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Seasonal population variations of the bark eating caterpillar (*Indarbela quadrinotata*) in *Casuarina* plantations of Tamil Nadu

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Casuarina equisetifolia is a tree of Australian origin with extended distribution to the islands of the Pacific and to South East Asia. It was introduced to India in the middle of 19th century. Because of the adaptability of this tree species to different eco-climatic and edaphic zones of the country, it has gained importance in afforestation programmes in a variety of habitats ranging from deserts, coastal sand dunes, mine dumps and other places, where soil nutrients and water are scarce (Kondas 1981). *C. equisetifolia* is a major species used for coastal afforestation in Tamil Nadu. It is also cultivated under agroforestry, both in coastal and inland regions of the State and plays a crucial role in the rural economy. Sasidharan (2004) reported that 40 species of insects are associated with *C. equisetifolia* in Tamil Nadu. Among them, the bark eating caterpillar, *Indarbela quadrinotata* was found to be the most economically important pest, which showed significant variation in infestation level in different agro-climatic zones of the State. Since an understanding of the population dynamics of the pest species is vital for evolving appropriate and timely management strategies, seasonal population variations of *I. quadrinotata* in relation to climatic conditions were studied in a *Casuarina* plantation located in the Cauvery delta zone.

The study was carried out in an 8 year old *Casuarina* plantation at Pudupattinam area of Nagapattinam district, coming under the Cauvery delta zone of Tamil Nadu, from December 2000 to September 2002. Two sample plots, each of 50 m x 50 m were selected and one plot containing 265 trees was taken as fixed tree plot and the other having 233 trees as the variable tree plot. In the fixed plot, 20 trees were selected randomly, serially numbered, and the number of active tunnels of *I. quadrinotata* recorded at monthly intervals. The tunnels are made by the larvae over the bark, with pieces of bark, excrements and silken thread. The larvae regularly maintain the tunnels (i.e. active tunnels) with fresh materials and when they die or remain inactive during the pupal stage, the tunnels get detached from the tree trunk, due to lack of maintenance. In the variable tree plot also 20 trees were selected randomly during each time of observation and the number of larval tunnels as indicated earlier was recorded at monthly intervals. The larvae hatching out of the eggs make new tunnels, which were considered as new larval establishments. The absence of fresh bark feeding, followed by detachment of the larval tunnels are indications that the larva has pupated. The pupation will be followed by moth emergence, during which the pupa wriggles out to the mouth

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of the borer hole. When the moth emerges out, the "pupal skin" remains at the mouth of the borer holes and the presence of projecting "pupal skin" is considered as evidence for moth emergence. In this manner, information on larval establishment, pupation and adult emergence was collected. Data on rainfall, number of rainy days and maximum and minimum temperature were obtained from the nearby weather stations at Kollidam and Port Novo and Pearson's Correlation co-efficients of the larval population with the weather parameters worked out. The significance of the correlation co-efficient was tested using t- test.

The population variation of *I. quadrinotata* in the fixed and variable tree plots are shown in Fig. 1. There were 3 peaks in larval population in February, August and November in the fixed tree plot. Almost a similar trend was noticed in the variable tree plot also. The moth emergence was observed during May - July, which coincided with the pre-monsoon showers from the south-west monsoon. The larval establishment was seen in the month of August and the first peak of infestation was also observed during this month. Another peak in larval population occurred during November, which emerged from the eggs laid by the moths late in the month of July. A third peak in larval population was noticed during January/ February, which coincided with the rainfall during these months. However, an increase in larval

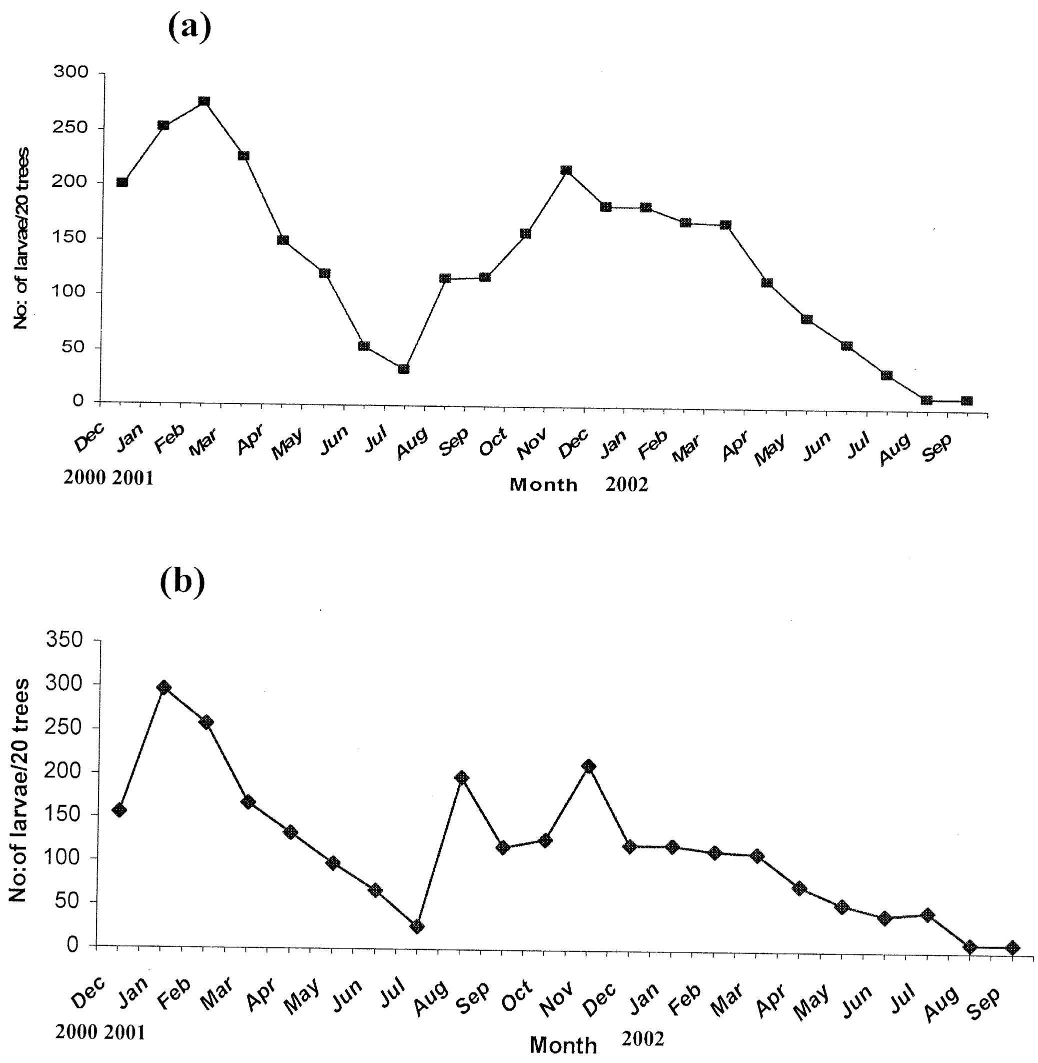

Fig. 1. Population variations of *I. quadrinotata* in (a) Fixed tree plot & (b) Variable tree plot.

population in January/February cannot be attributed to the moths emerged during May - July. Hence this larval build up may be from another set of moths emerged during November/ December in the same area or from an incoming population to the study site from elsewhere. From March onwards there was a declining trend of larval population, coinciding with pupation. Natural mortality factors like parasites, predators or pathogens were not detected and hence not played a role in bringing down the population.

The data for rainfall and temperature of the study area are given in Fig. 2 and the results of correlation analysis in Table 1. The larval population had significant negative correlation with the maximum and minimum temperatures. Weather has both direct and indirect effects on phytophagous forest insect populations (Martinat 1987). Hsiao & Yen (1964) found that when the temperature was low, there was an increase in density of the pine caterpillar, *Dendrolimus punctatus* Walker, in China. A similar relationship of maximum and minimum temperature and incidence of the borer pest of *Eucalyptus, Phoracantha semipunctata* (F.) was reported by Helal & Sebay (1980) in Cairo, Egypt. Azmy *et al.* (1978) also found that the population build up of wood borers like *Zeuzera pyrina* (L.), *Bostrychopsis reichei* (Mars) and *Phonapte frontalis* (Fhs.) was influenced by temperature regime. Thus the data obtained during the present study also support the above reports.

Available literature on the life cycle of *I. quadrinotata* shows that the insect has an annual life-cycle in India with the larval period from June to April, pupal period in February - March and moth emergence during May to July (Beeson 1941; Browne 1968; Mathew 1997). Beeson (*loc.cit.*) has also reported two peaks of moth emergence in March - April and at the end of the monsoon in October - November, in Myanmar. However, the present study reveals that the insect has more than one generation in a year, at least in the Cauvery delta zone, as seen from 3 peaks in larval population and presence of different larval instars at a time in the study area.

Various studies have shown that insects develop more rapidly during periods with suitable

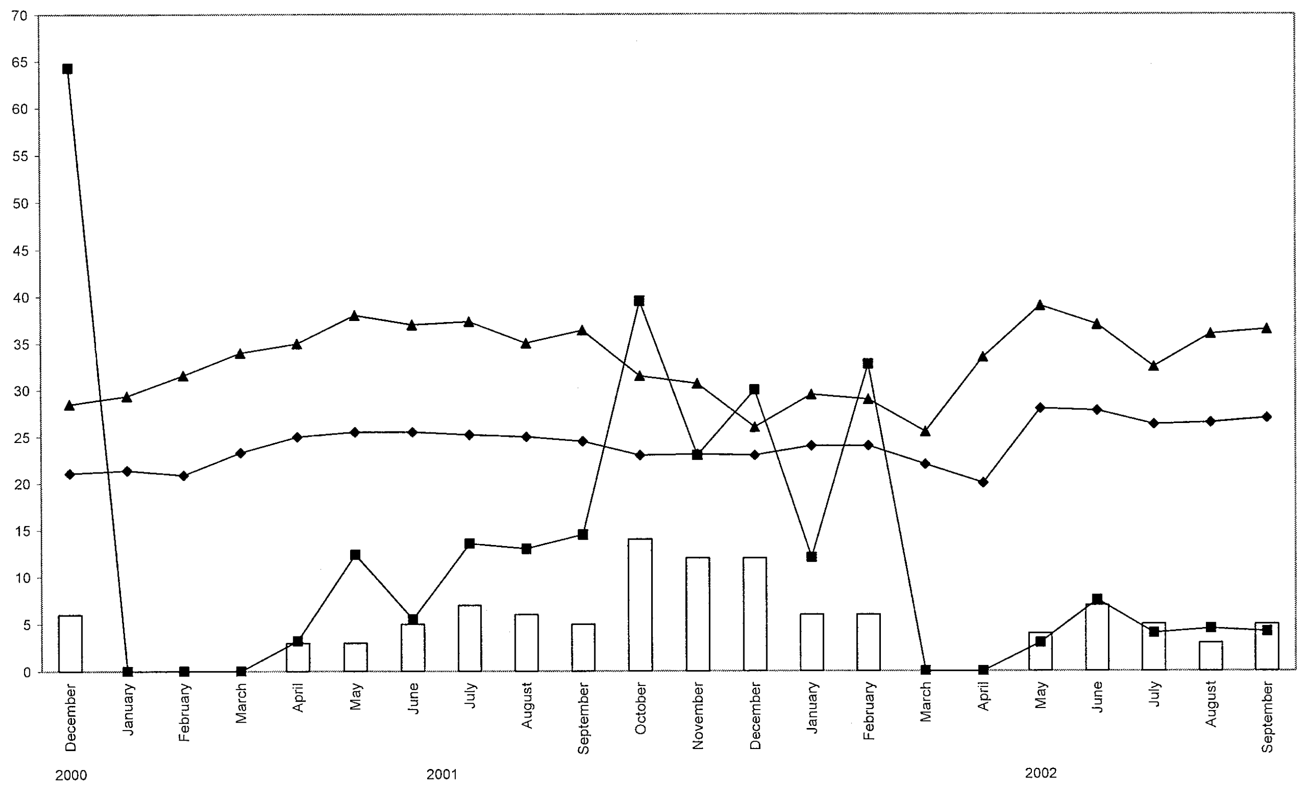

Fig. 2. Climatological data of Pudupattinam, Nagapattinam district, Tamilnadu. Bars = no. of rainy days, squares = rainfall (cm), triangles = maximum temperature (°C), diamonds = minimum temperature (°C).

Table 1. Correlation coefficients between climatological data and *I. quadrinotata* population.

Plot	Climatic variables			
	No. of rainy days	Rainfall (mm)	Maximum temperature (^oC)	Minimum temperature (^oC)
Fixed tree plot	-0.094	0.224	-0.652**	-0.763**
Variable tree plot	-0.119	0.106	-0.481*	-0.658**

****** Correlation co-efficient significant at 1% level
* Correlation co-efficient significant at 5% level

temperatures (Bale *et al.* 2002). The significant correlation found between the bark eating caterpillar and temperature will help to develop prediction models, by which the outbreak of this pest could be known in advance, so that timely control measures can be taken up to contain the problem. The climate change can affect the response of insect pests to the host plants. Although it is difficult to predict the impact of climate change on forest insect pests, the overall response is dependent on the impacts of climate change on the insect – tree host – natural enemy relationship. In many of the serious forest pests of temperate region, it has been predicted that warmer temperatures will result in higher population of insects and hence the pest problems are likely to aggravate due to global warming (Forestry Commission, UK 2007). Drought and high temperatures resulting from climate change have effects on virtually every plant process. Their impact on tree physiology, biochemistry and phenology will affect the nutritional quality of wood, foliage, sap and plant's mechanical and chemical defenses against pest attacks (Stamp 2003; Williams & Liebhold 1995). Gaelle *et al.* (2006) observed that prolonged water stress has negative impact on host plant resistance and the infestation of wood borers increased in forest stands subjected to water stress. It points to the need for monitoring the population dynamics of *I. quadrinotata* in the back drop of altered temperature and rainfall patterns associated with climate change, so that the pest could be managed before reaching outbreak situation.

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