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Short communication

Morphological variables of the butterfly guild and their functional role in foraging behavior on the visiting plants: Optimization by Artificial Neural Network Model

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Abstract

Butterfly species are regarded as one of the most important members of the plant-pollinator guild. They mainly feed on nectar, and occasionally they rely on pollen. It was reported that butterfly species collect nectar from a greater array of plants. Emperical studies demonstrate that morphological variables of the butterfly species play an important role in foraging. Four morphological variables and two indices, viz., proboscis length, wing span, body length, and weight, and proboscis index and the wing load index of the butterfly species, were used to check their effect on foraging behavior on two plants, viz., Lantana camara (LCA) and Tridax procumbens (TPR), for the current study. Wing load index emerged as the most sensitive factor for foraging on these two plants. Both plants have the highest rate of visits by the butterfly species, with *Lantana camara* being more frequently visited than *Tridax procumbens* (TPR). We can conclude that the information gained from this study may help to conserve and sustain the butterfly community in the wild, and this, in turn,

may also help to facilitate conservation strategies for the naturally growing nectaring plant species.

Introduction

Angiosperm evolution is closely associated with pollinating arthropod taxa (Barth, 1991). The pollinator insect community is intricately correlated with the scent of the visiting flower, its colour, and its morphology (Dobson, 1994; Lunau and Maier, 1995), and it is well known that certain flowering plants are preferred by specific pollinators (Omura and Honda, 2005). Pollinators such as honey bees and bumble bees use the chemical signals of plants to identify morphologically similar plants (Kunze and Gumbert, 2001). A good match is often found between the flower and the visiting insects' feeding structures (Heinrich, 1976; Grant and Grant, 1983; Kodric-Brown et al., 1984; Nilsson et al., 1985; Nilsson, 1988; Johnson and Steiner, 1997; Alexandersson and Johnson, 2002; Temeles and Kress, 2003). In the plant-pollinator guild, butterfly species play an important part, for they feed mostly on nectar and sometimes on pollen as well (Gilbert, 1984). During feeding, butterflies help in pollination of the visiting plants (Lewis, 1989; Lewis and Lipani, 1990; Goulson et al., 1997; Weiss, 2001; Weiss and Papaj, 2003). Butterfly species accept a diverse range of plant species as food sources (Hardy et al., 2007). They also depend on other food sources such as mud, animal feces, and plant sap (Hardy et al., 2007). They are described as opportunists and generalists in terms of their exploitation of flowering plants (Courtney, 1986; Shreeve, 1992). Studies on the behavior of butterflies have revealed that many species prefer blue colours (Daumer, 1958; Meyer Rochow and Eguchi, 1983), while several papilionids, pierids, and nymphalids prefer yellow colours (Ilse and Vaidya, 1956; Swihart, 1970; Scherer and Kolb, 1987a, Scherer and Kolb, 1987b; Tiple et al., 2006).

Nectar concentration and colour pattern of the flowers are important factors for the pollinators' flower preferences (Watt et al., 1974; Pivnick and McNeil, 1985; May, 1985; Tiple et al., 2006). Although the preferences depend on matching between the flowers' morphological characters such as corolla length (Kingsolver and Daniel, 1979) and butterfly morphology such as proboscis length and wing loading (Porter et al., 1992; Corbet, 2000). Scaling relationships of various body structures compared to body size, as well as adaptive deviations from typical allometric patterns, are prevalent in the animal world (Thompson, 1917; Kunte, 2007). In the case of insects, such interesting examples of adaptive departures are frequently observed (Emlen and Nijhout, 2000). Hawk moths often deviate considerably from the relationship in terms of allometry between body size and proboscis length (Agosta and Janzen, 2005, Weiss and Papaj, 2003). The multiplicity and benefits of this type of deviation from the allometric growth condition have been well established (Schmidt-

Nielson, 1984; Nilsson, 1988; Emlen, 2001). In the case of butterflies and moths, body size function is a strong predictor of proboscis length (Corbet, 2000). Some nectar-sucking species confer incongruently longer probosces in comparison to body size (Kunte, 2007). In the case of nectar thieves, those with a longer proboscis have a great advantage (Kunte, 2007), because a longer proboscis can suck nectar from deeper and more tubular flowers (May, 1992), which respond with higher-standing nectar crops (Brown et al., 1978; Grant and Grant, 1983; Kodric-Brown et al., 1984; May, 1988; Haber and Frankie, 1989). Many temperate butterfly species with high wing loading restrict their visits to plants by visiting those with clustered flowers, while those with low wing loading prefer solitary flowers (Corbet, 2000). Butterfly species with larger bodies are heavier and require larger wings to support them in flight (Dennis, 1993). Butterfly species with larger bodies and high wing loading require a rich, abundant food source and contain longer tongues to exploit a wider range of flowers (Tiple et al., 2009). The aim of the present study is to investigate, using ANN modeling, which morphological variables are most important for the flower choice of butterfly species. For the development of the model, the morphological variables of the visiting butterfly species were implemented as independent variables and the frequency of visits by the various butterfly species to the plants as dependent variables. Thus, which morphological variables would be most important for foraging butterfly species was determined through multilayer perceptron in the ANN model, and this result may be useful for instigating conservation strategies for butterfly species generally and pollinating species in particular.

Section snippets

Study area and species sampling

The study was carried out at three sites in Purulia, West Bengal, India, namely the campus of the Leprosy Mission (LM, 23.32939N, 86.33786 E), Surulia Mini Zoo and its outskirts (SM, 23.32201N, 86.39566 E), and the Sidho-Kanho-Birsha University campus (SK, 23.36126N, 86.33990 E). This survey was based on the two perennial plants, *Lantana camara* (LC) and *Tridax procumbens* (TPR). The study sites were selected based upon the presence of the two herbs and the large number of butterfly species…

Results

During the survey, 27 butterfly species were recorded to visit *L. camara* and *T. procumbens* (Table 1). Out of the 27 species, 18 visited *L. camara* and 17 visited *T. procumbens*. Seven butterfly species visit both plant species. Results of the *t*-test (t=2.6727, critical t value=2.0066, p<0.05) proved that there was a significant difference between visit frequency for *Lantana camara* and *Tridax procumbens*. In terms of frequency of visits, *L. camara* received more visits than *T. procumbens* (Fig. …

Discussion

The morphological variables (body weight, body length, proboscis length, wing span, proboscis index, and wing load index) of the butterflies contribute to foraging on *L. camara* and *T. procumbens*. Of all the morphological variables, 'wing load index' and 'proboscis index' emerged as the most sensitive variables in connection with foraging on these two plants. The frequency of visits by the butterflies was higher for *L. camara* than for *T. procumbens*. It was noticed that none of the members of the …

Conclusion

We observed that 27 butterfly species visited *L. camara* and *T. procumbens* flowers and out of the 27 butterfly species, 18 foraged on *L. camara,* while 17 visited *T. procumbens* and 7 on both plants. Visit frequency was higher on *L. camara.* The morphological variables were significantly different among species. The correlation analysis demonstrated that all morphological features were positively related, but the proboscis index showed a negative relationship with the wing load index, respectively. …

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Declaration of competing interest

The authors have no competing interests to declare.…

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