Proportion of Viruliferous Immigrants of the Brown Planthopper, *Nilaparvata lugens* STÅL (Hemiptera: Delphacidae) Transmitting Rice Grassy Stunt Virus during 1979–1983[1]

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Two rice virus diseases, grassy stunt and ragged stunt, transmitted by the brown planthopper, *Nilaparvata lugens* STÅL, are prevailing widely in Southeast Asia. Recently, the third virus disease, wilted stunt, vectored by the brown planthopper has been reported in Taiwan (CHEN et al., 1978). In Japan, grassy stunt was discovered in 1978 (IWASAKI and SHINKAI, 1979) and ragged stunt in 1979 (SHINKAI et al., 1980). The occurrence of both virus diseases has so far been restricted to Kyushu, one of the main southwestern islands in the Japanese archipelago; grassy stunt has been more prevalent than ragged stunt every year.

The brown planthopper cannot overwinter in temperate countries like Japan and Korea, but it migrates there from overseas during the Bai-u (rainy) season every year. It is, therefore, natural to consider that the viruses also are carried over by viruliferous immigrants from overseas. The source of immigrants are thought to be the central and southern parts of China (KISIMOTO, 1971).

It is important to clarify the proportion of viruliferous immigrants, since the results contribute to the forecasting of the degree of virus incidence in paddy fields. Rice plants infected by viruliferous immigrants become primary source of infestation, from which planthoppers acquire the virus in the subsequent generations and secondarily transmit it to more rice plants as the planthopper population increases. From this point of view, an attempt was made to monitor the proportion of viruliferous planthopper immigrants for grassy stunt during

Table 1. Proportions of grassy stunt virus viruliferous immigrants of brown planthopper collected at some localities of Kyushu and East China Sea between 1979 and 1983

Year	Locality of insect collection	Date of insect: Immigration	Date of insect: Collection	No. of tests	No. of insects tested[a]: ♀	No. of insects tested[a]: ♂	% viruliferous insects
1979	Chikugo	June 27	June 28–29	2	71	28	0
			July 2–3	2	107	22	0
1980	Chikugo	June 14–15	June 19	3	30	5	0
		June 26	June 28–29	2	23	19	0
		July 5–8	July 11	4	106	11	0
1981	Chikugo	June 22	June 23	2	5	0	0
		June 26–28	June 27	2	24 (1)	9	3.03
			June 28–30	2	266	117	0
			July 1	2	281 (1)	76 (1)	0.56
1982	Isahaya	May 31–June 1	June 4	2	109	74	0
	Kagoshima	July 6–7	July 8	2	151	40	0
	Chikugo	July 11	July 12	2	106	10	0
1983	Chikugo	June 20–21	June 22	2	108	39	0
	Isahaya	July 2–3	July 4	2	157	38	0
	Kagoshima	July 2–5	July 7	2	140	31	0
	East China Sea (31°N, 126°E)	July 15	July 15	2	186	79	0
		July 17	July 17	2	174	101	0

[a] Figures in parentheses show number of viruliferous insects detected.

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1979–1983.

Each wave of planthopper immigration was detected by light traps and airborne nets. Within a few days after immigration, test insects were individually collected from rice hills in paddy fields using an aspirator. Insect collection in each major wave of immigration was conducted in fields where rice seedlings were transplanted after the previous waves. Insects were collected in Chikugo (Fukuoka Pref.), north Kyushu, between 1979 and 1983, and at two additional localities between 1982 and 1983; Isahaya (Nagasaki Pref.), northwest Kyushu and Kagoshima (Kagoshima Pref.), south Kyushu. Furthermore planthoppers[2] were collected by airborne nets set on the mast of a weather observatory ship (The Japan Meteorological Agency) or with an aspirator on the wall of the ship on the East China Sea (31°N, 126°E) in 1983.

Insects collected were given a 2-day inoculation feeding period at 25°C, a single insect per rice seedling per test tube. The rice seedling used (cv. Reiho) was at the 1- or 1.5-leaf stage at the time of inoculation. The inoculation tests were conducted usually twice per insect sample. Throughout the experiments, inoculated seedlings were transplanted into plastic flats (32×25 cm) at 4×3 cm spacing, and the flats were kept in a glasshouse until disease symptoms appeared. The cultivar is highly susceptible, showing distinct disease symptoms at most within two weeks after inoculation.

The results from five years (Table 1) show that viruliferous immigrants were detected only twice in 1981 and that both of the proportions were very low. The overall results of the 5-day samplings (June 27–July 1, 1981) show that only three out of 773 individuals collected (0.39%) were viruliferous in the June 26–28 wave of immigration which was the last and the largest of three waves observed in Chikugo in 1981.

It is characteristic in Japan that the occurrence of both brown planthopper and grassy stunt is renewed every year; the rice plant, which cannot overwinter, is only the host of both planthopper and virus. According to the reports presented by the prefectural government at the regional annual meetings for the forecasting of pests (mimeograph), the total paddy fields infected by grassy stunt amounted to 19,539, 9,072, 674, and 5,982 ha in Kyushu in 1979–1982, respectively; Kagoshima and Nagasaki prefectures where the population density of brown planthopper was high accounted for more than 95% of virus incidence each year, while the area in Fukuoka Prefecture were less than 0.1, 1, 0.1, and 3 ha in the corresponding years. Unexpectedly, viruliferous immigrants were detected in the year with the lowest incidence of the virus, and the degree of virus incidence in the fields did not relate to the proportion of viruliferous immigrants. This fact showed that the monitoring method conducted in the present investigation may not be applicable to forecast the degree of virus incidence in the fields.

The seedling test for detecting viruliferous insects is laborious and time-consuming. Recently, the hemagglutination test such as the enzyme-linked immunosorbent assay (Iwasaki et al., 1982) and the latex agglutination test (Omura et al., in press) have been developed for the detection of grassy stunt virus in individual insects as well as in plants. It is generally said that the hemagglutination test is able to cover a disadvantage of seedling test to some extent, and therefore the two methods mentioned above are worth applying. Since the population density of brown planthopper immigrants is usually very low, an essential problem is how to collect numerous immigrants effectively.

Throughout the course of these experiments, no symptoms of ragged stunt were observed on the rice seedlings. The occurrence of ragged stunt was recorded in the fields in 1979 and 1980: only a few infected rice hills were found in both Kagoshima and Nagasaki prefectures (Shinkai et al., 1980). Thus, it seems impossible to detect viruliferous immigrants for this virus disease. Ragged stunt has so far been negligible in Japan.

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[2] Imported with the permission of the Minister, Ministry of Agriculture, Forestry and Fisheries, Japan, No. 826, as of June 11, 1983.

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Suppressive Effect of Magnesium Ions on the Peristalsis of the Gut of the American Cockroach, *Periplaneta americana* L. (Orthoptera: Blattidae)[1]

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Considering the critical role of magnesium ions as the co-enzyme and an effector of osmoregulation, the essentiality of this element in insect nutrition may be readily understood. Indeed the growth is stunted when insects are reared on an artificial diet lacking magnesium in *Anthonomus grandis* (VANDERZANT, 1965) and *Ostrinia nubilalis* (BECK et al., 1968). It is likely, however, that magnesium ions are also important in many other functions including those of the nervous system. It is known that magnesium influence the release of transmitter and that high magnesium depresses the excitatory junction potentials (EJP) (HOYLE, 1955). In a recent report from this laboratory, magnesium was suggested to prevent the release of chemical transmitter from the presynaptic membrane in the gut of the American cockroach, *Periplaneta americana* (FUKAMI and IZAWA, 1983). In this paper we report a suppressive effect of magnesium ions on the peristaltic movement of the cockroach gut.

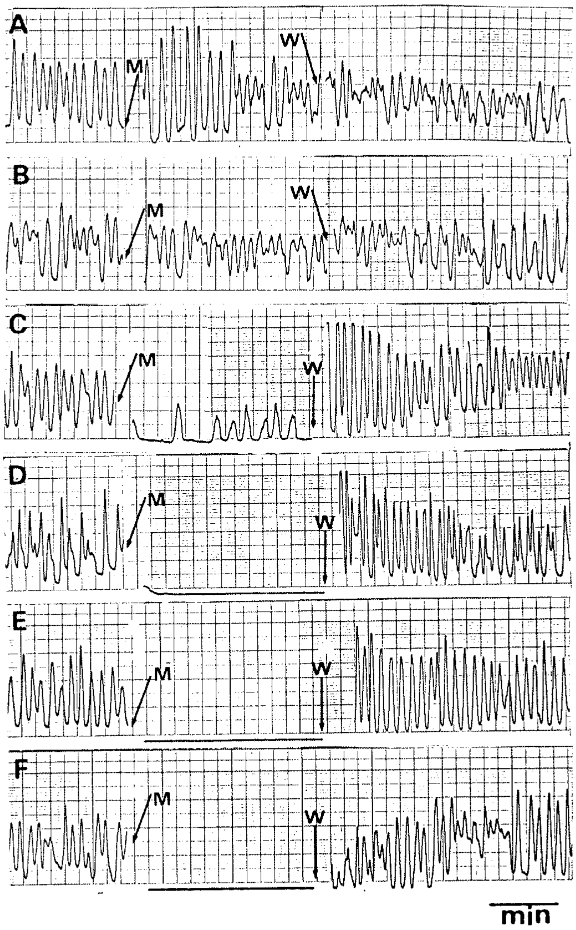

Fig. 1. Peristalsis of the gut of the American cockroach as influenced by the magnesium-free RINGER solution and the RINGER solutions containing magnesium ions. Arrows indicate treatment of each magnesium-containing RINGER solution (M) and magnesium-free RINGER solution (W), respectively. 0.1 mM (A), 1 mM (B), 3 mM (C), 4 mM (D), 5 mM (E), 10 mM (F).

MATERIALS AND METHODS

Male adult American cockroaches were reared on a pelleted diet and water at 25°C. The peristaltic movement of the isolated cockroach gut was measured as before (FUKAMI and IZAWA, 1983) by the method of KANEHISA (1965, 1966). American cockroaches were decapitated, then the legs and

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