Special Feature

Molecular Markers For Population Biology[1]

The ''molecular revolution'' has affected science and science policy at every level from local administrations to federal funding decisions. As this perspective gained momentum, many ecologists and population biologists may not have fully appreciated what molecules can tell us about populations, given the biomedical and reductionist orientation of most molecular research and funding. Our aim in this collection is to review another face of molecular biology, one where the focus is not so much on the molecules themselves, but in their use as ''markers'' that are specific to particular individuals or larger subsets of populations. As such, molecular markers can be used, for example, to follow relative successes and failures of individuals in populations, to estimate effective dispersal that occurs between populations, and to gauge the level of divergence among populations. Recently, the rapid development of new molecular techniques that allow us to view with unprecedented resolution the dynamics within populations have led to true advances in our understanding of population ecological processes. The new insights that have emerged have contributed so distinctly to disciplines within the broad field of ecology that they have been collectively referred to as a new subdiscipline, molecular ecology, and we have seen the birth of a popular new journal by that name.

We have assembled here a collection of four papers that illustrate those advances. The first, by Parker et al., is meant to explain the fundamentals of the techniques themselves; what are the molecules that are used, and what are the basic procedures that are followed in the lab work and in data analysis? How do researchers go about choosing the technique that is appropriate for their particular question? Summarizing the technical aspects in one paper allows the other three authors to focus on the direct application to ecological questions without the distraction of explaining how the lab work proceeds, which also prevents that potential redundancy between papers.

Colin Hughes describes how molecular markers have led to advances in our understanding of social systems of natural populations. Observing social relationships among individuals is often insufficient for accurately characterizing actual patterns of reproductive success, due to the unpredicted levels of cryptic mating that have been revealed through genetic studies. These findings have revolutionized the study of mating systems. Similarly, we can finally quantify the relationships among individuals in complex societies of vertebrates and invertebrates alike to describe the diverse routes by which sociality has arisen. Now that we can accurately characterize the different types of sociality in terms of the genetic relatedness of group members and their reproductive relationships, we can begin to examine ecological correlates of those population parameters; the evolutionary study of social systems has taken a giant step forward.

Mating systems in plants have been even more elusive than in animals, and are complicated by the fact that many plants are capable of selfing and/or clonal propagation. When dispersal of pollen and seeds is locally restricted, plants may be mating with close relatives. Mitchell B. Cruzan covers the spectrum of recent applications of molecular markers to plant populations, encompassing advances in studies of mating systems, population subdivision, and hybridization. Historically, plants have been more amenable to isozyme studies than many animal species, but novel molecular markers have opened up new areas for investigation, including genealogical patterns within populations and interspecific mating that results in cryptic hybridization. Given the number of positions advertised for plant molecular ecologists or plant evolutionary ecologists in recent years, it seems clear that the general interest in this application is growing exponentially.

[1] Reprints of this 67-page Special Feature are available for $10.00 each. Prepayment is required. Order reprints from the Ecological Society of America, Attention: Reprint Department, 2010 Massachusetts Avenue, N.W., Suite 400, Washington DC 20036.

Finally, the development of high-resolution molecular genetic tools has coincided with increased attention to genetic processes that contribute to declines of plant and animal populations. Susan Haig summarizes recent advances in conservation genetics, emphasizing the improved ability with which hybridization events can be revealed, the ability to quantify the distribution of genetic diversity within and among populations of formerly intractable study species, and the role of genetics in population viability analyses. It could be argued that conservation biologists are to some degree distracted from the issues of habitat degradation and stochastic population dynamics by the availability of seductive new genetic tools that have never been easier to use. At the same time, this review shows that the weight of new conservation genetic data strongly suggests that genetic variation in declining populations is often alarmingly low.

Taken together, these papers should point the way toward an exciting future in which molecular applications are used to their best advantage. Ecologists of all stripes need to be informed about when these new tools are most powerful and when they should be avoided in favor of simpler methods. By picking and choosing among the best techniques available, we can strengthen the rigor of our science and benefit from ties with biologists whose focus is aimed at the molecules themselves.

—ALLISON A. SNOW
Guest Editor
The Ohio State University
—PATRICIA G. PARKER
Guest Editor
The Ohio State University

Key words: conservation genetics; evolutionary ecology; molecular ecology; molecular markers; relatedness.