EVIDENCE FOR VISUAL AVOIDANCE OF PREDATORS IN CATERPILLARS: THE INFLUENCE OF PATTERNS OF CONSPICUOUS COLORATION ON PREDATION OF MODELS OF *Utetheisa ornatrix* (L., 1758)

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INTRODUCTION

Predation is often cited as a selective force affecting ecological and behavioral characteristics of organisms. For this reason, many organisms have evolved several strategies as defense against predation (Lima and Dill 1990; Vamosi 2005). Aposematism, in which animals exhibit a conspicuous coloration combined with, most commonly, chemical defense, is one of the main defense strategies observed in tropical arthropods (Edmunds 1974). The order Lepidoptera is a group in which the species have developed different forms and types of aposematism and conspicuous coloration. The genus Utetheisa (Lepidoptera: Arctiidae) shows several coloration patterns, ranging from black combined with yellow and/or white in the larval stages to white combined with red and black in the adults. Thus, some species are considered aposematic (e.g. Roque-Albelo *et al*. 2002). The species *Utetheisa ornatrix*, although extensively studied with respect to reproduction, biology and defensive strategies (predominantly chemical), there is no evidence that coloration characteristics of this species actually serve as warning coloration. The larva of *U. ornatrix* feeds mainly on plants of the genus Crotalaria sp., where they sequester the pyrrolizidine alkaloids contained in tissues of this plant (Eisner and Meinwald 1987). The larva have been shown to be unpalatable to spiders (Eisner & Eisner, 1991) and the coloration of the larva has been considered conspicuous (Dussourd *et al*. 1988), but there is no direct evidence of larval coloration serving as a warning.

OBJETIVOS

The aim of this study was to assess the influence of conspicuous coloration on predation of caterpillar models of *U. ornatrix*. Two hypotheses were tested: 1. Models that have conspicuous coloration similar to *U. ornatrix* are less preyed upon than cryptic models and non-conspicuous models. 2. Models that have the complete conspicuous coloration pattern of *U. ornatrix* (complete pattern) are less preyed than models with an incomplete pattern.

MATERIAL AND METHODS

Study Area

The study was carried out in a lowland Atlantic forest at the Núcleo Picinguaba Parque Estadual da Serra do Mar, São Paulo state, southern Brazil (23°21'43.64"S; 44°50'43.21"W), from 25th to 29th July 2012. The study was carried out in a strip of “restinga” vegetation, 50-100 m from the beach. In this area *Crotalaria vitellina* Kerr. Gawl (Fabaceae) is abundant and serves as a host plant for *U. ornatrix*.

Procedure in the field and data analysis

Caterpillar models were constructed out of plasticine, and were made to resemble different coloration patterns: 1) non-conspicuous coloration, consisting of brown plasticine to contrast with the green color of *C. vitellina* foliage; 2) cryptic coloration, made to resemble the green color of *C. vitellina* foliage; 3) the full conspicuous coloration of *U. ornatrix* (black with white and yellow rings); 4) black incomplete conspicuous pattern with white rings; 5) black incomplete conspicuous pattern with yellow rings; 6) black incomplete conspicuous pattern without rings;. Two experiments were carried out: the first compared the full conspicuous pattern with the cryptic and non-conspicuous models; the second tested the full conspicuous pattern against the incomplete patterns. In the field, a single model was placed on the youngest fully expanded leaf of a *C. vitellina* individual. After 48 hours the models were removed from the plants and analyzed for beak marks. If a model had one or more beak marks it was considered to have been “preyed upon”. To test the effect of predation on caterpillar’s models, we used a GLM approach, fitting the binomial response variable (preyed or not preyed) against the explanatory variable “coloration pattern”. After that, we performed model simplification in order to verify the importance of the variable "coloration pattern" in the model. Finally, we performed a contrasts analysis, to identify the possible differences between treatments.

RESULTS

For the first experiment, the variable "coloration pattern" had a significant effect in the statistical models ($\chi 22$ = 25.58, p =0.001), so it was kept. Predation on the non-conspicuous coloration was higher than the full conspicuous pattern and cryptic colorations (Z = 4.52, p <0.001). But, the predation on the cryptic models did not differ from predation on the full conspicuous pattern (Z = -0.70, p = 0.483). In the second experiment, the variable “coloration pattern” was significant ($\chi 22$= 15.422, p=0,001). The black incomplete conspicuous pattern was more preyed upon than the other patterns (Z = 3.01, p = 0.003), whereas the black incomplete conspicuous pattern with yellow rings was more preyed upon than the black incomplete conspicuous pattern with white rings (Z = 2.54, p =0.01). There was no difference in predation between the full conspicuous pattern and the incomplete conspicuous pattern with white rings (Z=0.28, p= 0.78).

DISCUSSION

The full conspicuous coloration pattern (black-white-yellow) and cryptic coloration seem to confer protection against predation, since we found no difference in predation between them, while the non-conspicuous pattern was the most preyed upon. Schuler and Hesse (1985) showed similar results where there were no differences in predation of earthworms with coloration pattern black-yellow and cryptic by domestic birds (Gallus gallus). Therefore, avian predators may not have identified the cryptic prey on the leaves of C. vitellina and may have avoided models with conspicuous coloration, which resemble *U. ornatrix*, producing the pattern of predation shown in this study. The results of this experiment indicate also, that the black-white pattern may already be sufficient to reduce predation, since there was no difference found in predation between the full conspicuous coloration and the black incomplete conspicuous pattern with white rings. In this experiment the yellow rings did not appear to be as influential in the recognition of conspicuous coloration by the dominant avian predators.

CONCLUSION

Avian predators avoided *U. ornatrix* models with the full conspicuous coloration, as well as cryptic models more than non-conspicuous models in experiment one. In the second experiment, the models with full conspicuous coloration, as well as the black models with white rings, were less preyed upon than the black models with yellow rings. The black models were those that suffered most predation.

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