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LOOKING AT LICHENS

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Fishes of the Gulf of Maine for the 21st Century: A Look at the New Bigelow and Schroeder

Bigelow and Schroeder's Fishes of the Gulf of Maine. 3rd ed. Bruce B. Collette and Grace Klein-MacPhee, eds. Smithsonian Institution Press, Washington, DC, 2002. 748 pp., illus. $75.00 (ISBN 1560989513 cloth).

Every fish biologist worth his or her salt has a copy somewhere of Bigelow and Schroeder's *Fishes of the Gulf of Maine* (1953). This reference book has been so useful for the last half-century that it is often still found in wheelhouses of many a fishing trawler and in almost every fish biologist's bag, both aboard ship and back on land. But much has changed for the fishes and fisheries of the Gulf of Maine since Bigelow and Schroeder's 1953 edition was published. Among other changes, there have been new classifications of species (e.g., the striped bass is now classified as *Morone* instead of *Roccus),* dramatic changes in fish composition and abundance as a result of intensive fishing by foreign and domestic fleets along the northeastern coast of the United States, and discoveries of several new species. Moreover, new management in the form of the Magnuson Fishery Conservation and Management Act of 1976 (later amended in 1996 and renamed the Magnuson–Stevens Fishery Conservation and Management Act) has altered the nature of fisheries in the Gulf of Maine since the 1970s. Sadly, at least for those of us who have considered Bigelow and Schroeder a good friend, the book has become dated.

The third edition of *Fishes of the Gulf of Maine* was revised by 38 authors under the editorship of Bruce B. Collette and Grace Klein-MacPhee. Collette is a senior scientist at the National Marine Fisheries Service's National Systematics Laboratory in Washington, DC, and an internationally known expert in fish systematics, specifically of mackerels and tunas. Grace Klein-MacPhee is a longtime research scientist at the University of Rhode Island's Graduate School of Oceanography and an expert in fish life-history studies, specifically of flatfishes. The third edition of *Fishes of the Gulf of Maine* was about 20 years in the making and will be gratefully received by the entire fish community.

The first edition, by Henry B. Bigelow (professor at the Museum of Comparative Zoology [MCZ] at Harvard University and the first director of the Woods Hole Oceanographic Institution) and William W. Welsh, was published in 1925 and was based on field work conducted in the first part of the 20th century with colleagues from NOAA's (National Oceanic and Atmospheric Administration) Bureau of Fisheries and MCZ. This edition was later revised by Bigelow and William C. Schroeder and issued in its second edition in 1953. In the third edition, Collette and Klein-MacPhee have been loyal to the primary goal of the editions that preceded it, which was "to provide a handbook for easy identification of fishes that occur in the Gulf of Maine, with summaries of what is known of the distribution, relative abundance, and more significant facts in the life history of each."

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The Gulf of Maine is one of the best ichthyologically studied areas in the world. Collette and Klein-MacPhee have added 10 families and 33 species to the new edition, including 9 new species not previously described, reaching a grand total of 118 families and 252 fish species. To maintain continuity with Bigelow and Schroeder (1953), Collette and Klein-MacPhee used the same 150-fathom (about 275-meter) contour line as the arbitrary offshore boundary for including all species likely to be caught within the Gulf of Maine and excluded most of the deep-sea fishes in the Atlantic outside the Gulf of Maine. For those of us who are reluctantly having to put aside the old, often salt-stained and scale-covered copies of Bigelow and Schroeder for Collette and Klein-MacPhee's edition, the transition is made less painful with references in the new edition to pages in the 1953 edition where the same species are described. In total, the new volume cites more than 3800 references (about 36 references per page) and represents a major scientific achievement in concisely summarizing an enormous body of work in fish biology over the last 100 years.

Adding to descriptions of individual fish species, Collette and Klein-MacPhee include data and descriptions obtained from the Northeast Fisheries Science Center (NEFSC) that are based on the descriptions and identifications by the eight regional fisheries management councils of essential fish habitat and distribution data from the MARMAP (Marine Resources Monitoring, Assessment, and Prediction) program. Collectively, this has resulted in the most comprehensive and cohesive database for establishing and describing the sections on habits, distribution, food, predators, and breeding for each species managed by the New England and Mid-Atlantic Fishery Management Councils. With the dramatic changes in abundance and distribution of fisheries since the 1950s and the enormous database provided by two generations of naturalists, ichthyologists, fishery biologists, and fishers, in addition to the extensive monitoring programs, Collette and Klein-MacPhee had a challenging job to organize and present the information while still being loyal to the format of the original 1953 book. It is in the descriptive accounting and management of this enormous and diverse database that Collette and Klein-MacPhee's organization, presentation, and summarization have triumphed over other references in the field and will make this edition the standard for the next 50 years.

In Collette and Klein-MacPhee's *Fishes of the Gulf of Maine,* there are clear demarcations among sections for each species. Still included are sections on each species' general morphological features: meristics, color, size, distinctions (where characters are given to differentiate the species in question from other Gulf of Maine fishes), habits (including depth range, bottom type, and temperature and salinity preferences), food, predators, and parasites. Further biological information is separately described under the subheadings of reproduction (which includes breeding habits, fecundity, early life history, eggs, and larvae), age and growth, general range, and occurrence in the Gulf of Maine (this

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section provides detailed information on local occurrences and is supplemented by beautiful distribution maps in the appendix for 38 species, based on the extensive bottom-trawling data of NEFSC). The last section for each species is "Importance to the Commercial Fishery." This is divided into two subsections: one with graphs of commercial landings and an index of abundance for 30 of the most important commercial species and, where appropriate, one reflecting the extensive changes in the last 50 years of resource management.

Among all this praise for the Collette and Klein-MacPhee edition, there is only one real disappointment: in the entire 700-plus pages of this impressive work, there was no room for pictures of the early life-history stages, as there was in the 1953 edition. Perhaps these earlier stages deserve a book to themselves? In all fairness, however, the written descriptions of early life-history stages are much more detailed than before, aided in no small part by the explosion in fish early life-history literature over the last couple of decades, which Collette and Klein-MacPhee adequately reference.

Perhaps Allen Peterson says it best in the foreword to this third edition of Bigelow and Schroeder's *Fishes of the Gulf of Maine* when he writes that he hopes it will become as well known and as widely used as the 1953 edition and will one day perhaps be known as "Collette and Klein-MacPhee." I am sure that Bigelow and Schroeder would approve.

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A MORE COLORFUL *INVERTEBRATES* TEXT

Invertebrates. 2nd ed. Richard C. Brusca and Gary J. Brusca. Sinauer Associates, Sunderland, MA, 2003. 936 pp., illus. $109.95 cloth (ISBN 0878930973).

Richard C. Brusca (director of conservation and research at the Arizona–Sonora Desert Museum and widely recognized invertebrate zoologist and isopod crustacean specialist) and Gary J. Brusca (professor at Humboldt State University from 1967 to 1998 and amphipod crustacean specialist) have published a substantial update to their 1990 *Invertebrates* text. Like its predecessor, this book is intended to support the lecture component of a one- or two-semester upper-division college course in invertebrate zoology. It is dedicated by Richard to his late brother Gary, who died in 2000. This book clearly reflects the two brothers' extraordinary collective efforts to update their already comprehensive coverage of invertebrate animals and Protista.

The striking image of a swimming medusa *(Pelagia)* on the new cover was my first clue to the pleasant surprise I got when I started exploring all the beautiful and informative illustrations, including many in full color, a contrast to the strictly black and buff illustrations in the former edition. These new illustrations are bound to please both instructors and students. An excerpt from the substantially revised chapter on Protista has been made available for downloading by the publisher in PDF format *(www.sinauer.com/brusca)*. I recommend that those familiar with the first edition download this chapter to see just how spectacular the illustrations are throughout this new edition. Another change is that the illustration sources and credits have now been moved to the rear, more directly conveying pertinent information to students yet also somewhat diminishing the appreciation of ongoing research for a student pondering a classic account of natural history.

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This new edition is 14 pages longer than the 1990 edition but slightly less massive because of its thinner, shiny white paper stock and slightly smaller font size. My side-by-side comparisons of old and new editions revealed that some outdated paragraphs or sections had been appropriately dropped, while other snippets of text reflecting updates had been inserted. Many problems with the first edition have been corrected. The references at the end of each chapter are somewhat updated, preserving most of the older citations. Like the former edition, this is hardly a text an instructor can expect students to read from cover to cover. Two recent invertebrate zoology texts (one by Janet Moore, *An Introduction to the Invertebrates,* and one edited by D. T. Anderson, *Invertebrate Zoology;* see *http://biology.fullerton.edu/biol461/texts.html)* are shorter and more affordable for students. On the other hand, I have found that most students prefer having a more encyclopedic reference when questions arise in the laboratory.

The approach taken in this edition of *Invertebrates* is very similar to that of the 1990 edition. The Bruscas have once again emphasized functional morphology and phylogeny as organizing principles. The introductory four chapters remain one of the best available overviews of the unifying principles of comparative zoology. These chapters are concise and general enough that they can serve as required reading assignments early in the semester, presenting the students with an excellent overview of, especially, functional morphology and development.

The overview of classification, systematics, and phylogeny (chapter 2) is somewhat less successful and is dense in places. One addition is a section entitled "The Bauplan and Related Concepts" (box 3A, p. 42). The Bruscas relate the notion of *bauplan* (from a German term meaning more precisely "blueprint" than "ground plan") directly to Richard Owen's 1848 essentialist concept of archetype, but they attempt to place it in a more evolutionary perspective. The expanded treatment is welcome, given how much this concept is featured in both editions. This is also one of the few places where new concepts and advances in "evo-devo" (the emerging field emphasizing comparative evolution and development from a molecular perspective) are discussed. Following Stephen Jay Gould and others, the Bruscas view the bauplan as related to developmental canalization, the notion that populations of organisms are constrained in how they might evolve by the conserved nature of their genetic tool kit controlling pattern formation. The connection between old hypotheses about bauplan and new understanding of pattern formation is interesting and relevant, but bauplan notions still reek of essentialism to me. Why not just point out that there are some very conservative characters in nearly every animal group? Bauplan reconstruction is also notoriously dependent on phylogenetic estimates, and there are generally more current alternatives than the phylogenetic views presented in this text (see the discussion of phylogenetic analyses of metazoans below). Even if the phylogeny were certain, there are invariably ambiguities associated with estimating ancestral character states for any particular taxon.

The first edition was one of an unlikely spate of excellent and generally encyclopedic invertebrate zoology texts published in the early 1990s, with other notable texts by Ruppert and Barnes, Pearse and Buchsbaum, Kozloff, Pechenik, and Meglitsch and Schram. Enrollments in invertebrate zoology courses were dwindling nationwide, and some of us wondered how the seemingly limited market could sustain this wealth of marvelous new texts. Then came the still ongoing molecular systematics boom, evo-devo became a vibrant emerging field, and bizarre animals from the Burgess Shale made it to the cover of *Time* magazine. In this decade, invertebrate zoology instructors are struggling to present newly emerging cross-disciplinary views and approaches, many involving phylogenetic considerations, yet current textbooks are all outdated. While most courses seem to be retaining a group-by-group style of presentation,

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there is now a tremendous opportunity to capture the excitement of emerging phylogeny-based comparative approaches within invertebrate zoology courses.

Despite its emphasis on phylogeny, Brusca and Brusca's new edition harkens back to 1990 not only in its dated phylogenetic hypothesis but also in its omission of many recent landmark studies, especially those from a molecular perspective. I found its updates in this area uneven, often reflecting the authors' skepticism toward newer results. Not surprisingly, given the crustacean expertise of the Bruscas, the arthropod chapters appear to be the most thoroughly revised, and the authors even suggest there is now molecular evidence supporting a clade of hexapods and crustaceans. As in the first edition, major groups such as Mollusca have not received as much attention. Recent alternative proposals of higher-level animal relationships, such as the growing evidence for the monophyly of Lophotrochozoa and Ecdysozoa groupings; sister taxon relationships within Deuterostomia (e.g., Echinodermata and Hemichordata); the proposed basal position of acoelomorph flatworms with Bilateria, apart from other flatworms; and the potential paraphyly of sponges are all examples of widely accepted new views that are almost completely ignored. The chapter on Protista unfortunately has no broad phylogenetic overview of where the covered taxa are found within eukaryotes. The evidence that choanoflagellates are the likely sister taxon of multicellular animals is obscure, at best, and there is no mention that metazoans and choanoflagellates are now considered part of Opisthokonta—a clade that also includes the recently characterized mesomycetozoeans (unicellular parasites of various fish, birds, mammals, and snails, also known as ichthyosporeans) and fungi, neither of which are mentioned.

The eclectic presentation of phylogenetic analysis and classification in the first edition is only slightly updated. The advertisements for this edition claim this text now incorporates "new developments in phylogenetics, developmental biology, and molecular genetics," but the Bruscas' text is more useful as a reference source than as a current overview of animal phylogeny.

This edition at least does have a character matrix (appendix B) in support of the authors' summary cladogram of animal relationships. Unfortunately, the matrix appears to be mostly a compilation of the authors' previously featured node-by-node listings of diagnostic features rather than a less tree-dependent attempt to score morphological variation. There is suspiciously little homoplasy indicated across any of the trees, and the authors still often assert an assumed polarity of character evolution or argue that particular characters are convergent when they conflict with their favored hypothesis. Thus, it is not surprising that Brusca and Brusca's new summary tree is effectively the same in topology as the corresponding one in the first edition, one that is at odds with many aspects of other current phylogenetic estimates of metazoans based on either morphology or molecules or a combination of these data types. Still, as a teaching device, the presence of a matrix and added explanation of the methods used to generate the tree figure is clearly a step in the right direction.

Despite the quirks I have noted, the book has worthwhile views to offer that are lacking in most competing texts.

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LOOKING AT LICHENS

Lichens of North America. Irwin M. Brodo, Sylvia Duran Sharnoff, and Stephen Sharnoff. Foreword by Peter Raven. Yale University Press, New Haven, CT, with the Canadian Museum of Nature. 2001. 828 pp., illus. $75.00 (ISBN 0300082495 cloth).

This gorgeously illustrated tome is a comprehensive guide to the world's genera of the larger and smaller lichens, in spite of the "North America" in its name. The cosmopolitan nature of lichen cover and the transcendent beauty of the plates make the book of profound interest to field naturalists, botanists, symbiosis biologists, and hobbyists far beyond the borders of Canada, Mexico, and the United States. What is missing are not the major common lichen genera of Antarctica, Asia, Europe, and South America but descriptions of the smaller, less conspicuous lichens found in all landscapes.

The lichen body (crustose, foliose, or fruticose), the nature of its reproduction (sexual or not), its propagules (asci, blastidia, isidia, schizidia, or soredia) and their dispersal, and its unique chemistry (over 600 compounds—many limited to lichens—which include depsides, depsidones, anthraquinones, and pulvinic acid derivatives) are explained such that the concepts of these lichenologists are made clear to scientists and teachers who are not specialists in the field. The readers are provided tools and range maps to identify more than 800 species. The glossary and other explanations—for example, of lichen coloration (chapter 4), physiology (chapter 5), and substrates (the rocks, barks, shells, live insect carapaces, and other materials upon which lichens grow; chapter 7)—are splendid. The ecology of lichens, productive pioneers that dominate the photic zone in rocky coastal ecosystems and complement the productivity of forest habitats, is well demonstrated (chapter 8). The ways that lichens relate to people—as food and fodder, as sources of dye, as indicators of pollution, as medicine, or even as poison

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(chapter 10)—are all nicely explained. In chapters 12 through 15, the book provides collection and study techniques, advice on names, and other practical information. The keys to the genera present a clear and comprehensive guide for all who desire a better understanding of these beautiful, enigmatic organisms.

The only obvious deficiency of this book, which prevents it from representing the worldwide diversity in lichens for readers at any level, is its failure to include the smallest and most difficult to identify and analyze "microlichens": for example, *Bactrospora, Biatoridium, Chiodecton, Cresponea, Epigloea, Julella, Leptorhaphis, Mobergia, Mycoporum, Protothelenella, Sclerophyton, Tomasellia,* and *Topelia.* The only North American publication that properly includes the tiny lichens is *Lichen Flora of the Greater Sonoran Desert Region* (2002), the comprehensive work in progress by the team led by Thomas H. Nash III. Only the first volume of the three-volume series has been published; the next two volumes are planned by 2005. Unfortunately, although it is up-to-date, entirely authoritative, and readable, the great work of the Nash group contains few illustrations, none of which are in color. This state of the literature of lichenology makes more precious the unique, truly wonderful book by Brodo and the Sharnoffs.

The old insult of "Schwendenerist" could justifiably be slung at this entire 828-page masterpiece, with more than 1700 beautiful photographs, drawings, and text. What can we possibly mean by "Schwendenerist"? In 1869, Simon Schwendener, the Swiss botanist of Basel, wrote his treatise on lichens and opened himself to ridicule and ignominy. Schwendener's theory that lichens are composite and complex organisms was rejected by the scientific community, and a misunderstanding of lichens as simple plants has persisted in many corners even until today. However, the great Russian plant physiologist A. S. Famintzyn, in his 1870 review, admitted that "Schwendener's discovery that lichens appear to be constructions of fungi and algae constitutes his merit" (Khakhina 1992). By 1937, Russian botanist K. A. Timiryazev defended Schwendener's conclusion, and by now all knowledgeable scientists agree: Lichens are not plants. Rather, they are individualized symbiotic composites of photobionts (oxygenic photoautotrophs, such as cyanobacteria or green algae) that are morphologically and metabolically integrated with mycobionts (heterotrophic fungi, usually ascomycota). Timiryazev wrote, "Some botanists still cannot wake from the impression evoked by this startling discovery and prefer to close their eyes to the obvious. If I am not mistaken, this curious subject has hardly been mentioned in our popular literature; nevertheless, it must be considered one of the most striking and unexpected discoveries of biological science of the last quarter century" (Khakhina 1992, p. 23). Microbiology, fine structure analysis, biochemistry, and molecular biology unambiguously support the unappreciated Schwendener—lichens are not plants at all.

The work of Brodo and the Sharnoffs reminds us throughout that lichens are polyphyletic, that is, they evolved separately: "Every recognizable lichen is derived from a different species of lichenized fungus" (p. 94). This statement of independent evolution applies to all, or nearly all, of the 3600 North American species and perhaps to as many as 15,000 species worldwide; detailed data support this generalization. The thoughtful, elegant coverage of these ubiquitous fungal partnerships is remarkably reliable and complete. Only when the authors claim that lichens "cannot be placed within the hierarchical systems of biological classification [kingdom, phylum, class] because they are dual organisms and each of the components has its own classification" do we disagree. Lichens, of course, can be appropriately classified like any other organism. After all, visible organisms—plants, animals, protoctists, and fungi—are at least dual composites. Indeed, most evolved from triple, quadruple, and higher-order symbiotic associations (Margulis 1993). Individuality, in the

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world of the nucleated (eukaryotic, visible) organisms, is composite, complex, and multidimensional at genetic, morphological, developmental, physiological, and molecular biological levels. Lichens, therefore, exemplify the fundamental difference between bacterial (prokaryotic) and all other life and are named, as are almost all eukaryotes, for the most conspicuous member of the symbiotic consortium. In the case of lichens, this means that they are named for the mycobiont, the fungus, rather than the photobiont, the alga, or cyanobacterium.

Students of lichens tramp through deserts and rain forests. They slide on icy mountain slopes and stumble on the tangled shores of mountain lakes. They return to the laboratory with samples that, nearly invariably, require microscopic and other analyses. Is the phycobiont *Trebouxia? Pseudotrebouxia? Nephroselmis?* How are the asci or the pycnidia formed and distributed? Are crystals present? What are the colors and chemistry of the pigments? Although the toehold of lichens on bare exposed rock impresses every hiker, and their capacity for revival from severe desiccation amazes the observant nature lover, the lichenological vocabulary, and especially the microscopic descriptions, baffle any nonspecialist. Brodo and the Sharnoffs' work wonderfully makes amends as it allows us access to the weird world of a great orphaned taxon. That after a quarter of a century of dedicated labor Sylvia Duran Sharnoff failed to live to see the book published in all of its glory is truly tragic.

These valiant authors, flaunting their wealth of detail, illustrate fundamental biological principles worthy of Schwendener's legacy. But, we trust, their beautiful book will not suffer the fate of his. Polyphyly is more apparent in lichens than in other symbiotic associations. Lichens exemplify the details of complex individuality. The relations between syntrophic metabolism and morphogenesis in the emergence of novelty through physical association is made obvious in these colorful creatures, and so too the contribution of symbiogenesis to speciation and taxonomy in them is manifest.

We recommend this book, a gift of world-class scholarship to the scientific community, without reservation. Given its current artificially low price, we suggest that all libraries, private and public, with even a remote interest in natural history obtain it now.

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