A Primer of Conservation Genetics

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Macquarie University
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A PRIMER OF CONSERVATION GENETICS

RICHARD FRANKHAM, JONATHAN D. BALLOU AND DAVID A. BRISCOE

A REVIEW BY ANDREA C. TAYLOR

MAMMALOGISTS who set out to acquaint themselves with a general understanding of the significance of genetics in conservation biology via Frankham, Ballou and Briscoe's 2002 offering, *Introduction to Conservation Genetics*, may be forgiven a little reticence in tackling its successor, *A Primer of Conservation Genetics*. The first book was originally touted as providing an 'accessible introduction' to the field. However the substantial size of *Introduction to Conservation Genetics* - partly due to repetition of concepts among chapters intended to provide the basis for undergraduate lectures - may be sufficient to deter all but the keenest professional student. For readers whose 'study' time is concentrated into office coffee breaks, train commutes or bed-time reading *A Primer of Conservation Genetics* is an infinitely better choice (as it is for less-specialist undergraduate courses). Professional wildlife managers these days are expected or even legally compelled to incorporate genetic issues into management programs and/or avail themselves of multi-disciplinary sources of information including that provided by 'molecular ecologists'. However the conservation genetics revolution has occurred sufficiently recently that it is only just beginning to infiltrate University teaching. Fortunately the false dichotomy between genetics and whole organism biology is breaking down, and the former is now recognised as providing valuable tools that undergraduate students are keen to master as part of a holistic education in biology. Nonetheless most practising wildlife managers have probably received little formal genetics training any relevance. *A Primer of Conservation Genetics* is ideal for absolute beginners as well as those seeking to consolidate knowledge. The authors bring to the book the wealth of their own experience in laboratory experimentation, hands-on genetic management and empirical data collection.

The book comprises essentially two conceptual sections, although they are not identified as such. The brief introductory chapter presents a raft of dismal but sadly familiar biodiversity loss statistics, the various classes of extinction drivers and a relatively comprehensive overview of the range of issues and applications that make up the discipline of conservation genetics. The next four chapters develop the argument for preserving genetic diversity as a vital conservation goal in itself. Ongoing scepticism in some quarters regarding the importance of genetic factors in conservation has prompted an almost overwhelming production of literature essentially aiming to unequivocally establish the link between inbreeding and extinction. The thorough assembling of this plethora of information into a logical, concise and convincing 'chain of evidence' is one of the greatest strengths of this book. Such evidence includes well-established evolutionary theory as well as results from agricultural selection programs, laboratory experiments, empirical studies of captive and wild populations, meta-analyses that illustrate the taxonomic generality and magnitude of impacts, genetic restoration programs and population viability analyses.

Chapter 2 is a very readable overview of concepts of genetic diversity. Included are definitions of basic genetic terminology, some important population genetic principles, descriptions of commonly used genetic marker systems and some statistics on the extent of the problem of reduced genetic diversity in threatened species. The point is made that oft-quoted genetic marker diversity may not be representative of variation in functionally important quantitative traits, which is generally difficult to measure directly. Potential solutions to this problem are not explored. Chapter 3 summarises how genetic diversity is maintained and how populations evolve via interactions between mutation, migration, gene flow and natural selection. Relevant quantitative equations are provided and are accompanied by clear verbal descriptions that serve to demystify them for the less mathematically minded. Chapter 4 sets out the special genetic problems faced by small populations, and sends the important message that genetic diversity parameters are governed by N_e - the effective (not census) size of the population. Thus even large populations may be genetically worse off than assumed if the species' biology exhibits one or more of the listed factors that reduce N_e relative to census size. A non-intuitive genetic quirk explained here is Wright's finding that a single migrant per generation is sufficient to prevent complete population differentiation, regardless of population size. One of my few criticisms of the book relates to another section in this chapter, which may fuel the common misconception that genetic diversity will inevitably be reduced in species whose populations fluctuate markedly. While this is expected and

demonstrably true for closed populations, it is not expected for those with high levels of connectivity such as the lynx (*Lynx canadensis*) and snowshoe hare (*Lepus americanus*) examples given. For such widespread species, if population fluctuations are highly localised, lost genetic diversity will be replaced via immigration. Even if population fluctuations are temporally and spatially synchronised, the meta-population effective size is likely to remain substantial. Although the mitigating effect of connectivity on loss of genetic diversity is dealt with in the following section, the link could be made more explicit in the fluctuating population case. The title of Chapter 5 – 'Genetics and extinction' – speaks for itself. The variable and unpredictable nature of inbreeding depression is highlighted and the underlying genetic basis of this variability explained. This is useful for conservation biologists struggling with the question of why some individuals, populations or species suffer deleterious effects of inbreeding while others seem not to (often mistakenly interpreted as evidence that genetic diversity is irrelevant).

The second half of *A Primer of Conservation Genetics* presents the more practical face of conservation genetics: guidelines for how actually to *do* genetic management, and an overview of the kinds of information that can be revealed by genetic marker analysis. Chapter 6 deals with clarifying taxonomic status and defining units for management. The authors outline five compelling reasons why it is imperative that biodiversity be adequately categorised for responsible management. They briefly discuss the sticky issues of species and sub-species concepts, and demonstrate the utility of genetic markers in delineating sympatric species while recognising their limitations for allopatric species. The lack of general agreement about the risks of outbreeding depression is dealt with here. Chapter 7 flows from an impressively useful flowchart of questions to guide genetic management of a threatened population or management unit in the wild. The fact that the complexity of issues can be compressed into a single figure should provide much needed encouragement to those charged with the task! Chapter 8 focuses specifically on genetic issues in captive management and reintroduction, such as how to minimise genetic adaptation to captivity, choose founders to minimise inbreeding in future generations and manage known genetic diseases. High profile mammalian case studies are nicely summarised at the end.

Chapter 9 may be of more general interest than the rest of the book, in that it touches on the exciting range of applications using genetic markers to advance our understanding of species' biology. It by necessity offers only a superficial coverage of molecular ecology, which is a substantial and growing field in its own right. However, all population biologists will find something here to fire their imagination and identify ways in which these tools would help them answer questions both big and small about their study organism. Again for managers, examples are given of forensic detection of illegal use of wildlife. Other topics covered are elucidation of population history (evolutionary and demographic), population size (via non-invasive sampling), secondary contact events, population structure, dispersal patterns, parentage, mating systems, gender, and the identity of disease organisms, parasites and dietary items. A notable absence is reference to the emerging field of landscape genetics, which weds spatial patterns in high-resolution genetic markers with geographic features by way of some very innovative analyses.

While *A Primer of Conservation Genetics* describes various genetic markers and their applications, there is little information on the molecular techniques and analyses required to exploit them – in short the nuts and bolts of data collection. Instead Chapter 9 lists several more technical publications as further reading. This is reasonable since the average reader would neither have access to appropriate laboratory facilities, nor the expertise to use them. Furthermore, the book offers no indication of the expense involved in modern molecular genetic analysis, and the factors that will determine this for each species/application.

So will *A Primer of Conservation Genetics* lead to greater advantage being taken of the opportunities offered by conservation genetics to aid in the preservation of our wondrous mammalian diversity? I believe its effective promotion of a greater understanding of genetic concepts is a major step in the right direction.

Frankham R, Ballou JD and Briscoe DA, 2004. *A primer of conservation genetics*. Cambridge University Press. 234 pages. Recommended retail AUD$59.95 paperback (ISBN 0521538270).

AC Taylor, School of Biological Sciences, Monash University, Victoria 3800, Australia.

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