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Evolution

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https://doi.org/10.1093/evolut/qpaf083

Evolution, 2025, **XX(XX)**, 1–2
https://doi.org/10.1093/evolut/qpaf083
Advance access publication 24 April 2025
Digest

Digest: the role of sexual selection in the evolution of aposematism

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This article corresponds to Maisonneuve, L., & Aubier T. G., (2025). The 'sexual selection hypothesis' for the origin of aposematism. *Evolution*, qpaf030. https://doi.org/10.1093/evolut/qpaf030

Abstract

Aposematism is an adaptation where individuals evolve conspicuous signals indicating the presence of anti-predator defenses. Maisonneuve and Aubier (2025. The 'sexual selection hypothesis' for the origin of aposematism. Evolution, qpaf030. doi:10.1093/evolut/qpaf030) explored the role of sexual selection in the evolution of aposematism using a mathematical model and found that some aposematic signals may have originated from sexually selected traits. Their findings suggest that these signals evolved through a combination of mate choice and predation pressure, highlighting the potential interaction between sexual selection and natural selection in shaping the evolution of aposematic signaling traits.

Keywords: aposematism, sexual selection, predation pressure

Aposematism is a mechanism by which prey signal their defenses to potential predators, indicating that they are dangerous to consume (Rojas et al., 2015). This strategy is widespread across diverse taxa, from plants to mammals, and provides a significant evolutionary advantage (Howell et al., 2021; Lev-Yadun, 2024). Signaling may initially increase prey detectability, leading to higher predation rates. However, once predators learn to associate a specific trait with a defense, they are less likely to attack, reducing the risk of predation for aposematic individuals (Leimar et al., 1986). The initial evolution of aposematism in species remains a subject of debate, with some studies supporting kin selection as the primary driver and others emphasizing the role of individual selection (Mallet & Singer, 1987). While no consensus has been reached, these mechanisms are not necessarily mutually exclusive and may play a role simultaneously.

Maisonneuve and Aubier (2025) contribute to this ongoing discussion by proposing that the evolution of aposematism may be linked to sexual selection. The authors suggest that signaling traits, now primarily associated with warning or defense, may have originally evolved as sexually selected signals that increased mating success (Estrada & Jiggins, 2008). To test this hypothesis, they developed a Wright–Fisher mathematical model that explores the co-evolution of signaling and defense traits within a population. Their model accounts for the costs of signal production, predator detection rates for prey with and without the signal, the influence of defense-associated signals on predator learning, the rate at which predators forget avoidance behaviors, and the strength of sexual selection. Their model considers either a sexually monomorphic or a sexually dimorphic population, with females as the selecting sex, incorporating either sex-dependent or sex-independent signaling traits.

Their findings indicate that sexual selection, in conjunction with predation, facilitates the evolution of aposematism (Figure 1). A conspicuous trait might lead to higher reproductive success among signaling males, thereby promoting the persistence of these traits. However, as signaling increases prey detectability, the likelihood of predation also rises, which in turn favors the evolution of defensive adaptations. As a consequence, the function of the signaling traits evolves from a sexual signal to an aposematic signal. Indeed, over time, predators learn to associate the signal with the defense and to avoid signaling individuals, reducing the predation pressure (Servedio, 2000). The results of Maisonneuve and Aubier (2025) also show that populations in which aposematism evolved via sexual selection tend to show higher sexual dimorphism, with males and females expressing not only different signaling but also different defense traits.

The hypothesis proposing sexual selection as the origin of aposematism does not necessarily contradict previous studies that emphasize kin selection or individual selection as key mechanisms in the evolution of aposematism (Mallet & Singer, 1987). Instead, these processes may act in combination (Estrada & Jiggins, 2008). Sexual selection could drive the initial evolution of a conspicuous signal used in mate choice, which later acquires an anti-predatory function. Stronger signaling and defense intensity may evolve through kin selection or individual selection if an individual with a stronger signal and defense increases the survival of its relatives or its own after an attack by enhancing the benefits

Received March 9, 2025; accepted April 22, 2025

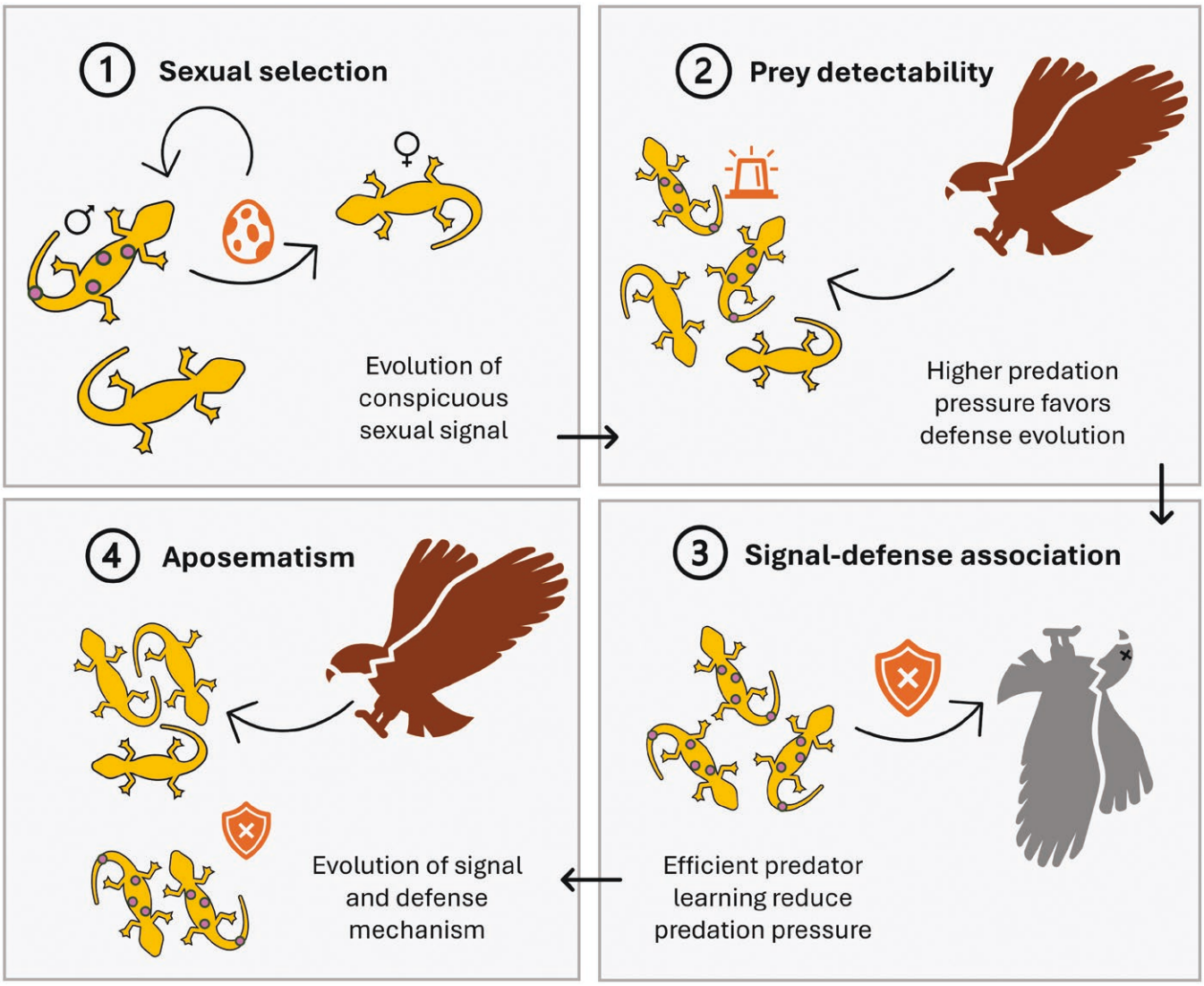

Figure 1. Graphical representation of the underlying mechanism driving the evolution of aposematism, as proposed by Maisonneuve and Aubier (2025). Males with conspicuous signals (spots) are sexually selected by females and are more detected by predators than other individuals. Predators learn to associate signaling with defenses and, consequently, avoid signaling individuals.

of predator learning. Although this study provides a valuable starting point, it should also encourage further research into alternative evolutionary hypotheses for the origin of aposematism, particularly those involving traits functional shifts.

Conflict of Interest

The author declares no conflict of interest.

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