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Research article

SPATIAL DISTRIBUTION PATTERN OF SPITTLEBUG NYMPH, *PTYELUS NEBULUS* (FABRICIUS) (HOMOPTERA, APHROPHORIDAE)

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ABSTRACT: Distribution pattern of spittlebug nymph, *Ptyelus nebulus* (Fabricius) (Homoptera, Aphrophoridae) was studied in the months of rainfall, June, July and August by using different statistical measures. All the estimators confirm that nymphs of spittlebug were aggregated in distribution. The cause of aggregation was also calculated by using formula of Arbus and Kerrich (1951) and it indicates that clumping of nymphs was due to environmental factors.

Key words: Aggregation, Distribution, Environmental factors, Nymph, *Ptyelus nebulus*

INTRODUCTION

Spittle bugs *Ptyelus nebulus* (Fabricius) are widely distributed in different parts of West Bengal. The bugs hide their nymphs in mass of white spittle like broth.

The spatial distribution patterns of species are important because it is the inherent characteristics of the species concerned and the habitat under which it lives. It is essential for understanding of population dynamics of a species.

The present paper reports on the spatial distribution pattern of spittle bug nymphs using different statistical measurements.

MATERIALS AND METHODS

Site description

The study was conducted at Suri (87°34' E, 23°54' N). Spittle bug nymphs are distributed in the open grass fields with a few small bushes here and there. Nymphs are very common in the months of rainfall i.e. from June to September when there are over growth of grasses. Height of the grasses ranged from 20-30 cm. There were 800 to 1000 grasses per square meter of soil surface.

Sampling method

Samples were taken for eight days from June 20 to August 28, 2011. On each sampling date 16 samples were taken at random using a folding quadrat of one square meter.

Description pattern

Aggregation has been measured most widely by using K in the expression:

$$S^2=m+Km^2$$

Derived from the negative binomial distribution (Bliss and Owen, 1958) where S^2 is the variance and m is the mean. In this method the degree of aggregation is determined from the value of K , which in case of extreme aggregation approaches zero.

The mean crowding (m^*) is defined by Lloyd (1967) as the mean number of other individuals per individual per quadrat. It relates to the mean population density (m) and the variance (δ^2) of the population in the following way:

$$m^* = m + (\delta^2)/m - 1$$

The ratio of mean crowding to mean density m^*/m , is called patchiness by Lloyd, which is identical with Morisita's (1971) dispersion index I^*A and Kuno's (1968) index C_A

$$m^*/m = (m^2 + \delta^2 - m)/m^2 = 1 + C_A = I^*A$$

The m^*/m provides a relative measure of aggregation. It equals unity in random and greater and smaller than unity in aggregated and regular distributions respectively.

Iwao (1968) suggested a linear regression equation of m^* on the m in the form

$$m^* = \alpha + \beta m$$

Hence the intercept α called the index of basic contagion, and the slope β named as the population density contagiousness coefficient, indicates the distribution pattern, $\beta=1$ when the basic components are distributed randomly, $\beta>1$ in aggregated distribution and $0 \leq \beta < 1$ when they are distributed regularly.

A X^2 test for small samples (Elliot 1973) was used to compare two distributions with the Poisson series, where

$$X^2 = S^2 (n-1)/x$$

Southwood (1966) further showed that the index dispersion can be measured in the following way:

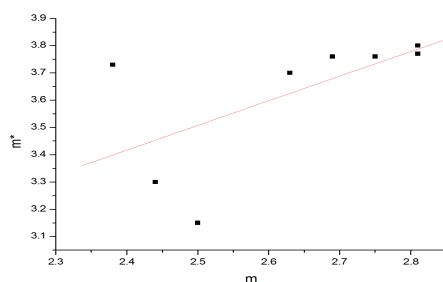
$$\text{Index of dispersion} = X^2 / (n-1)$$

The value approximate to unity in random distribution, a value of zero for regularly distributed and a value greater than one imply aggregation. Bliss (1958) showed that K is not always independent of m . If the mean and variance of a series of samples are plotted, they tend to increase together to obey as power law. This relationship has been shown by Taylor (1961), a commonly known as Taylor's power law and is expressed by, $S^2 = aX^b$

Where a and b are constants, a is largely a sampling factor where b appears to be true index of aggregation, when the population are regular in distribution b tends to zero, in a random distribution b is equal to one and in an aggregated distribution b will be greater than one.

RESULTS

There are various statistical methods to estimate distribution pattern. We used five types of equations to determine the distribution pattern of spittlebug nymph. The values of K for three months are shown in the Table 1. Nymphs of spittlebug show aggregation in these months. The m^*/m values in nymphal populations for three months are listed in Table 1 and the values indicate that the spittlebug nymphs are aggregated in distribution.



**Figure 1. Regression of mean crowding (m^*) on mean density (m) in *P. nebulus* population.
 $M^* = 1.69 + 0.74m$, $p < 0.01$**

Table 1. The values of different statistical measurement of P. nebulus population during different months of the year

Months	K value	Mean crowding(m [*])/mean density(m)	Index of dispersion	X ² **
June 20	0.34	1.34	1.95	29.31
June 30	0.57	1.57	2.35	35.26
July 8	0.40	1.40	2.07	31.01
July 18	0.37	1.37	2.01	30.18
July 29	0.35	1.35	1.99	29.86
August 7	0.26	1.26	1.65	24.80
Aug. 18	0.41	1.41	2.08	31.14
Aug. 28	0.35	1.33	1.89	27.37

**n=16 in each date, X²_{0.01&0.05}=30.58&24.99

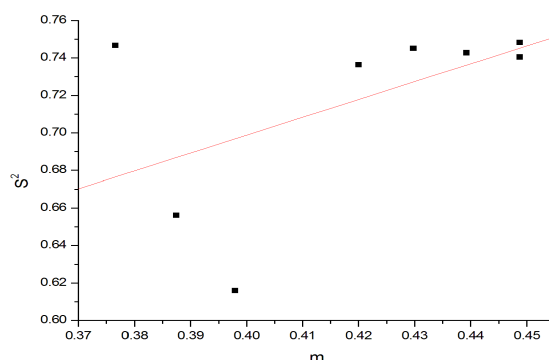
Table 2: γ values of Spittlebug nymph population using sample date

Month	γ values
June 20	1.28
Jun 30	1.23
July 8	1.21
July 18	1.26
July 29	1.28
August 7	1.15
August 18	1.19
August 28	1.12

The slope of β value ($\beta=0.74$) indicates mutual attraction among individuals (Fig 1).

In X² test all values were highly significant during different methods (Table 1)

By using Taylor's power law in the present study population inclines aggregation (Fig. 2).



**Figure 2. Regression of variance (S^2) on mean (m) in P. nebulus population (log scale).
Y=0.3130+0.9636X, p<0.05**

DISCUSSION

In the present study it is difficult to determine which estimator is the best to use. All the estimators confirm that nymphs of spittlebug were aggregated in dispersion during these three months. The aggregation may be due to either to active aggregation by the insects or to some heterogeneity of the environment at large (microclimate, food plant, natural enemies). Blackwith(1958) has suggested that if mean size of a clump is calculated using Arbous & Kerrich's (1951) formula and this is found to be less than 2, then the aggregation would seem to be due to some environmental effect and not to an active process. Aggregation of two or more insects could be caused by either factor. The mean number of individuals in the aggregation is calculated by

$$\gamma = x/2K.v$$

Using this formula the values of γ in all the sampling days ranged from 1.12 to 1.28 (Table 2) i.e. less than 2 which indicate that clumping nymphs is due to environmental factors.

Taylor (1961) criticizes the K method for calculating the degree of aggregation because K is not always independent of m and he suggested that an index of population structure should be the same at different population densities unless some actual change in behaviour is involved. Iwao (1977) pointed out that b of Taylor's power law does not provide a reliable means of measuring aggregation because it cannot distinguish whether the distribution is composed of individuals or colonies and because it leads to the unrealistic conclusion that the distribution will invariably change from a contagious through random, to regular pattern if $b > 1$ as is observed in many cases.

The regression of m^* on m technique is widely recognized in many species of insects and their immature stages (Kuno 1963, 68; Hokyo 1972 Iwao 1976).

The slope beta of the $m^* - m$ regression becomes higher when habitat conditions are heterogeneous as indicated by a simple model of Iwao & Kuno (1971). If the magnitude of environmental heterogeneity can be measured in some way, this may explain the reason why β is greater than unity in most of the observed patterns in the nature.

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