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Gordon M. Burghardt

Antipredatory Behavior
A Brief Overview

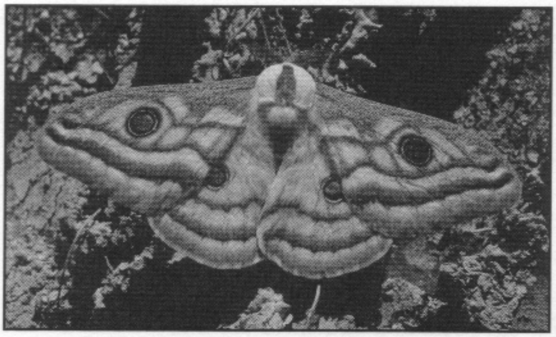
Virtually every animal at some point in its life has to avoid predation and there are a remarkable variety of ways to do so. Many of them work by making it unprofitable for a predator to find, pursue, kill, or eat a prey species.

Studies on great tits, a small European bird, foraging on worms have demonstrated that even slight increases in the time it takes to find prey can have a large effect on their foraging decisions. Thus, from the prey species' perspective, even slight camouflage (or crypsis) might save its life.

This pufferfish blows itself up so as to appear larger and more formidable to any potential predators.
© Anthony F. Chiffolo.

We commonly see morphological and behavioral adaptations to increase the searching time for predators. For instance, decorator crabs in the waters off New England camouflage themselves by placing sea grass on their carapace. Species without the ability to change their appearance are often quite selective about the background they settle on. Such "background selection" helps camouflage an individual and therefore makes it more difficult for a predator to detect them. Ptarmigan, a bird that lives in alpine and tundra habitats, annually molts its feathers into white plumage for the winter and a mottled dark plumage for the summer. Snowshoe hares have similar morphological adaptations. However, these animals are faced with a quandary once the snow melts. Male ptarmigan (who retain their white feathers for a few more weeks than females) actively soil their winter plumage after the snow has melted. By doing so, they reduce their conspicuousness before molting into their more cryptic summer plumage.

What can prey do once detected? Many species simply escape. Studies of noctuid moths being hunted by bats are a wonderful example of a system where the neurobiology of antipredator behavior is understood. Bats that hunt noctuid moths produce two types of ultrasonic cries: a slow-paced sound that is used when the bats are generally orienting and looking for food, and a faster-paced cry that is used in the final stages of attack to help them track moth movement in detail. In response to this, moths have evolved two sorts of neurons. The first (called the A1) fires at moderate intensity to the slow-paced bat calls. Moths use binaural cues to locate the bat (i.e., because they have ears on both sides of their body, differences in the right and left A1 cell firing rate allows left–right localization). However, if a bat gets too close and engages in the fast-paced echolocation cries, the moth's second neuron (called the A2) begins firing. This second neuron is connected to the flight muscles and when it fires, it results in erratic flight which, if the moth is lucky, results in escape. Another example which illustrates how selection acts on prey to avoid predators is seen in crickets who must avoid predation by bats and parasitoid flies. Studies of cricket hearing have demonstrated that they are most sensitive to the sounds produced by other crickets and to high-frequency sounds produced by bats. Parasitoid flies that lay eggs in crickets have exploited the cricket's calling behavior. Female fly hearing is most sensitive to the frequencies contained in the cricket calls. On islands where the parasitoids have recently arrived, crickets are more vulnerable to the flies than on the mainland; over time they begin to modify their calling behavior. These examples illustrate how selection to avoid predators has resulted in receptors exquisitely tuned to be responsive to the sounds of predators, and the opportunity for coevolutionary arms races to evolve between predators and their prey.



Many moths display false eyes, known as eye spots, to confuse birds.
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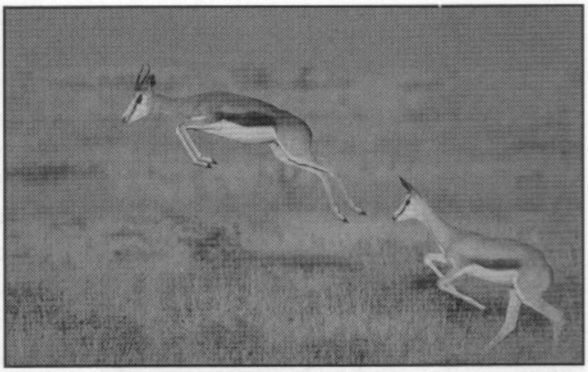
Some species misdirect attack, and in doing so, increase the chance that they will survive an encounter. For instance, those Antarctic krill that have a great likelihood of being killed, will engage in a tail flip and leave their exoskeleton floating in the water. If the predator attacks the exoskeleton, the krill has saved its life at the cost of having to re-grow an exoskeleton. Some lizards will attract a predator's attention to their tail by waving it around. Upon being attacked, their tail breaks off and the lizard flees. Tails may be important in social communication, but the lizard has survived the attack to engage in a future social encounter.

Other species engage in startling displays. Moths may uncover their hind wings which contain large "eye-spots." Vertebrates are particularly sensitive to looming objects and eye-spots which generate startle responses. Thus, when a foraging bird suddenly has the eye-spots of a moth flash beneath it, the bird may hesitate for a moment. If the moth is lucky, this moment may be sufficient to allow escape. Octopuses are well-known masters of disguise, but most avoid predation by being nocturnal. Recently, a diurnal Indo-Malayan octopus has been discovered that dynamically mimics poisonous species of snakes and fish. In doing so, the octopus escapes predators, which avoid it.

A broad class of adaptations helps species avoid predation by discouraging pursuit. Such pursuit-deterrent signals include the conspicuous *stotting* (a stiff gaited bounce) of ungulates (hoofed mammals) when chased by carnivores. On the African savannah, Thompson's gazelles *stot* when they are being pursued by cheetah. Stotting is likely to work by signaling to the predator that it is not profitable to continue pursuit; after all, a prey that can jump up and down is in sufficiently good condition to avoid capture. From the cheetah's perspective, they, like other *optimal foragers* are likely to be interested in maximizing their energy input over time. Thus, pursuing a healthy and stotting gazelle is likely not to be profitable.



This behavior, called stotting, discourages predators from pursuing these gazelle.

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Many species *aggregate* (gather in dense groups) to decrease predation risk. If such aggregations do not attract more predators, and if predators will kill the same number of prey regardless of group size, then by aggregating, the per-capita risk of predation decreases. In response to this increased safety in numbers, individuals in a group are able to allocate more time to foraging and less to antipredator vigilance. These "group size effects" are widely reported in birds and mammals and illustrate dynamic risk assessment.

See also Antipredatory Behavior—*Sentinel Behavior*
Antipredatory Behavior—*Predator–Prey Communication*
Antipredatory Behavior—*Vigilance*
Communication—Vocal—*Jump-yips of Black-tailed Prairie Dogs*
Social Organization—*Socioecology of Marmots*

Further Resources

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Daniel T. Blumstein

Antipredatory Behavior
Finding Food While Avoiding Predators

In every backyard and schoolyard animals are balancing success at eating with their risk of being eaten by predators. Familiar little birds such as sparrows and chickadees could be attacked by predators such as hawks, owls, and cats. Bird feeders are rich sources of food,