Digest: The role of linkage in mimicking "magic traits"

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Abstract: Can divergence in a mating trait increase local adaption by increasing ecological divergence? Servedio and Bürger (2020) propose that "pseudomagic traits", tightly linked complexes consisting of an ecological locus under divergent selection and a locus acting as a mating cue, can effectively mimic pleiotropy. Such pseudomagic traits can form even when linkage between ecological and mating loci is limited.

Main Text:

One scenario for ecological speciation that has recently drawn attention involves so-called "magic traits". A trait should be considered a magic trait when it is both under divergent selection and causes non-random mating. Such magic traits are thought to facilitate speciation in the presence

of gene flow (Gavrilets 2004) and have been identified in different groups of organisms, including animals (e.g. Derryberry et al., 2018) and plants (Schlüter 2018). For example, in ovenbirds (Aves: Furnariidae), traits such as body size and bill shape, which are subject to strong ecological selection, have been found to indirectly influence signal production (i.e. song), which acts as a mating cue (Derryberry et al. 2018). Under divergence with gene flow, magic traits are expected to form a localized peak of divergence (Figure 1A). However, if recombination is low, a locus under divergent selection and a locus acting as a mating cue that are physically linked can mimic this singular peak of divergence (Figure 1B), and non-magic genes may therefore function as if they were a magic trait (Servedio et al. 2011).

In this issue, Servedio and Bürger (2020) gather evidence for the latter scenario, which they term "pseudomagic traits", and further assess whether divergence in both a mating trait and a tightly linked ecological trait can enhance local adaptation. Although it is widely accepted that an ecological trait can subsequently cause divergence in a mating trait, Servedio and Bürger (2020) ask whether the direction of causality can be flipped and whether linkage at the mating trait can cause divergence at the ecological locus. They investigate two logically-constructed population genetics models: a two-island model and a continent-island model. These models consist of haploid populations in secondary contact under non-random mating, examining both symmetrical and asymmetrical migration. Previous papers hypothesized that the initial strength of linkage disequilibrium (LD) would be fundamental in determining whether or not a pseudomagic trait can mimic a magic trait upon secondary contact. Thus, their models evaluated the importance of the

initial LD strength with a population starting in full LD and the same population starting in complete linkage equilibrium.

Servedio and Bürger (2020) find that pseudomagic traits can indeed mimic magic traits, with the presence of a mating trait helping the ecological locus to reach higher levels of divergence, which can ultimately enhance local adaptation. These results suggest that two mechanisms can play an important role in evolutionary divergence: (i) pleiotropy between the mating and the ecological loci (magic traits) and (ii) linkage between them (pseudomagic traits). They also explore how tightly linked mating and the ecological loci need to be to produce pseudomagic traits. They find that even loosely linked mating and ecological loci can have a strong effect on evolutionary divergence and enhance local adaptation.

Servedio and Bürger (2020) challenge the singularity of true magic traits during evolutionary divergence, providing an alternative mechanism through which reproductive barriers can rapidly arise. Although theoretical studies such as this one have advanced our understanding of the role of assortative mating in speciation, further studies need to include an empirical approach and expand the range of scenarios explored (e.g. sympatry).

References

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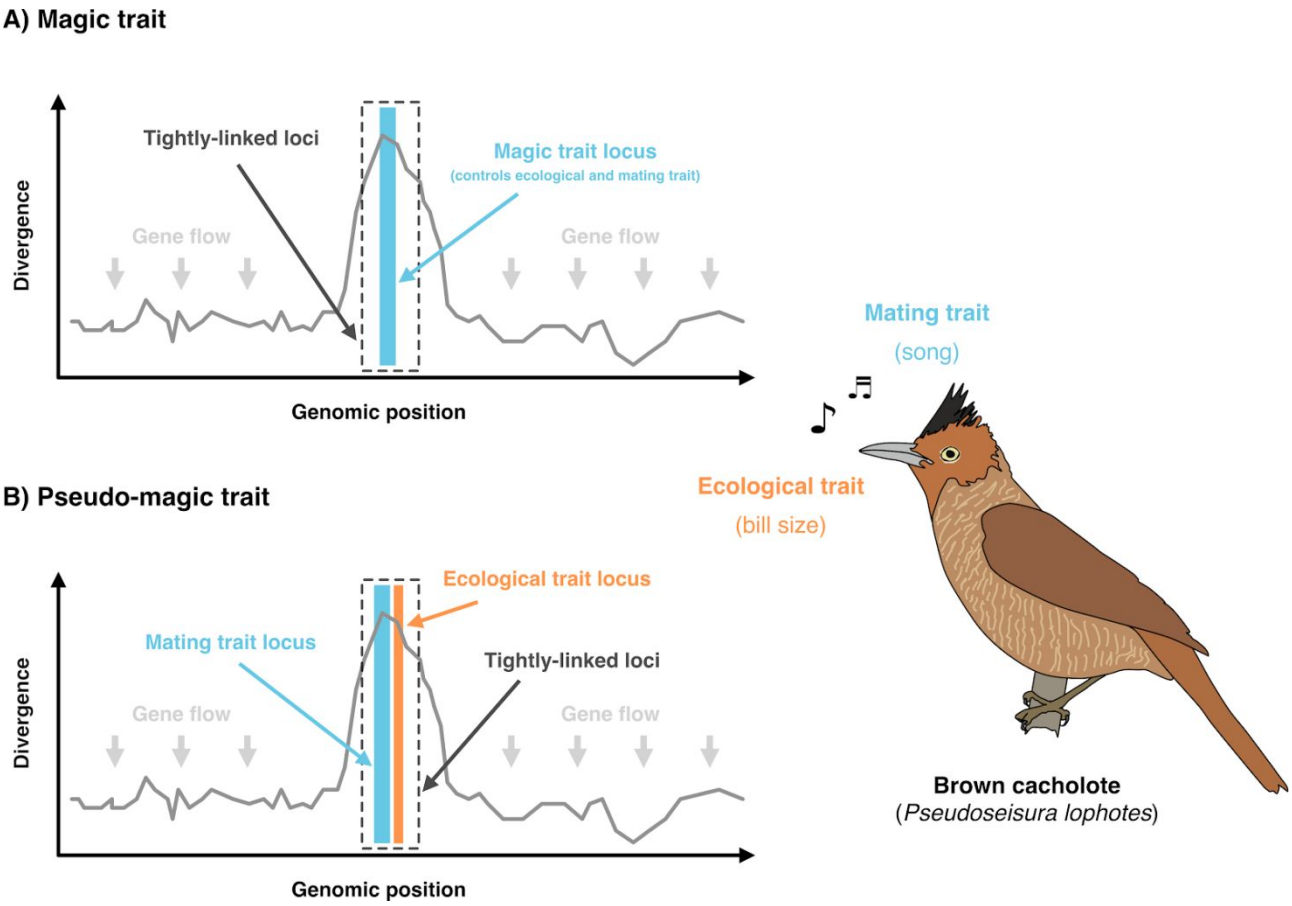

Figure 1. Illustration showing how magic traits and pseudomagic traits can produce regions of elevated divergence despite gene flow. (A) Selection at magic trait loci results in a region of elevated divergence containing the locus that controls both the ecological trait (bill size) and mating trait in addition to neighboring tightly-linked loci. (B) Two separate loci—a mating trait (song) locus and an ecological trait locus which are physically linked result in a region of elevated divergence comparable to selection operating at a magic trait locus. In ovenbirds (Aves: Furnariidae) coupling between an ecological trait (bill size) and a mating cue (song) has been identified (Derryberry et al., 2018)—this likely represents an example of a magic trait.