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Digest: Better constructing the future than choosing a new habitat

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What strategy should an individual follow in a heterogeneous environment when its phenotype is not optimized for its current environment: make changes to the environment (habitat construction), move to a different place (habitat choice), or both? Scheiner et al. used an individual-based model to investigate the interaction of habitat choice and habitat construction. In most situations, habitat construction was superior to either habitat selection or a mixed strategy.

Organisms can increase their fitness through adaptation, that is, by optimizing phenotypes for their environment. Adaptation can come in many forms (Fig. 1). In heterogeneous environments, for instance, organisms can rely on phenotypic plasticity (for themselves) or employ bet-hedging (for the next generation). Also, mobile organisms can choose a habitat that fits best their body conditions and needs (habitat choice). Alternatively, they can modify their current habitat by construction activities (habitat construction, e.g., Sultan 2015). Finally, a combination of options can be employed. In this study, Scheiner et al. (2021) investigate what happens when both habitat construction and habitat choice operate at the same time and how they may interfere with each other. Why is the way organisms adapt to their environment relevant? Different ways will have different effects on competition, population divergence, and speciation, and hence the course of evolution.

To understand the interaction between choice and construction, the authors created an individual-based model where the phenotype, the likelihood to disperse, and the likelihood to construct were based on five diploid loci each. An individual could then decide whether they would move to another habitat (after having compared the match of their phenotype to their current environment), and how much they would invest in construction (i.e., making favorable amendments to their environment). The authors compared two scenarios: one where construction occurred after habitat choice, and one where construction was performed before habitat choice.

Generally, the observed dispersal increased when the mismatch between the individual and the environment increased. One exception occurred with construction after dispersal: when the baseline fitness was very low, construction became more valuable, and the observed dispersal decreased slightly. However, the propensity to disperse was very similar for all scenarios, contrary to predictions that construction after dispersal would select against habitat choice, and that construction before dispersal would select for habitat choice.

The highest values for construction were observed when no habitat choice was allowed, especially when construction occurred after dispersal. By contrast, when individuals were constructing before they were allowed to disperse (i.e., habitat choice), the lowest amounts of construction were observed, because moving resulted in higher fitness gains than constructing.

Construction (without habitat choice) yielded always higher mean fitness than choice alone, or choice and construction. Therefore, if construction evolved before habitat choice, habitat choice would likely not evolve. In fact, habitat choice could be replaced by construction only.

As with all models, the results must not be generalized without acknowledging the underlying assumptions. More models using different approaches (e.g. hard selection; temporal disturbance) and incorporating more biological aspects of specific organisms will be required to fully understand the effects of

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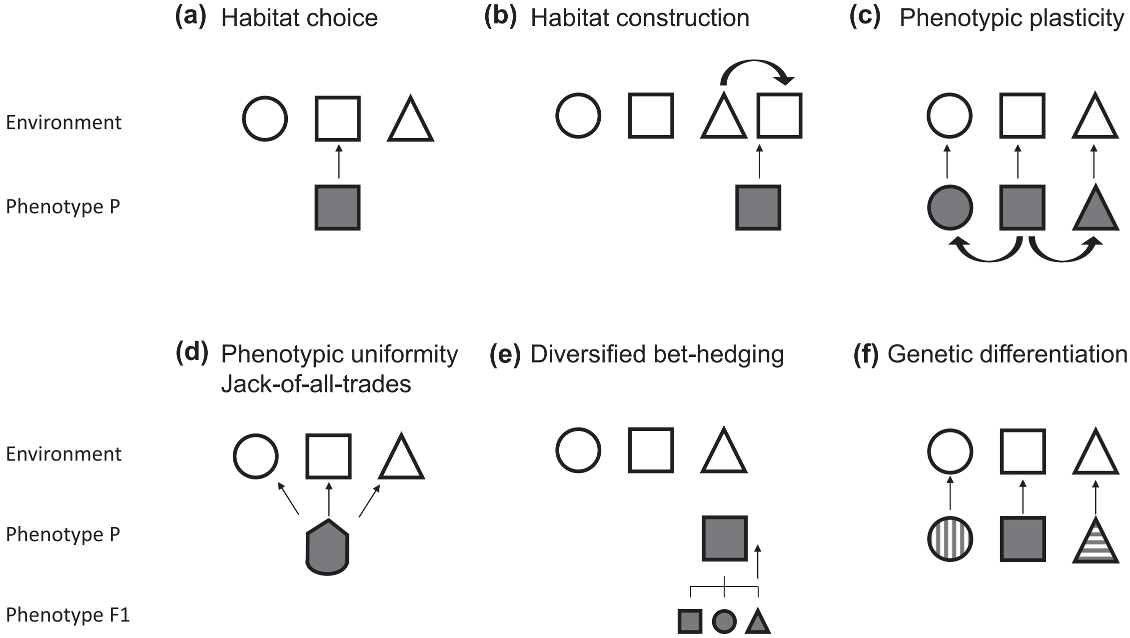

Figure 1. Six modes of adaptation in a fluctuating environment. Different environments are depicted by empty shapes. An individual (shown as filled shape) will have highest fitness when it has the same shape as the environment, indicated by a small upward arrow. Six modes (panels A-F) will lead to a close match between an individual's phenotype and the environment. Curved arrows indicate change in either environment (b) or phenotype (c). Note that these changes and matches are usually not as perfect as depicted. (a) Choosing the right habitat increases the match between individual and environment. (b) Changing the environment will increase the match. (c) Phenotypic plasticity increases the match with the environment. (d) One phenotype is sufficiently similar to all environments. (e) Bet-hedging enhances the chances that some offspring match well to the environment. (f) Different genotypes (indicated by different fill patterns) lead to different phenotypes, each fitting best to a particular environment.

habitat construction and habitat choice. Ideally, the model should be tested empirically, yet that might prove difficult: the model predicts that only one of the options will be present in any species, and hence interactions cannot be studied. However, phylogenetically informed species comparisons, or experimental evolution as an ultimate test, could discern the relative weight of choice, construction, and plasticity. Until then, it is safe to state: there is no simple answer as to which adaptation process usually prevails.

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