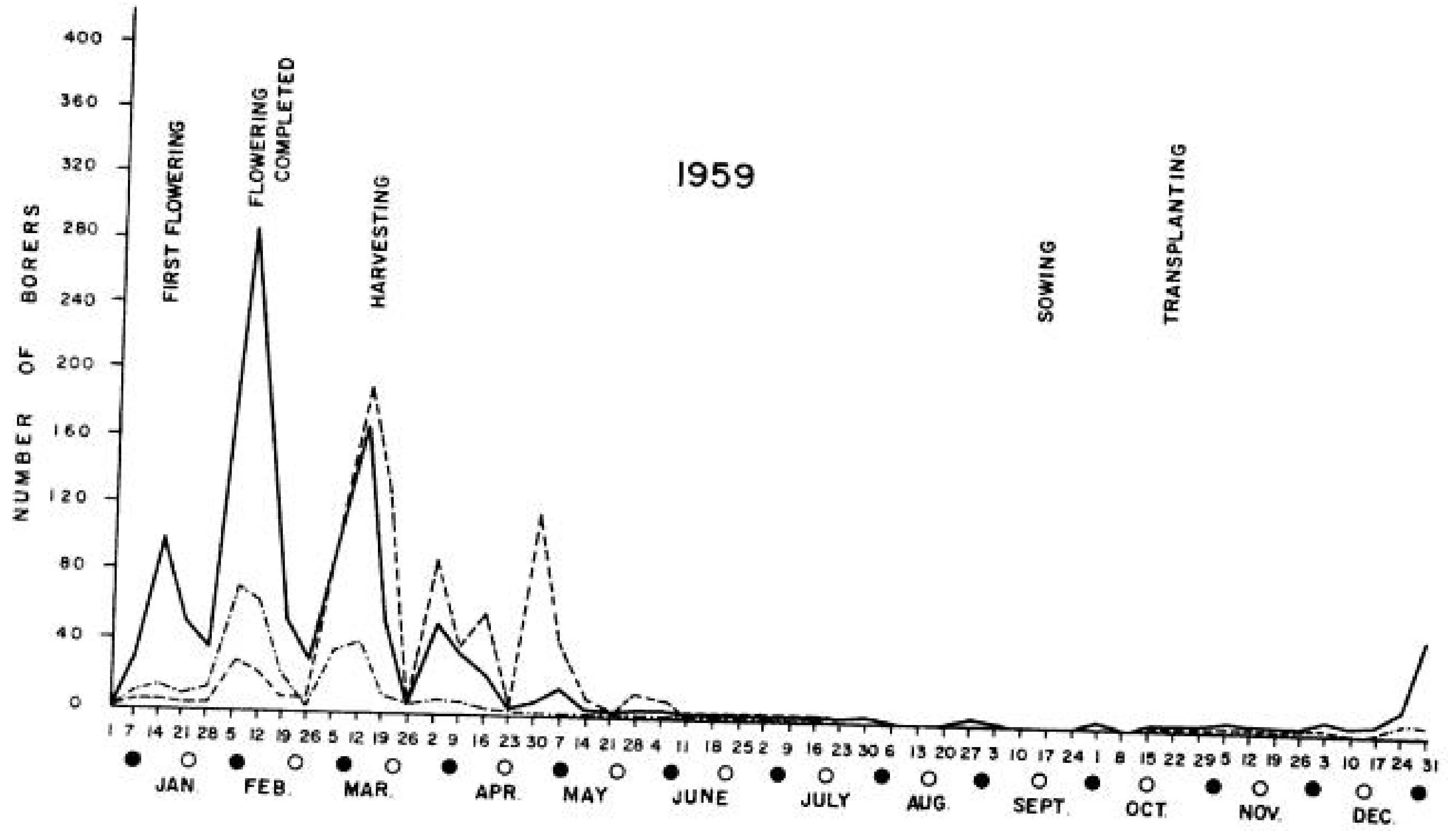
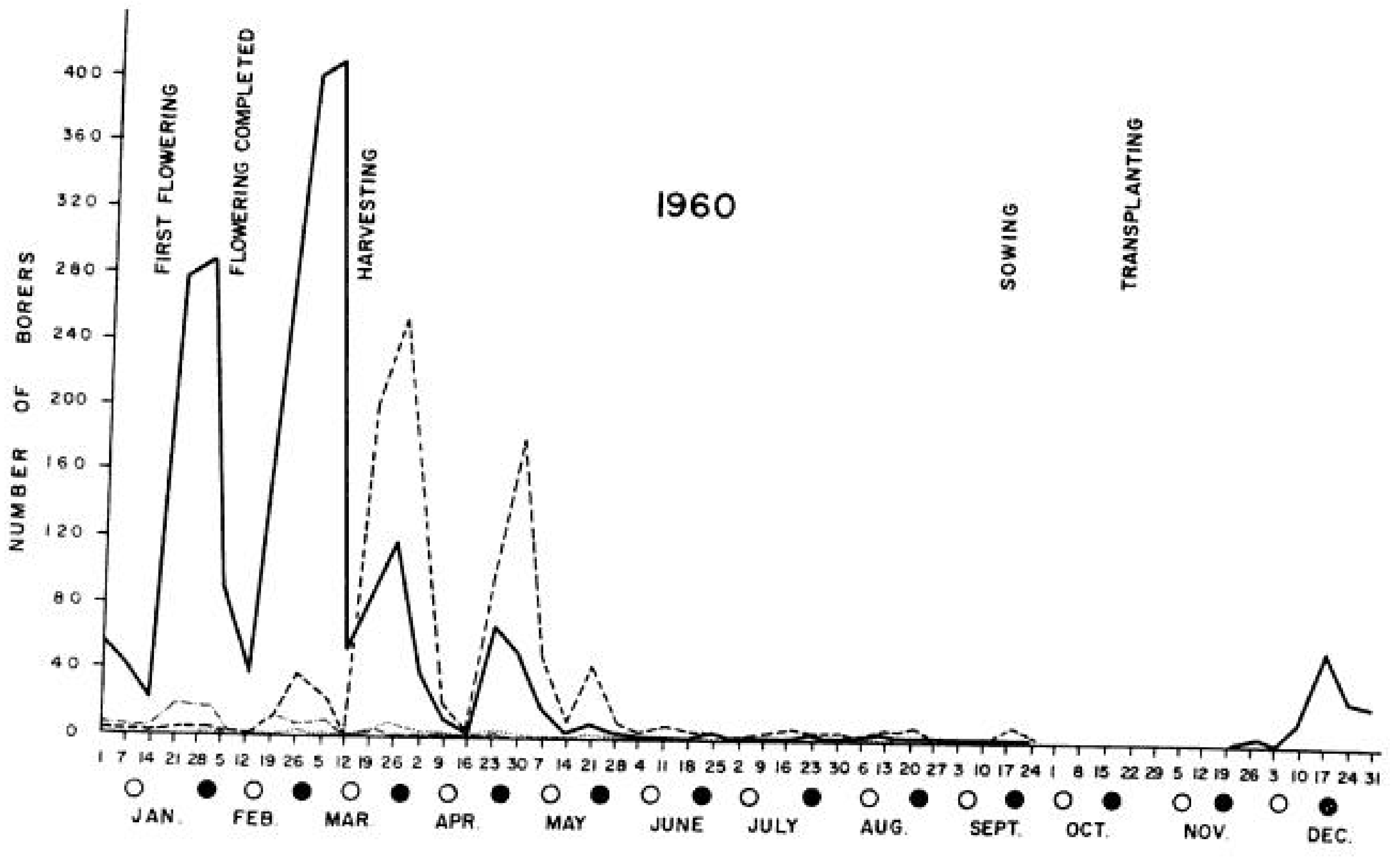


Fig. 33-4: Rice stem borer population at Pain Sater, P.T.S., from a 1958–64 study by light trap (six-day average).





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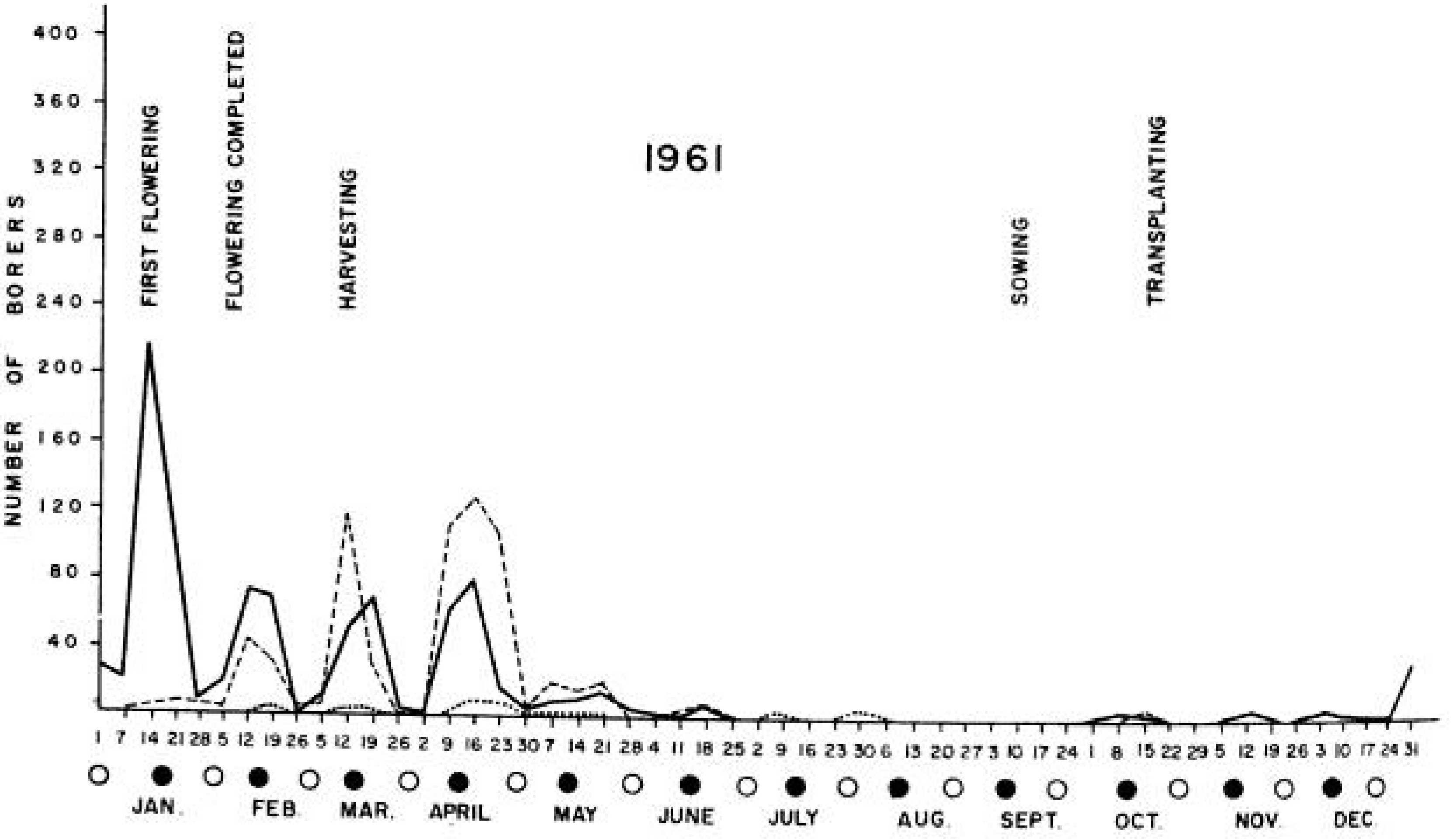

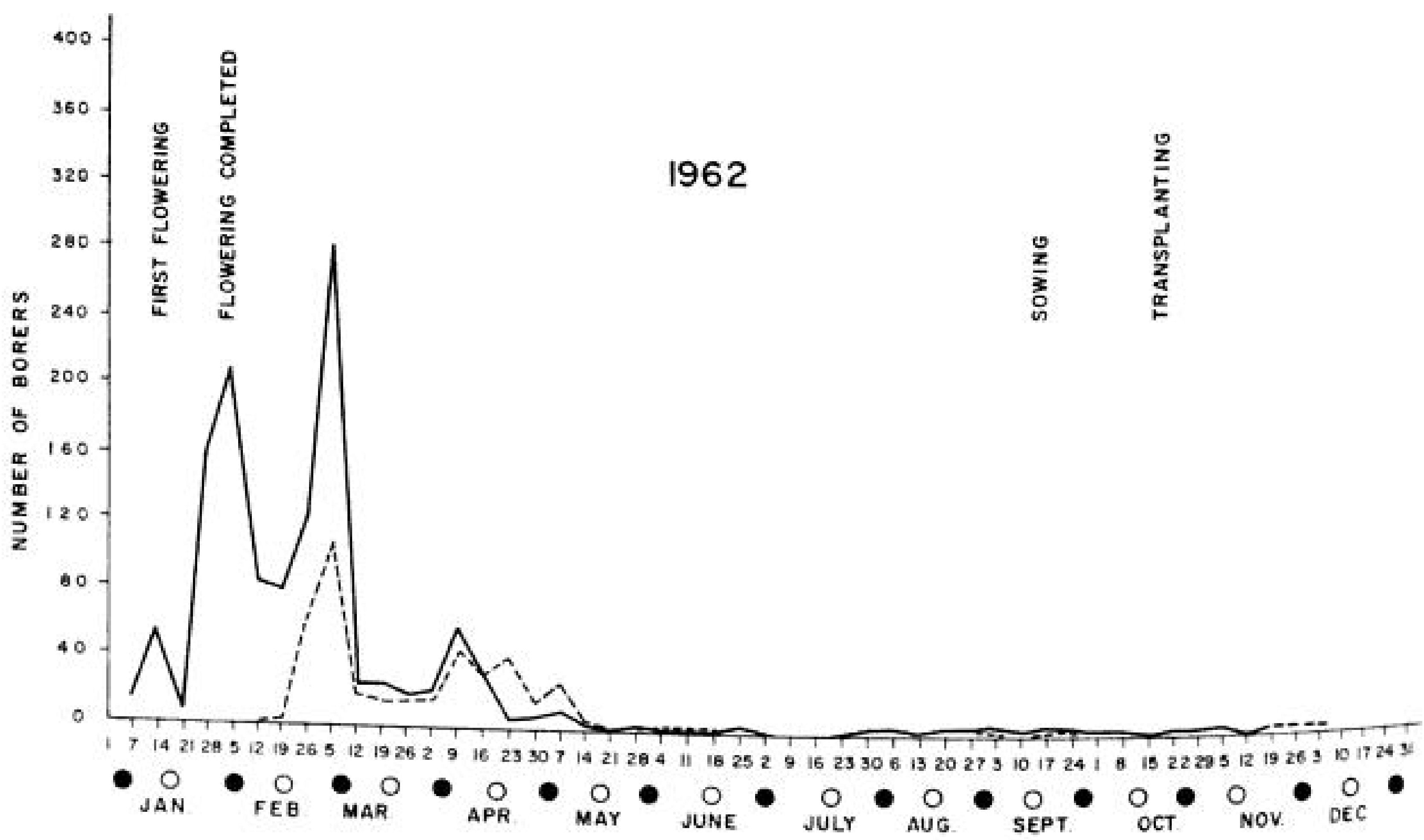

Fig. 33-4 (*continued*)

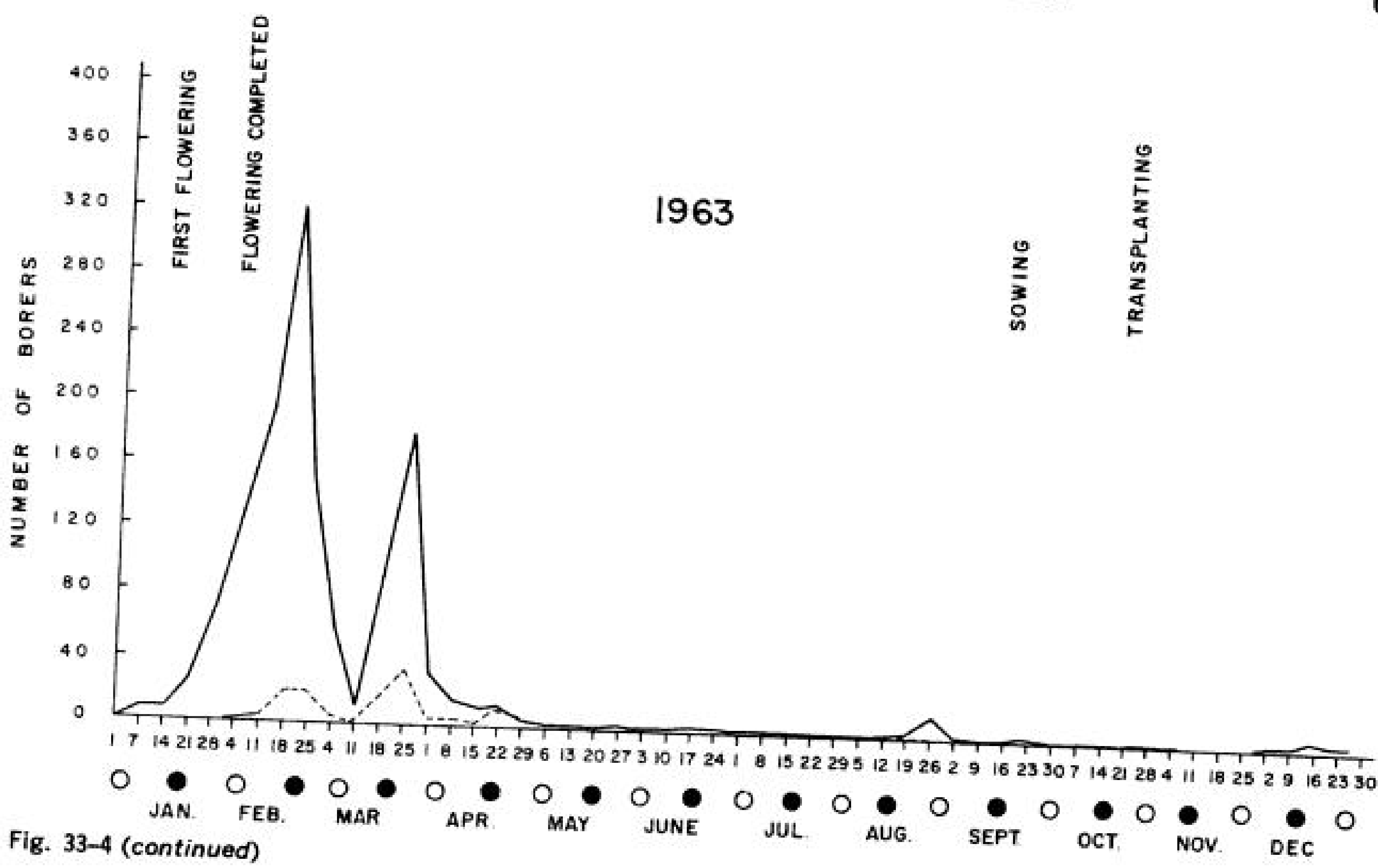

Fig. 33-4 (*continued*)

Scotinophara coarctata

Corbett and Yusope (1924) investigated this species in detail. Their work contained a description of this species and its life cycle.

Sogata *Species*

Serious outbreaks of *Sogata* species on paddy in 1925 and 1929 led Miller and Pagden (1930) to investigate the life history and feeding habits of these species. They found that draining off the irrigation water from affected fields controls this pest effectively.

RELEVANT NOTES ON THE RICE CROP GROWN IN MALAYA

Two types of paddy—dry and wet—are grown in Malaya. Dry paddy is grown on raised ground not readily supplied with water; it depends on rainfall for growth. It constitutes only about 5 per cent of the total acreage under paddy and is therefore relatively unimportant. Wet paddy is grown during the monsoon or rainy season, from about July to February each year, and depends primarily on irrigation water. Table 33–2 shows the acreage under wet paddy in the various states of Malaya and the varieties grown. It also shows the acreage under double cropping, a practice gradually gaining popularity among the farmers.

Table 33–2 shows that more than 20 varieties, mostly tall ones, are grown in the country. Applying insecticides often is a problem, especially when the planting distance is about 12 inches by 12 inches. Varietal resistance to the various pests has not been studied, except for some work done to determine the resistance of *Oryzae ridleyi* Hook to the rice stem borers (Van and Goh, 1959).

In double-cropping areas, the paddy crop is grown almost throughout the year, except for a short interval between crops.

Generally, work on the land starts in about July–August, and harvesting is completed in February–March. In the northern districts of Perak, the work is sometimes started as early as April–May. In some areas in Pahang, the work is started in April, and harvesting is completed in October–November.

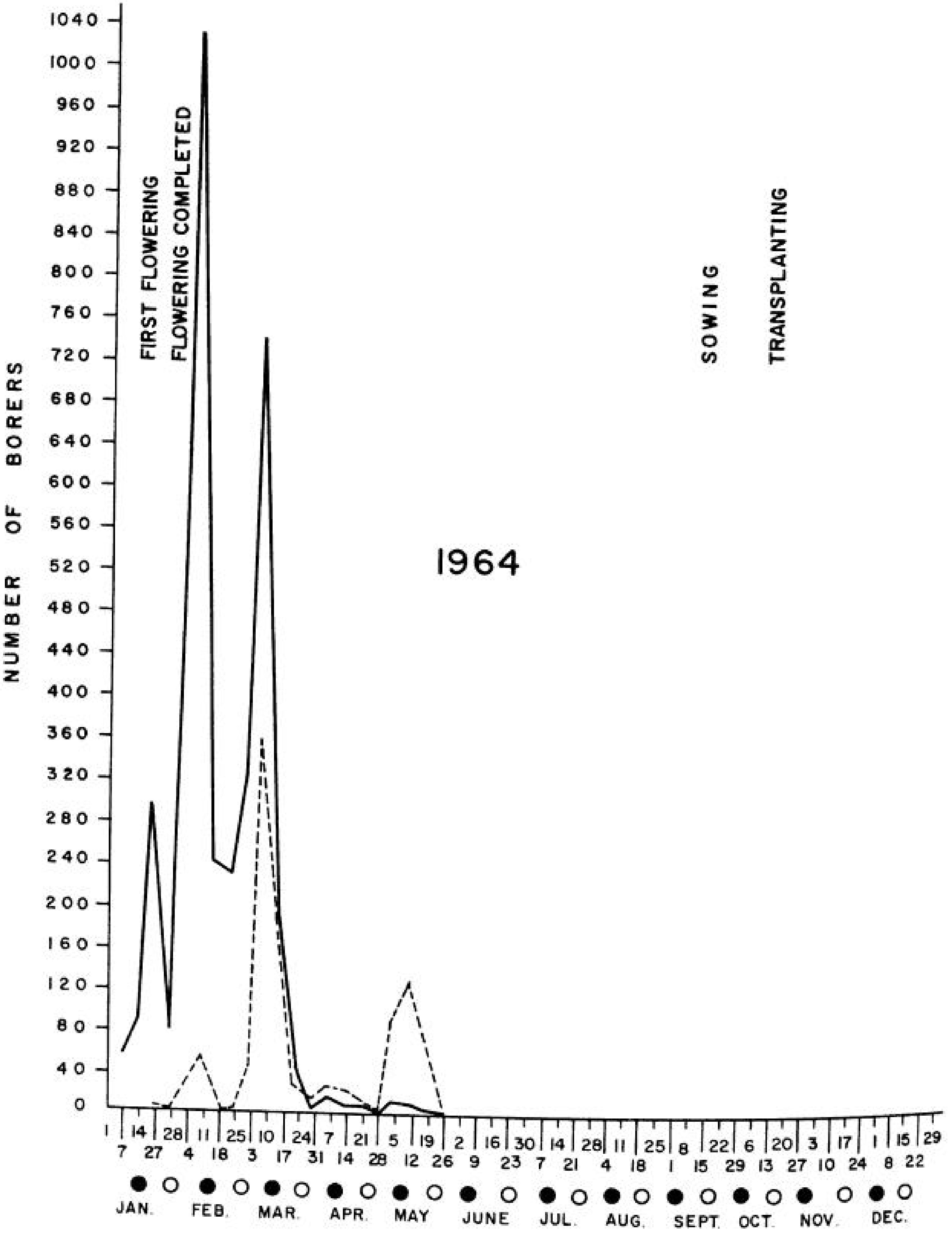

Fig. 33-4 (*continued*)

TABLE 33–1: Insects Occurring on Rice in Malaya

Scientific Name	Family	Common Name
Lepidoptera		
Ancylolomia sp.	*Pyralidae*	Seedling-eating caterpillar
Artona zebriaca Butler	*Zygaenidae*	Leaf-eating caterpillar
Borolia venalba Walker	*Noctuidae*	Leaf-eating caterpillar
Brachmia orotraea Meyrick	*Gelechiidae*	Leaf-eating caterpillar
Chilotraea polychrysa Meyrick	*Pyralidae*	Stem-boring caterpillar
Ref.: Anon, 1955		
Chilo suppressalis Walker	*Pyralidae*	Stem-boring caterpillar
Cnaphalocrocis medinalis Guenée	*Pyraustidae*	Leaf-eating caterpillar
Creatonotus (interruptus) gangis Linnaeus	*Arctiidae*	Leaf-eating caterpillar
Dasychira pennatula Faencius	*Lymantriidae*	Leaf-eating caterpillar
Endotricha melanobasis Hampson	*Pyralidae*	Stem-eating caterpillar
Endotricha puncticostalis Walker	*Pyralidae*	Root-eating caterpillar
Eublemma sp.	*Noctuidae*	Leaf-eating caterpillar
Euproctis variana Walker	*Lymantriidae*	Leaf, tussock moth
Eurypsyche (Sideritis) venalba Moore	*Noctuidae*	Leaf-eating caterpillar
Laelia suffusa Walker	*Lymantriidae*	Leaf, tussock moth
Refs.: Corbett and Gater, 1925; Gater and Yusope, 1925		
Laphygma exempta Walker	*Noctuidae*	Leaf-eating caterpillar
Mabra eryxalis Walker	*Pyralidae*	Leaf-eating caterpillar
Marasmia bilinealis Hampson	*Pyralidae*	Leaf-eating caterpillar
Melanitis leda (Linnaeus) *ismene* Cramer	*Satyridae*	Leaf-eating caterpillar
Ref.: Corbett and Gater, 1925		
Mocis frugalis Faencius	*Noctuidae*	Leaf-eating caterpillar
Monoctenocera brachiella Hampson	*Pyralidae*	Stem-boring caterpillar
Mycalesis mineus macromalayana Fruhstorfer	*Satyridae*	Leaf-eating caterpillar
Naranga diffusa Walker	*Noctuidae*	Leaf-eating caterpillar
Nymphula depunctalis Guenée	*Pyralidae*	Leaf-eating caterpillar
Nymphula enixalis Sump.	*Pyralidae*	Leaf-eating caterpillar
Nymphula fluctuosalis Zeller	*Pyralidae*	Leaf-eating caterpillar
Nymphula stagnalis Zeller	*Pyralidae*	Leaf-eating caterpillar
Nymphula sp.	*Pyralidae*	Leaf-eating caterpillar
Orsotriaena medus medus Fabricius	*Satyridae*	Leaf-eating caterpillar
Parnara bada bada Moore	*Hesperiidae*	Leaf-eating caterpillar
Potanthus omaha omaha W. H. Edward	*Hesperiidae*	Leaf-eating caterpillar
Potanthus tropica (Pl.) *tropica* (Pl.)	*Hesperiidae*	Leaf-eating caterpillar
Pelopidas mathias (Fabricius) *mathias* Fabricius	*Hesperiidae*	Leaf-eating caterpillar
Prodenia litura Fabricius	*Noctuidae*	Leaf-eating caterpillar
Psara licarsisalis Walker	*Pyralidae*	Leaf-eating caterpillar
Pyrausta coelesalis Walker	*Pyralidae*	Leaf-eating caterpillar
Rivula atimeta Swinhoe	*Noctuidae*	Leaf-eating caterpillar
Schoenobius dodatellus Walker	*Pyralidae*	Stem-boring caterpillar
Schoenobius incertulas Walker	*Pyralidae*	Stem-boring caterpillar
Refs.: Corbett, 1933c; Pagden, 1932; Miller and Pagden, 1930a; Pagden, 1930a		
Sesamia inferens Walker	*Noctuidae*	Stem-boring caterpillar
Refs.: Anon, 1954a, 1954c; Pagden, 1932, 1930a		
Spodoptera mauritia Boisduval	*Noctuidae*	Leaf, armyworm
Ref.: Corbett and Gater, 1925		
Spodoptera pecten Guen.	*Noctuidae*	Leaf, armyworm
Telicota augias (Linnaeus) *augias* Linnaeus	*Hesperiidae*	Leaf-eating caterpillar
Telicota bambusae (Moore) *bina* Evans	*Hesperiidae*	Leaf-eating caterpillar

TABLE 33-1 (*continued*)

Scientific Name	Family	Common Name
Coleoptera		
Alesia afflicta Mulsant	*Coccinellidae*	Paddy ear-eating beetle
Alesia discolor Fabricius	*Coccinellidae*	Leaf/ear-eating beetle
	Ref.: Pagden, 1932	
Anadastus filiformis Fabricius	*Languriidae*	Stem-boring grub
Anadastus nigrinus Wied.	*Languriidae*	Leaf/stem-boring grub
Anadastus scutellatus Cr.	*Languriidae*	Leaf/stem-boring grub
Apalochrus rufofasciatus Pic.	*Dasytidae*	Leaf-eating beetle
Calandra oryzae Linnaeus	*Curculionidae*	Paddy ear-boring weevil
Chaetocnema basalis Baly	*Halticinae*	Leaf-eating beetle
Coccinella transversalis Fabricius	*Coccinellidae*	Paddy ear-eating beetle
Exochomus nigromaculatus Geoze	*Coccinellidae*	Leaf-eating beetle
Formicomus ruficollis Saunders	*Anthicidae*	Paddy ear-eating beetle
Laltica caerulea Olivieri	*Halticinae*	Leaf-eating beetle
Haltica cyanea Weber	*Haliticinae*	Leaf-eating beetle
Hispa armigera Olivieri	*Hispinae*	Leaf-eating beetle
Lepadoretus compressus Weber	*Rutelinae*	Root-eating grub
Monochirus moestus Baly	*Hispinae*	Leaf-eating beetle
Monolepta bifasciata Hornst.	*Galerucinae*	Pollen-eating weevil
Nemoxenus bimaculatus Chevrolat	*Curculionidae*	Leaf-eating weevil
Odacantha graviliceps Bates	*Carabidae*	Leaf-eating beetle
Ophionea interstitialis Schm- Geob.	*Carabidae*	Leaf-eating bettle
Ophionea sp.	*Carabidae*	Leaf-eating beetle
Paederus sp.	*Staphylinidae*	Leaf-eating beetle
Trichogomphus simson Voll.	*Dynastinae*	Root-eating grub
Diptera		
Atherigona oryzae Mall.	*Anthomyiidae*	Stem-mining maggot
Chironomus oryzae Matsumura	*Chironomidae*	Stem-mining maggot
Chironomus sp.	*Chironomidae*	Stem-mining maggot
Drapetis (*Elaphropeza*) sp.	*Empididae*	Stem-mining maggot
Eristalis obscuritarsis de Meijere	*Syrphidae*	Rotted stem-boring maggot
Hydrellia sp.	*Ephydridae*	Leaf-boring maggot
Leptocera (*Limosina*) sp. nr. *latipes* Duda	*Borboridae*	Stem-boring maggot
Leptocera (*Rachispoda*) sp. nr. *subtinctipennis* Burmeister	*Borboridae*	Stem-boring maggot
Oscinella (*Conioscinella*) *minutissima* Strobl.	*Oscinidae*	Stem-boring maggot
Oscinella (*Discogastrella*) *inaequalis* Beck	*Oscinidae*	Stem-boring maggot
Oscinella paenultima Beck	*Oscinidae*	Stem (seedling)-boring maggot
Oscinella paenultima Beck (*inaequalis*) Beck	*Oscinidae*	Stem (seedling)-boring maggot
Phytobia (*Dizygomyza*) sp.	*Agromyzidae*	Leaf-mining maggot
Steleocerus ensifer Thomson	*Oscinidae*	Stem-boring maggot
Stomoxya calcitrans Linnaeus	*Muscidae*	Stem-boring maggot
Telmatoscopus albipunctatus Will.	*Psychodidae*	Decayed stem-boring maggot
nr. *Thressa* (*Chalcidomyia*)	*Chloropidae*	Stem-boring maggot
Hemiptera		
Agonoscelis nubila Fabricius	*Pentatomidae*	Paddy ears
Amyotea malabarica Fabricius	*Pentatomidae*	Paddy ears
Antestia degenera Walker	*Pentatomidae*	Paddy ears
	Ref.: Miller, 1931a	
Athysanus indicus Distant	*Jassidae*	Leaf
Cicadula sp.	*Jassidae*	Leaf
Cixius sp.	*Cixiidae*	Leaf

TABLE 33–1 (*continued*)

Scientific Name	Family	Common Name
Cletus punctiger Dall.	*Coreidae*	Paddy ears
Cletus trigonus Thunberg	*Coreidae*	Paddy ears
	Ref.: Miller, 1931a	
Cymus sp.	*Lygaeidae*	Leaf
Deltocephalus dorsalis Matsumara	*Jassidae*	Leaf
Dinidor obscura Lepelletier	*Pentatomidae*	Paddy stem
Eusarcoris montivagus Distant	*Pentatomidae*	Paddy ears
Eusarcoris ventralis Westwood	*Pentatomidae*	Paddy ears
Eusarcoris sp.	*Pentatomidae*	Paddy ears
Eusoelis sp.	*Jassidae*	Leaf
Hotea curculionoides Fabricius	*Pentatomidae*	?
Leptocorisa acuta Thunberg	*Coreidae*	Paddy ears, paddy fly
	Refs.: Anon, 1955a, 1951; Corbett, 1930c	
Leptocorisa corbetti China	*Coreidae*	Paddy ears, paddy fly
Leptocorisa costalis Herrick-Schaeffer	*Coreidae*	Paddy ears, paddy fly
Leptocorisa lepida Breddin	*Coreidae*	Paddy ears, paddy fly
	Ref.: Corbett, 1930c	
Leptocorisa varicornis Fabricius	*Coreidae*	Paddy ears, paddy fly
Megarrhamphus rostratus Fabricius	*Pentatomidae*	Stem
Menida histrio Fabricius	*Pentatomidae*	Paddy ears
Menida varipennis Westwood	*Pentatomidae*	Paddy ears
	Ref.: Miller, 1931a	
Mictis tenebrosa Fabricius	*Coreidae*	Paddy ears
Nephotettix bipunctatus Fabricius	*Jassidae*	Leaf/stem paddy ears
	Ref.: Corbett and Dover, 1926	
Nezara viridula Linnaeus	*Pentatomidae*	Paddy ears
	Ref.: Miller, 1931a	
Nilaparvata lugens St.	*Delphacidae*	Leaf
Nilaparvata sordescens Motschulsky	*Delphacidae*	Leaf
	Ref.: Corbett and Dover, 1926	
Nisia atrovenosa Lethierry	*Menoplidae*	Leaf
Nisia sp.	*Menoplidae*	Leaf
Orthaea vincta Say	*Lygaeidae*	Paddy ears
Phenice (Proutista) moesta Westwood	*Derbinae*	Leaf
Piezodorus rubrofasciatus Fabricius	*Pentatomidae*	Paddy ears
Pseudococcus sp.	*Coccidae*	Stem, mealy bug
Rhopalosiphum rufiabdominalis (Sasaki)	*Aphididae*	Leaf, aphid
Ricania pulverosa Stal	*Ricaniidae*	Leaf
Riptortus linearis Fabricius	*Coreidae*	Paddy ears
	Ref.: Miller, 1931a	
Scotinophara bispinosa Fabricius	*Pentatomidae*	Leaf
Scotinophara cinerea le Guill.	*Pentatomidae*	Stem
Scotinophara coartata Fabricius	*Pentatomidae*	Leaf/stem
	Refs.: Anon, 1951a; Corbett and Yusope, 1924	
Sogata distincta Distant	*Delphacidae*	Leaf
Sogata furcifera Horvath	*Delphacidae*	Leaf/stem
	Ref.: Corbett and Pagden, 1941	
Sogata sp.	*Delphacidae*	Leaf
	Ref.: Miller and Pagden, 1930	
Storthecoris tarsalis Walker	*Pentatomidae*	Stem
Tetroda histeroides Fabricius	*Pentatomidae*	Leaf
	Ref.: Miller, 1931a	
Saccharococcus sacchari Cockered	*Coccidae*	Stem, mealy bug
Tryphlocyba sp.	*Jassidae*	Leaf

TABLE 33-1 (*continued*)

Scientific Name	Family	Common Name
Orthoptera		
Acantholobus sp.	*Acrididae*	Leaf, grasshopper
Acrida turrita Linnaeus	*Acrididae*	Leaf, grasshopper
Aiolopus tamulus Fabricius	*Acrididae*	Leaf, grasshopper
Anisoptera longipenne Haan	*Tettigonidae*	Leaf, grasshopper
Anisoptera maculatum Le Guill.	*Tettigonidae*	Leaf, grasshopper
Atractomorpha crenulata Fabricius	*Acrididae*	Leaf, grasshopper
Atractomorpha psittacina de Haan	*Acrididae*	Leaf, grasshopper
Catantops splendens Thunberg	*Acrididae*	Leaf, grasshopper
Conocephalus (Xiphidium) longipennis Ridt.	*Tettigonidae*	Leaf, grasshopper
Cyrtacanthacris luteicornis Serv.	*Acrididae*	Leaf, grasshopper
Ducetia thymifolia Fabricius	*Tettigoniidae*	Leaf, grasshopper
Eucoptacra sp.	*Acrididae*	Leaf, grasshopper
Gesonia punctifrons St.	*Acrididae*	Leaf, grasshopper
Getonia mundata Walker	*Acrididae*	Leaf, grasshopper
Gryllus testaceus Walker	*Gryllidae*	Leaf, cricket
Oxya chinensis Thunberg	*Acrididae*	Leaf, grasshopper
Oxya diminuta Walker	*Acrididae*	Leaf, grasshopper
Oxya intricata St.	*Acrididae*	Leaf, grasshopper
Oxya velox Fabricius	*Acrididae*	Leaf, grasshopper
Oxya vicina Brunner	*Acrididae*	Leaf, grasshopper
Patanga succincta Linnaeus	*Acrididae*	Leaf, Bombay Locust
	Refs.: Anon, 1953, 1953c; Corbett, 1931	
Phlaeoba infumata B. & W.	*Acrididae*	Leaf, grasshopper
Tagasta marginella Thunberg	*Acrididae*	Leaf, grasshopper
Tetrix sp.	*Tetrigidae*	Leaf (seedling), grasshopper
Trilophidia annulata Thunberg	*Acrididae*	Leaf, grasshopper
Valanga nigricornis Burmeister	*Acrididae*	Leaf, grasshopper
Thysanoptera		
Haplothrips ganglbaueri Schmutz	*Thripidae*	Paddy ears, thrip
	Ref.: Corbett and Pagden, 1941	
Thrips oryzae Williams	*Thripidae*	Leaf, thrip

Note: Detailed information on references in this table are not available.

Methods of cultivation vary somewhat in different parts of the country to suit local conditions. While water buffaloes are commonly used in many areas in the northern states, they are unknown in several southern regions. Burning of stubble after harvest is common in the northern states. Mechanical cultivation is practiced in some areas.

TABLE 33-2: Acreages and Varieties Grown under Wet Paddy and under Double-Cropping Paddy in Malaya

State	Area under wet paddy in 1963-64 season (acres)	Area under double cropping in 1963 (acres)	Recommended varieties	Other varieties grown
Perlis	62,984	210	Radin Ebos 33	Subang Intan 16, Subang Intan 117, BM 5
Kedah	284,839	4,170	Radin Ebos 33, Subang Intan 117	Seraup 50, BM 5
Penang and Province Wellesley	39,358	28,790	Subang Intan 117, BM 5	Seraup 50, Mayang Sabatil
Perak	122,319	1,690	Seraup 50	Seri Raja, Machang, BM 5
Selangor	52,508	4,470	Radin Kuning, BM 5	Acheh Puteh
Negri Sembilan	28,209	nil	Serendah Kuning 60	Serendah Puteh, BM 5
Malacca	26,437	120	Siam 48	Nachin 39, Serendah Kuning, 26 and 60, BM 5
Johore	10,174	nil	Acheh Puteh	Tangkai Rotan, BM 5
Pahang	31,282	330	Milek Kuning, Serendah Kuning 60	BM 5
Kelantan	167,702	6,480	Anak Naga 21	Mayang Sagumpal, Cadong Ket, BM 5
Trengganu	54,089	2,670	Morak Sepilai, Padang, Trengganu	BM 5
Total	879,901	48,930	12	15

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Symposium on "

The Major Insect Pests of the Rice Plant

Proceedings of a Symposium at
The International Rice Research Institute
September, 1964

Published for THE INTERNATIONAL RICE RESEARCH INSTITUTE
By THE JOHNS HOPKINS PRESS, Baltimore, Maryland

Printed in the United States of America
Library of Congress Catalogue Card No. 65-27673

Part II
Sarawak

G. H. L. ROTHSCHILD[1]

An estimated 70 per cent of the rural population of Sarawak is engaged in rice production, the staple food of most of its indigenous people.

About one-third of the crop is grown as lowland rice, generally in coastal areas and on river levees. Standards of cultivation are low, and the land is usually cultivated only once in several years. Two-thirds of the total crop is grown as upland rice under the traditional system of shifting cultivation, mainly on the poor hill soils of the interior. A single-crop rice is grown during the northeast monsoon season, from October to March. Yields are low by world standards, averaging 600 lbs. per acre of upland rice and 1,200 lbs. per acre of lowland rice, using 1962 estimates. The Department of Agriculture is trying to raise rice cultivation standards and has included pest control in its program.

No entomological work was carried out in Sarawak before 1960. Between 1960 and 1962, C. R. Wallace of the Commonwealth Pool of Entomologists was assigned to the territory to establish an entomology division and build up a reference-insect collection. The author commenced work on specific pest problems in 1962. Although entomological problems in other crops will have to be dealt with, the present emphasis is on rice pests. Only one season's work (September, 1963–May, 1964) has so far been completed, and the present review is a progress report for this period.

In 1963, a preliminary survey of pests in lowland and upland rice was carried out in various parts of Sarawak to determine which problems required further investigation. The lepidopterous stem borers were found to be the most widespread and serious insect pests of lowland and upland rice in the country. Other insects, including armyworms, rice bugs, leafhoppers, and mole crickets, occurred in most areas, but were only of local importance.

RICE STEM BORERS

Work on rice stem borers began in 1963. The program included (*a*) observations of the life history of rice stem borers in the field and under controlled laboratory conditions, (*b*) ecological studies of larval and adult borer populations throughout the season, and (*c*) control of borers by means of insecticides.

At least four stem borer species occur in rice in Sarawak: *Sesamia inferens* Walker,

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TABLE 33-3: Incidence of Rice Stem Borer Larvae in Lowland Rice at the Padi Experiment Station, Paya Paloh (March–April, 1964)

	Date		
	3/12/64	4/15/64	5/19/64
Tillers bored, per cent	3.5	8.5	43.5
Total larvae per sample*	177	876	2,430
Estimated total per acre (to nearest 100)	6,400	29,200	86,700
Number of *C. suppressalis* larvae per sample	75	699	1,816
Estimated number per acre (to nearest 100)	2,700	24,900	64,800
Number of *Tryporyza* larvae per sample (both species)	58	99	445
Estimated number per acre (to nearest 100)	2,100	1,500	15,900
Number of *S. inferens* larvae per sample	44	78	169
Estimated number per acre (to nearest 100)	1,600	2,800	6,000

* Samples comprised all tillers from each of 1,200 'hills'.

Tryporyza incertulas Walker, *Tryporyza innotata* Walker, and *Chilo suppressalis* Walker. Although ratios varied with locality, *C. suppressalis* was the most abundant rice stem borer in the 1963–64 season, followed by *S. inferens, T. incertulas,* and *T. innotata,* in that order. Studies on the life history of these four species are under way.

Borer Ecology

Estimates of larval numbers were made in several localities between January and May. General trends are shown by the data from an area of lowland rice at the Padi Experiment Station at Paya Paloh, near Kuching (Table 33–3). Two-and-a-half months after transplanting, the borer incidence was very low, that is, 0.02 per cent of all tillers were bored; at three-and-a-half months, the figure had risen to 2.5 per cent; at four months, to 3.5 per cent; and at five months, one week before maximum flowering, to 8.5 per cent. At harvest, over 43 per cent of all tillers had been attacked. Estimates in terms of larval numbers are included in Table 33–3.

The *C. suppressalis* population generally increased later than those of the other three rice stem borer species (Table 33–3). The larval population increased more than twenty-fold between mid-March and May, whereas the numbers of *Tryporyza* and *S. inferens* increased more gradually (the larvae of *T. innotata* and *T. incertulas* were not separated).

Estimates of seasonal and daily periodicity of adult stem borers were obtained by running a 125-watt mercury-vapor light trap at the Padi Experiment Station at Paya Paloh. Trapping was carried out five nights a week from January to June, 1964. Temperature, rainfall, humidity, barometric pressure, and wind speed were measured at the trapping site. These light-trap samples have not yet been examined completely, but some preliminary data are given in Table 33–4.

The adult rice stem borer populations, particularly those of *C. suppressalis* and *S. inferens*, increased from February onward (Table 33–4); these increases corresponded to larval incidence in the crop. The relative number of *Tryporyza* adults, however, was unexpectedly high in February and March; this was possibly due to immigration or build-up of the population in alternative host plants. No evidence of the latter was noted at Paya Paloh. From the time intervals between peak numbers, it was estimated that the life cycle in the field averaged 36 days for *T. innotata* and 42 days for *Chilo*. No estimate was obtained for *S. inferens*, as there were no distinct peaks. From quantitative studies on the immature and adult borers, it is eventually hoped that a series of life tables for each species will be produced.

TABLE 33-4: Numbers of Rice Stem Borer Adults Caught by Light Trap in Lowland Rice at the Padi Experiment Station, Paya Paloh (February–June, 1964)

Species	Month				
	Feb.	Mar.	April	May	June
T. incertulas	14	98	73	143	130
T. innotata	37	106	62	58	93
Total *Tryporyza*	51	204	135	201	223
Chilo suppressalis	2	64	120	74	147
S. inferens	2	26	34	43	47
Total	55	294	289	318	417

Species composition of adults in trap samples and of larvae in the crop differed markedly at corresponding times. Although the *C. suppressalis* larval population was five times as large as those of the other species, light-trap catches of the latter were disproportionately high. The ratio of *Tryporyza* plus *S. inferens* adults to *C. suppressalis* adults was 1.0/1.2 in the light-trap samples. This may indicate that *C. suppressalis* adults do not respond as readily to light as do the adults of the other species, or that the former are less active during the trapping period—6 to 12 P.M. Mean seasonal sex ratios of the various species taken in the light trap were: *T. incertulas*, 13.0 females/1.0 males; *T. innotata*, 9.3 females/1.0 males; *C. suppressalis*, 14.3 females/1.0 males; and *S. inferens*, 1.7 females/1.0 males. The mean seasonal sex ratio of reared *C. suppressalis* material was 1.1 females/1.0 males, that is, one-fourth the number of females in the trap samples. *Tryporyza* material obtained by rearing was insufficient to estimate mean seasonal sex ratios; from the limited data available for this genus, however, it did appear that the ratio of females in the trap samples was unexpectedly high. This indicates that either mercury-vapor light is particularly attractive to female pyralid borers or that females are more active than males during the trapping period—6 to 12 P.M. No selective attraction was noted in the case of *S. inferens*; female pyralids and noctuids taken in the trap were often gravid. Evidently, further detailed work is needed on the relationship between larval numbers and adult numbers in the field.

As light-trap sampling was rather selective, it was decided to run a number of suction traps in addition to the mercury-vapor light trap at Paya Paloh. The sampling capacity of suction traps is less dependent on the physiological responses of the borer adults, and the samples, therefore, are likely to be more representative than those obtained at light traps. Measurements of flight periodicity also are likely to be more accurate, as flight behavior of moths in the vicinity of light is atypical. Only one week of trapping was possible in 1964, as the trap units arrived at the end of the season; some useful information on the relative efficiency of two types of trap, however, was obtained.

The first model, described fully by Taylor (1951), was a 9-inch Vent-Axia trap, with an air delivery of about 25,000 cu ft/hr. Small pyralids, including the rice case worm and leaf folder, were taken in this trap in low numbers, but rice stem borer adults were not collected. For this reason, two 18-inch propellor traps, with an air delivery of about 150,000 cu ft/hr, were used. The trap units were assembled locally, following the design of Johnson and Taylor (1955); a 12-inch aerofoil trap, with an air delivery of about 80,000 cu ft/hr, also was assembled, but was not tested in the field. Adults of all four rice stem borer species were taken in the 18-inch suction traps. Numbers trapped, however, were rather low—an average of 1.2 pyralids per 18-inch trap per four-hour trapping period as against 14.4 individuals in the light trap for the corresponding period. In the coming season, several suction traps will be run simultaneously to increase the total sample size. Work will include studies on the phenology and diurnal periodicity of the borers in relation to climatic factors and condition of reproductive organs. The traps will also be used to study the vertical distribution of aerial populations of borer adults.

Parasitism of Rice Stem Borers

Parasitism of *Tryporyza* (species not distinguished) and *C. suppressalis* eggs was only significant in the two months before harvesting, when the borer population also had increased considerably. At Paya Paloh, 74 per cent of the *Chilo* eggs were attacked by *Trichogramma* species. More than 50 per cent of the *Tryporyza* eggs were parasitized by *Tetrastichus schoenobii* Ferr. and *Telenomus rowani* Gah. Parasitism of larval and pupal stages of all four borers appeared to be less than 1 per cent; this was almost certainly an underestimate, as extensive rearing of borers to obtain parasites was not carried out. The larval parasites *Bracon chinensis* Szpl. and *Xanthopimpla stemmator* Thunb. and one species of hymenopterous pupal parasite (*Tetrastichus israeli* M. and S.) were bred from *C. suppressalis*. Up to 10 per cent of the larvae of all four stem borer species at Paya Paloh were attacked by a fungus, *Kirsutella barberi* (Giard) Petch.

Alternative Hosts

C. suppressalis and *Tryporyza* larvae were found in upland rice stubble up to two months after harvest, and in ratoon growth of lowland rice stubble more than three months after harvest. No larvae were obtained from grass or sedge samples. A large part of the residual borer population is probably supported by ratoon rice, as stubble burning, plowing, and similar measures are not practiced in Sarawak. *S. inferens* occurs in maize during the off season. More extensive sampling of wild grasses and sedges was undertaken during the 1964 off season.

INSECTICIDAL CONTROL OF STEM BORERS

There are no pronounced seasons in Sarawak, and rice stem borer moths may be found throughout the year. Their numbers are generally low between May and October, when little rice is grown, and only increase in the two months prior to harvestin (March and April at Paya Paloh) (Table 33 3). Timing is important in any chemical con trol program. Wyatt (1956, 1957) founc that in Malaya, the rice plant was most vul nerable just before flowering and not neces sarily when the borers were most abundant A timing trial was carried out in the 1963-64 season to establish whether a similar relationship exists in Sarawak.

Sevin at 1.4 lb. active ingredient per acre was applied at the following time intervals after transplanting: 7 weeks (A), 9 weeks (B), 11 weeks (C), 14 weeks (D), 17 weeks (E), and 20 weeks (F). The various treatments were applied singly and in combinations. Treatment F (one week before flowering) and a combination of E (four weeks before flowering) and F produced the highest yields, representing a significant yield increase of 17 per cent at the 5 per cent level. There was no significant difference between treatments F and EF, and treatment E alone did not produce a statistically significant yield increase. These results agree with those of Wyatt (1957), who found that a single treatment just before flowering was the most effective. There was no significant correlation between percentage of tillers bored three weeks before flowering and yield, or between the percentage of tillers bored at harvest and yield. Tiller dissections showed that the residual properties of sevin were poor, because borer incidence increased considerably between the flowering period and harvest—10.7 per cent to 36.1 per cent. From these results, it would appear that rice stem borer damage to the maturing crop is critical at the flowering and early postflowering periods; the rapid build-up of stem borers following these periods appears to have no significant effect on yield. Timing trials will be repeated in various localities in the coming season with an additional postflowering spray.

A comparative spraying trial was carried out at Paya Paloh to assess the efficacy of different insecticides under local conditions. The following insecticides were tested: heptachlor (0.3 lb. active ingredient per acre), aldrin (1.0), dieldrin (0.4), endrin (0.2 and 0.4), isobenzan (telodrin) (0.2), γ-BHC (0.3 and 0.6), DDT (0.5 and 1.0), detron—a penetrative formulation of 20 per cent DDT and 5 per cent γ-BHC (0.8 DDT and 0.2 γ-BHC), malathion (1.0), dimethoate (rogor) (0.3 and 0.6), menazon (0.4), fenitrothion (sumithion) (2.0), trichlorphon (dipterex) (1.6), diazinon (1.0), trithion (1.0), imidan (1.0), carbaryl (sevin) (1.0 and 2.0), and ryania (5.0). All insecticides were applied with 0.5 per cent tenac sticker (methyl cellulose). Treatments were made at five weeks and one week before flowering.

For various reasons, plant growth in the trial was uneven. This resulted in a high coefficient of variation (22 per cent) in plot yields. Only endrin produced significant yield increases of 25.8 per cent at the 5 per cent level. Dissection of tillers a few days after spraying showed that none of the insecticides was capable of killing larvae within the stems.

The mean percentage of bored tillers for all treatments other than endrin rose from 3.2 per cent after the first spraying to 8.1 per cent at the second treatment and reached a figure of 45.0 per cent four weeks later; corresponding mean figures for endrin treatments were 4.2 per cent, 8.4 per cent, and 27.0 per cent, respectively. This clearly demonstrated the poor residual properties of all the insecticides, even in the presence of methyl cellulose stickers. Low persistence was undoubtedly related to the fact that daily rainfall in the area frequently exceeded one inch. No significant correlation was obtained between yield and (*a*) percentage of bored tillers four weeks before flowering, (*b*) percentage of bored tillers at harvest, or (*c*) percentage of white ears.

This trial is to be repeated and will include additional treatments with demeton-methyl (metasystox), locally prepared derris extract (rotenone), and thuricide (a *Bacillus thuringiensis* preparation).

OTHER RICE PESTS

Work on rice pests other than stem borers has been confined to surveys, with some observations on their relative abundance in the field. Data on the seasonal incidence and flight activity of rice bugs, leafhoppers, and a number of other insects are being obtained from the light-trap samples. Ecological work on pests other than rice stem borers in 1964 was concerned mainly with *Leptocorisa oratorius* Fabricius (= *L. acuta* Thunberg),[3] the most common rice bug in Sarawak. The insect was abundant only in areas where planting had been staggered, leading to an extended ripening period. In one such locality, estimates of 360,000 nymphs and adults per acre were obtained. Over 50 per cent of the egg masses in the same locality were parasitized by *Hadronotus flavipes* Ashmead. Spraying trials showed that satisfactory control could be achieved with (carbaryl) sevin at the rate of 0.75 lb. active ingredient per acre.

In certain areas of Sarawak, seedling rice is regularly attacked by such pests as mole crickets and armyworms. It is hoped that insecticidal seed dressings will be useful in these areas. A preliminary field trial was carried out at Paya Paloh to discover whether seed dressings affected germination, seedling growth, and ultimate yield of lowland rice. Rice seed was treated with a slurry of insecticide, wood ash filler, with and without a 2.5 per cent methyl cellulose sticker. Each insecticide was applied at the rate of 0.5 g and 1.0 g of active ingredient per 100 g of seed. The seed was also treated with a fungicidal organomercurial dressing. The following insecticides were tested: aldrin, dieldrin, endrin, isobenzan (telodrin), heptachlor, γ-BHC, dimethoate (rogor), fenitrothion (sumithion), trichlorphon (dipterex), diazinon, menazon, carbaryl (sevin), and phorate (thimet).

[3] Renamed by Dr. I. Ahmad in his recent revision of the *Leptocorisinae* (personal communication).

In the absence of stickers, germination was reduced by almost 50 per cent in all treatments. In the presence of stickers, 1 per cent trichlorphon reduced germination to 47.1 per cent, as against 91.3 per cent with 1 per cent fenitrothion (sumithion). It is possible that the sticker prevents phytotoxic quantities of insecticide from passing through the seed coat. A delay in germination resulted from almost all treatments, particularly 1 per cen dimethoate, 1 per cent heptachlor, 1 per cen γ-BHC, and 1 per cent dieldrin. Menazo and isobenzan (telodrin) did not delay germ ination. At one month after sowing, there wa no significant difference in the number an height of tillers per plant between treatments

At harvest, there were no significant dif ferences in yield between treatments.

APPENDIX TO PAPER 33

Some actual or potential rice pests that have been recorded in Sarawak are listed below:

Orthoptera

Gryllotalpidae
- *Gryllotalpa africana* Beauvois

Acrididae
- *Atractomorpha psittacina* De Haan
- *Locusta migratoria manilensis* Meyer

Hemiptera-Homoptera

Cicadellidae
- *Deltocephalos dorsalis* Motschulsky
- *Nephotettix apicalis* Motschulsky
- *Tettigella* spectra Distant

Delphacidae
- *Nilaparvata lugens* Stal
- *Sogatella furcifera* Horvath

Hemiptera-Heteroptera

Coreidae
- **Leptocorisa oratorius* Fabricius (= *L. acuta* Thunberg)
- **L. acuta* Thunberg (= *L. varicornis* Fabricius)
- **L. costalis* H. S.
- **L. luzonica* sp. n.
- **L. tagalica* nom. n. (= *L. geniculata* China)

Pentatomidae
- *Scotinophara cinerea* le Guill.
- *S. coarctata* Fabricius
- *S. lurida* Burmeister
- *S. Serrata* Voll.

Lepidoptera

Pyralidae
- *Cnaphalocrocis medinalis* Guenée
- *Nymphula stagnalis* Zeller (= *N. depunctalis* Guenée)
- *N. fluctuosalis* Zeller
- *Chilo suppressalis* Walker
- *Tryporyza incertulas* Walker
- *T. innotata* Walker

Noctuidae
- *Sesamia inferens* Walker
- *Spodoptera acronyctoides* Guenée
- *S. exempta* Walker (= *L. exempta*)
- *S. pecten* Guenée
- *S. lituca* (= *Prodenia lituca* Fabricius)

Satyridae
- *Melanitis leda* L.

* Renamed by Dr. I. Ahmad in his recent revision of the *Leptocorisinae* (personal communication).

DISCUSSION

G. H. L. Rothschild, *Malaysia*

Questions

M. Yoshimeki (*Japan*): Concerning suction-trap catches, is there information available on the vertical distribution of the rice stem borer and other insects? If so, what about the importance of the aerial population in relation to the population of the following generations?

Answer: I have not yet obtained any information on the vertical distribution of the rice stem borer and other insects.

S. N. Banerjee (*India*): (1) How many suction traps do you use per acre? (2) Do you get any *Tryporyza* in suction traps? (3) Do you consider the suction trap to be superior to the light trap? If so, why?

Answer: (1) Two 18-inch traps are being used in the sampling site. (2) Yes. (3) For certain purposes, suction traps are more useful as sampling devices than light traps. Sampling stem borer adults is rarely random, as the catch depends on the phototropic response of the moth.

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