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Population trends of some monophagous and polyphagous fulgoroids in relation to biotic and abiotic factors (Insecta: Homoptera)

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Abstract. The population trends of the planthoppers, *Dichoptera hyalinata* Fabricius (Dictyopharidae), *Eurybrachys tomentosa* Fabricius (Eurybrachidae), and *Ricania fenestrata* Fabricius (Ricaniidae) were studied with reference to the abiotic factors like temperature, humidity and rainfall and biotic factors like two nymphal ectoparasites, *Dryinus* sp. (*A*)* and *Dryinus* sp. (*B*)* (Dryinidae: Hymenoptera) and two egg parasites, *Proleurocerus fulgoridis* Ferriere (Encyrtidae: Hymenoptera) and *Tetrastichus* sp. (Eulophidae: Hymenoptera).

Keywords. Fulgoroidea; population trends; biotic and abiotic factors.

1. Introduction

Investigations on the diverse aspects of biology and ecology of fulgoroids appear significant in view of their role as pests of crops and vectors of plant disease. As early as 1916 Misra observed the seasonal incidence of *Pyrilla perpusilla* and subsequent major studies, in India, in this area appear restricted to *Pyrilla perpusilla* (Pruthi 1937), *Nilaparvata lugens* (Baskaran *et al* 1979; Varadharajan 1979), and *Sogatella furcifera* (Atwal *et al* 1967; Satpathy and Maiti 1973). The present paper includes the population trends of three fulgoroids, *Dichoptera hyalinata* Fabricius, *Eurybrachys tomentosa* Fabricius, and *Ricania fenestrata* Fabricius.

2. Material and methods

The population trends of *Dichoptera hyalinata* (monophagous) on *Ficus bengalensis*, *Eurybrachys tomentosa* (polyphagous) on *Calotropis gigantea* and *Casuarina equisetifolia*, and *Ricania fenestrata* (polyphagous) on *Clerodendrum inerme* and *Casuarina equisetifolia* were analysed by periodic counting of various stages. Sixteen m^2 on the main trunk of *F. bengalensis*, 5 plants of *C. gigantea*, and 5 m^2 of *C. inerme* and *C. equisetifolia* (both edge plants in gardens) were taken as units for measuring the populations of respective planthoppers. Abiotic factors like temperature, relative humidity, and rainfall and biotic factors like parasites were correlated with the population trends of the above species of planthoppers.

* The two *Dryinus* spp. have been designated as (*A*) and (*B*) as they have been identified to be two new species (Dr Z Boucek, Commonwealth Institute of Entomology, London—Personal communication).

3. Observations

3.1 *Dichoptera hyalinata*

Population of *D. hyalinata* occurred throughout the year, being abundant during July, August and October (figure 1). The maximum total population was 36/16 m^2 in July and minimum 3/16 m^2 in December and January. Nymphal population exceeded that of the adults, the average adult and nymphal ratio being 1 : 3 (table 1), except during December, January and February when the nymphal population was negligible. A maximum of 33/16 m^2 (in July) and a minimum of 3/16 m^2 (in February) were observed in the nymphal population, while the adult population was high (6/16 m^2) in August, September, and October and low (2/16 m^2) in March, April and May. The male population was found to be on the increase in most of the months as compared to that of the females, with an average male-female ratio of 1 : 0·8 (table 1), while the female population was about double that of the males (1 : 2) in September. The populations of both the sexes were identical during August and March to May.

Both abiotic and biotic factors appear to play significant role in the fluctuations of the *D. hyalinata* population (figure 1). Since the adults of the hymenopterous ectoparasite, *Dryinus* sp. (*A*) on *D. hyalinata* (Swaminathan and Ananthakrishnan 1982), were free-living, the parasitised host nymphs were taken as a reliable index of the parasite population. This ectoparasite was found to play an essential role in controlling the host population. The percentage of parasitism reached the maximum (36·36 %) in November (table 1) followed by a notable decline in the total nymphal population of

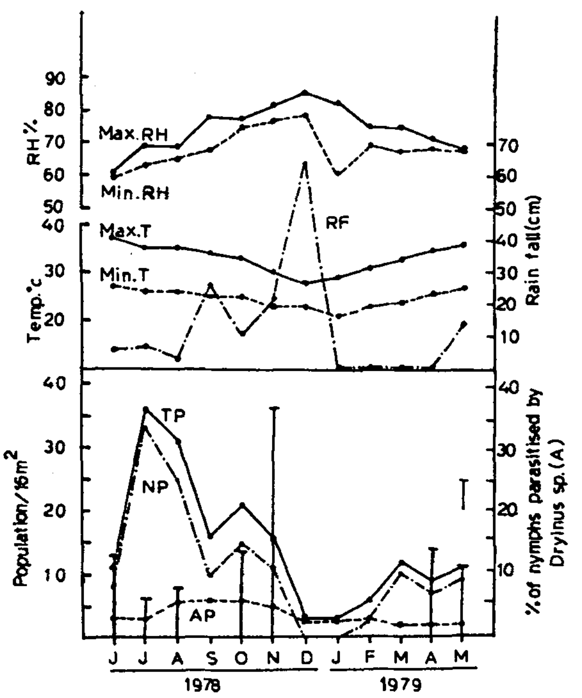

Figure 1. Population trend of *Dichoptera hyalinata*. (AP, adult population; NP, nymphal population; RF, rainfall; RH, relative humidity; T, temperature; TP, total population).

Table 1. Sex ratio, adult-nymphal ratio, and percentage of parasitisation by *Dryinus* sp. (*A*) of *Dichoptera hyalinata*.

Year	Month	Male : female	Adult : nymph	Percentage of nymphs parasitised
1978	June	1:0·5	1:3	12·5
	July	1:0·5	1:11	6·0
	August	1:1	1:4·5	8·0
	September	1:2	1:1·7	—
	October	1:0·5	1:2·8	13·3
	November	1:0·7	1:3	36·36
	December	1:0·5	—	—
1979	January	1:0·5	—	—
	February	1:0·5	1:1	—
	March	1:1	1:5	—
	April	1:1	1:4	14·0
	May	1:1	1:5	11·0
	Mean	1:0·8	1:3	

the host in subsequent months. The absence of parasitised nymphs during September may be attributed to the presence of only late nymphal stages in the field. Parasite activity was not observed from December to March and the parasite reestablished itself only in April.

The populations of both the host, *D. hyalinata*, and the parasite, *Dryinus* sp. (*A*), appear to be influenced by environmental conditions such as temperature, humidity, and rainfall (figure 1). The abiotic conditions which maintained the population of *D. hyalinata* were 30–37°C maximum temperature, 23–27°C minimum temperature, 61–82% maximum humidity, and 59–77% minimum humidity. The total population declined drastically in December when the rainfall (64·28 cm) and relative humidity (maximum 86% and minimum 79%) reached their peaks, while temperature declined (maximum temperature 27·9°C). The population was maintained at a low level during the following January, when the difference between the maximum and minimum humidity was high (22%). Among the environmental factors, the rainfall during the months of September (26·42 cm), November (21·54 cm), and December (64·28 cm) showed major influence on the *D. hyalinata* population, particularly on the total as well as nymphal populations, which correspondingly declined during this period. An integrated effect of all the three abiotic factors appeared to bring down the *D. hyalinata* population. Rainfall also influenced parasitisation as evidenced from the drastic decline in the percentage of parasitisation during the peak monsoon (December).

3.2 *Eurybrachys tomentosa*

The population of *E. tomentosa* was observed on two hosts *viz Calotropis gigantea* and *Casuarina equisetifolia*. The population on *C. gigantea* was restricted to a period of eight months from October to May, while the nymphal population alone occurred on *C. equisetifolia* throughout the year (figure 2). In the case of *C. gigantea*, populations of all stages were observed. A maximum total population of 42/5 plants (excluding eggs)

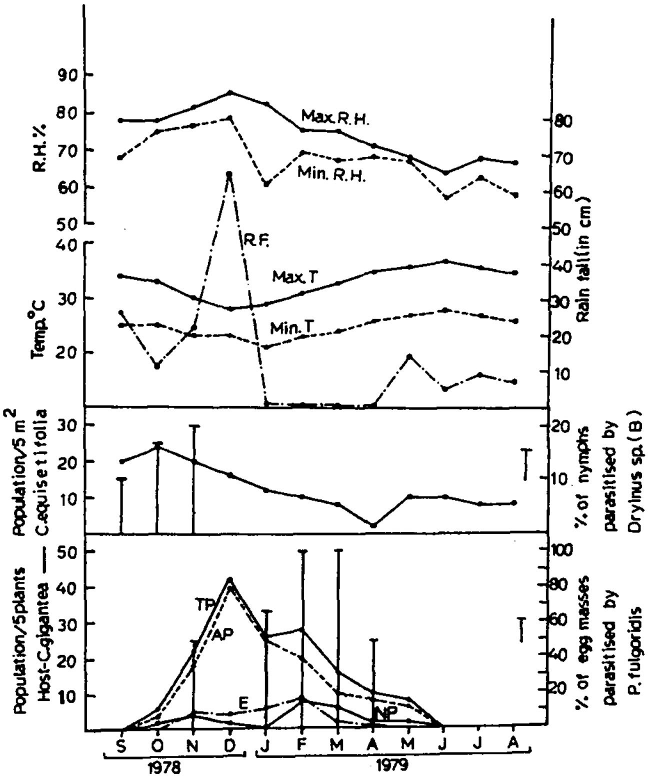

Figure 2. Population trend of *Eurybrachys tomentosa* (E, Number of egg masses).

Table 2. Sex ratio, adult-nymphal ratio, and percentage of egg masses parasitised by *Proleurocerus fulgoridis*, of *Eurybrachys tomentosa* – Host-*Calotropis gigantea*.

Year	Month	Male : female	Adult : nymph	Percentage of egg masses parasitised
1978	October	1:1	1:0·5	—
	November	1:2	1:0·2	50
	December	1:1·5	1:0·1	—
1979	January	1:1·6	—	66·7
	February	1:2·3	1:0·4	100
	March	1:0·7	1:0·6	100
	April	1:1	1:0·3	50
	May	1:0·5	1:0·3	—
	Mean	1:1·4	1:0·2	

(in December) and a minimum of 6/5 plants (in October) were recorded. The nymphal population was very low in *C. gigantea* ranging from 2 to 8 per five plants with the average adult-nymphal ratio 1 : 0·2 (table 2). The females were more abundant during the months November–February, while the males outnumbered the females during March and May; both sexes were equally abundant during October and April, the average male-female ratio being 1 : 1·4 (table 2). Nymphal population of *E. tomentosa* was present on *C. equisetifolia*, rarely with one or two adults. In October the maximum nymphal population (24/5 m^2) was recorded on this host, while the minimum (2/5 m^2) was seen in April.

Three natural enemies—one ectoparasite and two egg parasites—play a significant role in controlling *E. tomentosa* population. As in *Dryinus* sp. (*A*), the population of *Dryinus* sp. (*B*) on *E. tomentosa* nymphs (Swaminathan and Ananthakrishnan 1982) was also measured by counting the number of parasitised host nymphs in the field and the parasitisation was restricted only to the rainy season (September to November). When the percentage of parasitisation reached its maximum (20 %) during November, there was a corresponding decrease in the nymphal population. Among the two hymenopterous egg parasites, *viz Proleurocerus fulgoridis* and *Tetrastichus* sp. on *E. tomentosa* (Swaminathan and Ananthakrishnan 1982), *P. fulgoridis* played a significant role in controlling the host population. The number of egg masses parasitised was taken as an index of the *P. fulgoridis* and *Tetrastichus* sp. populations. The percentage of egg masses parasitised reached its maximum (100 %) from February to March (table 2 and figure 2) followed by a drastic reduction in the host population. *Tetrastichus* sp. showed weak incidence during the terminal period of *P. fulgoridis* activity (not shown in the figure).

The range of environmental conditions to maintain the population of *E. tomentosa* was 28–35°C maximum temperature, 21–26°C minimum temperature, 72–86 % maximum humidity and 61–79 % minimum humidity. Unlike *D. hyalinata*, the rainfall had no deleterious effect on the population of this insect and the peak population of *E. tomentosa* occurred during the period of maximum rainfall (figure 2). Maximum temperature and relative humidity played a significant role in the population trends of *E. tomentosa*. The peak population occurred when the temperature was low (maximum temperature 28°C) and relative humidity high (maximum 80 % and minimum 79 %) as seen in December. During the subsequent month the minimum humidity fell (from 79 % to 61 %), with a difference between maximum and minimum humidity (22 %) and a corresponding decline in the *E. tomentosa* population. The population of this species reached its minimum or was totally absent when the humidity was at its lower range and the temperature at its higher range (from May to August).

3.3 *Ricania fenestrata*

The population of *R. fenestrata* was restricted to a period of four months in summer (January/February–April/May) (figure 3). The population occurred in equal abundance on two hosts, *C. equisetifolia* and *Clerodendrum inerme*. The maximum and minimum number of total population varied from 113 and 2/5 m^2 in the case of *C. equisetifolia* and 131 and 4/5 m^2 in the case of *C. inerme*. The nymphal population outnumbered that of the adults except in March and May (1978) and February and May (1979). The average adult-nymphal ratio was 1 : 2·8 in *C. equisetifolia* and 1 : 2·7 in *C. inerme* (table 3). The average sex ratio recorded was about identical in *C. equisetifolia* and *C. inerme* being 1 : 1·2 (male-female) (table 3).

Abiotic factors such as rainfall, temperature and humidity appeared to considerably affect the population trend of *R. fenestrata* (figure 3). The range of environmental conditions for the maintenance of *R. fenestrata* population was 30–38°C maximum temperature, 22–28°C minimum temperature, 64–81 % maximum humidity, and

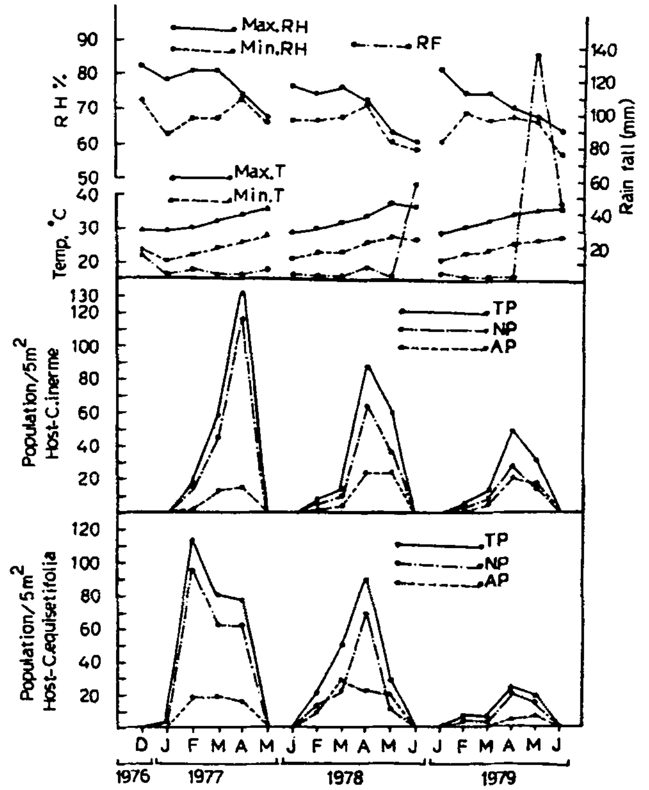

Figure 3. Population trend of *Ricania fenestrata*.

Table 3. Sex ratio and adult-nymphal ratio of *Ricania fenestrata*.

		Male : female		Adult : nymph	
Year	Month	*C. equisetifolia*	*C. inerme*	*C. equisetifolia*	*C. inerme*
1977	February	1:1	1:1	1:5·3	1:7·5
	March	1:1·3	1:1·6	1:3·4	1:3·5
	April	1:1·1	1:1·5	1:4·1	1:7·7
1978	February	1:1·7	1:1	1:1·5	1:3
	March	1:1·5	1:1	1:0·8	1:2·5
	April	1:1·1	1:1	1:3·2	1:2·7
	May	1:1·3	1:1	1:0·5	1:1·5
1979	February	—	1:1	—	1:1
	March	—	1:1	—	1:1·6
	April	1:1	1:1·3	1:9·5	1:1·3
	May	1:1	1:1·3	1:3	1:1
	Mean	1:1·2	1:1·2	1:2·8	1:2·7

61–74% minimum humidity. The peak population of this insect was noticed on both hosts during April, when the temperature and humidity were moderately high (maximum temperature 34 or 35°C, minimum temperature 24 or 26°C, maximum and minimum humidity 69–74%). After April with a further increase in temperature and decrease in humidity, the population of *R. fenestrata* declined. The effect of rainfall on the population of this species is significant and with the onset of monsoon in Madras in June there was a drastic decline in or a complete elimination of its population.

4. Discussion

Regarding the impact of climate on the population dynamics of insects, opinions vary. Pradhan (1972a, 1972b) observed fewer pests in crops growing in cooler seasons and colder regions. Kalode (1974) found high rainfall and very high or low temperature as being unfavourable for the population increase of leafhoppers and planthoppers in India, and in *Nilaparvata lugens* the population attained peak after cessation of rainfall. In Philippines Alam (1971) found an increase in *Nilaparvata lugens* population when the mean temperature increased. Tao and Nagoan (1970) observed high incidence of *Sogatella furcifera* in Vietnam in wet seasons. Heavy rainfall and high relative humidity were favourable for rapid multiplication of *Sogatella furcifera* (Satpathy and Maiti 1973).

In the present investigation *D. hyalinata* and *E. tomentosa* populations were found throughout the year with peaks of abundance during the pre-monsoon and monsoon periods respectively, while *R. fenestrata* population was restricted only to summer. Rainfall was found to decrease *D. hyalinata* population while an increase in the number of individuals in the population was noticed in *E. tomentosa*, particularly on the host, *Calotropis gigantea*. Moderate temperature and low humidity and low temperature and high humidity were the favourable climatic conditions for *D. hyalinata* and *E. tomentosa* respectively, while *R. fenestrata* preferred to multiply more under moderate temperature and moderate humidity. Very high temperatures were found to decrease the population in all the three species.

Though information on the incidence and biology of parasites of Fulgoroidea is available in plenty, their role in controlling the host population is very much limited. *Haplogonatopus vitiensis* Perk. and *Pseudogonatopus hospes* Perk. were observed to control the population of the sugarcane leafhopper, *Perkinsiella saccharicida* in Hawaii (Clausen 1949), while *Anagrus flaveolus* reduced the population of *Delphax maidis* (Marine–Acosta 1964). Studies on the intensity of parasitisation by various parasites (Strepsiptera, Dryinidae, Pipenculidae, and Nematoda) by Otake *et al* (1976), in Sri Lanka, on *Sogatella furcifera* and *Nilaparvata lugens* showed the combined effect of these parasites in checking the planthopper population. Kuno (1968) demonstrated that the parasites, including an egg parasite, *Anagrus* sp. played a fairly important role in controlling *Sogatella furcifera* and *Nilaparvata lugens* populations in Kyushu, Japan. *Dryinus* sp. (*A*) was able to control the *D. hyalinata* population to some extent particularly during the monsoon season. This can be attributed to the larger number of nymphs in the host population, particularly during peak periods, and restriction of parasitisation always to the nymphs. It was also observed that rainfall affected the numphs of *D. hyalinata*; consequently, it also affected the parasite population; but for this abiotic factor, the effect of this parasite would be greater on the host. The *E.*

tomentosa population on *C. gigantea* was effectively controlled by the egg parasite, *Proleurocerus fulgoridis*, the parasitisation reaching about 100% before the host population started declining. Although *Tetrastichus* sp. was found less effective on the eggs of *E. tomentosa* in the present studies, reports are available on the effectiveness of this genus as a successful biological control agent. Sen (1948) observed a high intensity of parasitisation of *Pyrilla perpusilla* by *Tetrastichus pyrillae* in Bihar sugarcane fields correlated with high yield in the crop, while Narayanan and Kundanlal (1953) showed the major influence of this parasite among the three chalcid parasites of *P. perpusilla*. In all the three insects studied, the abiotic factors played a major role in controlling the population. In *D. hyalinata* and *E. tomentosa*, a combined effect of biotic and abiotic factors was evident in the population fluctuations.

References

Alam S 1971 *Population dynamics of the common leafhopper and planthopper pests of rice*; Ph.D. Thesis submitted to the University of Cornell, New York, 141 pp.

Atwal A S, Chaudhary J P and Sohi B S 1967 Studies on the biology and control of *Sogatella furcifera* Horv. (Delphacidae: Homoptera) in Punjab; *J. Res. Punjab Agric. Univ.* **5** 547–555

Baskaran P, Narayanaswamy, and Vaithilingam C 1979 Population dynamics and control of brown planthopper in Chidambaram area; *Recent trends in rice brown planthopper control*; Colloquium on Rice Brown Planthopper, Kumbakonam, Tamil Nadu, June 1979, pp. 22–26

Clausen C P 1949 *Entomophagous insects*, (New York McGraw-Hill) 688 pp.

Kalode M B 1974 Recent changes in relative pest status of rice insects as influenced by cultural, ecological, and genetic factors. Paper presented in International Rice Research Conference, 1974, Philippines, AICRIP, Publ., 77

Kuno E 1968 Studies on the population dynamics of rice leafhoppers in a paddy field; *Bull. Kyushu Agric. Exp. Stn.*, **14** 131–246

Marine-Acosta J C 1964 The corn leafhopper *Delphax maidis* Ashm. (Homoptera; Delphacidae) in graduated corn culture, and its relationship with climatic factors; *Rev. Fac. Agron., Univ. Cent., Venezuela, Maracay*, **3** 42–68

Misra C S 1916 The Indian sugarcane leafhopper, *Pyrilla aberrans* Kirby. *Mem. Dept. Agric. India, Entomol. Ser.*, **5** 75–136

Narayanan E S and Kundanlal 1953 Studies on the chalcid egg parasites of *Pyrilla* spp. occurring in Delhi. Part I. Bionomics of *Tetrastichus pyrillae* Crawf., *Ageniaspis pyrillae* Mani, and *Cheiloneurus pyrillae* Mani; *Indian J. Entomol.*, **15** 173–179

Otake A, Somasundram P H and Abeykoon M B 1976 Studies on populations of *Sogatella furcifera* Horvath and *Nilaparvata lugens* Stal (Hemiptera: Delphacidae) and their parasites in Sri Lanka; *Appl. Entomol. Zool.* **11** 284–294

Pradhan S 1972a Paddy yield higher in cooler regions; *Entomol. Newsl.*, **2** 63–64

Pradhan S 1972b Paddy yield higher in cooler seasons (Rabi crop); *Entomol. Newsl.*, **2** 68–69

Pruthi H S 1937 On the *Pyrilla* pest of sugarcane in India; *Indian J. Agric. Sci.*, **7** 511–512

Satpathy J M and Maiti B K 1973 Studies on the seasonal variability in population density and distribution of rice hoppers; *Prakruti Utkal Univ. J. Sci.* **10** 45–54

Sen A C 1948 The *Pyrilla* pest of cane in Bihar and its control by the utilisation of its natural parasites: *Indian J. Entomol.* **10** 45–50

Swaminathan S and Ananthakrishnan T N 1982 New natural enemy complex of some fulgoroids (Insecta: Homoptera) with biological studies of three hymenopterous parasites (Insecta: Hymenoptera); *Proc. Indian Acad. Sci.* (*Anim. Sci.*) **91** 177–187

Tao L H and Nagoan N D 1970 An ecological study of white-back planthopper, *Sogatella furcifera* Horvath in Vietnam, 1968; *J. Taiwan Agric. Res.*, **19** 82–89

Varadharajan G 1979 Effect of meteorological factors on Brown planthopper population. Recent Trends in Rice Brown Planthopper Control. Colloquium on Rice Brown Planthopper, Kumbakonam, Tamil Nadu, June 1979, 39–40