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Digest: Evolution of camouflage patterns in geckos*

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Is variation in geckos' dorsal color patterns linked to specific camouflage strategies? In this article, Allen et al. investigate correlations at the interspecific level between color patterns and ecological traits, such as habitat or activity time, in 439 species of geckos.

Many animals avoid predation by either remaining inconspicuous to predators or making themselves difficult to catch. Color, alongside other traits such as overall shape and texture, plays an important role in camouflage strategies. Color can either be uniform over the entire animal body (plain pattern) or be arranged in complex patterns. Three pattern elements are found in many species: stripes, spots, and bands (Fig. 1).

Different pattern elements are thought to be involved in different camouflage strategies. In particular, bands are thought to be the most efficient pattern element to hide in typical hiding spots (e.g., crevices) by providing disruptive camouflage, that is, by breaking the animal's overall outline (Stevens and Cuthill 2006). This strategy is most effective if the animal does not move, meaning bands are expected to be found mostly in nocturnal species, which do not move during the day. On the other hand, stripes are often believed to be involved in motion dazzle, in which prey move in order to confuse predators about their speed and direction (Stevens et al. 2008). This strategy works best if the prey is mobile during the day, and thus stripes are expected to be found mostly in diurnal species.

Similarly, bands and stripes (anisotropic patterns) are thought to be more strongly dependent on the background and therefore are most likely to work in specific habitats. Banded and striped species would then be more likely to be habitat specialists, while plain and spotted species (isotropic patterns) would be more likely to be habitat generalists (Fig. 1).

In this issue, Allen et al. (2020) test these predictions by examining the correlations between pattern elements and behavior in 439 species of gecko (among the 1744 species in this group). Almost all species in this group display hues similar to the background on which they occur, suggesting a use of coloration for camouflage. However, there is also large variability in the pattern elements between species, making them a valuable study system to test for correlations with behavior.

The authors first collected photos of geckos from authoritative sources on the web and then asked volunteers to sort them into four categories: plain, spotted, banded, or striped. The first part of their analyses revealed valuable information about the evolution and development of coloration patterns, without taking into account the environmental selective pressures that give rise to them. They found that patterns are highly conserved throughout species evolution, and that only some transitions are possible. For example, it seems impossible to evolve bands or spots directly from plain patterns; instead, stripes always occur as an intermediary step, suggesting an influence of developmental pathways in the evolution of pattern elements.

The second part of the study specifically examined the relationship between color pattern elements and behavior. The main results are presented alongside the predictions in Figure 1 and confirm that banded patterns are linked with nocturnal activity. In addition, unpredicted correlations were found, such as between the presence of bands and open habitat living.

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Plain	Spotted	Banded	Striped
Open habitats		Nocturnal species	Diurnal species
Generalists		Specialists	

Figure 1. **Illustration of the four types of pattern found in geckos and the predicted correlations with ecological traits (habitat type and activity time). Predictions confirmed by empirical data have a blue background while predictions refuted by empirical data have an orange background. Photos by Tony Gamble.**

The authors suggest possible directions for future studies, mentioning how the motion dazzle hypothesis is based on human predators and how the use of photography does now allow for the investigation of ultraviolet (UV) patterns. It would be worthwhile to conduct similar studies using perceptual models emulating predator vision of patterns, such as the model presented in a recent article by Stoddard and Osorio (2019).

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