16. STUDY ON ECOLOGY OF THE RICE GALL MIDGE IN THAILAND

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Annual Fluctuation of Infestation of the Rice Gall Midge

The infestation of the rice gall midge in Chiengrai Province during the planting season was surveyed at an interval of 15 km from Payao to Maesai as long as 160 km or more in distance. In 1970, the survey was also extended to Lampang and Chiengmai Provinces for clarifying annual and seasonal flutuation of the damage to rice plants. Percentage of the damaged tiller (Fig. 1) was comparatively low in each place from June to July, but from September to October it prominently increased up to 15 to 65% in 1968. On the other hand, the striking outbreak of the rice gall midge was observed in this Province in 1969, and the percentage of the damaged tiller increased as much as over 85% in each place where the rice yield extremely decreased by 60%. The peak of the infestation was seen in September. It is provided that annual fluctuation of the insect population density has been observed in Chiengrai Province where they believe that severe damage caused by the insect occurs in every 3 to 5 years.

Distribution of the Rice Gall Midge in Thailand

It is interesting that the rice gall midge is distributed in east, northeast, and north districts in Thailand (Fig. 2.1-2). It was found that an isothermal line of mean temperature of 27°C in July in Thailand is in conformity with distribution pattern of the insect, and the mean temperature zone of 27°C in September, when the highest population of the insect occurs, occupied the area where the rice gall midge is distributed.

Effect of the Climatic Condition on Seasonal Prevalence of the Insect

A study on effect of climatic condition on seasonal prevalence of the rice gall midge adults was conducted (Fig. 3.1-5).

(1) The optimum mean temperature at which the rice gall midge emerged and laid her eggs in the paddy field ranged from 23 to 27°C. The mean temperature was over 25 to 27°C while the highest populatioin of the insect was seen in September at Pan, Chiengrai Province.

(2) Before the planting season, the rice gall midge began to appear in May, 1969 and at the end of March, 1970. This is suggesting that the appearance of the insect is closely related to the rainfall or water supply which is needed by the growth of the larvae on the alternate host plants. During the dry season before rain comes, the larvae on the alternate host plants were the first to second instar larvae so far as the writers examined plants grown in the dried place. On the other hand, a small

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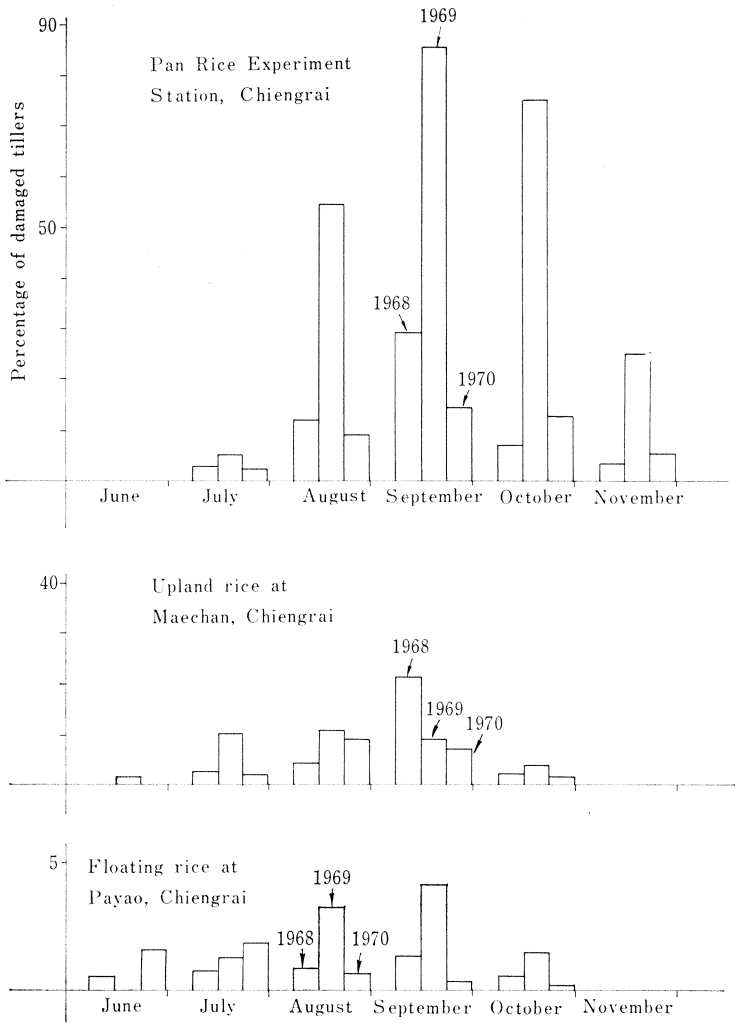

Fig. 1. Infestation of the rice gall midge in Chiengrai Province from 1968 to 1970.

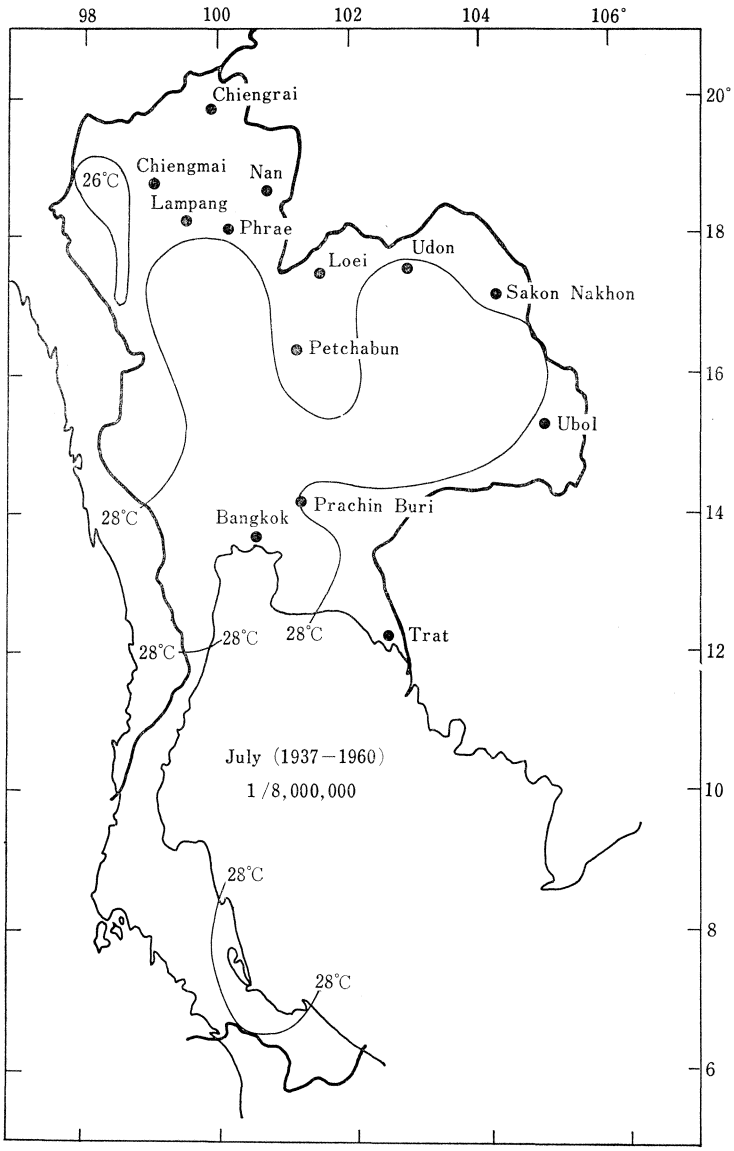

Fig. 2.1. Relation between distribution of the rice grll midge in Thailand and isothermal line of mean temperature.

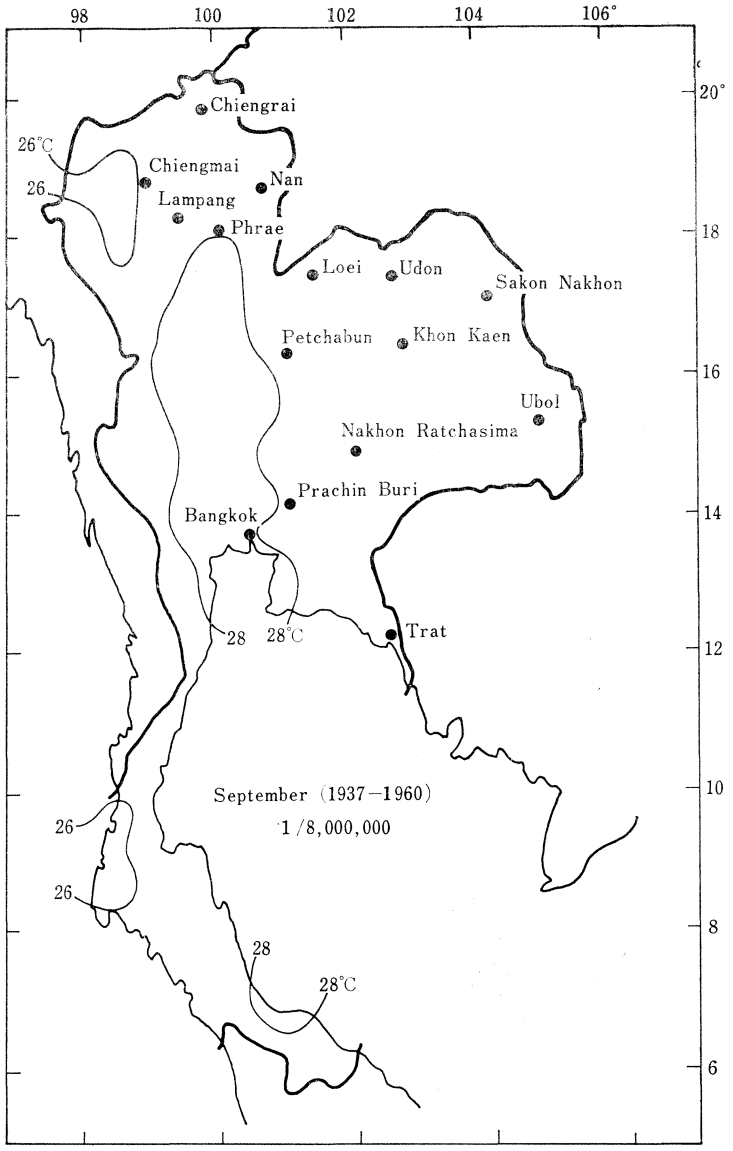

Fig. 2.2. Relation between distribution of the rice gall midge in Thailand and isothermal line of mean temperature.

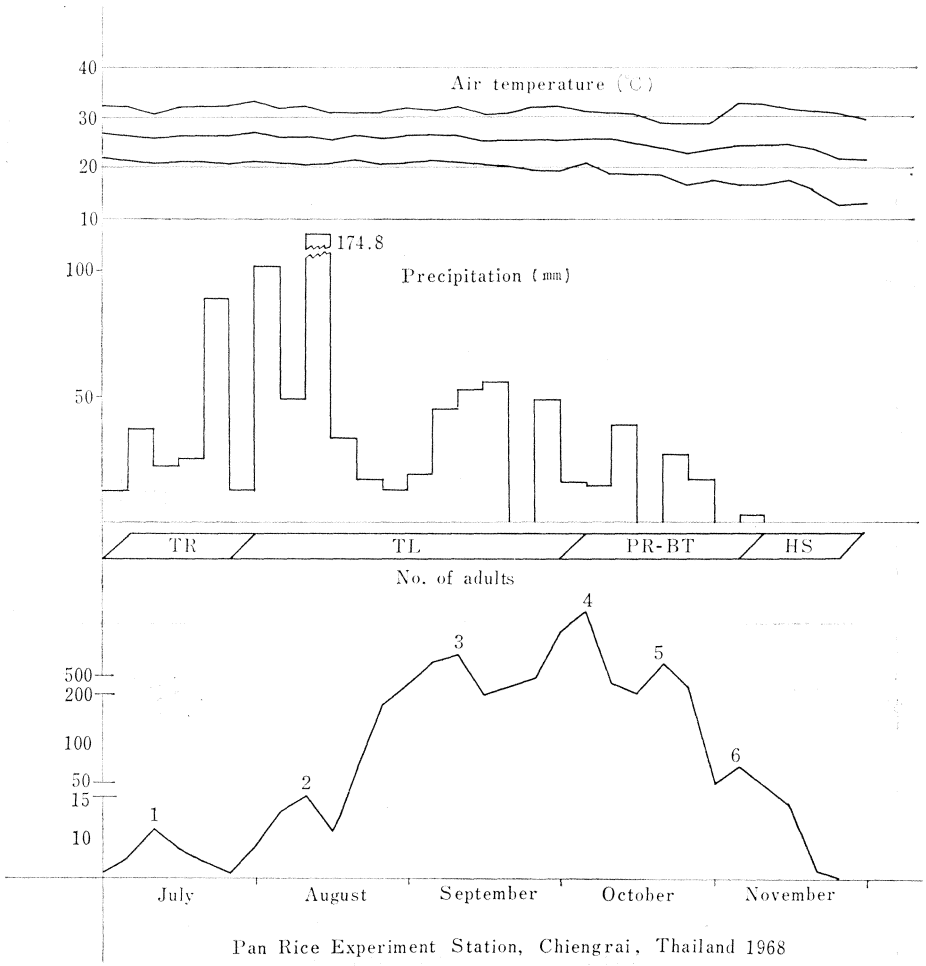

Fig. 3.1. Seasonal prevalence of number of the rice gall midge adults collected by the light trap at Pan Rice Experiment Station, Chiengrai, from 1968 to 1970.
HS; heading stage, PR-BT; primordium to booting stage,
TL; tillering stage, TR; transplanting.

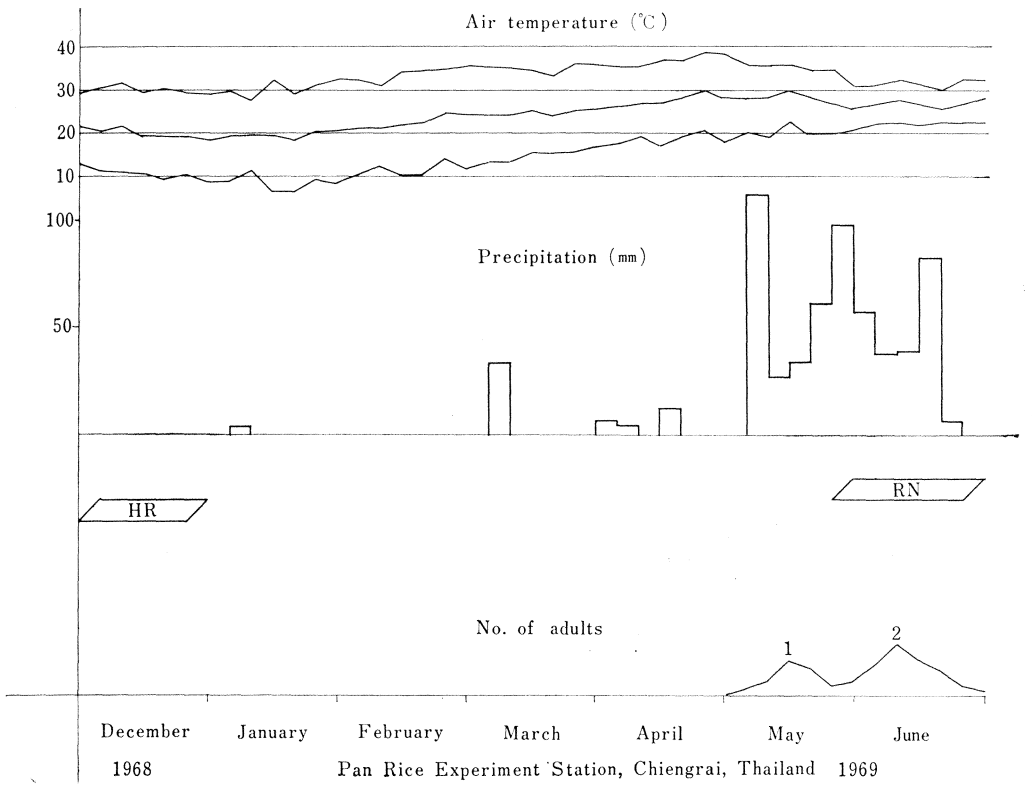

Fig. 3.2. Seasonal prevalence of number of the rice gall midge adults collected by the light trap at Pan Rice Experiment Station, Chiengrai, from 1968 to 1970.
HR; harvesting,
RN; rice nursery.

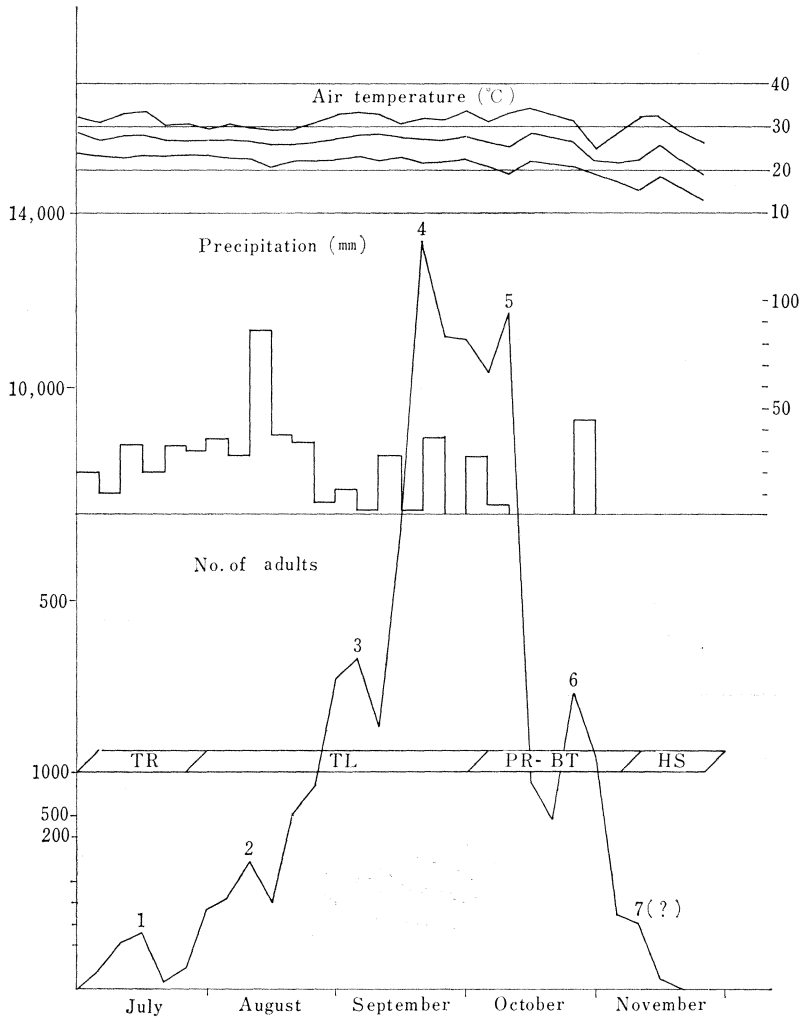

Fig. 3.3. Seasonal prevalence of number of the rice gall midge adults collected by the light trap at Pan Rice Experiment Station, Chiengrai, from 1968 to 1970.
HS; heading stage, PR-BT; primordium to booting stage,
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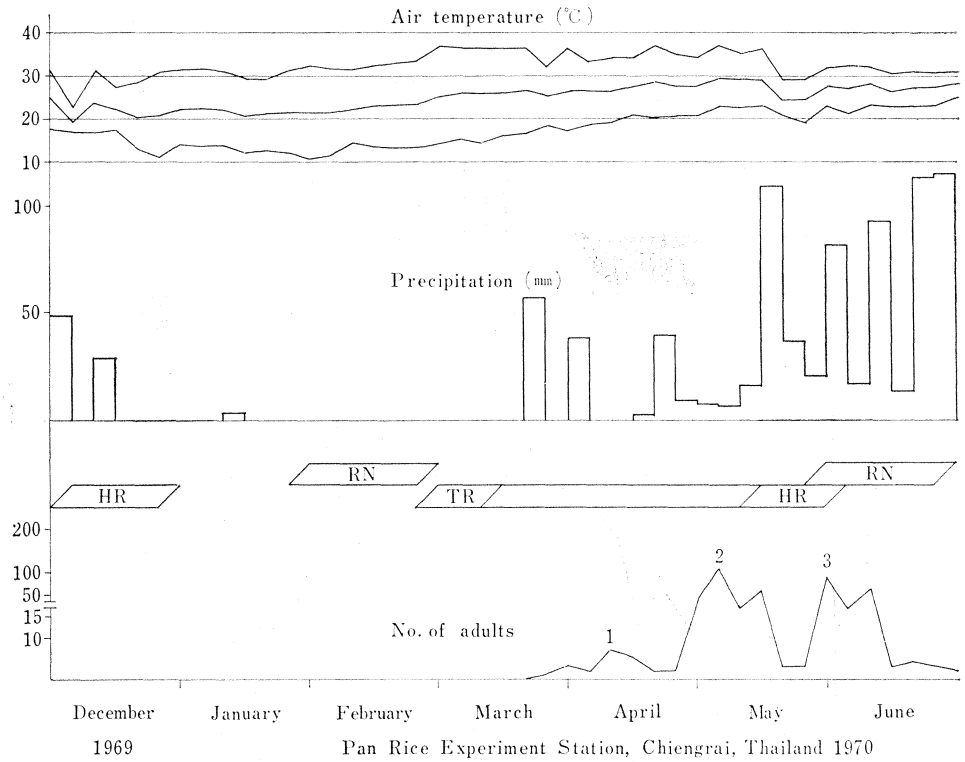

Fig. 3.4. Seasonal prevalence of number of the rice gall midge adults collected by the light trap at Pan Rice Experiment Station, Chiengrai, from 1968 to 1970.
HR; harvesting,
RN; rice nursery, TR; transplanting.

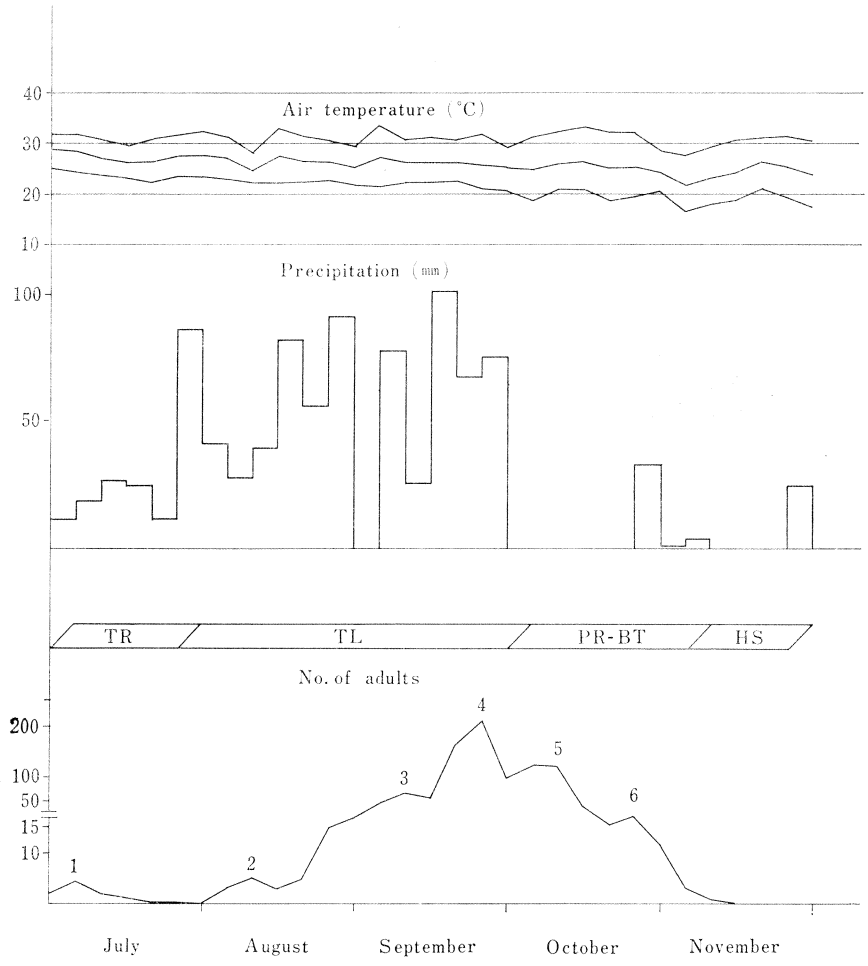

Fig. 3.5. Seasonal prevalence of number of the rice gall midge adults collected by the light trap at Pan Rice Experiment Station, Chiengrai, from 1968 to 1970.
HS; heading stage, PR-BT; primordium to booting stage, TL; tillering stage, TR; transplanting.

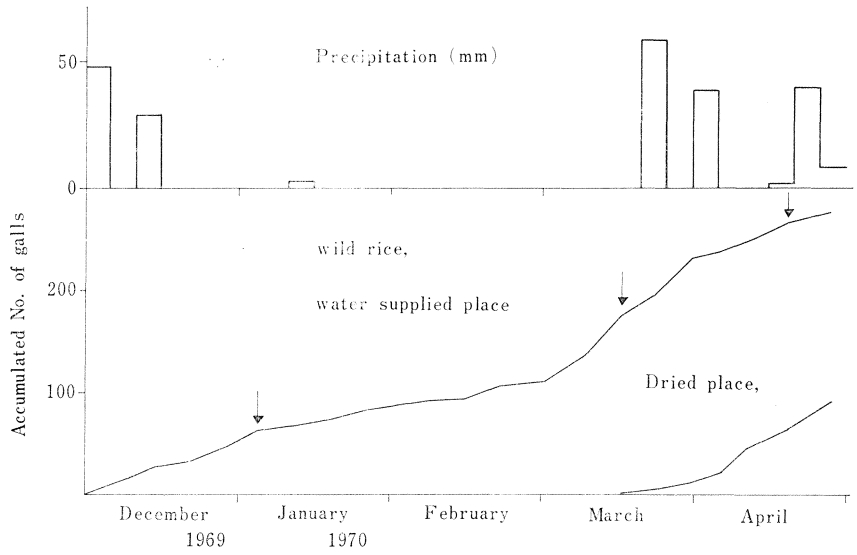

Fig. 4. Comparision of gall occurrence between water supplied and dried places during dry season at Pan, Chiengrai, 1969 to 1970. The mark arrow represents the peak of each generation.

number of galls appeared from the plants which were supplied with water throughout the dry season (Fig. 4).

During the planting season, much precipitation was observed in the middle of August. The rainfall continued everyday for almost two weeks around the middle of August. On those days, the peak of the second generation of the insect appeared, and then, adults of the second generation were under the optimum climatic conditions for laying her eggs and increasing percentage of hatched eggs. Moreover, the larvae of the third generation propagated more in number than those of the second generation. The insect adults also emerged abundantly in their numbers.

(3) While the rice gall midge population increased, cloud cover was more than 80 percent at the Pan Rice Experiment Station in August and September. On the other hand, sunlight hours per day of both months were less than 5 hours on the average, but the sunlight had not been seen at Pan for two weeks around the middle of August. It is presumed that the cloud cover gives apparently the important influence on the activity of laying her eggs, adult longevity, and percentage of hatched eggs which are also under the influence of the sunlight hour.

(4) The relative humidity during the rice gall midge occurrence in the paddy field was 75 percent on the average and the minimum relative humidity, while the insect disappeared, was 46 percent in December, 35 percent in January, 27 percent in February, and 23 percent in March. If adults of the rice gall midge emerge during the dry season from December to April, the adults will die of lower humidity under natural conditions, their longevity will be shortened because of longer sunlight hours especially in March and April, and theiir survival rate will also decrease in the day tiime during these months (cf. cultural practice—planting dates).

Under the above mentioned climatic conditions, actually six peaks in 1968 and 9 peaks in 1969 and 1970 were recognized throughout the year. The highest peak was observed during September in the said three years. The adults appeared from May in 1969 and from the end of March in 1970, and disappeared in the middle of November during the

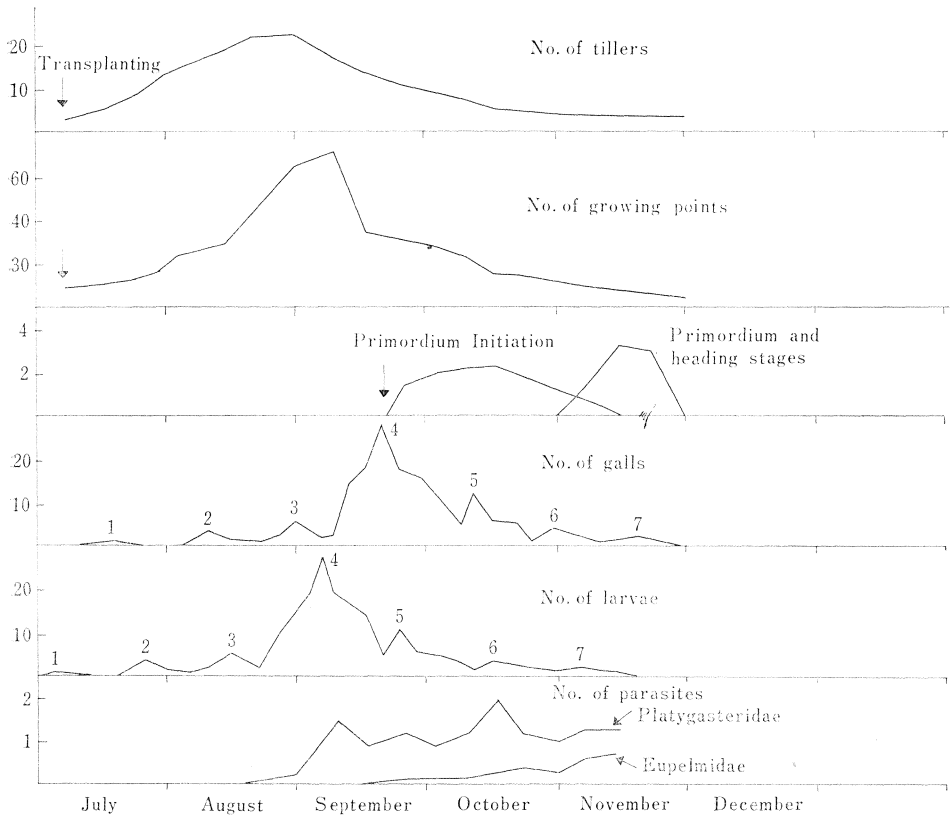

Fig. 5.1. Relation between growing stages of rice plants and gall occurrence in the different planting dates at Pan Rice Experiment Station, 1969. 5–1; transplanted in July 7, 5–2; transplanted in August 25.

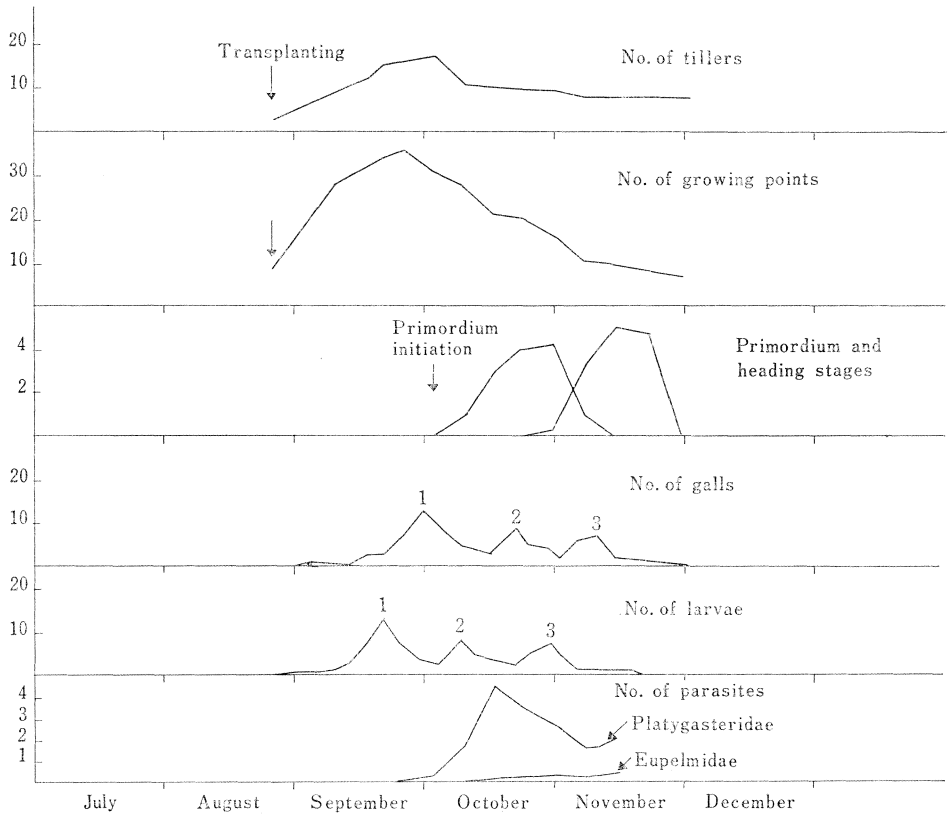

Fig. 5.2. Relation between growing stages of rice plants and gall occurrence in the different planting dates at Pan Rice Experiment Station, 1969. 5–1; transplanted in July 7, 5–2; transplanted in August 25.

past three years. During the planting season, they had six and seven generations so far as the writers examined at the Pan Rice Experiment Station. Number of generations in the different planting dates is also given in the Figures 5.1–2.

Control of the Rice Gall Midge

A study on control of the rice gall midge was successfully carried out by means of cultural practice and utilization of resistant varieties.

Effect of the Planting Dates on the Damage Caused by the Rice Gall Midge

Cultural practice with special reference to the different planting dates of rice plants was investigated at the Pan Rice Experiment Station in Thailand (Fig. 5.2-1 and Fig. 6). Rice plants transplanted in July were severely damaged; in another word, less infestation is obtained in late transplanting in August due to the short period of the vegetative growth when photo-sensitive rice varieties were examined. Rice yield apparently increased in late transplanting of rice plants as well as the number of the panicles and dried straw per hill. Less infestation was also observed in the second crops of rice during the dry season.

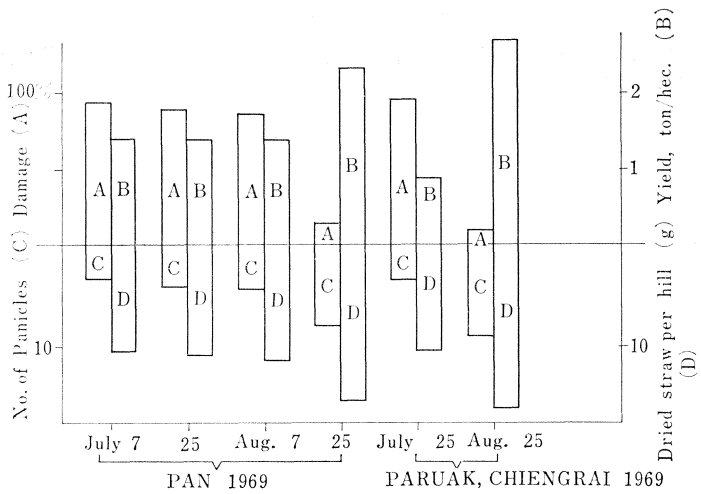

Fig. 6. Relation between damage and yield in different planting dates at Pan and Paruak, Chiengrai, 1969.
A; damage in per cent, B; yield in ton per hectare, C; No. of panicles per hill, D; dried straw per hill in gramme.

It was clarified that the insect population usually increased in number during vegetative growth of rice plants due to a lot of the growing points formed. The larval population of the fourth generation was more increasing than that of the other generation. The peak of the larva lpopulation of the fourth generation came at the time of the peak of the growing point formation. This is suggested that the insect population increased in proportion to the increase in number of the growing points. The primordium initiation began to increase in number and the peak reached in the middle of October. The larval population usually decreased after the primordium initiation which is the most important factor to reduce the larval population. In another word, the rice gall midge larvae can not grow on the primordium of rice plants.

Relation between Growing Stage of Rice Plants and Infestation of the Rice Gall Midge

The writers proved in 1968 that the most susceptible stage of rice plants against the rice gall midge attack was 30 to 45 days after sowing seeds (Fig. 7). The high

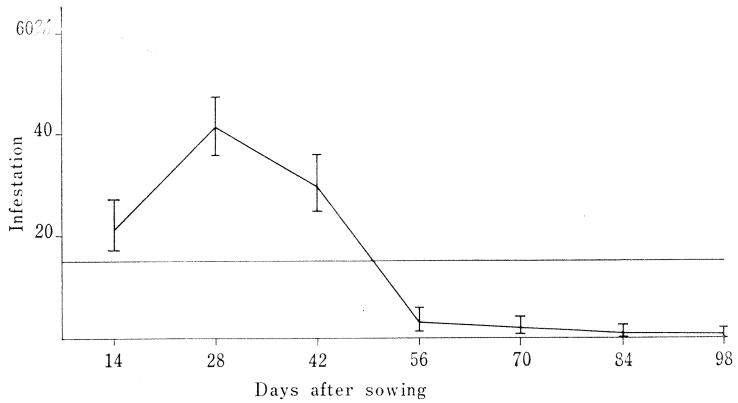

Fig. 7. Gall occurrence in different growing stages of rice plants at Bangkhen and Pan, 1968.

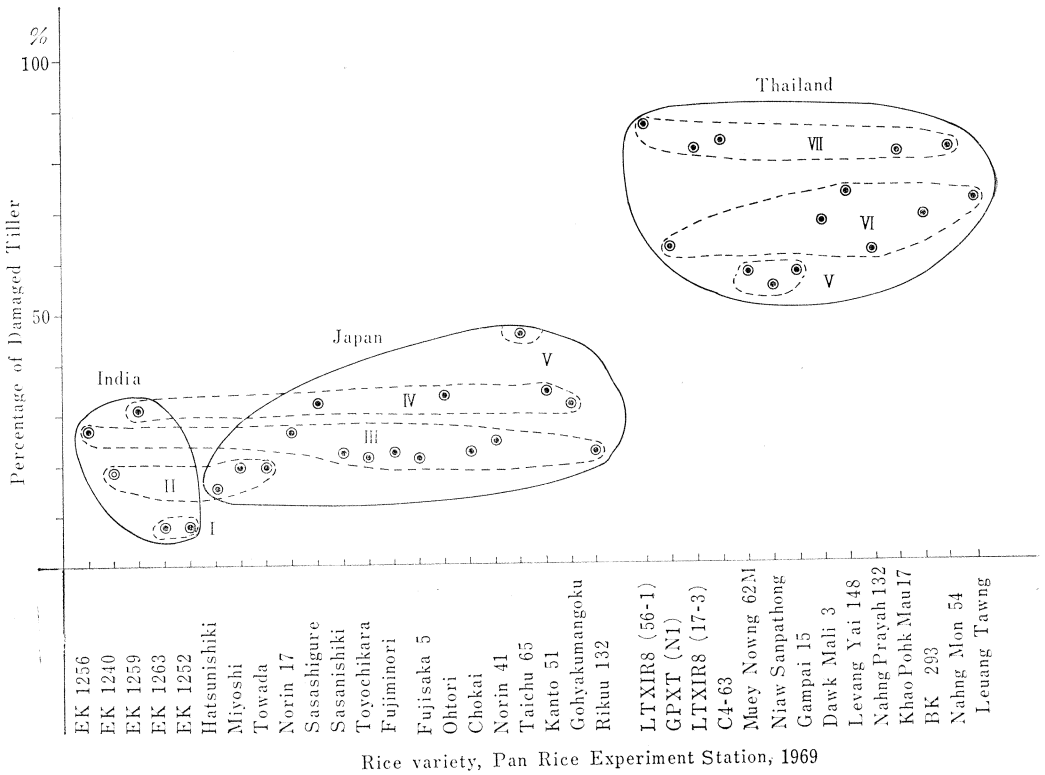

Fig. 8. Screening test of resistant varieties from Thailand, India, and Japan at Pan Rice Experiment Station, 1969.

mortality of the insect was seen from primordium to the heading stage of rice plants. It is also considered that the susceptible stage against the rice gall midge is suggesting the timing of insecticidal application.

Varietal Reaction against the Rice Gall Midge

155 rice varieties including 16 Japanese and 5 Indian varieties were tested in order to list up the resistant varieties (Fig. 8). Two lines of EK from India were so highly resistant that these could be used as a parent of hybrid for improvement of rice varieties in Thailand. Infestation of 16 Japanese varieties showed 15 to 35 percent of the damaged tillers. All of Thailand recommended varieties used in the present study were also susceptible.

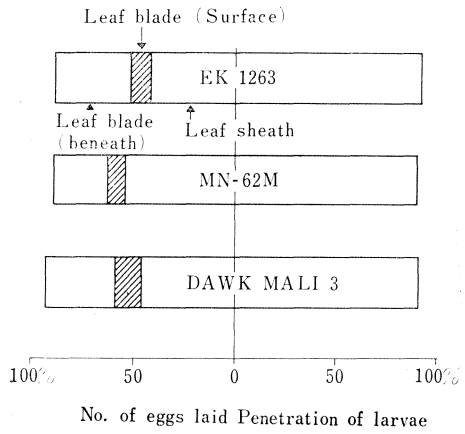

Fig. 9. Preference of egg laying and penetration of newly hatched larvae into growing points of 3 rice varieties at Pan, 1969.

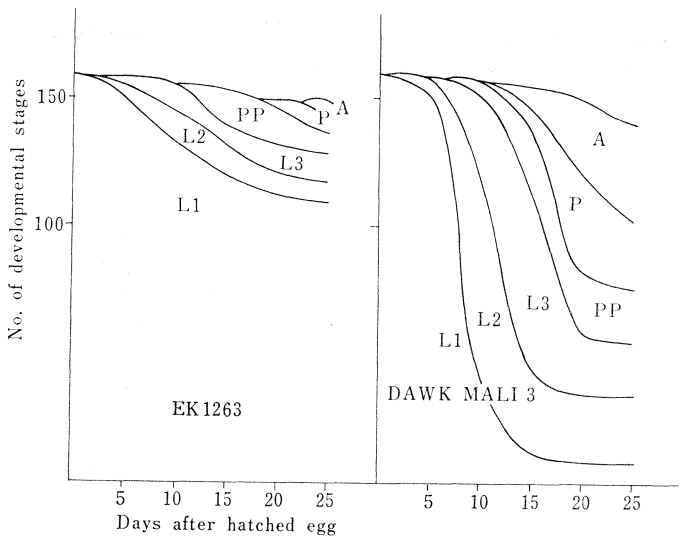

Fig. 10. Comparision of larval development between a susceptible (Dawk Mali 3) and a resistant (EK 1263) varieties at Pan, Chiengrai, 1970. L1-3; Larval instar, PP; prepupa, P; pupa, A; adult.

Resistant Mechanism on Rice Plants against the Rice Gall Midge

Factors of resistance against the insect between susceptible and resistant varieties were comparatively studied from the viewpoint of the number of egg laying, penetration of larvae to growing points, and the larval development of the rice gall midge on rice plants (Figs. 9 and 10). It was clarified that any difference of the number of egg laying and penetration of the larvae could not be found between susceptible and resistant varieties. However, the larvae on a highly resistant variety, EK 1263, could not grow to the advanced development stage and they were almost the first instar larvae. On the other hand, the larvae which penetrated into a susceptible variety, Dawk Mali 3, were seen to normally develop up to the adult stage. It is considered that the larval development is prominently inhibited by some kinds of substance in the resistant variety or that a nutritional substance, which is necessary for the larval development, will be deficient.

Bionomics of the Rice Gall Midge

Bionomics of the rice gall midge has been studied in the following facts.

The average longevity of adults was 2.28 days (Fig. 11), the average number of

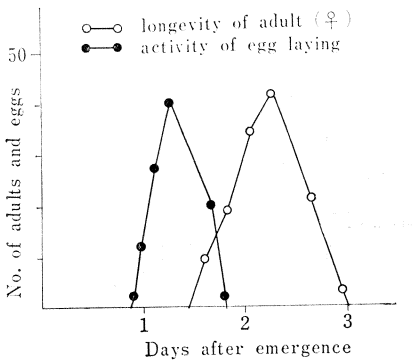

Fig. 11. Relation between longevity of adult female and activity of egg laying at Pan Rice Experiment Station, 1968.

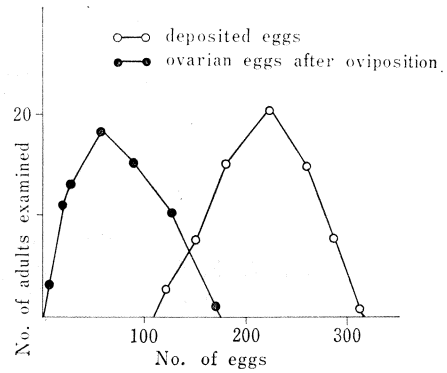

Fig. 12. No. of ovarian and laid eggs per female at Pan, 1968.

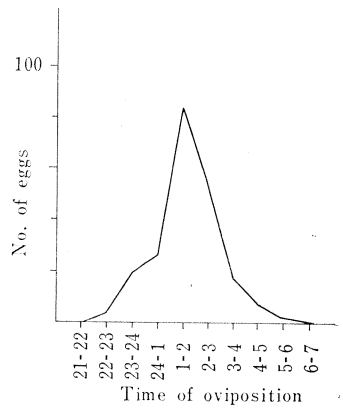

Fig. 13. Time of egg laying by the rice gall midge at Pan, Chiengrai, 1968.

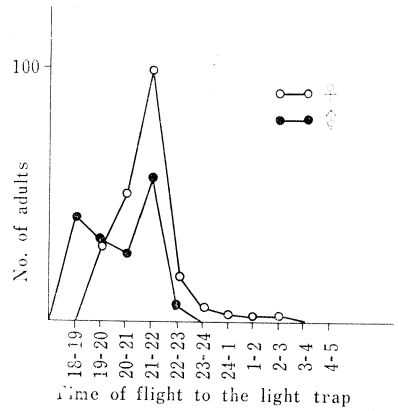

Fig. 14. No. of adults collected by the lignt trap at Pan, 1968.

ovarian eggs per female was 276.12 and the average number of eggs deposited was 221.26 (Fig. 12). The peak of egg laying was at midnight (Fig. 13). Most adults were caught at 21:00 o'clock in the light trap (Fig. 14) and the incubation period was 3.22 days on the average (Fig. 15). The peak of hatching occured at 3:00 a.m. (Fig. 16). Hatchiability was higher than 80 in percentage when the humidity was more than 60 percent (Fig. 17). As usual, the eggs were commonly deposited on beneath of the leaf blade of rice plants and the eggs were mainly laid on the fourth leaf of rice seedlings (Fig. 18). The larva had three instars, requiring four days for the first instar, six days for the second instar, and four days for the third instar, respectively (Fig. 19). The first instar larvae commonly penetrate down along the inside of the leaf sheaths until they reach the growing point of the tillers. After the penetration is over, the oval chamber is formed within two days. The period of the prepupae was three days and the pupae three days on the average. Pupation occurs around the growing point. Pupae just before emergence climbed up along the inside of the gall and reached to the spongy part of the gall, then, the pupal body was kept half way out. It was proved that the growth of the gall was in proportion to the developmental stage of the rice gall midge (Fig. 19), and especially that the gall had rapidly grown from prepupal to pupal stage. Usually the adults emerged at 22:00 o'clock (Fig. 20), beginning to

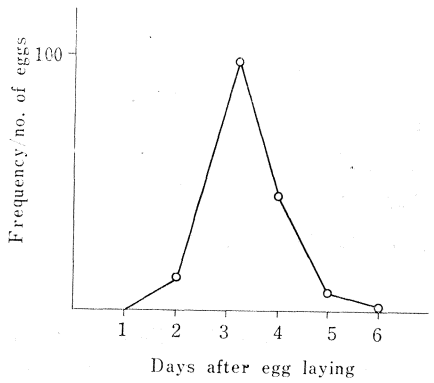

Fig. 15. Incubation period at Pan, 1968.

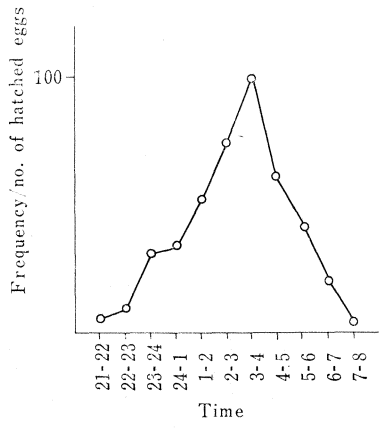

Fig. 16. Time of egg hatching at Pan, 1968.

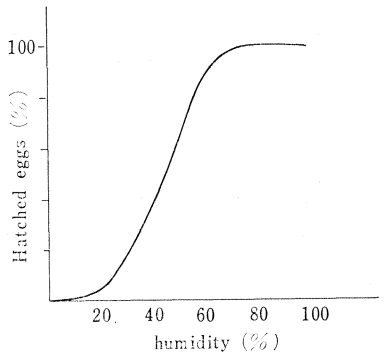

Fig. 17. Effect of humidity on hatchiability of the rice gall midge at Pan, 1969.

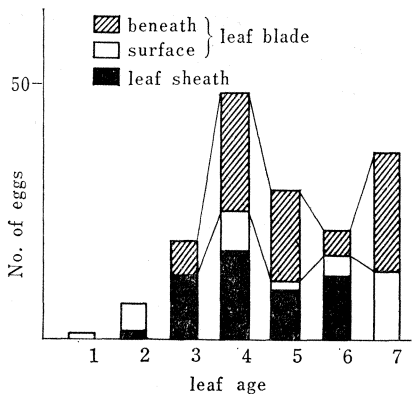

Fig. 18. Preference of egg laying on rice seedlings at Pan, 1968.

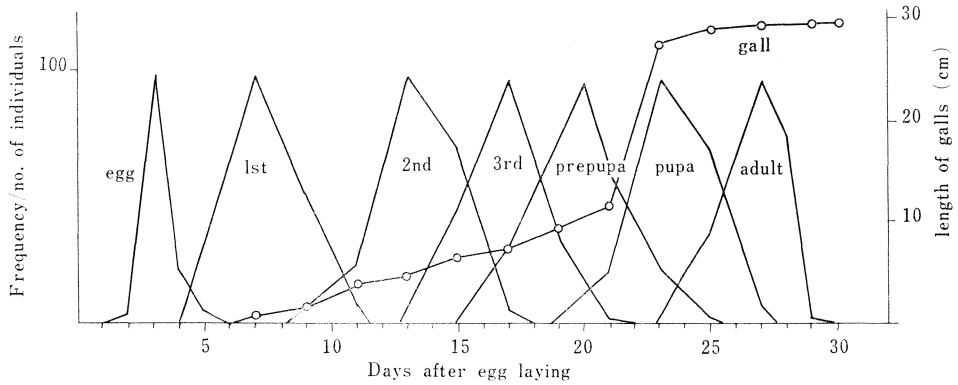

Fig. 19. Developmental stages of the rice gall midge and growth of gall at Pan, 1968.

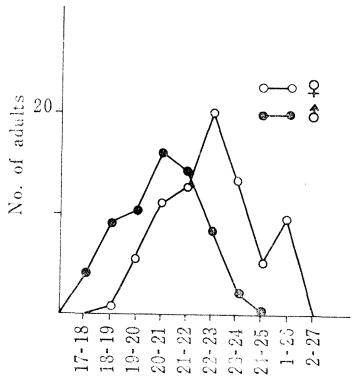

Fig. 20. Time of adult emergence at Pan, 1968.

lay the eggs one day after emergence (Fig. 11).

Number of days required for one generation was twenty five days in general, but sometimes the period was remarkably shortened as short as twenty days from October to November because of nutritional effect of rice plants after the primordium initiation period.

How to Distinguish between Healthy and Damaged Seedlings

During rice seedlings, the presence of the gall cannot be observed from outside of rice plants until the causal larva grows up around the prepupal stage. Sometimes it is very difficult to distinguish between healthy and damaged seedlings. The writers proved that the damaged seedling was significantly shorter than the healthy seedling. The details are given in the Table 1.

Preference of Larval Attack by the Rice Gall Midge on Rice Tillering

It is interesting that the larva of the rice gall midge prefers to attack mainly the primary tiller in which the insect developmental stages were the highest in the total number (Fig. 21). The population desity of the insect found in the growing points tends to be higher in the order of the primary, secondary, tertiary, fourth, and fifth tillerings. In the primary tillering, all of the developmental stages are found, but some of the stages could not be found in the secondary, tertiary, fourth, and fifth tillerings. In another word, it was seen that the older stage of the insect was always

Table 1. Distinguishable characters between healthly and infested rice seedlings.

Items	Infested rice seedling	Healthy rice seedling
1. Height of plant	24.21 cm	32.74 cm
2. Leaf age	4.95	6.12
3. Tillering	1—5	1—3
	The 5th leaf of main stem is districtly extended to 4th leaf auricle, distance between 4 and 5th auricles is about 2–3 cm in an average, the 6th leaf invible. The 4 and 5th leaf sheathes are clearly apart if 6th leaf occured.	The 6th is prominently visible
4. Colour	dull green	green
5. General status	basal part of stem rather hard and cylindered in shape	basal part of stem flattened softly

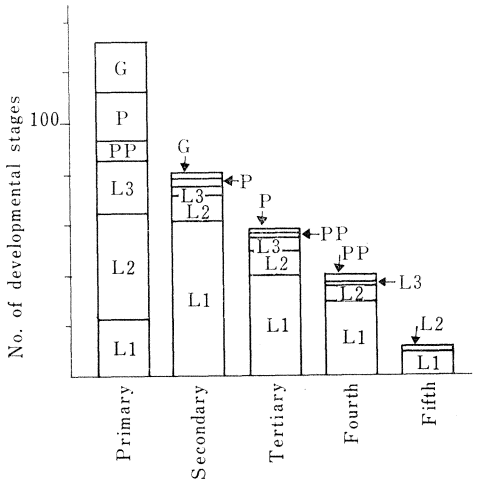

Fig. 21. Relation between larval development of the rice gall midge and growth of tillering of rice plants at Pan. L1–3; larval instar, PP; prepupa, P; pupa, G: gall.

in the primary tillering and the younger stage was in the secondary and tertiary tillerings. It is suggested that the larval development among these tillerings is closely related with the growth rate of the growing points of rice plants.

Alternate Host Plants of the Rice Gall Midge

Several kinds of the alternate host plants found in northern Thailand are as follows. 1. *Oryza officinalis* (wild rice), 2. *Ischaenum aristatum*, 3. *Echinoclora colonum*, 4. *Paspalum* sp., and 5. *Leersia* sp., which is belonging to the Family Graminanceae. Adults reared on *Ischaenum aristatum* is comparatively small in size and slightly darker in body colour than the adult which emerged from rice plants. The gall on *Ischaenum aristatum* is extremely shorter than that of rice plants. Adults from wild rice had the same body size and colour as those from rice plants. Adults reared on wild rice could attack rice plants and the larvae normally developed on rice plants. Larvae survived on *Leersia* sp. and *Echinoclora colonum* were extremely lower than those of wild rice and *Paspalum* sp. It is considered that the larval development may be inhibited

during the dry season because of shortage of water supply. Anyway, the wild rice would be the most suitable plants for sustaining the insect geneartion to generation and the plant will be occurrence sources of the insect before the planting.

Natural Enemies of the Rice Gall Midge

As far as the writers' investigation on natural enemies of the rice gall midge,

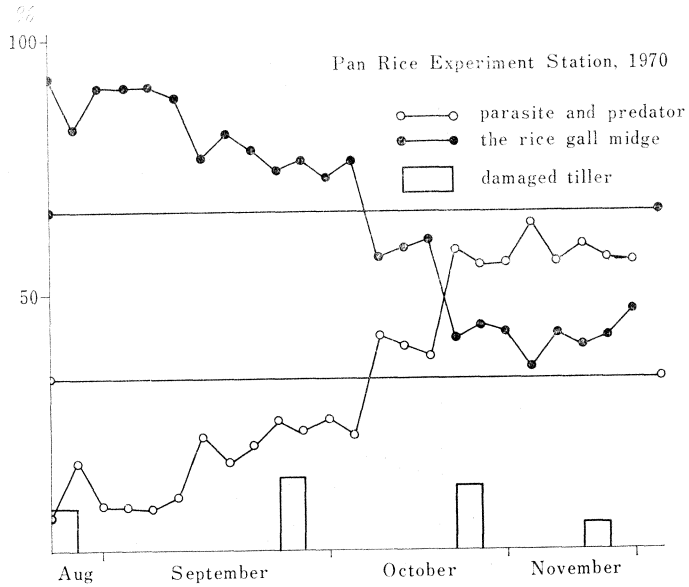

Fig. 22.1–A. Fluctuation of parasitism against the rice gall midge at Pan in Chiengrai Province, wet season, 1970.

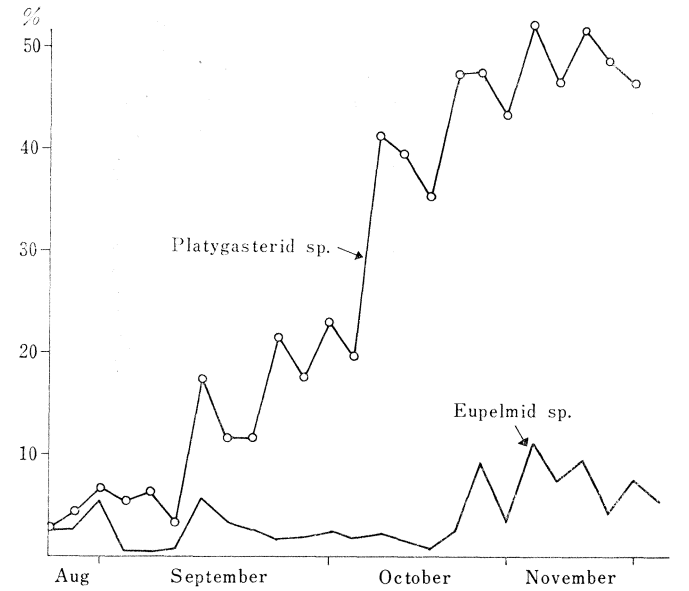

Fig. 22.1–B. Fluctuation of parasitism against the rice gall midge at Pan in Chiengrai Province, wet season, 1970.

three species of Hymenopterous parasites of the Families Platygasteridae, Pteromalidae and Eupelmidae were collected, besides one species of predator belonging to the Family Carabidae was also found in the paddy field. The parasitic and predacious activities at the Pan Rice Experiment Station in 1970 are given in the Figures 22.1 A and B. It is observed that the Platygasterid parasite was dominant among the natural enemies of the rice gall midge and that her population began to increase from September which correspond to larval occurrence of the fourth generation. On the other hand, in 1969, the parasite began to appear from the beginning of September and could not appear in the first to third generation of the rice gall midge in July and August (Fig. 5-1). Parasitism of the Platygasterid parasite reached at least 15 percent in

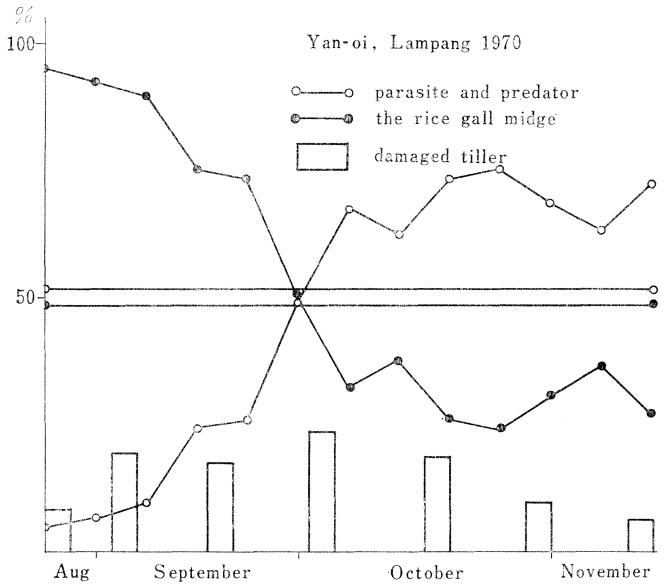

Fig. 22.2–A. Fluctuation of parasitism against the rice gall midge at Yan-oi in Lampang Province, wet season, 1970.

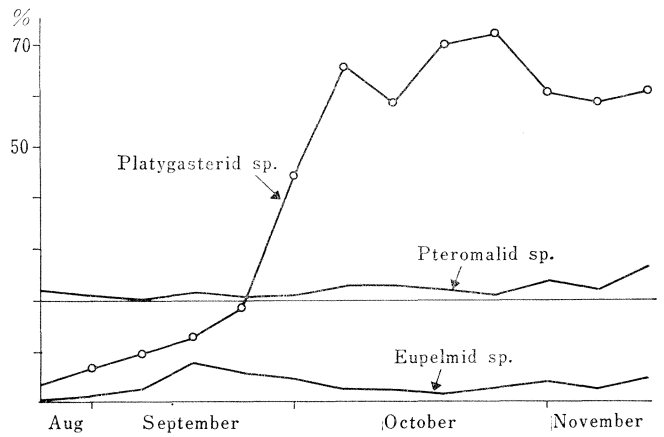

Fig. 22.2–B. Fluctuation of parasitism against the rice gall midge at Yan-oi in Lampang Province, wet season, 1970.

1969 and 65 percent in 1970. Parasitism of the Eulopid and Pteromalid parasites was lower than 7 percent in 1969 and 29 percent in 1970. In 1969, lower parasitic activity of the said parasites against the rice gall midge was observed at Pan which suffered from the severe damage caused by the insect occurred. The Parasitic activity at Yan-Oi in Lampang Province (Figs. 22-2 A and B) was so extremely high that severe

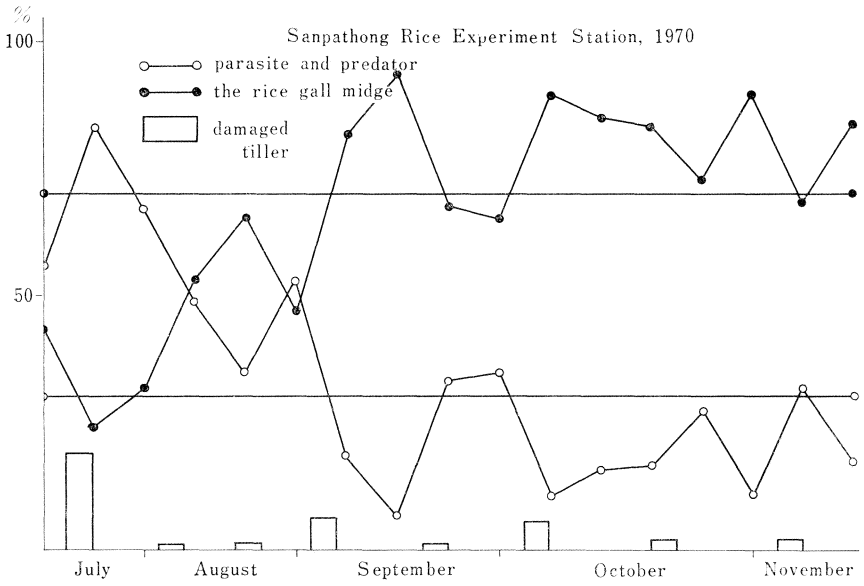

Fig. 22.3-A. Fluctuation of parasitism against the rice gall midge at Sanpathong in Chiengmai Province, wet season, 1970.

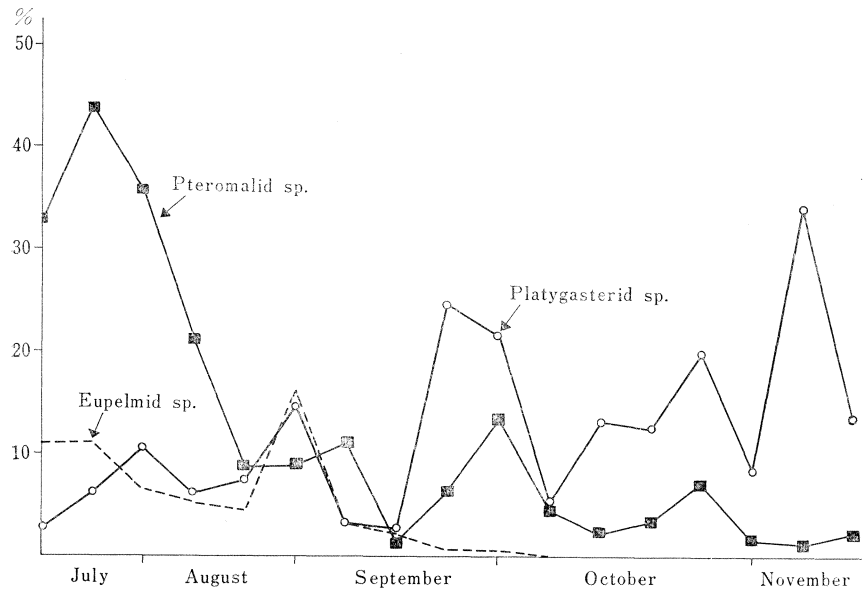

Fig. 22.3-B. Fluctuation of parasitism against the rice gall midge at Sanpathong in Chiengmai Province, wet season, 1970.

damage to rice plants had not been seen in recent years. It is considered that the rice gall midge is well controlled by the Platygasterid parasite. The parasitism reached 75 percent. The parasitism of Petromalid and Eulopid parasites reached 98 percent at the time of rice seedlings at the Sanpathong Rice Experiment Statio nin July, 1969. In 1970, the both parasites attacked the insect and the parasitism was 60 percent in July (Figs. 22-3 A and B), and then in the following months, August, September and October the rice gall midge maintained prominently lower population in the paddy field than in rice nursery because of the severe attack of these parasites.

Discussion

Soenardi, Indonesia: The gall midge is found on *Imperata cylindrica,* lalang grass in Indonesia. How about in your country?

Answer: There are a lot of these grasses in Thailand, too, but so far we have not yet found *I. cylindrica* on these grasses in our country.

Dyck, the Philippines: Have you found gall midge infestation on the alternate host plant?

Answer: Yes, I have, but the percentage we obtained was different from that which was got in the Philippines.

Pathak, IRRI: Have you noticed any increase in the area in Thailand attacked by the gall midge in recent years?

Answer: Yes, in 1970 we found that the east, north and northeast parts of Thailand were very seriously attacked, but we haven't got any report or any evidence in the south part at all.

Kimura, Japan: Do you have any idea of the control by chemical application such as the power sprayer?

Answer: We did a lot of chemical control in the field in the past.

Kimura, Japan: What part of the rice plant is attacked by the gall midge?

Answer: The eggs are laid mostly underneath the leaf blade, and then the larvae go down to the growing point.

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