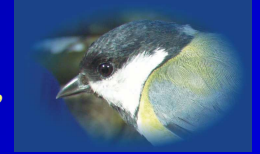


Reaction of Blue Tit (*Parus caeruleus*) and Great Tit (*Parus major*) to Shield Bug (*Graphosoma lineatum*)

Petr Veselý, Silvie Barcalová, Roman Fuchs and Jan Zrzavý

University of South Bohemia, Faculty of Biological Sciences, Branišovská 31, 370 05 České Budějovice, Czech Republic



Introduction

There are several species among true bugs that could be considered as aposematic (protected by chemical defence and warningly colored). The coloration of most aposematic true bugs is made of red background with black or white spots (see Fig. 1. and Fig. 2.). The shieldbug (*Graphosoma lineatum*) is a very extraordinary species. Its coloration consists of red and black longitudinal stripes (see Fig. 3). In this study we tested the aposematical function of this color pattern.



Fig.1- *Pyrrhocoris apterus*



Fig.2- *Lygaeus equestris*



Fig.3- *Graphosoma lineatum*

Hypotheses

- The reaction of the predator to the red and black shieldbug differs from the reaction to artificially non-aposematic one.
- The warning coloration is still functional on background that imitates the natural habitat of the shieldbug.

Methods

- Adult wild-caught individuals of great tit (*Parus major*) and blue tit (*P. caeruleus*) were used as predators.
- Adults of the shieldbug (*Graphosoma lineatum*) were used as a prey. (a) The wild form coloration was eliminated by painting of upper parts of a bug's body with brown water color to make up the "non-aposematic shieldbug" (see Fig.4). (b) The wild colored shieldbugs were presented on two different backgrounds with two patterns: (i) brown pattern imitating twigs of an umbel (Fig. 5), (ii) the shieldbug-like pattern (Fig.6).
- The experiments consisted of 10 successive trials (each 5 minutes long). Each bird was offered five mealworms and five bugs alternately.
- Two basic elements of bird's behaviour were recorded: (i) handling the prey (whether the bird touched or pecked the prey by the bill) and (ii) killing the prey.
- We used two forms of the data for statistical analyses: (i) numbers of birds that handled or killed at least one of the offered bugs, (ii) numbers of bugs handled or killed by individual birds.



Fig.4 - Artificially non-aposematic form of the shieldbug

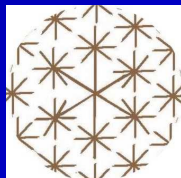


Fig. 5 - UMBEL background

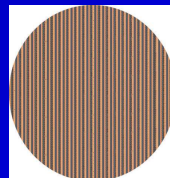


Fig. 6 - STRIPES background

Results

Wild vs. artificially non-aposematic form of *Graphosoma lineatum* (GL)

Parus caeruleus

The blue tits avoided both forms of GL. There was no difference found between numbers of birds that handled (Fisher exact test, $p=0,605$) or killed ($p=1$) any form of the shieldbug.

Parus major

Tested birds tended to avoid the wild form of GL more than the non-aposematic one. Although the difference between numbers of great tits that handled both forms of the bug was not significant (Fisher exact test, $p=0,111$), the difference in killing rate was more important ($p=0,0915$). Nevertheless, the comparisons of numbers of both handled and killed bugs was proved as highly significant (Tukey HSD test: handling - $p=0,0079$, killing - $p=0,0056$).

Brown GL on white background vs. wild GL on modified background (*P. major*)

UMBEL

There was no difference found in numbers of birds that handled and/or killed at least one brown bug presented on the white background and wild bug presented on the UMBEL background (Fisher exact test: handling - $p=0,3431$, killing - $p=0,2351$). Nevertheless, the number of handled and/or killed wild shieldbug presented on the UMBEL background was higher than the number of handled and/or killed brown bugs on the white background (Tukey HSD test: handling - $p=0,0868$, killing - $p=0,0256$).

STRIPES

There was no difference found in the numbers of birds that handled and/or killed at least one brown bug on the white background and a wild bug on the STRIPES background (Fisher exact test: handling - $p=0,3431$, killing - $p=0,7164$). There was no difference in numbers of the handled/killed bugs as well (Tukey HSD test: handling - $p=0,5519$, killing - $p=0,8181$).

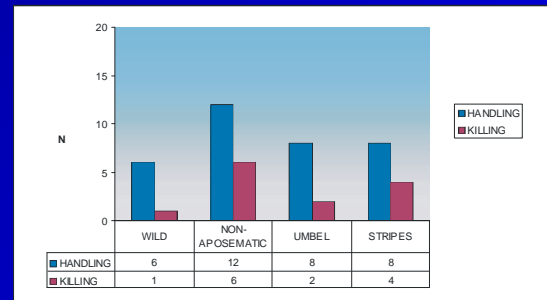


Fig. 7 - Numbers of great tits that handled or killed at least one of the offered shieldbugs.

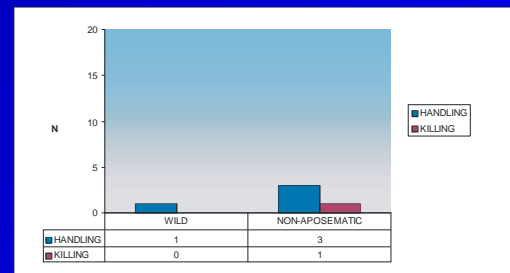


Fig. 8 - Numbers of blue tits that handled or killed at least one of the offered shieldbugs.

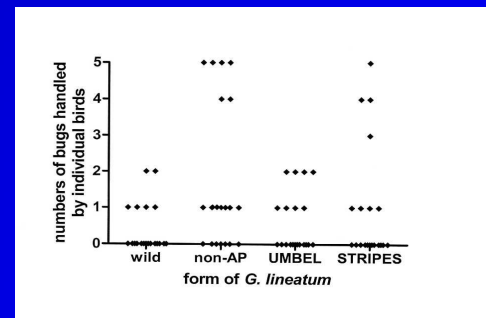


Fig. 9 - Numbers of bugs handled by individual great tits. Each point means one individual bird.

Discussion

1) The blue tit avoided both wild and non-aposematic forms of the shieldbug. These results show that there is another parameter influencing their reaction than the color of a bug (body size, body shape).

2) More great tits handled non-aposematic bugs than the wild ones. However, this difference was not corroborated statistically. On the other hand, statistically significant difference in numbers of handled bugs suggests that the warning coloration is important in cases of repeated encounter of predator and prey. There are two possible explanations of this phenomenon. (i) The predator recalls that such a coloration is usually not connected with edible prey and will not attack another similar individual. (ii) The predator finds out the unedibility of such colored prey during the first attack and will refuse another one.

3) The rate of handling of non-aposematic bugs presented on white background was higher than the rate of handling of wild bugs presented on the UMBEL background, but this difference was not proved as significant. This result indicates that the warning function of the shieldbug coloration is still present on this type of background but its power is weakened. Bugs presented on a background imitating the shieldbug pattern were handled equally as non-aposematic bugs on the white background. The warning function of the coloration is eliminated on this type of background.

Conclusion

- The blue tit recognizes that the shieldbug is unpalatable by other signals than by coloration.
- The great tit recognizes the shieldbug coloration as effectively warning.
- The aposematic signal is weakened by the disruptive backgrounds. On the red and black striped background shieldbug coloration is no more aposematic.