Title: Digest: Climate change and agricultural intensification influence the strength and direction of natural selection in tree swallows

Running Title: Natural selection in tree swallows

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Abstract

How does environmental heterogeneity affect natural selection on tree swallow nestlings? Houle et al. (2020) show that more precipitation and higher temperatures result in stronger selection on body mass and wing length and that agricultural intensity can affect the direction of selection. These findings raise the question of how genetic diversity changes under strong selection pressures, which will be especially important under ongoing agriculture intensification and climate change.

Commented [KM1]: Abstract that introduces the question being investigated by the study and briefly summarizes the findings. Less than 75 words.

Main Text

Natural selection can not only affect the means of quantitative traits (i.e. linear selection), but also the shapes of their distributions (i.e. non-linear selection). To gain a complete picture of selection dynamics, it is important to consider both linear and non-linear selection components by using the classical framework by Arnold and Lande (1983), which allows one to estimate linear and nonlinear selection in two separate regression analyses. In addition, local environmental conditions can influence the evolutionary response to selection and should thus be taken into account (Siepielski et al. 2013).

Commented [KM2]: Introduction that puts the research in a broader context and provides added value through citations not included in the original article.

In this issue, Houle et al. (2020) quantify selection pressures on 12-day-old tree swallow (*Tachycineta bicolor*) nestlings while considering local environmental conditions. The authors assessed the influence of several climatic variables, including temperature and rainfall, and the intensity of agriculture on the linear and non-linear selection components. In general, body mass and wing length were under positive selection in tree swallow nestlings. In other words, birds with larger body mass and longer wings were more likely to fledge. Local weather conditions did not affect the direction of selection, but did influence the strength of selection. Smaller nestlings were more vulnerable to rainy conditions and higher temperatures compared to larger ones, resulting in stronger selection pressures in hot and wet conditions. Hence, climatic variables mainly affected the linear component of selection (i.e. a change in the mean values of traits). In contrast, the level of agricultural intensity significantly influenced the non-linear component of selection: overall, larger birds with longer wings were more likely to survive in extensively cultivated areas.

Commented [KM3]: Summary of original article's methods and results.

These findings illustrate the importance of taking into account multiple environmental variables when quantifying selection pressures. Moreover, the environmental variables considered in this study are expected to become increasingly important due to ongoing climate change and continuing intensification of agriculture. This study focused only on certain morphological traits, raising the question of how changing selection pressures might impact the genetic diversity in these tree swallows. Stronger selection pressures might reduce genetic diversity in particular genomic regions, potentially affecting the adaptive potential of these populations.

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The expectation is that under harsh circumstances, population size will be reduced, and individuals will die irrespective of their trait values. This will result in higher levels of genetic drift in the population, increasing the chance of losing genetic variation at any locus in the genome (Figure 1). However, as demonstrated in this study, survival is not random, and therefore selection against lower body mass and shorter wings is amplified. Strong selection will lead to a rapid increase of the beneficial alleles that underlie the preferred phenotype (Stephan 2019). On a population level, this results in lowered genetic diversity, especially at the loci that are in close proximity of the selected variant through hitchhiking, as has been suggested for passenger pigeons (*Ectopistes migratorius*, Murray et al. 2017). Thus, the overall reduction in genetic diversity under harsh circumstances is amplified in genomic regions under selection, leading to even more reduced adaptive potential in the future.

Commented [KM5]: Discussion connecting this work to other studies – provides added value through citations not included in original study.

References

Houle, C., Pelletier, F., Bélisle, M., and Garant, D. 2020. Impacts of environmental heterogeneity on natural selection in a wild bird population. Evolution. doi: 10.1111/evo.13939

Lande, R., and Arnold, S. J. 1983. The measurement of selection on correlated characters. Evolution 37:1210-1226.

Murray, G. G., Soares, A. E., Novak, B. J., Schaefer, N. K., Cahill, J. A., Baker, A. J., Demboski, J. R,. Doll, A., Da Fonseca, R. R., Fulton, T. L., Gilbert, T. M. P., Heintzman, P. D., Letts, B., McIntosh, G., O'Connell, B. L., Peck, M., Pipes, M.-L., Rice, E. S., Santos, K. M., Sohrweide, A. G., Vohr, S. H., Corbett-Detig, R. B., Green, R. E. and Shapiro, B. 2017. Natural selection shaped the rise and fall of passenger pigeon genomic diversity. Science 358:951-954.

Siepielski, A. M., K. M. Gotanda, M. B. Morrissey, S. E. Diamond, J. D. DiBattista, and S. M. Carlson. 2013. The spatial patterns of directional phenotypic selection. Ecol. Lett. 16:1382–1392.

Stephan, W. 2019. Selective sweeps. Genetics 211:5-13.

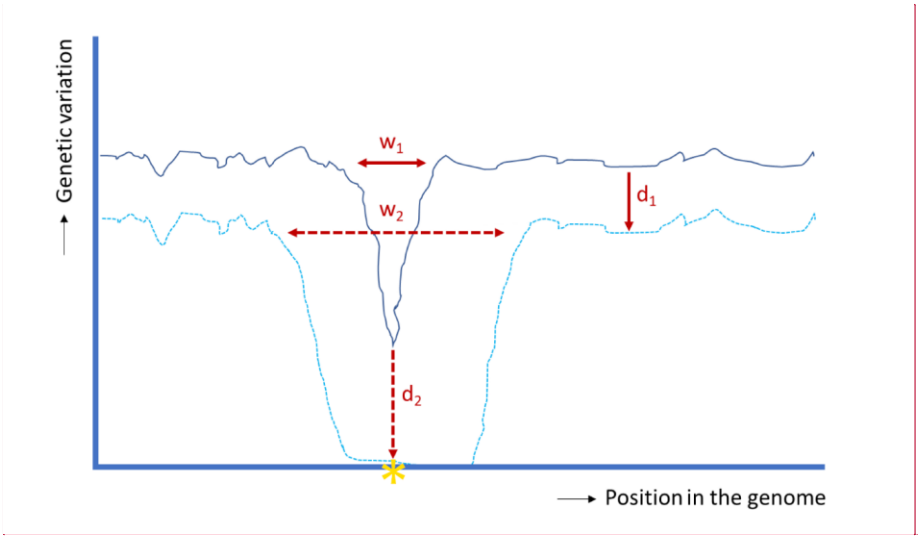

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Figure 1. Genomic consequences of selection under mild conditions (solid dark blue line) or harsh conditions (dashed light blue line). The yellow star indicates the locus under selection. Under harsh conditions, the overall genetic diversity in a population will be reduced because of drift at neutral loci (d1). At the locus under selection, the selection can be amplified, resulting in a stronger (d2) and wider (w2) sweep.