PRETENDING TO BE POISONOUS: COULD A WEAK SIGNALING REPEL PREDATORS ?

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INTRODUCTION

The difficulty of observing interactions between predators and their prey in natural systems have promoted the use of artificial mechanisms. Plasticine models have proved to be a good technique within snakes to demonstrate the importance of color to repel predators (Brodie & Janzen 1995, Buasso *et al*., 2006). Vipers are generally cryptic and highly venomous snakes, easily recognizable by their triangular head (Werner 1985). The head shape of vipers is an identifiable feature by snake predators that may be predisposed to attack the snake on the head or on the tips of the body (Smith 1977).

Several non - venomous or non - dangerous snakes, as members of Colubridae family, display very similar traits to those of sympatric vipers (Greene 1997), including color and/or morphology, what would suggest a Batesian mimicry system. Head triangulation is widespread and present in many unrelated taxa which has been interpreted and largely accepted as a defensive behavior (Werner & Frankenberg 1982). However, such attribute has never been confronted to the mimicry hypothesis and no experimental evidence was provided to support its efficacy.

OBJECTIVES

To test the hypothesis that triangular head shape in snakes confers protection against visually oriented predators and also test the hypothesis that predators tend to attack snakes in the head when compared to midbody or tail.

MATERIAL AND METHODS

The study was conducted between 30 August and 02 September 2005, in a 10,000 ha of preserved central Amazon upland rainforest named terra firme (2º24'S, 59º44'W). We used non - toxic plasticine to construct snake models with round - shape head, as most colubrids, and lance - shape head as vipers. All models (210 of each type) were brown, 22 cm in length (3 cm of head, 17 cm of midbody, and 2 cm of tail) and 1 cm in body diameter. We used the heads of fresh killed P. patagoniensis and B. jararaca specimens imprinted in wax as models to produce the head shape types.

The experiment was conducted in six trail transects, 1 m wide and varying from 600 m to 900 m in length. Each transect was 100 to 500 m far from each other. The two kinds of plasticine models (round and lance head shape models) were placed randomly along the transect and systematically 10 m apart from each other and 0.5 m from the border of the trail. After 24 h they were checked for predatory marks. We recorded which part of the body (head, tail or mid - body) were attacked, remodeled and replaced the models in a new transect. Only marks made by mammals and birds were considered as attacks.

We compared the attacks between lance - shape head and round - shape head using a Generalized Linear Model with Binomial distribution to determine if predatory rates were different between the two treatments. Thus, a likelihood ratio test (LRT) was performed with two kinds of model: a null model and another one containing the shape of head as a explanatory variable. An adherence Chi - Square test was used to compare the frequency of attacks among head, mid - body, and tail. The expected values were calculated according to the length of the body segment, as follows: body (13,63% of total body length), midbody (77,27% of total body length) and tail (9,1% of total body length). Statistical tests were performed using R 2.3 statistical software (R Development Core Team 2006).

RESULTS AND DISCUSSION

From 420 models, 24 (5.7%) had attack marks made by vertebrates (mammals = 9; birds =15). The probability of attack in round - shape heads was slightly larger (6,6%) than in lance - shape (4,8%). The number of attacks in round - shape (N=14; 3,3%) and in lance - shape (N= 10; 2.4%) was not significant different (?2= 0.399; df = 2,3; p= 0.41).

Attacks ocurred mainly in the head, comparing to mid - body and tail (?2 = 37.36; df = 2; p < < 0.001). Four replicas had marks in more than one part of body and were excluded from the analysis, as well as marks from lizards or ants (N = 100). Seven replicas were lost.

Defensive tactics of snakes in central Amazon seem to be directed to visually oriented predators, including flee, trash the body, and bite (Martins & Oliveira 1999). The overall predation rate obtained here is similar to those observed in other studies realized in the same site (Oliveira - Filho 1998; Gaiarsa 2008), but a little smaller when compared to Central America (Brodie 1993; Brodie & Janzen 1995). The higher predation rate observed in Central America could be explained by a higher number of native avian predators, and additional immigrant predators from the north hemisphere (Karr *et al.*, 1990).

Although body displays are mentioned as useful against predation, head triangulation seemed not to provide protection in the present study, since the number of attacks on lance - shape head and controls did not vary significantly. Snakes show a vast defensive repertory. Even not useful alone, the head triangulation conjugated with other threat displays could reinforce the warning signal, contributing to the learning process of avoidance by predators.

Concentrated strikes on the head suggest that predators perceive models as hazardous, and could indicate an ability to maneuver dangerous prey. Even predators such as rodents, which may only eventually attack or feed on snakes, are expected to attack on the head. Because of the venom and the eyes, head is a vital part of the snake body and can be easily damaged by predators (Bonnet *et al.*, 1999).

Attacking the wrong part of the snake's body may cost predator's life. Even non - poisonous snakes are able to inflict injuries. Snake predators in central Amazon seems to perceive the danger, aiming the attacks on the tips of their preys (Oliveira - Filho 1998). This same pattern was observed in the Rainforest of Costa Rica and in the Chaco of Argentina. Nevertheless, the present work is the first to demonstrate that tropical snake predators are able to discriminate between head and tail of their prey.

The shape of head isolated might does not confer protection to snakes. Most likely, a set of traits, including color and behavioral displays, may work in synergy to warn and discourage predator attacks. Despite the probable weak signal of head shape, predators perceive and tend to attack models on the head as an attempt to immobilize the prey.

Experimentation on mimicry using plasticine models has been done exhaustive on coral patterns arranged in rings. But that kind of experiment has never been done focusing the body shape. Additional studies must explore the role of body shape in snakes as succesful defensive behaviors.

CONCLUSION

We indicate the shape of head, per se, as not confering protection against predation. Snakes present a diverse set of defensesive traits that when conjugated may work effectively. Therefore, head shape could be combined to other traits as warning signaling to their predators. Predators are able to aim attacks straight to the head, as an attempt to immobilize dangerous prey.

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