by oxygen that diffuses from the air across the skin and into their bloodstreams.'' All anurans use cutaneous respiration and withdraw oxygen from whatever environment they occupy (Shoemaker et al., 1992). On page 27, we are told that the vocal sacs of male *Rhinoderma darwinii* are used for incubation of developing eggs; however, males pick up hatching larvae, not eggs (Crump, 2002; Busse, 2003). The same mistake is repeated on page 66. The chapter on food and feeding is disappointing because the authors could have organized their functional morphological information around the various tongue structures in anurans and the fascinating ways in which these tongues work—i.e., salamander-like tongues of basal anurans, aquatic frogs with vestigial or completely attached tongues, the majority of neobatrachians with long tongues operating with a catapult mechanism, and specialists that protrude their tongues with a hydrostatic mechanism (e.g., *Hemisus, Rhinophrynus,* and microhylids). The authors attribute ''maxillary'' teeth to anurans, but overlook the teeth on the premaxillae and vomers, and do not mention modifications such as fanglike teeth that are fused to the bones of the upper jaw in *Limnonectes*.

The aspect of this book that I find most puzzling is determining the audience for which it was intended—high school students, college-educated adults? The writing style is didactic, revealing neither the authors' passions for these organisms nor their enthusiasm for their study. The questions are worded simplistically, yet many answers are laced with specialist terms such as *brumation, hydric brooding, paedomorphosis,* and *phylogeny*. In most cases the terms need not be used, and arguably, these are words that are unfamiliar to even the informed lay public, let alone middle- or high-school students. In the one instance that the authors should have used the appropriate word—Chapter 12 dealing with the science and scientists dealing with amphibians—the chapter is entitled ''Frogology.'' Why not ''Batrachology,'' or better, ''Herpetology?''

The reader seeking information on anuran ecology, behavior, and conservation will find this volume useful; those seeking information about form, function, and systematics are likely to be disappointed and in some cases misinformed. This is an example of a book that would have profited from a critical reading by herpetologists who specialize in areas complementary to those of the authors, and one that deserved more thorough and professional editing before it went to press.

## LITERATURE CITED

**Busse, K.** 2003. Fortpflanzungsbiologie von *Rhinoderma darwinii* (Anura, Rhinodermatidae) und die stammesgeschichtliche und funktionelle Verkettung der einzelnen Verhaltensabläufe. Bonner Zoologische Beiträge 51:3–34.

**Crump, M. L.** 2002. Natural history of Darwin's frog, *Rhinoderma darwinii*. Herpetological Natural History 9:21–30.

**Evans, S. E., and M. Borsuk-Białynicka**. 2009. The Early Triassic stem-frog *Czatkobatrachus* from Poland. Palaeontologia Polonica 65:79–105.

**Frost, D. R.** 2011. Amphibian Species of the World: an online reference. Version 5.5 (31 January 2011). Electronic Database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York.

**Frost, D. R., T. Grant, J. Faivovich J, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. de Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler**. 2006. The amphibian tree of life. Bulletin of the American Museum of Natural History 297:1–370.

**Roček, Z., and J.-C. Rage**. 2000. Tertiary Anura of Europe, Africa, Asia, North America, and Australia, p. 1332–1387. *In*: Amphibian Biology. Volume 4. Palaeontology. The Evolutionary History of Amphibians. H. Heatwole and R. L. Carroll (eds.). Surrey Beatty & Sons, Chipping Norton, New South Wales, Australia.

**Shoemaker, V. H., S. S. Hillman, S. D. Hillyard, D. C. Jackson, L. L. McClanahan, P. C. Withers, and M. L. Wygoda**. 1992. Exchange of water, ions, and respiratory gases in terrestrial amphibians, p. 125–150. *In*: Environmental Physiology of the Amphibians. M. E. Feder and W. W. Burggren (eds.). University of Chicago Press, Chicago.

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**An Empirical Synthetic Pattern Study of Gars (Lepisosteiformes) and Closely Related Species, Based Mostly on Skeletal Anatomy. The Resurrection of Holostei**. Lance Grande. 2010. American Society of Ichthyologists and Herpetologists Special Publication 6:i–x, 1–871; supplementary issue of *Copeia* 10 (2A). (hard cover).—In *Fishes of the Central United States,* Tomelleri and Eberle (1990) state, ''The family has a poor reputation among anglers, who believe gars would have been better suited as land dwellers had they been able to stand their own reflections in the water.'' Such has been the opinion about this long misunderstood group, the focus of Lance Grande's recent and much-anticipated monograph. Grande preemptively counters the negative connotation attributed to lepisosteids in his opening remarks stating, ''their primitive look is both a thing of aesthetic beauty and of scientific appeal.'' Whether the reader considers this ancient group of fishes creatures of beauty or nuisances, Grande brings to light vast amounts of new information about lepisosteiforms. In this empirical synthetic study he describes a new family, Obaichthyidae, thoroughly surveys extant and fossil species of gars, and provides evidence to resolve a long-standing discordance between morphological and molecular phylogenies with the resurrection of Holostei (Halecomorphi + Ginglymodi).

Using primarily skeletal anatomy of extant and fossil species, Grande demonstrates how traditional comparative biology can still be used to resolve important phylogenetic questions in the age of molecular phylogenies. In fact, Grande makes the strong case that it was a fossil group, the newly described obaichthyids, or ''spiny gars,'' that served as the missing link providing evidence of a strong phylogenetic relationship between bowfins and gars (Holostei).

The volume begins with an introduction to Lepisosteiformes and an overview of previous phylogenetic studies, including comparisons to the two classic phylogenies of lepisosteids by Suttkus (1963) and Wiley (1976). The study continues with a thorough systematic survey of all 21 recognized species in the order, comprising over 700 pages of the book. Two extant species, the Longnose Gar, *Lepisosteus osseus,* and Alligator Gar, *Atractosteus spatula*, serve as model species for the full skeletal analysis (covered in over 100 pages each), although all other lepisosteiforms are still investigated in greater detail (in terms of skeletal anatomy) than in any previous studies of the group. Over the course of this comprehensive survey, Grande describes nine new fossil species and a new genus within Lepisosteidae, *Cuneatus*. He also introduces the family Obaichthyidae, the spiny gars, comprised of four species in two genera, *Obaichthys* and *Dentilepisosteus*. All species are presented in numerous highly detailed combination plates, comprised of both photographs and complementary illustrations. The book contains over 180 tables and 1,800 figures, many of which are detailed color photographs. Among the many notable photographs is the catalog of holotype specimens and color images of living examples of all extant lepisosteids. Although not the primary focus of this work, several references are listed for the natural history and ecology of each species, further adding to the value of the book.

This publication is meant to be a companion to the earlier volume by Grande and Bemis (1998) on Amiiformes (bowfins), with the general format of tables, figures, and terminology remaining consistent for easy reference between volumes. Grande states that although he always intended on carrying out this study as a companion to the Amiiform volume, the end result, the resurrection of Holostei, was not anticipated. This work therefore serves as an excellent example of how an empirical synthetic study can yield unpredictable and phylogenetically informative results.

The book follows the detailed species accounts (which also include several outgroups for comparison, e.g., *Polypterus*) with a phylogeny of Lepisosteiformes. Grande concludes with sections on historical biogeography of Lepisosteiformes and thoughts on future directions for phylogenetic analysis of the group. The themes and concepts introduced in Grande and Bemis (1998) are further discussed and updated with comments on the newly resurrected Holostei. Grande's closing remarks stress the importance of periodically revisiting the ''classic groups of fishes'' (e.g., gars, bowfins, sturgeons), as technology for further phylogenetic study continues to improve and additional fossils are discovered. He notes that the current study uncovered a surprisingly large amount of new information on a group of fishes that have been known for over 250 years.

This book represents the most comprehensive survey of Lepisosteiformes to date, including several new insights regarding actinopterygian evolution. It is extremely well written and incredibly detailed. My minor criticisms of the book include the use of captive specimens for some photographs rather than wild specimens. Also, additional specimens for morphological analysis may have proven useful for species with wide or disjunct distributions, such as *Atractosteus tropicus* and *Lepisosteus oculatus*. These species in particular were represented by specimens from a more narrow distribution than seen in nature. However, despite these minor issues this volume must be seen as integral to any study of this ancient group of fishes. It is highly recommended to those with interests in actinopterygian evolution, skeletal anatomy, and comparative biology in general.

## LITERATURE CITED

**Grande, L., and W. E. Bemis**. 1998. A comprehensive phylogenetic study of amiid fishes (Amiidae) based on comparative skeletal anatomy. An empirical search for interconnected patterns of natural history. Society of Vertebrate Paleontology Memoir 4:i–x, 1–690; supplement to Journal of Vertebrate Paleontology.

**Suttkus, R. D.** 1963. Order Lepisostei. Fishes of the western North Atlantic, part 3. Memoir Sears Foundation of Marine Research 1:61–88.

**Tomelleri, J. R., and M. E. Eberle**. 1990. Fishes of the Central United States. University Press of Kansas, Lawrence.

**Wiley, E. O.** 1976. The phylogeny and biogeography of fossil and Recent gars (Actinopterygii: Lepisosteidae). University of Kansas Museum of Natural History Miscellaneous Publication 64:1–111.

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**Fish Karyotypes: A Checklist**. Ryoichi Arai. 2011. Springer. Tokyo. ISBN 978-4-431-53876-9. 340 p. (hard cover).—Paradigm shifts in the field of cytogenetics would make for a fascinating scientific history. The field remained in its infancy for nearly half a century during which time it was largely accepted that the number of human chromosomes was 48 (Painter, 1923). In part due to a slow rate of technological advances and some bad choices (chromosome numbers were counted from several Japanese subjects that had mutated cells because of exposure to atomic bomb radiation), the accurate diploid count of 46 was not discovered until 1956 (Tijo and Levan, 1956). Some authors argue that this discovery led to a Kuhnian paradigm shift (Kuhn, 1970; and see Unger and Blystone, 1996 for the cytogenetic arguments). Whatever the case, karyotype cytogenetics had its ups and downs in popularity and relevance over the years, moving from merely descriptive work to playing a role in testing evolutionary and biogeographic hypotheses (Carson, 1970, 1983). Which brings us to today and Arai's (2011) important contribution to fish cytogenetics. Within a few seconds of picking up the text you will realize that *Fish Karyotypes: A Checklist* is just that—a checklist of fish karyotypes. The vast majority of this book is made up of a huge table and references cited in that table. The value of this book to the reader depends on your level of interest in knowing the counts, classification, and quantitative morphology of fish chromosomes throughout fish lineages (from Myxini to your favorite advanced bony or cartilaginous clade). If nothing else, the table is exhaustive and the book is the most comprehensive review of fish karyotypes to date. So why is this information useful in this day and age? As we move from simply the molecular age of systematics to the genomic age, it will be extremely useful to know which taxa have what size genomes, and this book may play a key role in decisions about what taxa to sequence. Want to sequence the genome of a sarcopterygian? The smart way to spend your money is to go with a coelacanth over a lungfish because lungfishes have one of the largest vertebrate genomes while species of *Latimeria* have a more average size (and one that is 10- to 20-fold smaller than any dipnoan). In reading this book I was surprised to discover how much variation there is in genome size among closely related taxa. As next-generation sequencing helps us learn more about why that is, we can thank reference books like Arai's for making it easier to discover where to look for interesting genomic comparisons.

## LITERATURE CITED

**Carson, H. L.** 1970. Chromosomal tracers of evolution. Science 168:1414–1418.