INTER-SPECIFIC ASSOCIATION AMONG PREY, *Chloropulvinaria psidii* (Maskell) PREDATOR, *Cryptolaemus montrouzieri* Mulsant AND ANT, *Camponotus compressus* Fabricius IN A GUAVA ECOSYSTEM

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**ABSTRACT**: A study was conducted in an unsprayed guava ecosystem in Bangalore to find the inter-specific association among *Chloropulvinaria psidii* (Maskell) *Cryptolaemus montrouzieri* Mulsant and ant, *Camponotus compressus* Fabricius a prey, predator and ant, respectively. Analysis showed a positive significant association between prey-predator only at a higher predator-prey ratio. This has bearing on suppression in biocontrol releases. A positive association between predator and ant was seen only when the mean prey population was lower, implying competition. At higher mean prey number, the predator and ant showed positive association implying coexistence. The implication of the study in biological control is discussed.

**Key Words**: *Camponotus compressus, Chloropulvinaria psidii, Cryptolaemus montrouzieri,* guava, inter-specific association

**INTRODUCTION**

In monocrop agro-ecosystems, diversity of insects is relatively low compared to natural ecosystems. The reduced diversity still exhibits an interplay of associations ranging from negative to neutral to positive, leading to processes like competitions, co-existence, etc. Several inter-specific studies have shown that competing species over a period tend to get into a stable equilibrium, through inter-specific adaptations and coexist indefinitely (Price, 1975). One of the ecological measures, which gives insight into these is the inter-specific association among the insect fauna in the community of an ecosystem.

Guava (*Psidium guajava* L.), an important commercial fruit crop, is fast becoming a major monocrop ecosystem and probably as a consequence, the insect pest problems are on the rise. Spraying of insecticides is detrimental as guava fruits are harvested at regular intervals and consumed fresh. Insect pests therefore, have to be managed taking advantage of natural enemies. If the natural enemies are indigenous and already existing in the insect community, they should be first exploited for insect pest management. This is possible only if the inter-specific association among the species, which constitutes phytophagous, carnivorous and polyphagous species in a community with reference to the crop ecosystem are understood.

The inter-specific effects between prey and predator, prey and ants and predator and ants will have impact on the pest (prey) species. If the association between species is positive, the two species may require similar conditions and/or it
may imply mutualism or predator-prey relationship or if negative they require different conditions or actively compete with each other (Southwood, 1978). It was expected that among prey, predator and ants, there would be positive trends, initially. However, if predators are effective in suppressing prey, the trend is expected to be negative, especially on a longer temporal scale. Ants may chase/drive predators, or predators may avoid ants. Therefore these may show a negative relationship between them. So a negative trend is expected. The present study therefore has been carried out to understand the type of association among three major insect species and attempt is made to discuss the inter-specific effects in a guava ecosystem.

MATERIALS AND METHODS

An established ten year old pesticide-free guava orchard on the outskirts of Bangalore was selected. The study was conducted during 1990 and 1991.

The predominant species of the insect community of the selected guava ecosystem were the green shield scale Chloropulvinaria psidi (Maskell) (Homoptera: Pseudococcidae) which is a serious pest on guava (Mani and Krishnamoorthy, 1990). The honeydew excretion from scale attracts the ant, Camponotus compressus Fab. (Hymenoptera: Formicidae). The scale is preyed upon by Cryptolaemus montrozieri Mulsant (Coleoptera: Coccinellidae) (Mani and Krishnamoorthy, 1990).

In the study area, guava flush emerged by March. Fortnightly observations were taken on the insects following standard sampling plans (Verghese, 1992). Ten trees were randomly selected and marked. From each tree, 20 leaves were randomly chosen and in situ visual counts of C. psidi settler were taken. The ants attending the C. psidi settlers were counted. The adult, grub and pupal counts of C. montrozieri on a single terminal branch corresponding to the sampled leaf of C. psidi were counted. The grubs and adults preferably fed on egg masses, and therefore, moved in search of prey. So, sampling had to be on a bigger unit, viz. terminal branch in this case. The observations were repeated every fortnight, for 19 successive fortights between March to December 1991. Thus, at each sampling, data from 200 sampling units were obtained.

The data of July was found to have maximum insect activity, in terms of the prey, predator and ant. Therefore, the data of two fortights of July were subjected to inter-specific association analysis, taking two species at a time in a 2 x 2 contingency table because this analysis gives best results when all the insect populations are abundant. The $\chi^2$ was used as the test for the association as it makes very few assumptions about the type of distribution (Southwood, 1978). The cells in the contingency table corresponded to presence and absence of species A and B, the former being more abundant. These cells were designated respectively, as a, b, c and d as follows:

<table>
<thead>
<tr>
<th>Species A</th>
<th>Present</th>
<th>Absent</th>
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<tbody>
<tr>
<td>Species B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Absent</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td>a + c</td>
<td>b + d</td>
</tr>
</tbody>
</table>

$\chi^2$ was calculated using the following formula,

$$\chi^2 = \frac{n(ad - bc) - (n/2)^2}{(a + c)(b + d)(a + b)(c + d)}$$

Further, the mean data of each insect from 200 samples were averaged for each fortnight. These were analysed using simple correlation analysis, to evaluate the overall numerical association between species. These correlation analyses were done to test the assumptions given earlier.

RESULTS AND DISCUSSION

The correlation coefficient based on mean numbers of insects from 19 fortights are presented in Table-3. All the three species showed
significant positive trends in their numbers (Table-3). Cryptolaemus montrouzieri is partly dependant on C. psidii, while C. compressus forages on the honeydew. These trends, however, showed in spite of negative association between predator and ant, an overall co-existence exists in the ecosystem. This explains the positive significant correlation between predator and ant.

Table-1 shows the $\chi^2$ values of inter-species association on two sampling dates, when all the species were present abundantly. Between sampling dates, there is consistency in association only between C. psidii and C. compressus, which was highly significant and positive. This consistency is because of the ratios between scale and ant on both sampling dates were almost same 1 : 0.14 and 1 : 0.13, i.e. on 16 and 31 July 1991, respectively (Table-2).

The inter-specific association between C. psidii and C. montrouzieri showed that there is a positive association between the two. The relationship became significant by the 31 July when the prey-predator numerical ratio was higher (Table-2). Therefore, the numerical ratio between the two species influences association.

The association between C. compressus and C. montrouzieri showed duality. It was significantly positive in the first sampling when prey density was higher (Table-2) but negative in the second sampling. When the mean prey numbers showed a decline in a fortnight, mean

<table>
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<tr>
<th>Table 1. Inter-species association</th>
<th>Type of Relationship and $\chi^2$ values</th>
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<tbody>
<tr>
<td>Inter-species</td>
<td>16 July '91</td>
</tr>
<tr>
<td>C. psidii and C. montrouzieri</td>
<td>+ 0.89</td>
</tr>
<tr>
<td>C. psidii and C. compressus</td>
<td>+ 23.04**</td>
</tr>
<tr>
<td>C. compressus and C. montrouzieri</td>
<td>+ 23.16**</td>
</tr>
</tbody>
</table>

* Positive relationship
- Negative relationship

*, ** Significant at $P = 0.05$ and $P = 0.01$, respectively

<table>
<thead>
<tr>
<th>Table 2 Mean and ratios of scale, predator and ant</th>
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<tbody>
<tr>
<td>C. psidii Mean per leaf</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>16 July '91</td>
</tr>
<tr>
<td>31 July '91</td>
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</tbody>
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<tr>
<th>Table 3. Correlation coefficient ($r$) showing numerical trends between scale, predator and ants in a guava ecosystem (n = 19 fortnights).</th>
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<tr>
<td>Variables</td>
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<tr>
<td>C. psidii and C. montrouzieri</td>
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<tr>
<td>C. psidii and C. compressus</td>
</tr>
<tr>
<td>C. montrouzieri and C. compressus</td>
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*, ** Significant at $P = 0.05$ and $P = 0.01$, respectively.
number of predator showed a higher trend (Table-2). So a negative association between predator and ant by second sampling is probably suggestive of competition for the scale either as prey or for honeydew, by the predator or ant, respectively. At a higher mean density of scale, there is probably a tolerance between ant and predator, which explains the significant positive association in the first sampling. But under competitive pressure, there is no co-existence, as was evident between Chelomenu sena s elseculata and C. compressus in a guava ecosystem (Vergheese and Tandon, 1987).

CONCLUSION

Thus, the study showed that between the scale C. psidii and predator C. montrouzieri significant positive association existed only at a higher prey predator ratio. Otherwise, the association was only a chance. This study therefore, gives a clue to biocontrol of the scale using C. montrouzieri in that a prey-predator ratio of 1 : 0.08 gives significant association. Hence, suppression may be expected, only if for every 100 settlers there are about 8 predators. But, the positive significant correlation coefficient between the two indicate a co-existence than suppression, which may be the order in a naturalised guava ecosystem. Any inundative release of the predator or insecticidal spray can upset this association. Recommendations for C. psidii should, therefore, be hinged to prey density. C. montrouzieri is recommended on tree basis (Mani and Krishnamoorthy, 1990). A realistic approach would be to make a preliminary estimate of scale and predatory density using standard sampling plans (Vergheese and Urs, 1995).

The predator and ant showed both positive and negative associations. A negative association may be suggestive of competition when a common resource like the scale became limited. An opportunistic foraging by C. compressus was reported earlier with regard to Chelomenu sena s elseculata in a guava ecosystem (Vergheese and Tandon, 1987). But an overall significant positive 'r' with predator shows coexistence or tolerance. The present study therefore, indicated that the three species are capable of coexisting in a guava ecosystem, while interspecific association changed depending on numerical ratios.

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REFERENCES


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