Food Scarcity Hones Competitive Edge

"A major goal of evolutionary biology has been the development of a general theory that will allow the prediction of those life history traits most likely to evolve under different ecological settings." This is how Laurence Mueller of Washington State University introduced his report of a simple but convincing laboratory experiment designed to test an important principle in evolutionary ecology. That principle has to do with the evolutionary response of organisms to life under different population densities: specifically, the honing of the competitive edge in the quest for food.

In a set of results that will surely strike a chord in those from large families, Mueller says: "I report experimental evidence of competitive abilities that have evolved in response to selection at extreme population densities in a manner consistent with the theory of *r* and *K* selection." Mueller worked with *Drosophila melanogaster*, and found that those populations that were raised under extremely high population densities vastly outcompeted—by 58%—low-density populations in consuming food. To put it crudely, individuals from the high-density population could eat faster than their low-density competitors.

This difference is a genetically determined pattern, not a simple, short-term behavioral response. "What you see here is the outcome of experimental natural selection," Mueller told *Science*, a crucial issue in testing the any aspect of evolutionary ecology theory.

The theory of *r* and *K* selection is central to much of evolutionary ecology, addressing as it does a series of potential adaptations by a species to the availability of essential resources, most notable of which is food. For instance, species adapted to unstable environments, in which availability of resources fluctuates greatly, reproductive output is high, the population is usually below carrying capacity, and competition is low: this is *r* selection. In a stable environment, where resource availability is relatively constant, reproductive output is low, the population is at or near carrying capacity, and competition is keen: this is *K* selection.

Mueller notes that the theory comes in two forms, verbal and mathematical, and says that his work is restricted to the latter. "The verbal theory made a lot of predictions to do with life-history phenomena, such as body size, reproductive rate and so on," says Mueller. "Some of these predictions have been substantiated, but many have not. I decided to stick with the mathematical formulation, and address the question of competitive abilities."

Only infrequently is it possible to perform experimental tests in evolutionary ecology, but in this particular case the fruit fly offers a possible system. Mueller set up two types of population, *r* and *K*, the former being restricted to 50 adults in a half-pint culture, the latter as much as 20 times higher. The *r* populations enjoyed essentially unlimited resources whereas the *K* populations faced severely limited resources. According to theory, the *K* environment will select for competitive abilities, for obvious reasons. And this is what Mueller found.

Mueller tested the competitive zeal of the *r* and *K* populations by pitting them separately against a third, standard population. "In every case, the competitive ability of the *K* population is greater than its matched *r* population," reports Mueller.

Mueller realized that it was theoretically possible for the *r* population to have fared badly for reasons other than straightforward natural selection. "The *r* populations will certainly be more affected by genetic drift due to their small adult populations," he notes. "This raises the possibility that deleterious recessive alleles present in the founding populations may become fixed in the *r* populations, due to drift, and cause a decline in competitive ability." Because each of the *r* populations would be likely to have accumulated different deleterious alleles, crossing the populations to form an F_1 generation would restore normal competitive ability, through hybrid vigor.

In fact, both F_1 populations were close to their parental populations in competitive abilities. "This is precisely the result expected if one assumes the differences between individual *r* and *K* populations are due to alleles that have additive effects on competitive ability," concludes Mueller.

These findings are important, because they are consistent with the notion that the evolutionary response to limited resources is a genetically underwritten increase in competitive ability. "The theory of density-dependent natural selection provides a general framework for predicting the evolution of life-history phenomena, such as competitive ability and density-dependent rates of population growth in environments with various density-regulating mechanisms," concludes Mueller. "The present results and other studies with *Drosophila* have verified key predictions of this theory and thereby justify the central role this theory has assumed in the field of evolutionary ecology."

■ ROGER LEWIN

ADDITIONAL READING

L. D. Mueller, "Evolution of competitive ability in *Drosophila* by density-dependent natural selection," *Proc. Natl. Acad. Sci. U.S.A* **85**, 4383 (1988).

Human Genome Goes International

The genome project has now officially gone global with the founding of an international Human Genome Organization, already dubbed HUGO. The goal of HUGO, which had its origins at an informal session of an April meeting at Cold Spring Harbor Laboratory, is to further collaboration and communication in the worldwide effort to map and sequence the human genome.

Loosely modeled on the European Molecular Biology Organization (EMBO) in Heidelberg, HUGO will have worldwide representation and three offices in North America, Europe, and Asia, which in HUGO's definition includes Australia and New Zealand. (Unlike EMBO, HUGO's plans do not include a laboratory.) Sir Walter Bodmer of the Imperial Cancer Research Fund in London has offered about $40,000 a year, and Kenichi Matsubara of Japan's Human Frontiers Science Program has also pledged financial support.

Victor McKusick of Johns Hopkins University is the acting president, and John Tooze of EMBO is the acting secretary. The founding council, which will number about 30, includes Bodmer, Matsubara, James Watson, Frank Ruddle, Jean Dausset, Renato Dulbecco, Harold zur Hausen, Leroy Hood, Thomas Caskey, and Walter Gilbert.

The group plans to meet outside Geneva on 6 to 8 September, with funding from the Howard Hughes Medical Institute, to draft bylaws and otherwise plan activities.

As envisioned now, HUGO will take over management of the biannual Human Gene Mapping Workshops as well as organize other international conferences and instructional courses. The founders want a role in overseeing the efforts now under way to link various databases. HUGO's offices may also serve as centers for data collection and dissemination.

Other functions include advising governments and funding agencies on support for genomic research, helping to distribute funds for research training or data-management facilities, and generally keeping abreast of the commercial and ethical issues.

■ LESLIE ROBERTS