

Tolerance for Starvation in the Brown  
Planthopper, *Nilaparvata lugens* STÅL  
(Hemiptera : Delphacidae)<sup>1</sup>

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The brown planthopper, *Nilaparvata lugens*, is an important pest of rice all over the Asian countries. In Japan, considerable long-term efforts have been made to search for the overwintering of the brown planthopper together with the other important planthopper, *Sogatella furcifera*. In the early 1960's several researchers reported the overwintering of these two planthoppers at the diapausing egg stage in the gramineous winter grasses under experimental conditions (TAKEZAWA, 1961a,b; MIYAKE and FUJIWARA, 1962; OKUMURA, 1963). However, actual overwintering at any stage has never been observed as yet under natural conditions except the limited spots near a hot spring. In July of 1967, a meteorological observatory ship happened to meet a mass flight of these planthoppers on the Pacific Ocean far from Japan (ASAHINA and TSURUOKA, 1968). This was an epoch-making incident with respect to the complex problem of overwintering of these pests. Since then, navigation surveys of planthopper catches with tow nets above ships have been conducted during the rainy season (June to July) on the East China Sea. The results suggest transoceanic long-distance migrations of these planthoppers accompanied by a frontal system moving from the west or south-west to Japan in June and July (KISIMOTO, 1971, 1972). However, it has not been clarified where the planthoppers come from.

Consequently, tolerance for starvation plays an important role in the performance of transoceanic migrations. Only a few data have been reported on the starvation of the planthoppers (YOSHIMEKI et al., 1961; KISIMOTO, 1965) in contrast to much data on their fecundity. The present study was aimed at clarifying the tolerance

for starvation of the brown planthopper adults in relation to the different day-feeding periods after emergence (Age in days in Figs.), and the results were discussed in view of migrations.

Two mated brachypterous females were released in potted rice plants covered with a screened insectary cage under outdoor conditions. Most of their progeny which emerged one month after release were brachypterous in females and macropterous in males because of low rearing densities. Adults of each wing form were transferred to another potted rice plant of about 70 days old within 24 hours after emergence. Two groups of brachypterous females were left on a potted rice plant for one day (B♀ 1.5 in Fig. 1) and for four days (B♀ 4.5), respectively, after transferring, and another one group of macropterous males (M♂ (L) 3.5 in Fig. 2) was also left for three days. After each feeding period in the adult stage, 20 individuals in each group were randomly collected and used for the experiments. One set, consisting of a single macropterous male and two brachypterous females derived from the same group, was put into each glass tube.

Similarly, under high rearing density conditions in potted rice plants (20 mother females per pot), most of the progeny were macropterous both in females and in males. The same procedure was employed in all experiments; 20 individuals of each sex in each group having 1.5-, 3.5-, and 6.5-day-feeding period in the adult stage. One set, consisting of two males and two females with the same feeding period, was put into each glass tube.

During the course of experiments, the glass tube used was 20 cm in length and 3 cm in diameter, and the water was only provided through a strip of filter paper on the inside wall of the tube. We may suppose that the relative humidity in the tube was more than 90%. Daily observations were made until all of the planthoppers died. We conducted the experiments in a room with a constant temperature of  $23 \pm 1$  °C from late August to September in 1974.

As has already been shown by YOSHIMEKI et al. (1961) and KISIMOTO (1965), there was a marked difference in the tolerance for food deprivation between the two wing forms of females (Fig. 1). The longevity of the females under the conditions of food deprivation was longer in the macropterous than in the brachypterous.

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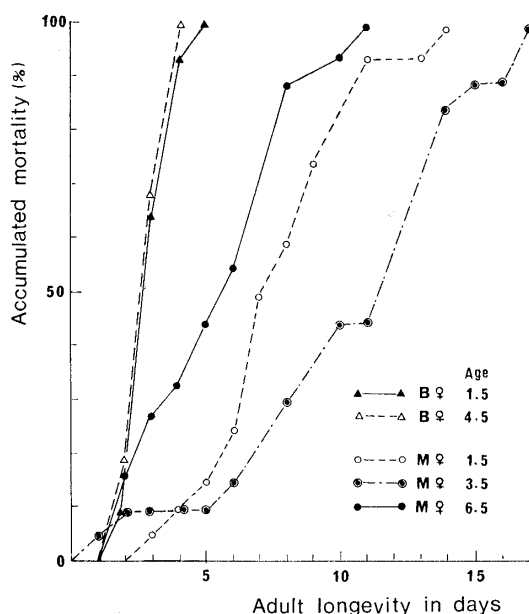


Fig. 1. Adult longevity in females of both wing forms without food. B: brachypterous, M: macropterous. For details see text.

Concerning the effect of the feeding period on the longevity, the difference could even be seen among macropterous females with different feeding periods. The longevity of macropterous females with 3.5-day-feeding period was the longest, and this 3rd or 4th day after emergence coincided with the period when the feeding activity was low but the locomotive activity for the flight was highest (KUSAKABE, unpublished). It may follow that a macropterous female at the age of 3 or 4 days has finished the storage of energies enough for the long-distance migration and that, therefore, the tolerance for starvation would be the strongest at this age. This statement is supported by the results of the same experiment in macropterous males (Fig. 2). The macropterous male with a 3.5-day-feeding period derived from the high rearing density conditions showed the longest longevity. Another experiment showed that all of the planthopper adults died within one day regardless of ages, sexes or wing forms when they were kept in a glass tube without water. This indicates the importance of water for the longevity.

Under the constant temperature of 25 °C, the preoviposition period of the brown planthopper is 6.6 days (HIRAO, 1972). The reproductive organs of macropterous females caught by tow nets at a height of 15 m above the ground or the sea were all found to be immature (KISIMOTO

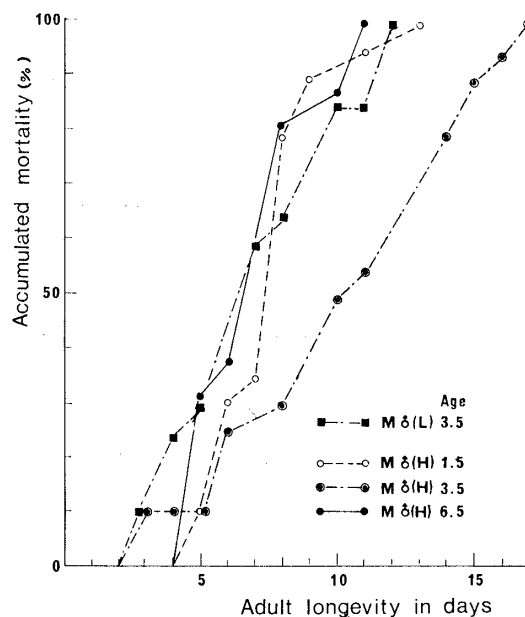


Fig. 2. Adult longevity in males without food. M ♂ (L) and M ♂ (H) indicate the macropterous males reared under low and high density conditions, respectively.

1971). Considering these facts, it follows that the long-distance migration of the brown planthopper would take place on the 3rd or 4th day after emergence.

Another interesting point is that the longevity of macropterous males with a 3.5-day-feeding period that were derived from low rearing density conditions was markedly shorter than that of macropterous ones with the same feeding period derived from the high rearing density conditions (Fig. 2). This difference may be considered to reflect the qualitative difference of each group even if the wing form is the same. In fact, only a small number of macropterous males which emerged from the low density conditions in the summer generation were caught either by the yellow pan trap or by the Johnson and Taylor's aerial suction trap (KUSAKABE, unpublished). Therefore, we may infer that the macropterous males grown in the favorable habitat may be different in physiological quality and behavioral responses from those of the fall generation grown in an unfavorable habitat, even if they have the same wing form.

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On the Origin of the Sex Pheromone Components of the Smaller Tea Tortrix Moth, *Adoxophyes fasciata* WAL-SINGHAM (Lepidoptera : Tortricidae)<sup>1,2</sup>

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Recently, HENDRY et al. (1975a,b) reported that several compounds identified as the sex pheromone components of the oak leaf roller moth, *Archips semiferanus* WALKER, were present as such in host plants of this insect. Based on the results of their work, they proposed a hypothesis on the insect-host relationship in the mating behavior of phytophagous Lepidoptera. They believe that the pheromonal compounds, 21 isomeric tetradecenyl acetates, of the oak leaf roller moth are directly derived from the host plant, and that "the adult male may be programmed to select for a mate that conforms to certain materials it has contacted during feeding" (HENDRY et al., 1975a). The proposed hypothesis is particularly interesting from an evolutionary standpoint in

insect-host relationship. If their data are correct, the oak leaf roller moth might be an example of the insect species which still remain in an ancient situation of chemical communication in mating behavior. However, the most recent data on the oak leaf roller moth indicated that a particular mixture of (*Z*)-11- and (*E*)-11-tetradecenyl acetates was the major female sex pheromone of this species and these compounds were contained in female moths of this species reared on an artificial diet free from their host plant material (MILLER et al., 1976). HENDRY (1976) reported, however, that 14 carbon acetates were present in the artificial diet which was used by MILLER et al. (1976) to rear the oak leaf roller moth and that their hypothesis remains worthy of further testing.

We can expect that most lepidopterous species have the ability of synthesizing their female sex pheromones (INOUE and HAMAMURA, 1972). Therefore, we made a series of experiments to determine whether the sex pheromone of the smaller tea tortrix was derived directly from their food or produced by the females.

The insects were reared on a standard artificial diet composed of dried tea leaves, parched soy bean, and brewer's yeast as major ingredients (TAMAKI, 1966). Besides the standard diet, a tea-leaf-free diet, a soy-bean-free diet, and a lipid-free diet, were used to rear the insects. The tea-leaf-free diet was prepared by substituting the tea leaves in the standard diet by parched soy bean, and the soy-bean-free diet was prepared by substituting the soy bean by tea leaves. The lipid-free diet was prepared by exhaustive extraction of lipids from the standard diet with a Soxhlet apparatus (chloroform-methanol, 1:1) and then supplemented with cholesterol and methyl linolenate

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