Apple Snail in Japan

—The present status and management—

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Introduction

The apple snail, *Pomacea canaliculata* (LAMARCK), which was introduced for snail culture in around 1980, had settled in irrigation canals in some southern districts of Japan especially in Kyushu and Okinawa Islands. It has been known that it attacks rice plants, lotus roots, and rush plants[6].

The Ministry of Agriculture, Forestry and Fisheries of Japan designated the snail as a harmful pest in December, 1983. Since then, the import of the snail from abroad has been prohibited. On the other hand, the snail breeders and dealers abandoned their jobs, because the snail had lost its value as a foodstuff on the market. The snail escaped from the abandoned snail culture spread to paddy fields, irrigation canals, and other watery areas.

Although relatively little work has been reported, because the snail became an important crop pest only in the last few years in Japan, the present paper is intended to review the present status and management of the apple snail in Japan.

The actual status of occurrence

1) Recent occurrence of damage and distribution

The statistical data of 1985, 1986 and 1987 published by the Kyushu Regional Agricultural Administration Office are shown in Table 1. The occurrence of the snail was confirmed in all prefectures of the Kyushu region. The largest occurrence area, approx. 6,000 ha, was observed in Kumamoto in 1987. This area corresponds to about 10% of the total gross cultivated area of this prefecture. On the other hand, the area of crop damage caused by the snail was rather small as compared with the occurrence area in any prefecture. For example, in Kumamoto it was less than 1,500 ha. However, it must be noted that the rate of yearly increase of the total crop damage area was far greater than that of the total occurrence area. The former is as high as 3.3 and 8.9 times per year, though the latter shows only 1.61 and 1.59 times per year. In any district, supplementary or repeated transplanting has to be done in paddy fields where rice seedlings were severely damaged by feeding attack of snails.

The occurrence of snails in the whole country in 1986 is illustrated in Fig. 1[8]. The damage by snails in Tokyo, Shizuoka, Mie, Wakayama, Ehime and Nagasaki Prefectures was newly recognized and 13 prefectures in total suffered damage habitually.

2) Feeding habit and damage

The amount of rice seedlings ingested by the snail and the effect of water temperature on the feeding behavior were examined in the laboratory to estimate the damage of rice seedlings immediately after transplanting[9]. The snail feeds on stems or leaf blades of rice plants. Snails with a shell height of less than 1.6 cm could not attack rice seedlings. However, adult snails with a shell

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Table 1. Recent trend of occurrence of the apple snail in the Kyushu region

Prefecture	Occurrence area (ha)			Damage area (ha)			Injured crops
	1985	1986	1987	1985	1986	1987	
Fukuoka	418.0	671.0	1,097.9	8.0	9.5	18.0	Rice, lotus
Saga	18.1	40.2	303.1	5.2	9.2	29.5	Rice
Nagasaki	49.3	85.5	214.1	—	0.2	4.8	Rice, lotus
Kumamoto	2,130.3	3,469.8	6,066.6	15.5	91.1	1,374.3	Rice, lotus
Oita	44.0	35.7	53.0	0.2	1.3	1.0	Rice, lotus
Miyazaki	66.0	527.0	642.4	4.3	12.6	22.6	Rice
Kagoshima	910.0	1,035.0	958.0	14.0	42.9	31.4	Rice, taro
Okinawa	41.3	55.2	65.4	3.1	0.01	0.4	Rice, rush, taro
Total	3,677.0	5,929.4	9,400.5	50.3	166.8	1,482.0	

Cited from the reports compiled by the Kyushu Regional Agricultural Administration Office in 1986, 1987 and 1988.

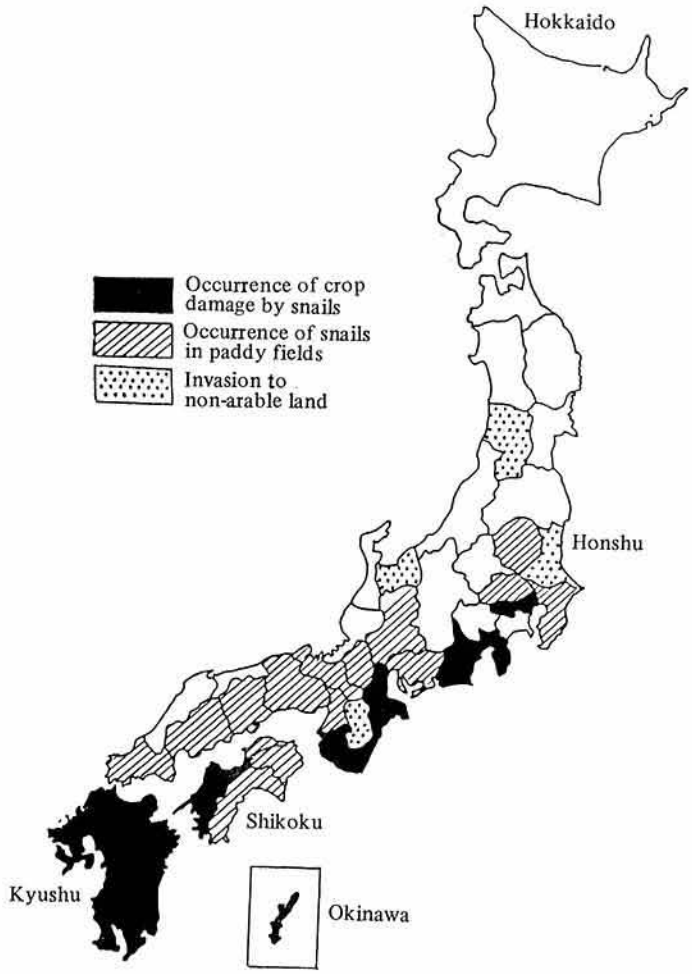

Fig. 1. Distribution of occurrences of the apple snail in 1986 (Morita, 1987)

height of more than 3 cm were able to attack rice plants at the 7th to 8th leaf stage. The average number of rice seedlings ingested per day by snails with shell height of 2.9, 3.9, 4.8 and 5.7 cm at the temperature of 28°C was 4.5, 6.3, 12.6 and 23.5, respectively. The amount of ingestion was proportional to the cube of shell height. The regression line between the number of rice seedlings ingested per day (Y) and the shell height (X cm) was expressed as follows:

$$Y=0.1190X^3+0.261$$

The water temperature most suitable for feeding was 30°C.

3) Population census in a paddy field

Population census of the apple snail was conducted in a paddy field at Fukuoka, in 1985[2]. The average number of egg-masses per square meter was 0.4. The average size of the egg-mass was 91.6 (the number of eggs), which is definitely small as compared with that sampled from the water grass in an adjacent irrigation canal, i.e., 528.8 on an average. The number of snails per square meter was 12.1 and 19.1, on September 2 and October 4, respectively. Snails with a shell height of more than 3 cm, which are recognized as adult[3], accounted for 4 and 2% of the total number on September 20 and October 4, respectively. Snails less than 2 cm high accounted for 93% on September 20, and 96% on October 4. The distribution pattern of both eggs and snails in the paddy field was considered to be contagious. On the basis of the results obtained in this census, no definite correlation between the number of egg-masses and the population of the snails in each census quadrate was recognized.

4) Overwintering in Kyushu district

The field survey and laboratory experiment on the overwintering of the apple snail in Kyushu were conducted[10]. When irrigation water is removed from paddy fields in autumn, snails creep into the ground to a depth corresponding to the height of their shells. In late December, 3 months after the removal of irrigation water, the survival rate of the snails crept underground was 80% or more, whereas that of the snails under withered grasses was about 40%. This difference was probably due to the difference in the degree of exposure to low temperature. The mortality of the overwintering snails gradually increased from midwinter (January) to late winter (March). Snails kept in storage incubators at 0°, −3°, and −6°C died within 25, 3, and 1 day, respectively. These results suggest that in the temperate zone, the survival of overwintering snails is strongly affected by low temperatures below 0°C. The field investigation made on April 19 showed that the survival rate of the snails was about 20% in a paddy field but only 5% in a dried irrigation canal. Young snails with a shell height of 2–3 cm seemed to be more tolerant to low temperature than mature ones of greater size. After transplanting of rice, overwintered snails gradually appeared on the surface of the field in a period of 1 month. In the field where rice and wheat are cropped in succession, 4.1–6.8% of the snails detected in the autumn were observed 17–28 days after transplanting of rice in mid-June. Kiyota and Okuhara[4] reported that the overwintering ability of the apple snail was influenced by soil hardness, air temperature in winter, the presence or absence of water, timing of drainage, and the size of shells.

Overwintering at the egg stage of the snail was confirmed in the northern Kyushu in winter[5]. The hatching ability of egg-masses sampled in the field throughout the whole year from April to February was also examined[5]. The egg-masses sampled in December, January and February showed very low percentage of hatching.

Management

In Japan, the ultimately efficient method of controlling the apple snail has not yet been established. In each prefecture suffering from crop damage by the snails, control measures adapted to its situation (the occurrence status and geographical conditions) are employed. Some of the recent status of agronomic and

chemical control measures will be reviewed.

1) Agronomic control method

Removing manually overwintered apple snails in irrigation canals or paddy fields is a laborious operation but is considerably effective in controlling them. Especially, removing the adult snails from the paddy field before the rice-transplanting season was very effective in reducing the immediate damage of rice seedlings. According to the report (unpublished) of Miyazaki Agricultural Experiment Station (1987), it took about 1.5 hr to pick up about 1,000 individuals of the snail per 0.1 ha of paddy field. However, two times of that operation conducted after puddling and transplanting definitely prohibited the occurrence of crop damage.

Plowing the paddy field in winter, especially in midwinter, reduces the population of overwintering snails in soils. According to the report (unpublished) of Kumamoto Agricultural Experiment Station (1987), the higher the frequency of winter plowing, the more the reduction of snail population. The degree of breakage of the snail shell by plowing varies with the size of the shell. The rotary plowing and tilling of the field caused the shell breakage in 2–36% of the snails with a shell height of 0.5–3.0 cm and in 20–60% of the snails with a shell height more than 3 cm (unpublished report, Saga Agricultural Experiment Station, 1987).

2) Chemical control method

Four pesticides, i.e., cartap, etrimfos, bensultap and calcium cyanamide, are presently registered for the control of the apple snail. The three pesticides except calcium cyanamide inhibit feeding activity of the snail. Cartap and bensultap are able to protect rice plants from feeding of the snail for about 3 weeks in paddy fields[1]. Calcium cyanamide has a direct controlling effect. It kills the snails when applied to the paddy field at the rate of 30 kg per 0.1 ha before transplanting of rice[7].

Conclusion

Presently, the apple snail is distributed far up to Yamagata Prefecture in the northern part of Honshu. The further expansion of its distribution seems to depend on whether or not it succeeds in overwintering and increasing its populations in the northern districts of Japan.

The more advanced combination of the control measures should be developed for the purpose of establishing the effective management of the snail.

Basic and precise population surveys as well as behavioral and ecological researches are the most important prerequisite to know whether the apple snail, which has already settled down in watery areas, causes further increased crop damage or not.

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