SHORT COMMUNICATION

Mean Longevity of Adults in a Field Population of the Brown Planthopper, *Nilaparvata lugens* STÅL (Hemiptera: Delphacidae), as Estimated by HOKYO and KIRITANI's Method[1]

The adults of *Nilaparvata lugens*, like those of the other species of rice leafhoppers, begin to lay eggs some days after their emergence, and oviposition continues through rather long periods thereafter. The rate of adult survival in the field will therefore critically affect the rate of population growth in the succeeding generations.

In this paper an attempt has been made to estimate the natural longevity of the brachypterous females which play an important role in reproduction in paddy fields. The study was made in a field pot of Kyushu Agricultural Experiment Station by applying the method proposed by HOKYO and KIRITANI (1967). In following this method, it is easy to estimate the daily survival rate, K, mean longevity, L, and the total number of emerged adults, N, by knowing successive changes of both population density of the females and the proportion of females with mature ovaries during the period to cover a given generation; *viz.*,

$$\hat{K}=\left(1-\frac{\hat{F}_{\alpha}}{\hat{F}}\right)^{\frac{1}{\alpha}} \quad (1)$$

$$\hat{L}=\frac{1}{1-\hat{K}} \quad (2)$$

$$\hat{N}=\frac{F}{\hat{L}}\times\delta \quad (3)$$

where $F=$ the sum total of the daily observed numbers of females, $F_{\alpha}=$ that of the females with immature ovaries, $\alpha=$ mean length of the period for ovarial maturation in days and $\delta=$ correction factor to convert the relative population estimate obtained to the absolute one per unit area. In the case where population census is conducted at a constant interval I longer than one day, F and F_{α} can be estimated by multiplying the obtained sum totals of the females and immature females by I, respectively. Further, if the daily rate of oviposition (m) is known, we can estimate the number of eggs laid in the field per female as

$$\hat{T}_{E}=\frac{\hat{K}^{\alpha}}{1-\hat{K}}\times m \quad (4)$$

(For details, see HOKYO and KIRITANI, *l. c.* and HOKYO and KUNO, 1970).

In Kyushu district the *N. lugens* population invade paddy fields usually in July. They arrive as macropterous adults and successively propagate through three generations until October (KUNO, 1968). In the practical application of HOKYO and KIRITANI's method to this insect, we used the data obtained in 1968 for the first generation of adults produced by the initial immigrants. The population census was conducted every other day by direct counting of the number of brachypterous females on the 200 hills of rice plants sampled systematically. In this generation almost all the females (94%) were brachypterous. The paddy field selected for the census had an area of 250 m² where 4,250 hills of rice plants (variety Hôyoku) were transplanted on 28th June according to the conventional methods in practice in the locality. In the females of *N. lugens*, maturation of ovaries is accompanied by an externally detectable change in body size, i. e., the swelling of the abdominal part of the body (see Fig. 1), so that for convenience we have referred here to the proportion of those females that had swollen abdomens as the percentage of matured females. Concurrently,

Fig. 1. Side views of immature (left) and mature (right) brachypterous females of *Nilaparvata lugens*.

[1] Appl. Ent. Zool. 5(4) : 225—227 (1970)

the duration (α) needed for full swelling of the abdomen under outdoor conditions was examined by rearing brachypterous females on potted rice plants. Thus we obtained α as 2.5 days (Table 1). The value of δ in (3) was estimated as 1.61 from the regression of the population estimates derived by suction machine collecting over those obtained by direct counting on the corresponding census dates (Fig. 2). The mean daily oviposition rate m for brachypterous females in the relevant generation was obtained by releasing 5~7 day-old females for 5 days on potted rice plant under outdoor conditions. Although the females were released at varying densities, from 3 to 27 per pot, the oviposition rate did not significantly differ

Table 1. Changes in the Proportion of Mature Females with the Lapsing of Time after Emergence, as Observed on Potted Rice Plants under Outdoor Conditions Using 10 Brachypterous Females which Emerged between 13th and 15th August

	Days after emergence			
	0.5	1.5	2.5	3.5
Proportion of fully mature individuals	0 10	0 10	4 10	9 9
(%)	(0)	(0)	(40)	(100)

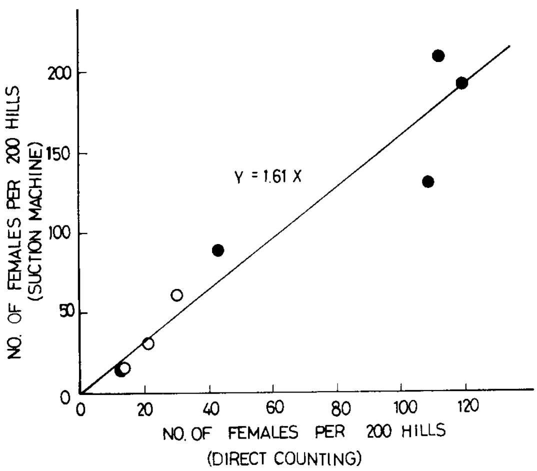

Fig. 2. Relationship of the population estimates by suction machine collecting (Y) to those by direct counting in the field (X) for brachypterous females. Hollow circles indicate the data corresponding to the period for the present analysis.

among different densities, so that its overall mean value for 69 individuals in total (74 eggs per individual per day) was used as m in (4). Fig. 3 shows the successive changes of both total and mature female populations in the census field, from which both $\hat{F}$ and $\hat{F}_\alpha$ were obtained by summation. The estimates of K, L, N and T_E from formulae (1), (2), (3) and (4) are presented in Table 2, from which the following points may be worth noting: (1) The estimated mean longevity, $\hat{L}$, (about 8 days) is considerably shorter than the physiological life span of adults which is considered to be more than 20 days (e.g. Kishimoto, 1965; Suenaga, 1963). (2) Correspondingly, the estimated number of eggs laid per female, $\hat{T}_E$, (about 400) also is fairly small compared with the original fecundity; for example, Kuno (1968) observed more than 800 eggs per female for the corresponding generation under confined outdoor conditions on potted rice plants.

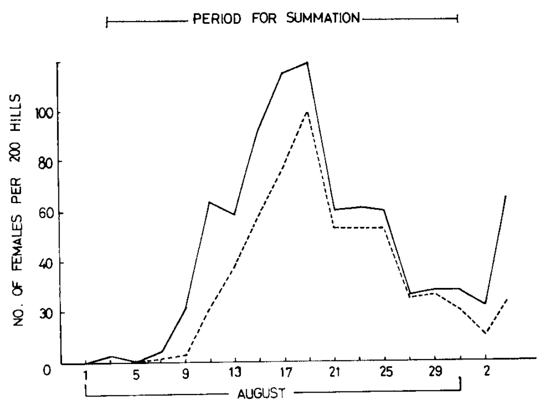

Fig. 3. Population trends of the total (——) and mature (······) brachypterous females in the field for the first generation produced by initial immigrants.

Table 2. Estimates of the Daily Survival Rate (K), Mean Longevity (L), Total Number of Adults Emerged per 200 Hills (N) and Number of Eggs Laid per Female (T_E) Based on Formulae (1)~(4) in the Text

$\hat{F}$	$\hat{F}_\alpha$	$\hat{K}^\alpha$	α[a]	$\hat{K}$	$\hat{L}$	$\hat{N}$	$\hat{T}_E$
			2	0.848	6.56	363	350
1478	416	0.7185	**2.5**	**0.876**	**8.08**	**295**	**428**
			3	0.896	9.59	248	511

[a] Estimated value of α was 2.5 (see Table 1).

The natural longevity of adult *N. lugens* was obtained by KISIMOTO (1965) using marking techniques. He obtained the longevity estimate of about 9 days for the brachypterous females of the comparable generation, which is rather close to the value obtained here.

Unlike the case of the green rice leafhopper, *Nephotettix cincticeps*, (HOKYO and KUNO, 1970), the dispersal of adults from or into the field was not likely to occur in the present case since brachypterous females of this insect are very inactive in their movement. Such a reduction in the adult longevity is therefore wholly attributable to the action of a variety of natural mortality factors, of which the attack by several species of spiders will probably be of greatest importance. In this study we did not exclude those females that were parasitized by a nematode, *Agamermis unka*, or by a Strepsiptera, *Elenchinus japonicus*, from the calculation of $\widehat{F}$ and $\widehat{F}_\alpha$; but the disturbing effect of parasitism on the estimation was considered to be small since the total percentage of parasitism was as low as 10% in the generation concerned.

Basic features of the population dynamics of *N. lugens* in paddy fields have been discussed to some length (e.g. KISIMOTO, 1965; KUNO, 1968), but its detailed process or mechanism are yet mostly unclarified, owing primarily to the technical difficulty in obtaining accurate population estimates for specific developmental stages (especially the egg stage). An important implication of the present study will thus be that the application of HOKYO and KIRITANI's method provides a promising approach to such analytical population studies for this insect that would otherwise be very difficult. It is possible not only to estimate the total population of emerged adults but also that of the eggs laid in the field, and thus we may be able to make life tables of this insect by the successive application of this technique for a series of generations if data on natural egg mortality are concurrently available. Using the present results for *N. lugens,* and also the data for *Nephotettix cincticeps* previously analyzed (HOKYO and KUNO, 1970), we have made a preliminary attempt for such a line of analytical study, which will be described elsewhere in reference to the comparison of population performance between the two species (KUNO and HOKYO, in preparation).

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Received August 4, 1970

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