cer, Okada includes a cogent discussion of metaplasia in adult cells. Also discussed is the transdifferentiation that occurs during regeneration, where cells in lower vertebrates have the ability to grow new limbs, tails, and eyes after loss of these structures. Finally, the author reviews some of the possible factors and mechanisms influencing transdifferentiation. These include, but are not limited to, the number of mitotic cycles, the loss of the pre-existing phenotype, and the disruption of cell-cell contacts. The mechanism underlying transdifferentiation may vary depending upon the cell types and organisms involved.

In this book Okada gives a balanced view of transdifferentiation in many systems, presenting all sides of the argument in areas where discrepancies exist and providing useful historical perspectives. Given the large amount of information presented in a concise format, the sheer load of data is sometimes daunting. Because so little is known about changes in gene expression that accompany the process of transdifferentiation, this area is ripe for molecular analysis. The wide scope and potential significance of the underlying molecular mechanisms make Okada's monograph a review that should hold the attention of developmental, cell, and molecular biologists alike.

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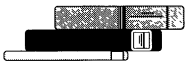

Priorities for Plants

Genetics and Conservation of Rare Plants. DONALD A. FALK and KENT E. HOLSINGER, Eds. Oxford University Press, New York, 1991. xviii, 283 pp., illus. $49.95. Based on a conference, St. Louis, MO, March 1989.

No contemporary biologist is oblivious to the gathering cloud of extinctions that threatens to engulf our planet in a biological holocaust. If we are to forestall these losses, our efforts must be guided by both general principles and information specific to individual species. Falk and Holsinger have tidily assembled a distinguished set of population biologists to ponder and discuss the role of genetics in rare-plant conservation. To what degree should we concern ourselves with genetic factors? How does the distribution of genetic variation within and among populations affect population vulnerability? How can we best sample existing genetic variation for off-site preservation? What are the hazards of such *ex situ* conservation efforts?

The contributors differ widely in perspective and address a diversity of issues. Nevertheless, the chapters are of consistently high quality and will interest plant conservation biologists and those seeking genetic sophistication in their reintroduction or restoration efforts. Apart from their interest for conservation, many chapters stand alone as summaries of great value to population biologists interested in the causes and consequences of rarity. The editors and publisher have also succeeded in producing a useful book by providing a complete index and a comprehensive bibliography (850 references). Though the book is predictably parochial in focusing primarily on North American plants, the principles discussed are general and one chapter (Bawa and Ashton) is concerned with tropical plants.

Considerable consensus emerges on many scientific issues, including the variable (and often minor) role genetic diversity plays in population persistence, the advantage of making genetic surveys before designing sampling or protection schemes, and the differential sensitivity of populations and species to the damaging effects of genetic impoverishment. Such consensus, however, does not obscure controversy elsewhere: Should we always use locally adapted source material when restoring populations? When is it appropriate intentionally to amalgamate (or inbreed) captive stock?

The sharpest debate dividing contributors to the book concerns the wisdom of "off-site" preservation. Should biologists try to conserve rare species and their genetic variation through careful sampling and cryogenic storage or repeated propagation? Three chapters deal with how best to sample, assess, and maintain genetic material from plants, implicitly assuming that such *ex situ* programs will be needed to compensate for our growing failure with *in situ* conservation. Other chapters caution us against such measures, noting that captive-bred stock will be subject to reduced genetic variability and unpredictable levels of artificial selection. Some might wonder further whether *ex situ* preservation might serve as an excuse to allow further losses among natural populations.

Readers seeking discussions of how ecological variation affects the partitioning of genetic variation within and among populations will find them in the chapters by Hamrick *et al.*, Karron, and Millar and Libby. Those wanting a comprehensive review of ideas and data regarding the ecological importance of this variation should read Huenneke's stimulating chapter. Cladistics enthusiasts will be pleased to find discussions of how isozymes (Barrett and Kohn, Karron) and particularly analyses of cDNA and mtDNA variation (Schaal *et al.*) can be used to infer population bottlenecks. There are also up-to-date discussions about how such bottlenecks may actually release quantitative genetic variation. Several authors describe in some detail the hazards of combining genetic contributions from different areas ("outbreeding depression").

Barrett and Kohn emphasize the importance of population history and note a surprising persistence of inbreeding depression in many populations seemingly already inbred or otherwise depauperate in genetic variability. Studies of isozyme, DNA, and quantitative genetic variation frequently generate contrasting results, as reviewed by Schaal *et al.* and Millar and Libby. Brown and Briggs use the neutral theory and quantitative genetics to predict that rare alleles will be both scarce and of limited utility for captive breeding programs, favoring small samples for such efforts. Ironically, given the focus of the book, genetic factors only occasionally precipitate plant population declines. Most authors concede the preeminence of other factors, primarily habitat loss and degradation, in species conservation. Menges stresses these non-genetic concerns, injecting ecological common sense in his chapter on assessing minimum viable populations.

Neither ecology nor genetics appears to matter for some species needing protection. *Oryctes nevadensis* exists in only a few sites in California, is threatened by cattle trampling, and constitutes the only member of its genus in an economically important family, the Solanaceae. Yet the California Fish and Game Commission has twice failed to grant this "weedy looking" plant protection, perhaps in part because this species lacked the foresight to avoid growing on lands now owned by the Los Angeles Department of Water and Power. Holsinger and Gottlieb, however, also fault the conservation community in this instance for failing to rank rare species according to taxonomic uniqueness and the economic value of their relatives.

Falk agrees that priorities should be set and ambitiously attempts to link the diminishing returns for sampling allelic variation within populations to economic models based on setting of priorities in a world of limited resources. Conservation biologists, however, will hardly need to be reminded to allocate resources carefully and are unlikely to be enlightened by this superficial economic analysis. Even assuming conser-

vation biologists could agree on priorities, it is unlikely they would match either public sentiment or current endangered-species laws. These laws, rightly or wrongly, work to protect species regardless of their appearance, taxonomic rank, or economic utility.

The authors have obviously been prompted by the editors to make practical suggestions to foster conservation. Millar and Libby make several intriguing suggestions, including the establishment of large-scale and spatially integrated networks of "genetic management systems" aimed at species with broad ranges that have not yet become rare or threatened. Falk and the Center for Plant Conservation summarize many other recommendations in their appendix on "Genetic sampling guidelines for conservation collections of endangered plants." These guidelines have the virtues of being specific and simple (sample 10 to 50 individuals from each of 3 to 5 populations, modified for life history, pattern of distribution, and so on) and will likely be widely applied. With such simple rules of thumb, however, it will be tempting to sidestep the tedious steps recommended by many authors to measure and assess population parameters and genetic variability prior to designing sampling schemes. In addition, a formulaic approach ignores the specific complexities emphasized as important by many of the authors.

Despite controversies over such technical issues of implementation, the authors all agree we must vastly expand our conservation efforts. This volume has greatly advanced the field by crystallizing the genetic issues and providing a convenient and authoritative source for those practicing in the emergency wards of conservation biology.

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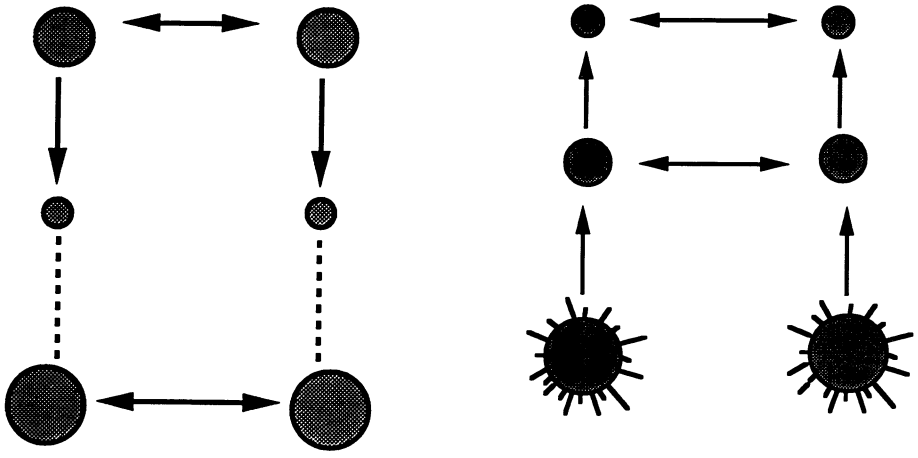
Big Questions in Ecology

The Balance of Nature? Ecological Issues in the Conservation of Species and Communities. STUART L. PIMM. University of Chicago Press, Chicago, IL, 1992. xiv, 434 pp., illus. $62; paper, $26.95.

This is a wondrous book, filled with fascinating questions and sweeping patterns based on huge statistical data sets. It deals with the big questions in ecology. How quickly will species recover following catastrophes? Can we predict which species are particularly vulnerable to extinction? Which species will succeed if they are introduced into communities? Its tack is to get far back and squint and see what stands out.

Pimm begins by breaking ecological stability into five related parts: stability in the strict sense, resilience, variability, persistence, and resistance. He defines each, gives the units in which each is measured, and then sets about presenting data sets that show how each form of stability is influenced by various biological attributes of species and the way they are dynamically imbedded in multi-species and multi–trophic-level communities. The problem, of course, is that phenomena that occur on such large spatial and temporal scales do not lend themselves to experimental manipulation. Like cosmologists, ecologists must rely on mathematical extrapolation. Yet unlike the situation in cosmology, the equations governing the dynamics of interacting species are only caricatures. The ecologist concerned with the big picture is faced with huge scales, complex interactions, and unknown relationships. Pimm is undaunted and seeks patterns.



Sketches of two hypotheses according to which removal of herbivores from a community would have little effect. *Left*, " 'The world is green' hypothesis of Hairston *et al.* (1960). Solid lines indicate strong interactions, and dashed lines indicate weak interactions. Predators compete and limit [folivores], which then do not limit plants, and, in consequence, the plants do compete. Granivores, frugivores, and nectarivores do compete, however, because seeds, fruits, and nectar are in limited supply." *Right*, " 'The world is prickly and tastes bad' hypothesis of Murdoch (1966). . . . Plants are difficult to eat, and so the availability of digestible, accessible plants limits herbivores (which compete), and these, in turn, limit carnivores (which also compete)." A survey of data "unequivocally rejects" both hypotheses. "Herbivore removals *do* have effects." [From *The Balance of Nature*]

Sure enough, patterns emerge. Yet, as Pimm often points out, the large scatter about most of the plots relating his various stability measures to suspected individual characteristics (for example, body size, reproductive rate, population density) or the way a species is linked to others (number of trophic levels, number of prey species) suggests that ecology still has a lot to learn about these stability measures. Perhaps we have not yet identified some of the most pivotal influences. One possibility, not discussed much here but emerging as a contender, is that the stability properties of a particular species's population are affected at least as much by the abundance of habitat space and the arrangement of habitat patches in space as by the population densities of species with which the species interacts or the temporal variability of the climate. Could it be, for example, that the relatively common population cycles of species in the arctic and subarctic zones have less to do with classical predator-prey dynamics as a driving force than with the fact that in the boreal zone a large continuous expanse of homogeneous habitat still exists and that this allows dispersal to act in nonlinear ways?

The exposition dealing with temporal variability (chapters 3 through 6), its detection and interpretation, is lucid and up-to-date. The complications inherent in time-series analyses based on few data points are not likely to be resolved soon. The synthesis of meta-studies on introduced species is also extremely useful. Pimm compares this empirical literature with simulation models that also show that species-rich, highly connected communities are harder to invade. One small quarrel concerns the cause of this result. The notion (p. 185) that "the more competition, the less likely a species will be able to invade" implicitly invokes the idea that under high competition the invader is less likely to displace the resident than vice versa. But why? Competition would work in both directions and the models do not build any priority effect for residents into the pairwise descriptions of species interactions that form their core. How does this priority effect for residents emerge? Pimm's answer seems to beg the question.

The subtitle "Ecological Issues in the Conservation of Species and Communities" suggests that broad-based general models like those Pimm reviews will have utility in directing management plans for conservation. As Pimm notes in a chapter on the limitations of such models (curiously placed near the very end of the book), this is a