Insect Parasites in the Natural Control of Species of Rice Stem Borers on Luzon Island, Philippines

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ABSTRACT

The egg and larval parasites of rice stem borers were reared from monthly collections of hosts from 5 major rice-growing regions of Luzon Island, Philippines. Adult parasites also were collected. Apanteles schoenobii Wilkinson, Erioborus sinicus Holmgren, Shirakia schoenobii Vierck, and Tetraestichus schoenobii Ferriere were recorded as most common parasites. Itoplectis norryan Ashmead), Temelucha sp. nr. nigromaculata Cameron, and Brachymeria sp. collected during these studies are new records for the Philippines. Laboratory rearing of field-collected borer larvae failed to yield any dipterous parasites.

Various species of rice stem borers are the most destructive pests of rice on Luzon Island, Philippines. Tryporyza incertulas (Walker) and the Asiatic rice borer, Chilo suppressalis (Walker), are the 2 most important species, constituting about 70% of the borer fauna in the rice fields (Kamran and Raros 1968). The other species found are Sesamia inferens (Walker), Chilotraca polychrysa (Meyrick), and Tryporyza incertulas (Walker).

In the Philippines the borers have been reported to be parasitized in the field by many different species of insects. Uichanco (1930) listed 11 insects, most of them unidentified, as attacking rice stem borers. Del-finado (1959) reared 17 species from field-collected borers. Cendaña and Morallo (1961) added several more to the list bringing the total to 25. Nickel (1964), in his comprehensive review of rice stem borers and their parasites, listed 34 insects which attack the borers.

There are no quantitative records about the abundance and effectiveness of stem borer parasites in the Philippines. In July 1965 we organized a biological control program against the borers on Luzon Island. We felt that some knowledge of the abundance and effectiveness of the local insect parasites was necessary before decisions could be made regarding the feasibility of introducing foreign parasites. This paper presents the results of studies evaluating the role played by local insect parasites in the natural control of rice stem borers on Luzon.

MATERIALS AND METHODS

Samples of parasites were obtained primarily by making monthly collections of borer larvae and eggs and rearing them in the laboratory. Collections were made at selected localities in the following 5 regions on Luzon: Isabela in the Cagayan River Valley, Southwestern Nueva Vizcaya, the Central Luzon Plain, Laguna, and the Bicol region. The localities and the manner by which the samples were collected have been reported elsewhere (Kamran and Raros 1968). Apart from these monthly collections, borers were collected also at irregular intervals from the Central Luzon Plain and The International Rice Research Institute farm in Los Banos, Laguna.

In the laboratory the field-collected borers were separated according to species and reared individually in rice stalks. The rice stalks were cut into 6-in. lengths so that the lower portion of the cut stalk had a node about 1-1/2 in. from its end. The borers were introduced into the stalks from the upper end and the stalks were placed in test tubes plugged with cotton. Field-collected pupae also were kept in rice stalks in test tubes. The test tubes were examined every 3 days and the stalks were changed whenever necessary. Egg masses collected in the field were reared in petri dishes with moist filter paper.

In calculating the percentage of parasitism, borers that had died in the test tubes were excluded from the totals. This exclusion probably resulted in lower estimates of the overall percentage of parasitism, but time did not permit the dissection of borers that failed to survive in the laboratory, i.e., died before yielding either an imago or a parasite.

While collecting borer samples in the field, we also swept rice fields with a Kyoritsu Power Suction Catcher for adult parasites. These collections provided additional specimens for identification purposes.

RESULTS

Table 1 gives the results obtained from rearing the field-collected borers in the laboratory. Larvae of T. incertulas were delicate and difficult to rear in the laboratory. Of the 1826 larvae of this species collected from the various regions, only 1029 survived. C. suppressalis had the best survival rate in the laboratory among the 4 species; of the 2155 collected, more than 80% survived. Of the field-collected S. inferens borers, 78% were successfully reared in the laboratory. Slightly more than 66% of the 406 C.
polychrysa borers survived in the laboratory. C. polychrysa was the rarest of the 4 species of borers and did not yield any parasites from any region during this investigation.

_Tetristichus schoenobii_ Ferriere.—This species is a widespread egg parasite of rice stem borers in Southeast Asia. We found it in our sweeping samples from all the 5 regions on Luzon. In October 1965 it parasitized 9% of the egg masses of _T. incertulas_ we collected in the Central Luzon Plain, and in October and November of the same year it attacked more than 20% of the egg masses of _T. incertulas_ collected in Laguna. The highest parasitism by this species was recorded in April 1966 when it attacked more than 70% of the egg masses of _T. incertulas_ collected in Laguna and was occasionally found attacking eggs of _C. suppressalis_. It does not seem to attack _S. inferens_ eggs. It is present in the rice fields all year round, but is more abundant in April and May. From July to September it becomes very scarce. This scarcity may result from the adverse effect of rainy weather which prevails during these months. Overall parasitism by this species was calculated to be 2.1% on _T. incertulas_ and negligible on _C. suppressalis_.

_Trichogramma australicum_ Girault.—This species has been reported to attack eggs of _T. incertulas_ in the Philippines, Taiwan, and Indonesia (Jepson 1954, Nickel 1964). Delfinado (1959) reported this species as having been introduced from Taiwan in 1954, and released in 16 provinces on Luzon and on Palawan Island. We collected it from the Central Luzon Plain, Laguna, and the Bicol region. The highest parasitism by this species was 10.1% on _C. suppressalis_ egg masses in Laguna in May 1966. It was scarce during the rest of the year.

_Telenomus rowani_ (Gahan).—This parasite of rice stem borer eggs is fairly common in the Central Luzon Plain and Laguna in the dry season. Cendana and Calora (1967) have reared it from eggs of _T. incertulas_ as well as of _C. suppressalis_, but we recovered it from only the former. In Laguna, in April, we recorded 12% parasitism of egg masses by this species. During the rest of the year it was scarce.

_Apanteles schoenobii_ Wilkinson.—This braconid parasite occurs throughout Southeast Asia (De Silva 1961, Rao 19656) where it attacks larvae of _T. incertulas_ and _C. polychrysa_. It is widespread on Luzon Island as evidenced by our having collected it in sweeping samples from all 5 regions. It was abundant in the rice fields in the wet season but was rare in the dry season. The highest parasitism by this species was recorded in November 1965 when 16% of the _T. incertulas_ and _C. suppressalis_ larvae collected from Nueva Vizcaya and the Bicol region were found to

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be parasitized. It was not reared from *S. inferens* and *C. poychrysa*. Overall parasitism was low, 1.4% on *T. incertulas* and 0.5% on *C. suppressalis*. These data indicate the negligible role played by this parasite in the natural control of rice stem borers. A hyperparasite, *Xenosternum* sp. (Braconidae), was found attacking it in Laguna and the Central Luzon Plain in March 1966.

*Bracon chinesis* Szepligeti.—This species is another widespread larval parasite of rice stem borers in Southeast Asia. We recovered it in sweeping samples from all the regions on Luzon where we collected. The highest parasitism by this species was recorded in the Central Luzon Plain in November 1965 where it attacked 11.5% of the collected borers. It was abundant also in April 1966 in Laguna and the Bicol region, where 8.2 and 5.7% of the borers were attacked. Overall parasitism by this species was low; 0.3% on *T. incertulas*, 0.5% on *C. suppressalis*, and 0.6% on *S. inferens*.

*Eriborus sinicus* Holmgren.—This larval parasite of rice stem borers is well known in the Philippines, Taiwan, China, and Japan (Subba Rao and Chawla 1964, Townes et al. 1961). Because of its large size it is a prominent species in the rice fields on Luzon. In our sweeping samples we recovered it from July to December 1965 and January to March 1966 from the Central Luzon Plain, Laguna, and the Bicol region. In October 1965 it parasitized 15.5% of the borers collected in Laguna. In March 1966, 10.5% of the borers from the Central Luzon Plain were attacked. The total parasitism recorded was 1.2% on *C. suppressalis*, 0.8% on *T. incertulas*, and 0.4% on *S. inferens*.

*Itoptelctis narayanae* (Ashmead).—This record is the first for the occurrence of this parasite in the Philippines. Previously it was reported only in China, Japan, Korea, and the neighboring islands (Townes et al. 1961) where it attacks *C. suppressalis*, *S. inferens*, and many other insects. It seems to be widespread on Luzon, since we found it in sweeping samples from Nueva Vizcaya to the Bicol region. In the laboratory we reared it from both the just-mentioned borers. Adults of this species reared from *S. inferens* were generally larger than those reared from *C. suppressalis*. In Laguna the parasite attacked 10% of these 2 borers collected in October 1965, and 9.5% of those collected in March 1966. Total parasitism by this species from all regions was recorded at 0.6% on *C. suppressalis* and 0.8% on *S. inferens*. Townes (1954) thought it to be of minor importance as a parasite of rice stem borers in Japan and Taiwan. The same assumption seems to be true for the Philippines.

*Shirakia schoenobi* Viereck.—This species attacks various species of rice stem borers from West Pakistan to Japan (Carl 1962, Subba Rao and Chawla 1964). Many were collected in our sweeping samples from all 5 regions. We found it to be abundant in rice fields in Isabela in November 1965 when the crop was heavily infested with *S. inferens*. However, in the laboratory we recovered it from only *T. incertulas* and *C. suppressalis* larvae. The highest value for field parasitism by this species was obtained in October 1965 from the Bicol region, where it parasitized 15.4% of the *T. incertulas* larvae we collected. Parasitism for all 5 regions was 0.7 and 0.5% on *T. incertulas* and *C. suppressalis*, respectively.

*Stenobracon nicevillei* (Bingham).—This large braconid parasite of rice stem borers enjoys a wide distribution from India to Japan (Rao 1965, Townes 1954). In the Philippines it has been reported to attack *T. incertulas* and *C. suppressalis* in the Central Luzon Plain and Laguna (Delfindo 1959). In November 1965 it was reared from 10% of the *T. incertulas* larvae we collected in the Bicol region. In April 1966 it parasitized 67% of *T. incertulas* larvae collected in the Central Luzon Plain. Thus it seems to be active in both the wet and dry seasons. In October 1965 we reared it also from *T. incertulas* larvae collected from Palawan Island.

*Temelucha* sp. nr. *nigromaculata* Cameron.—This record is the first of this larval parasite of rice stem borers in the Philippines. It had previously been recorded only from Orissa, India, where it was found to attack *Chilotraea auricilia* (Dudgeon) (Rao 1965). It seems to be a common species in the rice fields on Luzon. It resembles *Temelucha philippinensis* Ashmead, which has been reported in Laguna and the Central Luzon Plain (Cendana and Morallo 1960). We recorded 11.0% parasitism on *T. incertulas* larvae in Nueva Vizcaya in January 1966. In the Central Luzon Plain this species attacked 19.5% of *T. incertulas* larvae in October 1965 and 21.2% in the following month. However, overall parasitism on *T. incertulas* was a mere 1.4%, indicating that this parasite is of only minor importance on Luzon.

*Xanthopimpla stenmator* (Thunberg).—This large ichneumonid is well known in South and Southeast Asia as a parasite of rice, sugarcane, and maize borers. We recovered it in sweeping samples from all 5 regions, where it seemed to be equally abundant in the dry and wet seasons. We recorded 10.7% parasitism on *C. suppressalis* larvae collected in December 1965 from the Bicol region. The highest parasitism by this species was recorded in Laguna in February 1966 when it parasitized 12.5% of collected larvae of *C. suppressalis* and *S. inferens*. Overall parasitism was low; 0.8% on *C. suppressalis* and 0.5% on *S. inferens*. As a natural control agent, it appears to be insignificant.

*Tetrastichus ayyari* Rohwer.—This species has been recorded as a pupal parasite of pyralid borers in India, the Philippines, and China (Nickel 1964, Walker 1959). It does not seem to be widespread on Luzon; we collected it from only Laguna where, in March...
1966, it parasitized 5.5% of collected *S. inferens* pupae. Field-collected pupae of other species of borers did not yield any specimens of this parasite.

In addition to these 12 species, a few individuals of the following species were reared from field-collected borer larvae:

*From *T. incertulas*:
- *From *C. suppressalis*:

Among the 5 regions, borers from Bicol had the highest overall incidence of parasitism: 6.8%. The important parasites in this region were *S. schoenobii* and *B. chinensis*. Borers from Isabela had the lowest percent parasitism: 1.1%, and only *X. stemmator* was reared from field-collected borers. Borers from the other 3 regions had similar degrees of overall parasitism, varying from 3.1 to 4.3%. *A. schoenobii*, *T*. sp. nr. *nigromaculata*, and *E. sinicus* were the prominent parasites in these regions. However, these values for parasitism in the field are extremely low, indicating the negligible role played by insect parasites in the natural control of the rice stem borers on Luzon.

**DISCUSSION**

Including the 3 new records reported in this paper, ca. 40 insect species attack rice stem borers on Luzon. Of these species, it seems that *A. schoenobii*, *E. sinicus*, *S. schoenobii*, *T*. sp. nr. *nigromaculata*, and *T. schoenobii*, though rare, are the only ones that attack rice stem borers with any degree of regularity. Most of the others appear to be of academic interest only. The results of our study show that the incidence of parasitism on Luzon is extremely low. Apparently, insect parasites play a negligible role, if any, in the natural control of rice stem borers on this island.

Not all parasites of the rice stem borers on Luzon are indigenous. One imported species, *T. australicum*, has already been mentioned. There are 2 more parasites that were imported and released: *Tetrastichus japonicum* Ashmead from Japan in 1934 and 1954, and *T. minutum* Riley from Hawaii in 1934 (Baltazar 1964, Cendaña 1953, Delfinado 1959). These 3 species were introduced to control various lepidopterous pests of rice, sugarcane, and corn, and are reported to have become established here. But despite considerable efforts at mass rearing and liberating these wasps (Baltazar 1964, Porquez and Tabayoyong 1959) it is doubtful if any favorable results have been achieved. We were able to recover only 1 of these species and only in extremely low numbers, indicating that they are ineffective as parasites of rice stem borers.

At the present time the use of insecticides in the rice fields, though very rapidly increasing, is still rather limited. In our sampling we carefully avoided areas where insecticides had been used. We feel that because of this precaution our data give a fair picture of the incidence of natural parasitism of rice stem borers on Luzon.

There is considerable doubt about the presence of dipterous parasites of rice stem borers in the Philippines. Uichanco (1930) reported an unidentified fly parasitizing *C. suppressalis*, and another, possibly the same, attacking *T. incertulas*. Cendaña and Morallo (1961) also recorded an unidentified fly attacking borers in Laguna. However, later attempts have failed to substantiate these records. The list of rice stem borer parasites prepared by Nickel (1964) does not contain any dipterous parasites reported from the Philippines. Recently Cendaña and Calora (1967) found the larvae of a chloropid fly, *Anathrichus araneae* Loew, to be consistently associated with dead *T. incertulas* larvae, but did not ascertain whether they were truly parasitic or merely saprophagous. On many occasions in the field we have obtained tachinid fly puparia from between the leaf sheaths and stems of rice plants. However, these flies were probably parasites of armyworms and cutworms such as are reported by Dagan (1962). Our laboratory rearing of field-collected borers has not yielded any dipterous parasites.

The seasonal abundance of the parasites we studied on Luzon seems to be influenced significantly by the change from the hot, dry weather in April and May to the rainy season in July and August. This effect is specially apparent in the small egg parasites. Our records show that the 3 species of egg parasites that were abundant in the dry season became very scarce during the rainy season. The larger larval parasites, particularly the ichneumonids, seemed to be less affected by this seasonal change.

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**REFERENCES CITED**


De Silva, M. D. 1961. A preliminary list of the native...
Response of Flying Bollworm Moths and Other Tympanate Moths to Pulsed Ultrasound

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ABSTRACT

Free-flying bollworm moths, Heliothis sea (Boddie), and 10 other species of tympanate moths (Lepidoptera: Noctuidae) made evasive maneuvers (turn-aways, loops, and dives to the ground) when they were exposed to pulsed ultrasound; the looping (spiraling) was the more successful method of evading pursuing bats. Ultrasound that was most effective in causing evasive responses in bollworm moths was delivered at frequencies of 18-40 kilohertz (4-15 pulses/sec) with pulse durations of 4-10 milliseconds in pulse trains of 2-6-sec duration at sound levels of 80 decibels (db) or higher (0 db = 2x10^-10 dynes/cm^2). A pulse rate of 2/sec or less was not as effective. Not all moths exposed to pulsed ultrasound made evasive responses. However, a check of the acoustic sensitivity of the 2 sound-detecting cells in the tympanum of some nonresponding H. sea showed that the acoustic cells were responding to the stimuli; hence, the pulsed ultrasound had been detected. Habituation at 2nd or higher order neutral levels probably explains the behavior of the nonresponders.

Griffin et al. (1960) demonstrated that flying insectivorous bats emit pulsed high-frequency sounds that reverberate off the insects and thus allow the bats to track and capture their prey. Roeder and Treat (1957) showed that many noctuid moths have tympanic organs which detect this pulsed ultrasound, and that the moths subsequently make evasive flight maneuvers tending to carry them away from the bat (Roeder and Treat 1961). Ultrasound generated by electronic instruments also caused evasive actions by such tympanate moths (Roeder 1962).

Roeder (1962, 1964) classified the evasive maneuvers of tympanate moths in response to batlike sounds into 4 categories: (1) no response—moths continued normal flight; (2) turn-away—moths varied direction of flight away from the source of the sound; (3) loop—moths made spirals or loops in the air without any particular orientation to the source of sound; and (4) dive response—moths made power or freefall dives to the ground or came near the ground and then resumed flight. Subsequent electrophysiological studies (Roeder 1966, Agee 1967) demonstrated that the A11 acoustic receptor, the more sensitive of the 2 acoustic cells in each tympanum of the bollworm moth, Heliothis sea (Boddie), was most sensitive to 18-25 kilohertz (kHz; 1 kHz = 1000 cycle/sec) pulses. However, the activity produced in bollworm moths by the pulsed sound was not studied, partly because it was difficult to capture moths that responded to the ultrasound; those that turned away from the source had to be caught with a net, and those that dived or looped to the ground often hid in the grass.

Since tympanate moths react evasively to ultrasound, pulsed ultrasound with the proper characteristics might be used to reduce or prevent infestation of the bollworm, an important pest of many fiber and food crops. This study was made to determine (1) the reaction of bollworm and other tympanate moths to pulsed ultrasound and (2) which ultrasound stimuli were most effective in eliciting the evasive responses.

METHODS AND TESTS

Moth Response at Several Sound Levels.—Since the capture of flying moths or of moths that dived into the grass was particularly difficult, insect netting (50x50 ft) was spread over the lawn between a laboratory building and a cotton field near Florence, S. C., to prevent the moths from hiding in the grass. Thus, the area of observation was the airspace in a 180° arc on the horizontal plane by the side of the building. Assistants with flashlights stationed on each side of the netting could capture the moths as they evaded the pulsed ultrasound and rested on the net-