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Population dynamics of the dusky cotton bug *Oxycarenus laetus Kirby* in relation to climatic variation (Heteroptera: Lygaeidae)

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Abstract. The population trend of the dusky cotton bug, *Oxycarenus laetus* Kirby is studied for two years, on three principal hosts namely *Abutilon indicum*, *Sida acuta* and *Thespesia populnea* in relation to climatic variation. Population density varies significantly over the months as shown from the analysis of variance thereby indicating that the population build up is favoured by certain climatic factors. Regression analysis shows that variables such as temperature and relative humidity have very significant effect on the growth of the population. Peak population is recorded during hotter months March-July; the population is at its low ebb during colder winter months November-January. High temperature (35°C-40°C) and moderately high humidity (45-60%) seem to be the favoured climate for rapid growth of the population, whereas very high humidity adversely influence the population as indicated by the negative regression values obtained consistently in both years.

Keywords. Population dynamics; *Oxycarenus laetus* Kirby.

1. Introduction

Distant (1904) first described *Oxycarenus laetus* kirby from India and later Maxwell-Lefroy (1907, 1909) reported the dusky cotton bug as a minor pest of cotton and described its habitat and nymphal instars. At present, it is very widely distributed. It is recorded from all the cotton cultivating regions in India (Quadiruddin Khan and Rao 1960). The injury caused by this bug is rather well documented (Distant 1904; Maxwell-Lefroy 1907, 1909; Subramania Iyer 1922; Fletcher 1923; Hussain 1925). Misra (1921) estimated more than 20% loss of crop yield from severely infested fields and considerable work was done on its control measure. Nangpal (1948) recommended plucking of infested bolls and destroying them, Gupta and Joshi (1955) advocated dusting with 5% DDT, Patel and Katarki (1957) and Maheswariah and Puttarudraiah (1956) recommended dusting with 5% BHC. Other studies on this bug in India pertained to that of its genitalia (Singh-Pruthi 1925) and chromosome analysis (Banerjee 1959; Jande 1959). Apart from a few observations on the life history (Misra 1921; Pillai 1921; Fletcher 1922), morphology (Prasad 1956), feeding behaviour (Thangavelu 1978a) host plants and factors influencing host specificity (Thangavelu 1978b) of this bug hardly anything is known about other aspects of its ecology. A preliminary attempt is being made to study the population dynamics of the dusky cotton bug in the field conditions in relation to climatic variations on the three perennial weeds viz., *Abutilon indicum*, *Sida acuta* and *Thespesia populnea*. These wild host plants are very common in the cotton growing tracts of South India.

2. Materials and methods

The incidence of the population of *O. laetus* on *A. indicum*, *S. acuta* and *T. Populnea* was recorded over a period of two years from January 1975 to December 1977. Population was sampled by direct counting. Weekly counts were made on 20 capsules of *S. acuta* and 5 capsules each of *A. indicum* and *T. populnea*. The said number of capsules, randomly collected from the plants, were separately brought in polythene bags to the laboratory and each locule was carefully examined with a hand lens, as the first instars are very minute in size. It was felt necessary to open every locule in the capsule, as large number of smaller nymphs were found feeding on the seeds and counts on the external surface of the capsule alone were often found to be misleading. Individuals from first nymphal instar to adult were counted throughout the study period and eggs were not taken into account. This study was conducted at Madras (latitude 13° 4′6″ N and 80° 17′22″ E on the coast of Bay of Bengal) and meteorological data were recorded with the help of the Regional Meteorological Station at Madras. Variation in the population density due to months was derived from analysis of variance (tables 1 and 2). The population trend on *A. indicum* and *S. acuta* was graphically examined (the square root values of the original data is plotted against weeks) and depending upon the population trend, the relevant data (3rd to 27th week) were subjected to regression analysis for

Table 1. Analysis of variance

Host plant	Source of variation	Degree of freedom	Summer square	Mean summer square	Freedom	Standard error	Critical difference 1%	Critical difference 5%
A. indicum	Between weeks	3	1·11	0·37	0·18			
1975	Between months	12	365·05	30·42	14·49**	0·728	2·78	2·08
	Error	36	75·48	2·10				
S. acuta	Between weeks	3	0·57	0·19	0·05			
1975	Between months	12	518·9675	43·25	10·27**	1·0246	3·92	2·93
	Error	36	151·69	4·21				
T. populnea	Between weeks	3	10·29	3·43	0·52			
	Between months	7	1946·93	278·13	42·14**	1·2845	5·14	3·78
	Error	21	138·59	6·60				
A. indicum	Between weeks	3	0·48	0·16	0·14			
1976	Between months	12	455·33	37·94	32·15**	0·5477	2·08	1·57
	Error	36	42·38	1·18				
S. acuta	Between weeks	3	0·25	0·08	0·02			
1976	Between months	12	1238·31	103·19	19·77**	1·1445	4·38	3·27
	Error	36	188·04	5·22				
T. populnea	Between weeks	3	2·72	0·91	0·15			
1976	Between months	6	1342·27	223·71	35·68**	1·2529	5·10	3·72
	Error	18	112.80	6.27				

Table 2. Combined analysis of variance between years

Host plant	Source of variation	Degree of freedom	Summer square	Mean summer square	Freedom	Standard Error	Critical difference 1%	Critical difference 5%
A. indicum	Between weeks	3	0·33	0·11				
	Between months	12	690·27	57·52	35·5**	0·45	1·077	0·81
	Between years	1	0·10	0·10				
	Weeks × years	3	1·27	0·423				
	Months × years	12	130·32	10·86	6·7**	0·6363	2·153	1·618
	Error	72	116·96	1·62				
S. acuta	Between weeks	3	0·058	0·019				
	Between months	12	1204·53	100·3775	22·531**	0·745	1·783	1·341
	Between years	1	10·08	10·08				
	Weeks × years	3	0·585	0·195				
	Months × years	12	571·877	47·656	10·697**	1·055	3·57	2·684
	Error	72	320·77	4·455				
T. populnea	Between weeks	3	10·828	3·609				
	Between months	6	1996·893	332·815	14·774***	1·678	6·416	4·795
	Between years	1	65·979	65·979				
	Weeks × years	3	4·689	1·563				
	Months × years	6	550·563	91·76	4·073**	2·373	12·439	8·211
	Error	36	810·991	22·5275				

estimating the effects of variables such as temperature and relative humidity on the population.

3. Observations and results

O. leatus is observed on *A. indicum* and *S. acuta* throughout the year in the entire South India and only during April-October on *T. populnea*. The infestation on *T. populnea* is only secondary, the source of infestation is primarily *A. indicum* and *S. acuta*. Although the bug population is noted throughout the year, a heavy build up of population is recorded during the hottest seasons of the year (March-July), when the maximum temperature exceeds 40°C (32°C–41°C) whereas maximum relative humidity very rarely exceeds 65% (55%–70%) in the month of May. The population build up is very insignificant during the winter months (November-January) when the maximum temperature does not exceed 30°C (26°C–30°C) and the minimum temperature goes below 19°C (December) and the maximum relative humidity reaches 91% (80%–91%). 80% of the summer population constitute the nymphs as against 15% of the winter population. Analysis of variance over the years also shows significant F value due to months and between months and years (table 2). Significant regression coefficients were observed between the population level and maximum temperature as well as population level and minimum temperature in both years on *A. indicum* and *S. acuta* (only these two were subjected to analysis). Although a significant value was observed between the population level and minimum humidity in the year 1975 on *A. indicum*, it was not consistent. However, consistently negative regression coefficients were observed between population level and high humidity.

4. Discussion

As the harmful side effects of many insecticides and the development and subsequent build up of resistance to insecticides in more number of insects are increasingly well known, the need for more research on the natural population of insect pests is essential for economic and judicious pest management programme in our agriculture (Bindra 1975). Hence the natural population of the dusky cotton bug *O. laetus* hitherto not well known, is studied in relation to climatic variations. In general, it is well known that food and climate affect the population density of animals; food acts as a density dependant and climate as a density independent factor (Smith 1935). Further, it is known that density dependant factor is primarily responsible for regulating the population size and the density independent factor in determining the changes (Varley *et al* 1973). The study was conducted under natural conditions to record the effect of climate on the population dynamics of *O. laetus* and wild host plants were selected as they escape pesticides and other artificial hazards in the manipulation of the environment, being far away from cultivable land and therefore support an undisturbed natural population throughout the year.

Seed is the prime diet of the dusky cotton bug (Gadkari 1961; Sweet 1960) and it feeds on the seeds of malvales (Thangavelu 1978b). *T. populnea* blossoms during December and February and hence seeds are formed only after March. The mature, dry capsules of *T. populnea* start shedding from September and the tree is practically free of dry capsules from November to February and hence *T. populnea* cannot support a permanent population of *O. laetus* and the infestation is therefore an alternative one. Further, it is observed that *A. indicum* and *S. acuta* grow in abundance alongside and therefore these two plants support a continuous population and form the main host plants. Fresh capsules of *T. populnea* are never found to be infested by these bugs (Thangavelu 1978b) and the dry capsules appear after March and remain through part of October and hence the population of *O. laetus* is also recorded during the same period. Figures 1 and 2 show the trend of total population of *O. laetus* on its three principal hosts against the independent variables, temperature and relative humidity for the two years 1975 and 1976 respectively. The total population within the capsules of these three host plants vary drastically and it is related to the volume of the capsule (Thangavelu 1978b). Capsules of *T. populnea* being larger, they support a huge population, whereas those of *S. acuta* being vary small, host a few only. Therefore 20 capsules of *S. acuta* and 5 capsules each of *A. indicum* and *T. populnea* were counted in this study. The very huge population build up of *O. laetus* on *T. populnea* (figures 1 and 2) is mainly due to the very large size of its capsule. From February, the population trend increases steadily until it reaches a peak in May, when the maximum temperature rises to 41°C (36°C–41·6°C) but the maximum relative humidity scarcely reaches 65% (45–60) which seems to be the favoured climate for the rapid growth of the population. From May onwards a declining trend in the population is observed till July. During winter (November–January) the population growth is slow, when the maximum relative humidity reaches an all time high level of 91% (80%–91%), whereas the maximum temperature scarcely reaches 30°C (26·8°C–30°C). As the population surviving in winter is mostly of adults (85%) it is assumed that winter does not favour active oviposition, whereas in summer, oviposition is greatly increased and therefore the nymphs constitute the major population (80%). Similarly, in cotton leaf worm *S. littoralis*, the highest rate of oviposition was reported to be at 69% RH and in higher ranges of humidity egg laying was reduced (Nasr and Nassif 1974).

Analysis of variance clearly indicates that there is tremendous variation in the population size in different months in all the three host plants and this variation due to months is highly significant. The analysis of variance combined over both the

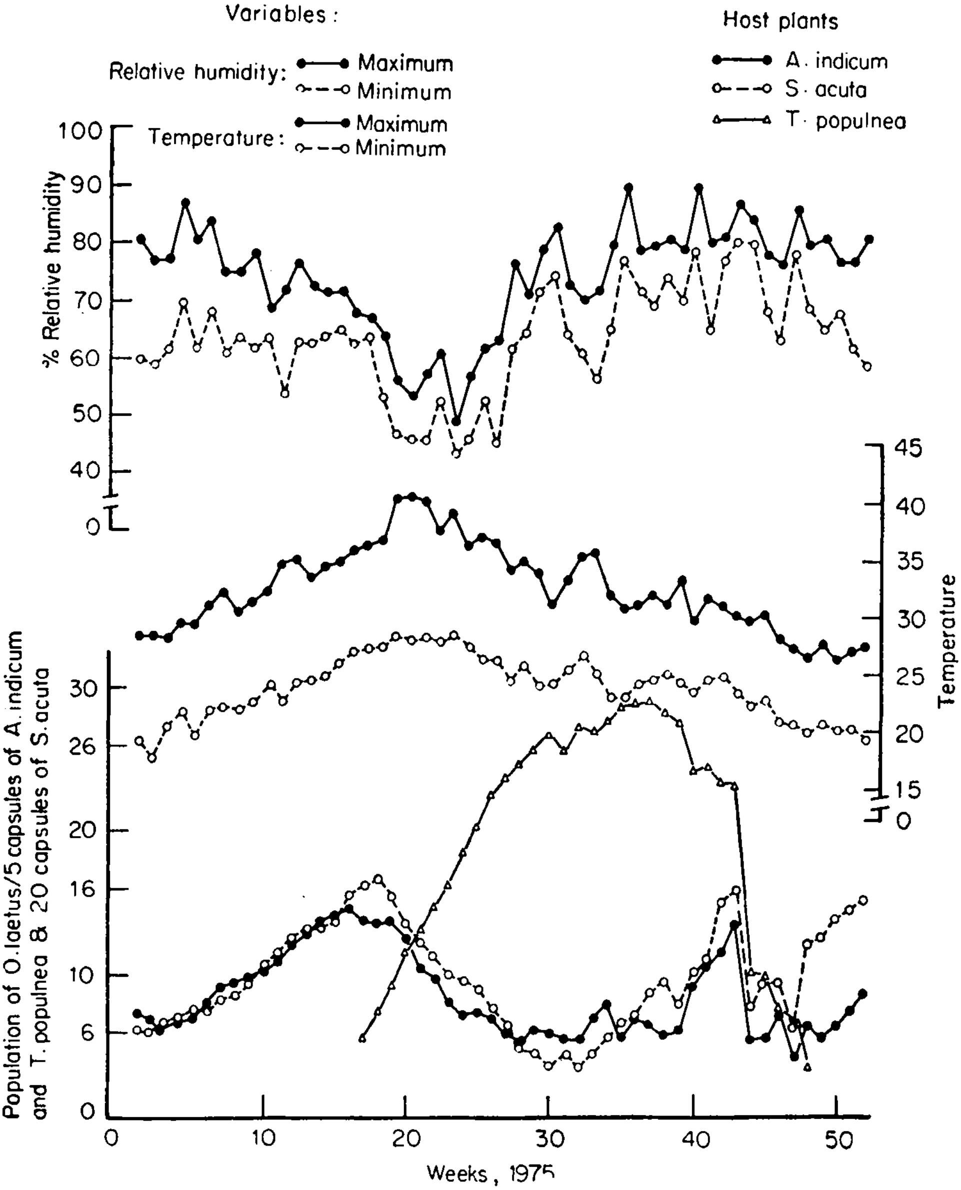

Figure 1. Population fluctuation of *O. laetus* on three principal host plants, in 1975.

years also bring out the significant differences due to months; in addition the interaction between months and years also play a significant role in determining the population growth in the three host plants (tables 1 and 2). If this proposition is true, then the population build up is favoured by certain climatic factors which will prevail in some months of the year. By analogy, in this present study it was observed that *O. laetus* population increases from February and reaches the peak in May and declines towards July and thus there is a regular increase followed by a decrease in the population size and after July, the population fluctuates continuously and

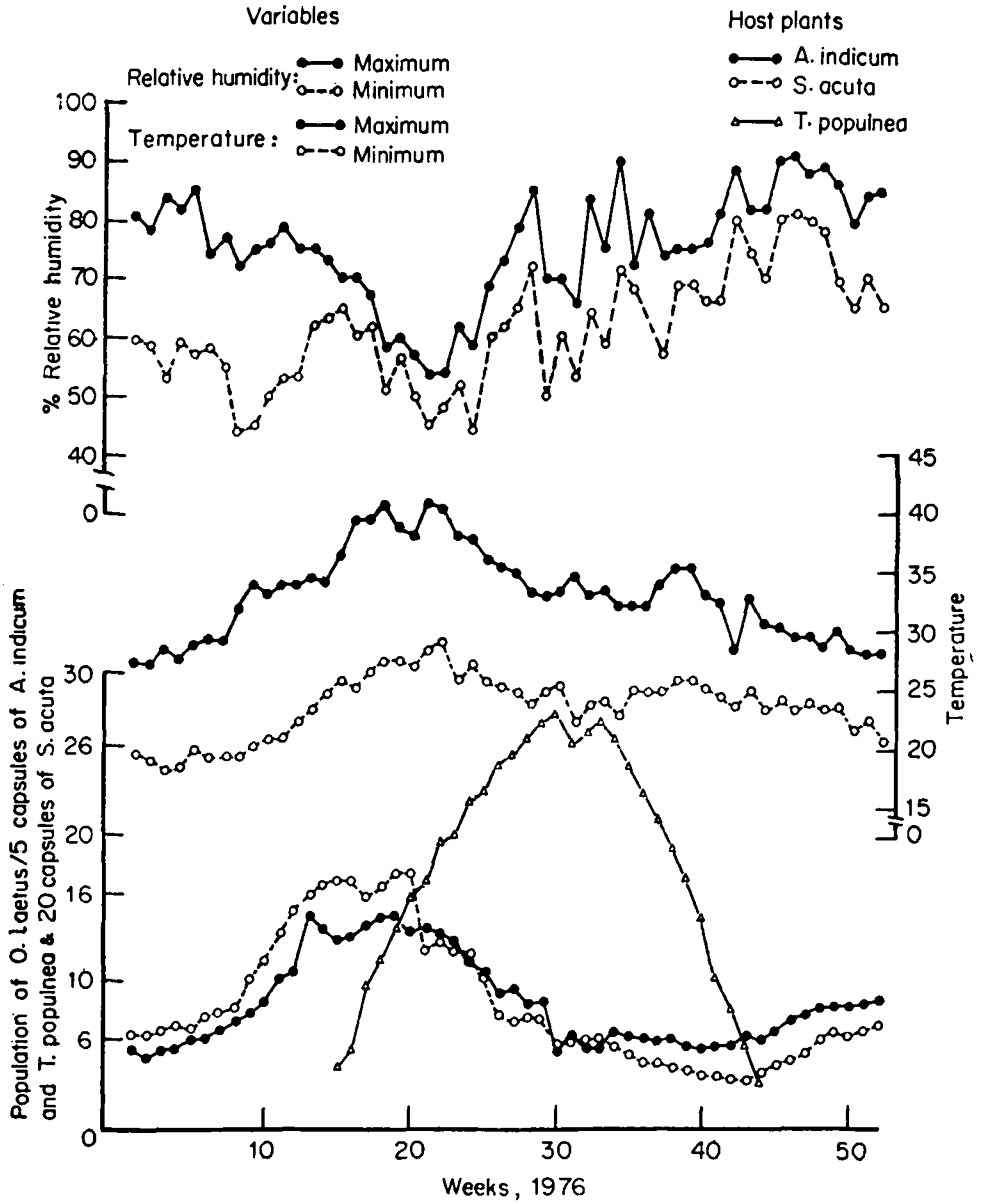

Figure 2. Population fluctuation of *O. laetus* on three principal host plants, in 1976.

there is no equilibrium in the population level. The peak population level is well correlated with the high level of maximum temperature and lowest level of maximum humidity (figures 1 and 2). Although the above description of the population trend does not fit well with that of *T. populnea*, the growth phase of population occurs before June and thereafter the growth is not steady. In this case, there is a sudden growth phase followed by a small peak period and a steep declining trend. Thus the fluctuation in the natural population of *O. laetus* as observed here can be attributed to the independent variables, temperature and relative humidity and the influence is statistically highly significant. Similarly Davidson and Andrewartha (1948a,b) interpreted the changes in the number of *Thrips imaginis* Hood in roses to changes in the weather and later Andrewartha and Birch (1954) stated that variable weather determines population change. There are numerous other interpretations, supporting the effect of climate on the natural population of animals (Howard and Fiske 1911; Smith 1935; Nicholson 1933, 1954; Varley *et al* 1973).

Regression analysis shows that independent variables such as temperature and relative humidity significantly influence the population trend. The maximum and minimum temperatures and minimum relative humidity are positively correlated with the population trend while the maximum humidity adversely influence the population growth, which is known from the negative significance of the regression coefficient, suggesting that very high relative humidity does not favour the population growth. High humidity is physiologically disadvantageous to insects adapted for drier conditions (high temperature and low humidity) and this might be true of *O. laetus*. High humidity is favourable for the growth and development of fungi and pathogens, which generally are disadvantageous to these insects. Although there is no record of fungus or other pathogen on *O. laetus* from India, the development of black mould (*Aspergillus* sp.) on the capsules of these malvales in high humid condition may act adversely on the build up of *O. laetus* population. Even though humidity has no direct effect on the metabolic system in insects as temperature has, it indirectly affects them through water content (Bursell 1970). Quite a few other works on the effect of relative humidity on the activity, population growth, oviposition and development reveal that various species of insects react differently to various relative humidity ranges. In some species, higher ranges of relative humidity favour population growth, while in other species the same affect adversely. The predaceous bug *Xylocoris flavipes* is capable of population increases even in humidity conditions up to 98% RH, though optimum recorded is 60%–80% RH (Arbogast 1975), similarly in *Laspeyresis pomonella*, length of adult life, mating activity, number and viability of eggs laid are greatest at 70%–80% RH and lower ranges of humidity considerably affected the population (Pristavko and Chernii 1971). In contrast, the lower ranges of humidity favour the population growth of *Oryzaephilus surinamensis* and *O. mercator* (Arbogast 1976) and the activity of *Forficula auricularia* (Medge and Buxton 1975) and *Tanymecus dilatiocollis* (Sheludko 1975) and high humidity is responsible for greater morality and lower rate of survival of larvae of *Hemerobius pacificus* (Neuenschwander 1975) and development was slower in *Spodoptera littoralis* (Nasr and Nassif 1974). Thus from the present study on the population trend of *O. laetus*, it is suggested that the population growth is favoured by high temperature (35°–41°C) and moderately high relative humidity (45%–60% RH), whereas very high humidity (80% and above) is detrimental to the growth of population.

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