



---

Review: [untitled]

Author(s): Jack W. Sites, Jr.

Reviewed work(s):

Molecular Markers, Natural History, and Evolution by John C. Avise

Source: *Copeia*, Vol. 1994, No. 4 (Dec. 19, 1994), pp. 1061-1064

Published by: American Society of Ichthyologists and Herpetologists

Stable URL: <http://www.jstor.org/stable/1446738>

Accessed: 02/09/2009 18:33

---

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=asih>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit organization founded in 1995 to build trusted digital archives for scholarship. We work with the scholarly community to preserve their work and the materials they rely upon, and to build a common research platform that promotes the discovery and use of these resources. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).



American Society of Ichthyologists and Herpetologists is collaborating with JSTOR to digitize, preserve and extend access to *Copeia*.

<http://www.jstor.org>

fisheries, and geographical distribution. It will certainly be among the reference books taken on the next Smithsonian shorefish-collecting expedition. We thank D. G. Smith for his help in setting up and analyzing the results of the identification test.

## LITERATURE CITED

- ABU-HAKIMA, R. 1987. Aspects of the reproductive biology of the grouper, *Epinephelus tauvina* (Forsk.), in Kuwaiti waters. *J. Fish. Biol.* 30:213-222.
- BALDWIN, C. C., AND G. D. JOHNSON. 1993. Phylogeny of the Epinephelinae (Teleostei: Serranidae). *Bull. Mar. Sci.* 52:240-283.
- CLARO, R., A. GARCIA-CAGIDE, L. M. SIERRA, AND J. P. GARCIA-ARTEAGA. 1990. Características biológico-pesqueras de la cherna criolla, *Epinephelus striatus* (Bloch) (Pisces: Serranidae) en la plataforma cubana. *Ciencias Biológicas* 23:23-42.
- HEEMSTRA, P. C. 1991. A taxonomic revision of the eastern Atlantic groupers (Pisces: Serranidae). *Bol. Mus. Mun. Funchal.* 43:5-71.
- HOOD, P. B., AND R. A. SCHLIEDER. 1992. Age, growth, and reproduction of gag, *Mycteroperca microlepis* (Pisces: Serranidae), in the eastern Gulf of Mexico. *Bull. Mar. Sci.* 51:337-352.
- JOHNSON, G. D. 1983. *Niphon spinosus*: a primitive epinepheline serranid, with comments on the monophyly and intrarelationships of the Serranidae. *Copeia* 1983:777-787.
- RANDALL, J. E., AND P. C. HEEMSTRA. 1991. Revision of Indo-Pacific groupers (Perciformes: Serranidae: Epinephelinae), with descriptions of five new species. *Indo-Pacific Fishes*, 20:1-296.
- SADOVY, Y., M. FIGUEROLA, AND A. ROMAN. 1992. Age and growth of red hind *Epinephelus guttatus* in Puerto Rico and St. Thomas. *Fish. Bull., U.S.* 20: 516-528.
- SMITH, C. L. 1971. A revision of the American groupers: *Epinephelus* and allied genera. *Bull. Am. Mus. Nat. Hist.* 146:1-241.
- SMITH-VANIZ, W. F., G. D. JOHNSON, AND J. E. RANDALL. 1989. Redescription of *Gracila albomarginata* (Fowler and Bean) and *Cephalopholis poleni* (Bleeker) with comments on the generic limits of selected Indo-Pacific groupers (Pisces: Serranidae: Epinephelinae). *Proc. Acad. Nat. Sci. Philadelphia* 140:1-23.
- CAROLE C. BALDWIN AND G. DAVID JOHNSON, *Division of Fishes, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.*

03771-8 (hardcover) and 0-412-03781-5 (softcover), 511 p., \$89.95 (hardcover) and \$37.50 (softcover).—The preface of this book succinctly sums up its purpose: it is a treatise in “molecular natural history and evolution” and it is written for “the advanced undergraduate or graduate student, or for scientists in fields such as ecology, genetics, ethology, molecular biology, population biology, and conservation biology who may wish a readable introduction or refresher to the burgeoning application of molecular markers to problems in their disciplines.” The author is unabashedly enthralled with the subject matter, and the book is a spectacular success in revealing the breadth and diversity of questions in organismal biology that can be profitably explored with an expanding molecular “tool kit.”

The text consists of nine chapters presented in two parts. Part I (Background) contains four chapters, including the Introduction, History of Molecular Phylogenetics, Molecular Tools, and Interpretive Tools. Part II (Applications) includes five chapters on Individuality and Parity, Kinship and Intraspecific Phylogeny, Speciation and Hybridization, Species Phylogenies and Macroevolution, and Conservation Genetics. The text is written in a single-column format, with specialized topics (mathematical algorithms, for example) set apart in boxes. Illustrations are appropriate and of uniformly high quality. The book contains both a general index and an index to taxonomic names, and the 101 pages of Literature Cited contain, by my count, 1984 references published through 1993!

The Introduction describes the many reciprocal benefits resulting from the merger of molecular biology with ethology, field ecology, comparative morphology, systematics, paleontology, and conservation biology. This is the major focus of the book, and the author emphasizes the genealogical continuum from micro- to macroevolution and summarizes the advantages and disadvantages of using molecular markers for this continuum of genealogical questions. The two major disadvantages to the use of molecular markers are technical training and costs, both of which are nontrivial for some methods.

Chapter 2 begins with a review of the classical versus balance debate on the evolutionary significance of genetic variability and how the nature of the issue shifted with the input of molecular data in 1966. The discussion continues today without resolution as the neutralist/selectionist controversy. There is also a brief review of the phenetic/cladistics philosophies, and

Box 2.5 (p. 42) provides a very informative chronology of the development and deployment of new molecular methods.

Chapters 3 and 4 together present a thorough overview of both contemporary molecular tools and commonly used methods of analysis and interpretation of the raw data generated by these methods. Technologies are divided into protein (immunology and isozyme electrophoresis) and DNA assays. DNA methods are further subdivided into three major categories of techniques, including DNA-DNA hybridization, restriction enzyme analysis [and its application to animal mitochondrial (mt)DNA, plant mtDNA and chloroplast (cp)DNA, single-copy nuclear (scn)DNA, ribosomal RNA genes and other middle-repetitive gene families, minisatellite sequences, DNA fingerprints], and PCR/DNA amplification sequencing protocols. Each of these is described with respect to the basic principles, procedures, and type of data collected. Techniques are considered further according to whether they produce discrete character or distance data and whether the data represent a single gene or linkage group, versus multiple gene loci. All methods are then summarized according to the hierarchical level for which they are most appropriate [from identification of individuals in populations to "deep history" phylogenetic events (splits  $> 50 \times 10^6$  years)]. Molecular clocks and methods of phylogenetic inference are also briefly discussed, and readers not familiar with the "gene vs species trees" issue will find a very readable summary of this important concept (p. 126–138). These two chapters collectively update much of the material presented in the Hillis-Moritz (1990) volume but without the detailed information needed to actually implement the methods.

The second part of the book summarizes a wealth of information on a large array of different applications of various molecular methods at all hierarchical levels of divergence. Among other things, readers will find examples of the use of molecular methods to address questions in human forensics, the units of selection in clonal organisms, parentage and multiple paternity, kinship in cohorts of highly social organisms, gene flow and population structure, intraspecific phylogeography, nonneutrality and the possible influence of selection on some molecular markers, determination of species boundaries, and hybrid zone dynamics and speciation. At higher levels of divergence, the use of supraspecific phylogenetic hypotheses for studies in character evolution, adaptation, and historical biogeography, and the deep structure

of the history of life, are reviewed in some detail. The final chapter discusses the conservation implications of molecular data in both population genetic and phylogenetic contexts and in law enforcement.

With respect to organismal diversity, the book includes case studies of organisms ranging from bacteria to whales, but ASIH members will delight in the many examples taken from the ichthyological/herpetological literature. For example, various methods suitable for intraspecific questions demonstrate that juvenile cohorts of the highly social serranid fish *Anthias squamipinnis* represent random samples of progeny (from many matings) and are not close genetic relatives (p. 192), and individual toads (*Bufo americanus*) returning to breed at their natal ponds appear to avoid sib matings (p. 204). Many marine fishes with pelagic larvae show the expected open population structure characterized by geographic uniformity in allozyme or mtDNA haplotype frequencies over large areas, whereas those without pelagic larvae (*Acanthochromis polyacanthus*) show highly structured populations (p. 215–217). The value of molecular data in understanding the influence on population structure of long-distance migration and natal homing is vividly illustrated for American and European Eels (*Anguilla*) and sea turtles (*Chelonia*), and genealogical concordance in phylogeographic patterns is demonstrated for six species of freshwater fishes in the southeastern United States (p. 246). The *Ensatina eschscholtzii* complex of salamanders is described as a record case for the extent of genetic divergence prior to the completion of speciation, and plethodontid salamanders are used as a general showcase for the value of molecular markers in revealing cryptic species. A number of North American freshwater fishes are used as examples of the value of molecular studies in hybridizing populations (p. 280–297) and the origin of unisexual biotypes (p. 299). At the higher category level, the author reviews the coelacanth-lungfish-tetrapod question (p. 312–314) and summarizes vicariance biogeographic studies of anurans in western Australia, Pacific tropical marine-shore fishes, and Caribbean amphibians and reptiles (p. 323–324). In the last chapter, *Cyprinodon* is discussed at length in the context of conservation recommendations derived from studies of the partitioning of within- vs among-population genetic diversity.

I found very few weaknesses or omissions in the text; but because no one can be completely familiar with all of the topics addressed in this book, there are some. Among those obvious to me are the following. The summary of species

concepts and definitions (Box 7.1, p. 253) includes the "concordance principles" originally described by Avise and Ball (1990), which attempt to incorporate the strengths of both the biological and phylogenetic species concepts. This point could have been strengthened by inclusion of Kluge's (1990) discussion of the same issue from a different philosophical perspective. The important point about reproductive isolation is that it is the only process that guarantees the historical individuality of a species for an indeterminate future; and the expected outcome of such a process will be the accumulation of independently derived characters that are "stopped" at the same boundaries (by lack of gene flow) and will, therefore, be concordant in their taxonomic distributions.

On pages 267–269, the author reviews the interesting question of a correlation between speciation rates and divergence rates, based on the "rectangular" model developed by Avise and Ayala (1975). This model is a neontological genetic extension of the original punctuated equilibrium model proposed by Eldridge and Gould (1972) to explain gaps in the fossil record. Various critiques and revisions are considered (Mayden, 1986), and a single recent study is cited that failed to corroborate predictions of rectangular (= punctuated) change (Lemen and Freeman, 1989). However, the only available character-based parsimony analysis [the Mindell et al. (1989) study of sceloporine lizards], which attempted to incorporate the concerns raised by Mayden (1986) and gave results consistent with rectangular predictions, was omitted. This paper generated further discussion (Sanderson, 1990; Mindell et al., 1990), and the entire issue remains poorly studied and unresolved from a neontological/molecular perspective.

On page 308, the author considers the utility of phylogenies for the study of evolution of specific characters and/or to test adaptational hypotheses by mapping traits onto trees (Coddington, 1988) and suggests that "the phylogeny of the cladogram itself must be estimated using data that are different from and independent of the attributes to be mapped." This is a widely cited narrative (Brooks and McLennan, 1991) that has intuitive appeal based on the avoidance of circularity, but the issue is more complex and could have benefited from a consideration of alternative views (reviewed in Kluge and Wolf, 1993).

The book is remarkably free of spelling errors; but on page 194, line 14 in paragraph two, "that" should be "than," and on page 335, line 12 in the first paragraph, "medussa" should have

only one s. Finally, on page 386, in line 2 of the second paragraph, tuataras are emphatically not "impressive lizards" (Gauthier et al., 1988).

I point out these few omissions in the spirit of constructive review and with the utmost humility; Avise is one of the few people capable of pulling together such a wide array of information and distilling it into an extremely enjoyable and readable book. Indeed, his research program at the University of Georgia is responsible for some of the original contributions that stimulated several research topics reviewed in this book. Perceptive students will discover an abundance of exciting research ideas; seasoned practitioners will be reminded of the depth to which an array of ecological and evolutionary questions can be probed with appropriate molecular methods; and conservation biologists will gain a realistic grasp of what molecular markers can and cannot provide for practical management issues. I think the book fulfills the objectives of its author, overlaps very little with other molecular evolution or methods books currently available, and is a must read for serious students of any aspect of evolutionary genetics and organismal biology.

#### LITERATURE CITED

- AVISE, J. C., AND F. J. AYALA. 1975. Genetic change and rates of cladogenesis. *Genetics* 81:757–773.
- , AND R. M. BALL, JR. 1990. Principles of genealogical concordance in species concepts and biological taxonomy. *Oxford Surv. Evol. Biol.* 7:45–67.
- BROOKS, D. R., AND D. A. McLENNAN. 1991. Phylogeny, ecology, and behavior. Univ. of Chicago Press, Chicago, Illinois.
- CODDINGTON, J. A. 1988. Cladistic tests of adaptational hypotheses. *Cladistics* 4:3–22.
- ELDRIDGE, N., AND S. J. GOULD. 1972. Punctuated equilibrium: an alternative to phyletic gradualism, p. 82–115. *In: Models in paleobiology*. T. J. M. Schopf (ed.). W. H. Freeman, San Francisco, California.
- GAUTHIER, J., A. G. KLUGE, AND T. ROWE. 1988. Amniote phylogeny and the importance of fossils. *Cladistics* 4:105–209.
- HILLIS, D. M., AND C. MORITZ (eds.). 1990. Molecular systematics. Sinauer Associates, Inc., Sunderland, Massachusetts.
- KLUGE, A. G. 1990. Species as historical individuals. *Biol. Phil.* 5:417–431.
- , AND A. J. WOLF. 1993. Cladistics: what's in a word? *Cladistics* 9:183–199.
- LEMEN, C. A., AND P. W. FREEMAN. 1989. Testing macroevolutionary hypotheses with cladistic analysis: evidence against rectangular evolution. *Evolution* 43:1538–1554.
- MAYDEN, R. M. 1986. Speciose and depauperate phy-

lads and tests of punctuated and gradual evolution: fact or artifact? *Syst. Zool.* 35:147-152.

MINDELL, D. P., J. W. SITES, JR., AND D. GRAUR. 1989. Speciation evolution: a cladistic test with allozymes and *Sceloporus* (Class: Reptilia). *Cladistics* 5:1-13.

\_\_\_\_\_, \_\_\_\_\_, AND \_\_\_\_\_. 1990. Assessing the relationship between speciation and evolutionary change. *Ibid.* 6:393-398.

SANDERSON, M. J. 1990. Estimating rates of speciation and evolution: a bias due to homoplasy. *Ibid.* 6:387-391.

JACK W. SITES, JR., *Department of Zoology, Brigham Young University, Provo, Utah 84602.*

KEEPING ALL THE PIECES. PERSPECTIVES ON NATURAL HISTORY AND THE ENVIRONMENT. W. Gibbons. 1993. Smithsonian Institution Press, Washington, D.C. 182 p., \$16.95 (softcover).—To most herpetologists, W. Gibbons is perhaps best known for his long-term research on the biology of amphibians and reptiles on South Carolina's Savannah River Site, particularly the turtles. Anyone familiar with his earlier book *Their Blood Runs Cold* (Gibbons, 1983) also knows him as an outstanding storyteller, particularly when it comes to alligators climbing through the window of a pickup truck. What many people outside the southeast do not know, however, is that Gibbons has been writing natural history columns for the *Aiken Standard* and *Tuscaloosa News* for some time; occasionally his columns have found their way even to distant Gainesville, Florida. Many of these columns as well as other natural history essays are reprinted in *Keeping All the Pieces* for others to enjoy.

*Keeping All the Pieces* is not a serious polemic on the need to conserve biodiversity, although the message is quite clear throughout the book. Instead, it is a personal account of animals, plants, and ecosystems, particularly in the southeastern United States, that have attracted Gibbons' fascination through the years. Harking back to A. Leopold's dictum on intelligent tinkering, the essays are derived from Gibbons' concern for environmental systems, brought about perhaps by a long association with real animals and plants in real ecosystems. Within the personal essays, he sometimes brings up difficult topics in such an easy manner that it is easy to forget the seriousness of the subject. Should snapping turtles (or other animals) be commercially harvested only if it is shown in

advance that they can sustain harvesting? Should prospective employees consider the social and environmental consequences of working for employers? What are the effects of natural disasters such as droughts and hurricanes on species already stressed by human activity?

The book is divided into four sections (Natural Complexity, Endangered and Threatened Species, Search for Environmental Culprits, Curbing Environmental Destruction) with from five to seven essays per section. Most essays are rather short, perhaps in recognition of a newspaper's word restrictions. Sometimes shortening an essay is unfortunate since it necessitates simplifying rather complex issues or makes it sound as though there is widespread agreement about controversial approaches. For example, the conservation and management of the Florida panther has provoked considerable controversy, heated debate, and lawsuits (Alvarez, 1993); and it is probably inaccurate to imply that all individuals, organizations, or agencies have acted solely out of benign concern for the species. Despite Gibbons' optimism, it is unlikely that attitudes toward land use regulations will change in the foreseeable future, certainly not in time to help the panther. One might also question Gibbons' unbridled praise of a federal wildlife agency (p. 65) often criticized for its inability or unwillingness to cope with changing environmental concerns and priorities.

Except for the sugar-coated and overly optimistic last chapter, Gibbons brings his literary skills to full force as he describes a multitude of topics, from looking for rattlesnakes in Arizona to the inability of "half-way" technology to solve complicated problems, from alligators and ice to Antarctic fish-amphipod-pteropod relationships, from Reelfoot Lake to the need to control human population. It is here, particularly, that he pulls no punches, noting that "natural laws are not influenced by even the most eloquent justifications" and that "they will not be swayed by political rhetoric or emotional arguments or apologies." Human population must be controlled to prevent environmental collapse. This is not the message that Gibbons' native Bible Belt residents, or inhabitants of many other parts of the world for that matter, and politicians want to hear.

I enjoyed reading the essays, although I was left at times wondering who the intended audience was. The essays are sometimes thought provoking and always entertaining, but they are not for an audience attuned to S. J. Gould's level of sophistication. Entwining conservation messages within tales of natural history is an effective method to interest the general public in the