Occurrence of the Rice Leafroller in Japan

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The rice leafroller (*Cnaphalocrocis medinalis* Guenée) was known by its sporadic outbreaks in pre-War period (Sakai et al. 1942). However, it was after 1970's that it occurred habitually, particularly centering in Kyushu region. It is interesting that the occurrence has increased in contrast to the decrease in outbreaks of the rice stem-borer (*Chilo suppresalis* Walker). Several recent reports[2,5,9] showed that *C. medinalis* does not overwinter in Japan except Okinawa, but it comes from overseas by long-distance migration every year in the Bai-u season (rainy season in June–July) just like other important rice pests, the white-backed rice planthopper (*Sogatella furcifera* Horváth) and the brown rice planthopper (*Nilaparvata lugens* Stål).

Fig. 1. Distribution of occurrences of rice leafroller in 1973. Occurrences are expressed by ratios of infested area to the total rice area. Figure drawn by using data of Hirao (1977): Shokubutsu Boeki 31 (12) 493–496.

Distribution of the occurrence in Japan

Distribution of the occurrence of *C. medinalis* in 1973, a year with a relatively severe outbreak is shown in Fig. 1. As evident in the figure, the outbreak was most frequent in Kyushu, followed by Shikoku and Chugoku in that order, and least frequent in the middle part of Japan. In Tohoku and Hokkaido, there was only a few occurrence. Such a pattern in the occurrence as above was observed almost commonly in every year, irrespective of different severity of total occurrences.

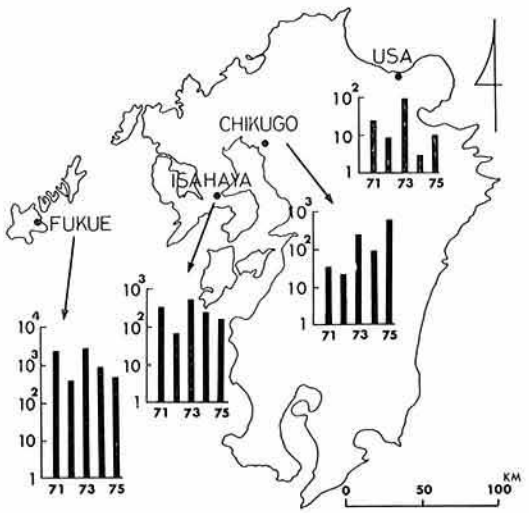

Fig. 2. Number of rice leafroller moths trapped at 4 locations in Kyushu.

Details of the occurrence in both Kyushu and Tohoku region are shown in Figs. 2 and 3, respectively.

In Fig. 2, the total number of moths trapped by a light trap during a year is shown for 4 locations and for 5 years from 1971 to 1975. Of the 4 locations, Fukue, Isahaya and Chikugo are at the west, i.e., the East China Sea side, of the Kyushu mountain backbone, which stretches from north to south in the central part of Kyushu, while Usa is located at the east of the mountain, i.e., the Pacific side.

Fukue, a westmost site, in a remote island of Nagasaki Prefecture is known to show the

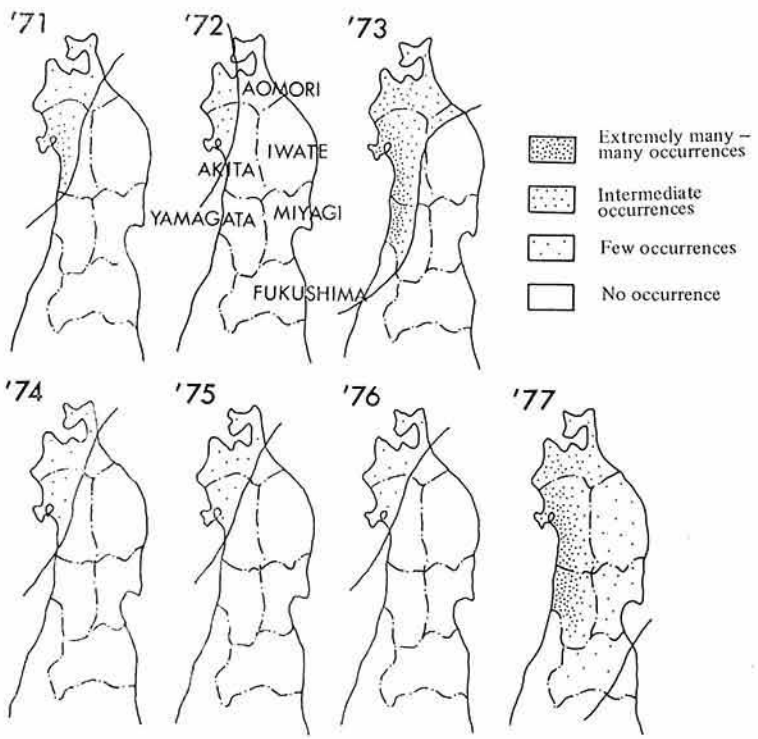

Fig. 3. Recent occurrences of rice leafroller in Tohoku region[9].

greatest number of trapped moths as compared with those of all other prefectures of Kyushu. This fact is shown also in Fig. 2. Isahaya, located in Nagasaki Prefecture, but in Kyushu main island, showed less number of trapped moths, and Chikugo, further east from Isahaya, showed further less number. Usa, in the Pacific side, showed the least number, as low as only 1/50 that of Fukue.

An example in Tohoku region, shown in Fig. 3, is cited from Sato and Kishino (1978). A trend similar to Kyushu can be observed: in Akita and Yamagata prefectures both in the west, i.e., the Japan Sea side, of the Oou mountain backbone showed more occurrence as compared to Miyagi and Fukushima prefectures located in the Pacific side. Thus, the general trend is more occurrence in west side, while less occurrence in east side in the whole Japan archipelago.

In the Korean peninsula, the first occurrence in early July was started in the south and west coasts, and the occurrence by the following 1–2 generations spread to the northeast.[1]

The geographical distribution of occurrence of this insect in Korea and Japan is relatively similar to those of *S. frucifera* and *N. lugens*. The both planthoppers are known to migrate flying on the front moving eastwards over the East China Sea in the Bai-u season of June–July.[4] The rice leafroller may show the similar pattern of occurrence as those of these two species, because it takes the similar course of migration.

Overwintering and migration

Overwintering of the *C. medinalis* has been confirmed only in Okinawa.[10] It is not clearly observed in the Amami Islands, north of Okinawa, and not confirmed in Kyushu main island and north. As the insect does not hibernate[9] low temperature in the winter affects overwintering. Sato and Kishino (1978)[9] made clear that eggs and larvae of this insect can not survive but detailed study on its cold hardiness is required.

The long-distance migration by flight of this insect is supported by the fact that the insect, together with *S. frucifera* and *N. lugens*, is caught by surveys made in Bai-u seasons every year on the East China Sea at about 126 degrees of east longitude and 31 degrees of north latitude, although the quantity of the insect varys with different years.[5]

On the other hand, the author (Miyahara et al. 1981) examined the number of adults which appeared every day on early-planted rice in Chikugo, Fukuoka Prefecture, during the period of June–July, with the purpose of knowing the arrival of the insect. The result showed that the adults were discovered after the later half of June every year, and it was 1–3 days after the arrival of migrated *S. frucifera* and *N. lugens*. All the females discovered have already mated and had matured ovaries. It was reported that[3] insects which make long-distance migration have generally inmature ovaries during the migrating flight. The females caught on the East China Sea were also found to show very low rate of mating (Miyahara, 1980). Therefore, it is highly possible that the discovery of females on early-planted rice fields took place after a certain length of time since their landing, and the insect might have migrated together with *S. frucifera* and *N. lugens*. However, the number of the insect was very small as compared to the planthoppers, i.e. less than 10 per 0.1 ha during the survey period.

Arrival of rice leafroller at Tohoku region is later than Kyushu. In Shonai district of Yamagata Prefecture, the insect is caught by black-light traps starting from mid-July in years of early appearance, but usually from August.[2]

Seasonal variation in the occurrence

Seasonal variation of moth catch by black-light trap during a rice season at Chikugo is shown in Fig. 4, as an example of seasonal prevalence of *C. medinalis*. As clearly shown, the number of trapped moths varied extremely

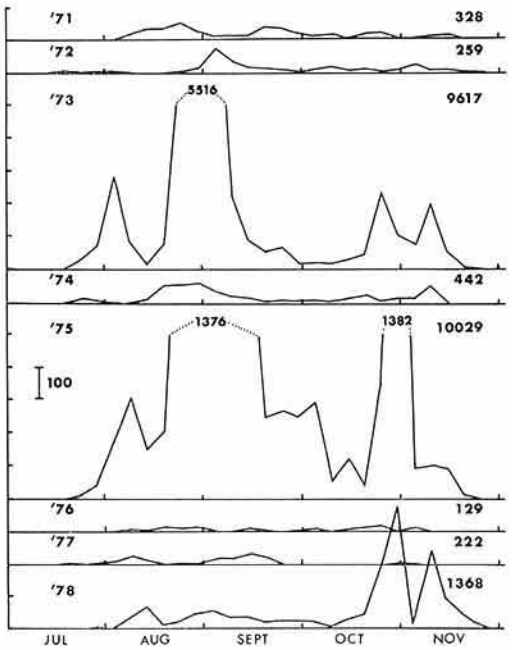

Fig. 4. Seasonal variation in number of rice leafroller moths trapped in a quarter of month in Chikugo.
Numerals in the right indicate annual total numbers.

with years. This is a remarkable characteristic of the type of occurrence of this insect.

In the years with severe outbreak, 1973 and 1975, a peak of occurrence appeared at the beginning of August. As rice transplanting is finished by the end of June, and the insect adults appear from the later half of June in Chikugo, this peak at the beginning of August is caused by the adults of next generation, developed from eggs laid by the insect which arrived by migrating flight. The largest peak appeared from late August to the early half of September was caused by the subsequent generation.

As heading occurs at early September, damage of rice plants by larvae is most serious at this stage. Although the trend after this stage to the harvest at the end of October was not clear, the presence of another 1–2 generations is presumed, that means a total of 3–4 generations in Chikugo.

As the greatest outbreak which occurs from late August to early September is closely correlated with the outbreak at the preceeding generation, the former can be forecasted at the beginning of August.[7] However, it is not possible yet to forecast the latter, i.e. the outbreak of the next generation of migrated moths. It may probably be determined by the number of moths arrived by early July and the environmental conditions affecting subsequent larval growth. As to the number of arrived moths it is difficult to grip the number, and there is a problem that they are not caught by light trap for forecasting. Therefore, the use of sex pheromone to determine the number of migrated moths is now under study, but effective pheromone has not yet found. The main bottleneck is that the method of mass rearing of adults from which pheromone is to be extracted has not been established yet. As an immediate countermeasures, the use of naturally occurring virgin females is been examined, as virgin females are obtained after the middle of September in some years in certain areas around Chikugo City.[13]

Study on population ecology in paddy fields is now in progress. The following 7 species of natural enemy were found: egg parasite: *Trichogramma* sp., larval parasite: *Trathala flavo-orbitalis*, *Goniozus japonicus*, *Apanteless* sp., pupal parasite: *Itoplectis narangae*, *Brachymeria excarinata*, and parasitic fly: *Pseudoperichaeta nigrolineata*.[6]

Recent trend of occurrences in Kyushu

Recent trend of occurrences of *C. medinalis* and other important rice insect pests is shown in Fig. 5. As already mentioned, the occurrence of *C. suppresalis*, most important so far, has decreased from year to year since 1970, whereas *C. medinals* has increased apparently to a level equal to *N. lugens*. On the other hand, the occurrence of green rice leafhopper (*Nephotettix cincticeps* Uhler) continued almost unchanged.

As to the reason for such an increase of *C. medinalis* occurrence, the author considers

that the shift of rice varieties from panicle-weight type to panicle-number type, and the accompanied change in fertilizer application may be the reason. As shown in Table 1, rate of nitrogen application has increased with more emphasis on top dressing. It is highly possible that such changes bring about favorable condition for larval growth of *C. medinalis*, and cause enhanced fecundity of adults emerged.

The change in the type of rice varieties is considered to have caused the decrease of *C. suppresalis*, and the recent decrease reached to a level not requiring insecticidal control. As a result, *C. medinalis* population was not effected by the insecticide for *C. suppresalis*, because it kills *C. medinalis* too. This is the second reason for the increase of *C. medinalis* occurrence.

Method of transplanting has also been changed: use of rice transplanters, introduced in 1970, has spread to 80% of the rice area of Japan in 1977. For the mechanical transplanting, young seedlings were used, and consequently time of top dressing differed from that in manual transplanting culture. There is already a survey indicating that the difference in top dressing time induced an increase of *C. medinalis* population. Attention has to be kept on such changes in the insect occurrence pattern associated with changes in rice variety and cultural practices in the future.

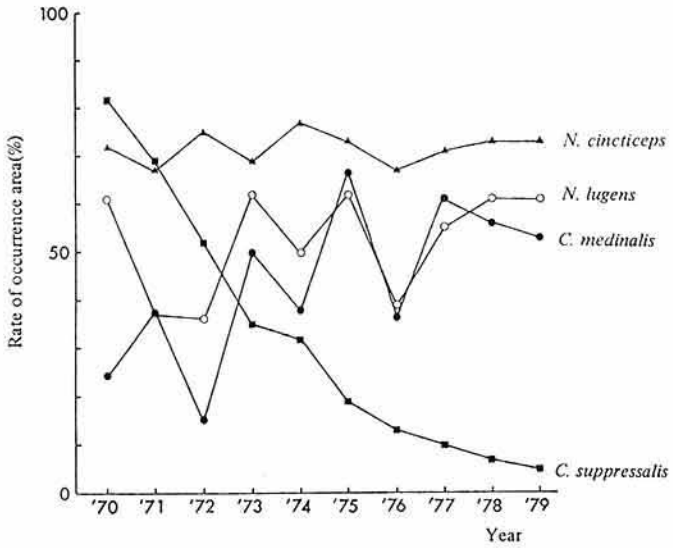

Fig. 5. Recent trend of occurrences of rice insect pests in Kyushu.
Cited from Kyushu Plant Protection Promoting Council: Ten years of history, 1–147 (1980).

Table 1. Changes in nitrogen application to ordinary season rice in Kyushu

Year	Variety	N kg/10a in prefectures indicated below			Percentage of N used for top dressing		
		Fukuoka	Saga	Kagoshima	Fukuoka	Saga	Kagoshima
1958	medium-long culm	7- 8	6- 8	6- 7	35	40	40
1965	medium-long culm	9-10	6- 8	7- 9	40-50	40-60	20-45
1974	medium-long culm	9-10	10-12	7- 9	40-50	40-60	15-45
1974	short culm	11-12	12-14	9-12	45-50	60-65	40-60

Cited from Seino (1980): Nogyo oyobi Engei 55(10) 1239–1243.

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