POPULATION DYNAMICS OF THE CHESTNUT GALL-WASP, *DRYOCOSMUS KURIPHILOS* YASUMATSU (HYMENOPTERA: CYNIPIDAE)

IV. FURTHER ANALYSIS OF THE DISTRIBUTION OF EGGS AND YOUNG LARVAE IN BUDS USING THE TRUNCATED NEGATIVE BINOMIAL SERIES

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INTRODUCTION

In this paper we re-examine two aspects of previously published work on *Dryocosmus kuriphilus*, a species thought to be obligatorily parthenogenetic and which oviposits in buds of the chestnut tree. Firstly we overcome the confusion between eggs and first-instar larvae which MIYASHITA et al. (1965) recognised in an earlier paper (Itô et al., 1962). And secondly we examine the possibility that a truncated negative binomial series might be a more appropriate model to describe the frequency distributions of eggs and first-instar larvae as they occur in the buds.

Since TAMURA (1960) pointed out that the eggs and first-instar larvae of this species were virtually indistinguishable, counts of eggs were always made in July, before any hatching could have occurred. In this way a valid comparison can be made between the distributions of the two developmental stages.

Itô et al. (1962) showed that the frequency distribution of young larvae per bud was usually bimodal, a high proportion of the buds containing no larvae. This is due, among other causes, to the fact that new buds continue to be formed after oviposition has ended and these buds, which were not available for oviposition, cannot be distinguished, at the time of sampling, from buds that were present at oviposition. For this reason it was decided to disregard uninfested buds altogether in the analysis of the frequency distribution and to consider the distribution instead as a truncated series excluding the frequency class zero.

BLISS (1958) considers that the negative binomial series appears to be more generally descriptive of events involving insects than the POISSON series. In this instance, however, the negative binomial series did not seem to provide a suitable model because the ratio, variance/mean (the coefficient of dispersion) in the samples did not vary in linear relation to the mean, as expected in a negative binomial series. On the other hand a truncated POISSON series was found to fit reasonably well in

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many cases, despite a slight, yet significant, tendency to over-dispersion.

These conclusions must now be reconsidered because of the following reason. To test the linearity between variance and mean, we use the following equation:

$$\frac{\sigma^2}{\lambda} = \frac{\left(\sum (x - \bar{x})^2 \right)}{\bar{x}^2} / \left(n' - n_0\right) = \left(\frac{\sum x^2}{n' \bar{x}}\right) - n' \bar{x}' .$$

Where $\bar{x}'$ is the observed average number of eggs per bud excluding egg-free buds, $n'$ the number of buds with one or more eggs, and $n_0$ the number of buds without eggs, if the data were ideally of a complete series. Further, $\hat{\lambda}$ and $\sigma^2$ are the estimated mean and variance. Equation (1) is a modified form of the one originally proposed by DAVID and JOHNSON (1952) which is based on the truncated POISSON, and the coefficient of dispersion would be underestimated if the distribution was strongly over-dispersed. Finally, in our calculations we have been able to make use of the method of maximum likelihood in deriving the parameters of the negative binomial distributions because we have had an electronic computer available to us, which was not the case when the previous work was done.

**MATERIALS AND METHODS**

Investigations were carried out at seven permanent stations, which have already been described by NAKAMURA et al. (1964). Another four stations have been added since 1964. Sample shoots were taken from selected trees in September of each year to find the first-instar larvae, which had been described as "young larvae" in MIYASHITA et al. (1965). (These first-instar larvae will be referred to simply as "larvae" throughout this paper unless otherwise specified). Every bud on these sample shoots was dissected under a microscope, and the number of larvae per bud was recorded. Since 1963, sample shoots were also taken in July, to determine the number of eggs per bud.

The abbreviations like the following examples will be used throughout this paper to denote sets of samples taken in various years and places:

3SCIQ 1963, Summer (Egg), Chiba Station I, Tree Q.
4AOIIIF 1964, Autumn (Larva), Oyama Station III, Tree F.
5STM 1965, Summer, Tama, Tree M.
6AHIA 1966, Autumn, Hiratsuka Station I, Tree A.

In the Hirakata stations, cultivated varieties of trees were used for the study.

Both the sample means and variances were determined for each sample tree, as the inter-tree variance was so big that it was considered not to be homogeneous. In the estimation of these parameters, the number of buds without eggs or larvae (though it was known) was omitted in order to fit a theoretical truncated series.

As already pointed out (ITô et al., loc. cit.), there is a variety of chestnut trees which is resistant to gall-wasps. It seems that wasps do not discriminate between the resistant and susceptible varieties when they lay eggs. The eggs laid on the resistant variety do not hatch before the end of September, while those on the susceptible variety do, and gradually die out during October leaving brown symptoms on the