A COMPARATIVE ANALYSIS ON THE DISTRIBUTION OF NYMPHAL POPULATIONS OF SOME LEAF- AND PLANTHOPPERS ON RICE PLANT

Eizi Kuno
Section of Phytopathology and Entomology, Kyūshū Agricultural Experiment Station, Chikugo, Fukuoka

INTRODUCTION

If adequately analyzed, studies on the pattern of spatial distribution will give insight into the sideview of population dynamics of the insect under study, in addition to preparing statistical basis for interpreting field data and designing appropriate sampling.

Most of the distributions of insects are known to be more or less 'contagious,' and it has been proved by the recent advance in the method of statistical analysis that the negative binomial distribution is very useful as a mathematical model for describing such contagious distributions of various insects, as shown empirically in several field studies.

This paper deals with the description of spatial distribution of the nymphs of the three species of hoppers, the brown planthopper *Nilaparvata lugens* Stål, the small brown planthopper *Delphacodes striatella* Fa llen and the green rice leafhopper *Nephotettix cincticeps* Ul ler based on the negative binomial distribution. The purpose of the present report is to obtain some ecological knowledges and practical methods for making extensive studies on populations of these serious pests of rice plant through the appropriate method of analysis.

The brown planthopper is regarded as serious through direct injury by sap-sucking, and the other two mainly through transmission of some virus diseases. They invade into paddy field usually in July when the host plant is at early stage and reproduce themselves there, passing through several generations until autumn. The present analysis concerns exclusively with the last generation at which their populations reached peak in 1961.

SAMPLING PROCEDURE

The data analyzed are based on five sets of samples obtained in the period from 3rd till 31st October in 1961 at a regular time interval of a week. This period nearly corresponds to the last generation on rice plant for every species concerned.

The paddy field surveyed is located in Kyūshū Agricultural Experiment Station,
Chikugo city, and is about 2.5 are in area, where 4250 hills of rice plant (variety Hōyoku) had been planted at a regular interval of 25 cm and 20 cm in N-S and E-W direction, respectively. No insecticides were sprayed on the area surveyed throughout the season of rice cultivation.

The hill of rice plant which had been originated, as a rule, three seedlings transplanted together on 28th June was used as a sampling unit, and 80 hills were sampled on each surveying date by a systematic method with random start.

A standardized 1 h. p. suction machine described by Suenaga (1959) was used for collection of insects: A tin cylinder (30 cm in diameter and 50 cm in height) having the edges of nylon gauze at both ends was put on the hill to be sampled, and after the gauze at the lower side of the cylinder was tightly closed around the lowest part of the hill so as to prevent the hoppers from dropping on the earth, the nozzle of suction machine was inserted from the upper end and all the hoppers in the cylinder were carefully collected.

The hoppers thus obtained were examined in the laboratory under a binocular microscope to identify the species and instars. In counting the hoppers, the nymphs of 1st and 2nd instars were excluded because identification is rather difficult in these young nymphs. As to the nymphs of 3rd-5th instars, the species can be easily determined by their color and form (Suenaga and Nakatsuka, 1958), and the instar by the form of wing bud.

**Analysis on the Pattern of Spatial Distribution**

*Relation between mean and variance*: The analysis is started with the relationship between the first two moments of basic importance, that is, mean and variance. For the convenience of treatment, the present author analyzes the relationship between ratio of variance/mean and mean instead of variance itself.

The mean density per hill (\( \bar{x} \)) and the unbiased estimate of variance (\( V \)) were calculated for both separate and total counts of the 3rd, 4th and 5th instar nymphs from five sets of samples and shown in Table 1. The values of \( \frac{V}{\bar{x}} \) were, then, computed and plotted on \( \bar{x} \) for both total (Fig. 1, left) and separate (Fig. 1, right) counts.

The relation of \( \frac{V}{\bar{x}} \) to \( \bar{x} \) in the figure indicates that the variance/mean ratio increases linearly with the rise of mean in every species, almost always exceeding unity, and that its rate of increase differs remarkably with species, being higher in the order of Nilaparvata, Delphacodes and Neophotettix.

Since \( \frac{V}{\bar{x}} \) is to approximate unity independent of mean if the frequencies follow Poisson series, it is obvious from Fig. 1 that the distributions of these hoppers are far from randomness and highly contagious. The discrepancy from randomness can be statistically confirmed in Fig. 1 from that, except at very low densitits, the values