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1 **Digest: Positive selection and recombination shape the genomic landscape in flycatchers**

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16 **Footnote:** This article corresponds to Chase, M. A., Ellegren, H., & Mugal, C. F. 2021. Positive
17 selection plays a major role in shaping signatures of differentiation across the
18 genomic landscape of two independent *Ficedula* flycatcher species pairs. *Evolution*.
19 doi:10.1111/evo.14234. <https://onlinelibrary.wiley.com/doi/10.1111/evo.14234>

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23 **Abstract:** Whether background selection is sufficient to explain observed genomic
24 differentiation is a long-standing debate. Using four species of flycatcher, Chase et al. (2021)
25 addressed this issue and found that the effect of background selection may not be as great
26 as previously thought. Instead, both positive selection and recombination were shown to
27 have a significant effect on genomic differentiation.

28
29 **Main Text:**

30 Genetic diversity and differentiation within and between species is not uniformly distributed
31 across the genomic landscape. Instead, there are “differentiation islands”, genomic regions
32 that show high levels of differentiation. Speciation with gene flow is usually considered an
33 important driver of heterogeneity of overall genomic differentiation (Nosil 2008). Natural
34 selection may also contribute to genomic differentiation.

35 Natural selection can be classified into three categories based on its effects on allele
36 frequency (Fig 1A). The first, positive selection, increases the allele frequency of a beneficial
37 variant while reducing the surrounding neutral genetic diversity via linked selection (also
38 known as a selective sweep) (Hermisson & Pennings 2005). The second category, negative

39 selection, removes the deleterious variants from the population while maintaining a low
40 surrounding genetic diversity via linked selection (also known as background selection)
41 (Charlesworth, et al. 1993). The third category, balancing selection, maintains an
42 intermediate allele frequency.

43 Of the three categories, background selection is thought to play a key role in generating
44 differentiation islands. Gene density and recombination rate determine the intensity of this
45 type of selection. If gene density and recombination rate are conserved between certain
46 species, background selection should behave similarly in these species and persist over a
47 long evolutionary timescale, resulting in reduced genetic diversity, reduced divergence, and
48 elevated shared F_{st} peaks. This proposed process is known as the recurrent selection model.
49 But empirical and simulated data suggest that this model alone is not sufficient to explain
50 the existence of differentiation islands, and that there are additional evolutionary forces
51 involved in their creation and maintenance.

52 In this issue, Chase et al. (2021) compared the genome-wide genetic diversity (π), F_{st} , and
53 divergence (D_{xy}) within four species of *Ficedula* flycatcher to test whether positive selection
54 could generate lineage-specific and/or shared signatures of differentiation, and whether
55 recombination rate change could be a reason for lineage-specific differentiation.

56 First, the authors found that the four species exhibited a similar level of genetic diversity but
57 distinct levels of D_{xy} and F_{st} . Then, by using Fay and Wu's H and a composite likelihood ratio
58 (CLR), they identified the genomic regions of selective sweep and found that these tended
59 to overlap with F_{st} peaks, which suggests that positive selection results in genetic
60 differentiation. Third, they found a decreased correlation of π with increased species
61 differentiation and a reduction in D_{xy} in shared F_{st} peaks compared with that found in
62 lineage-specific F_{st} peaks (Fig 1C). This provides support for a recurrent selection model.
63 Lastly, by examining the distribution of recombination rate and gene density in different F_{st}
64 regions, they concluded the changes in recombination rate may be responsible for the
65 lineage-specific F_{st} .

66 Whether background selection is sufficient to explain genetic differentiation remains
67 controversial in evolutionary biology. By ruling out the confounding effects resulting from

68 incomplete lineage sorting (ILS) and gene flow (Fig 1B), the results of Chase et al. (2021)
69 provide insights into the generation of differentiation islands in flycatchers and highlight the
70 critical role of positive selection and recombination in shaping the genomic landscape.

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72 **References**

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