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ANURAN COMMUNICATION. Michael J. Ryan (ed.). 2001. Smithsonian Institution Press, 750 9th Street, Northwest, Suite 4300, Washington, DC 20560-0950. ISBN 1-56098-973-4. 252 p. \$50.00 (hardcover).—This edited volume is derived from a symposium held at the 1998 joint ASIH/SSAR/HL meetings in honor of A. Stanley Rand. Rand, himself a contributor to two chapters in this book, has been instrumental in the study of anuran communication and tropical herpetology. He has introduced many to the study of tropical amphibians and reptiles, including, as noted in the book's preface, most of the contributors to the book. The book contains 17 chapters by 25 authors with a diversity of approaches to anuran communication. The book is divided into five parts: Introduction to Anuran Communication (Chapters 1–2), Physiology and Energetics (Chapters 3–6), Acoustic and Visual Signaling (Chapters 7–10), Neural Processing (Chapters 11–13), and Behavior and Evolution (Chapters 14–17). The grouping of chapters seems a bit forced at times, but the structure is unlikely to bother anyone other than a book reviewer.

The chapters represent a diversity of approaches, both in terms of the study of anuran communication and chapter content. Five chapters are broad reviews of some aspect of anuran communication. Wilzcynski and Chu (Chapter 3) review three neurochemical systems that have been linked to reproductive behavior and communication in frogs. Wells (Chapter 5) re-

views several aspects of the energetics of calling in frogs, including the influence of social interactions on the cost of calling, the morphological and biochemical correlates of calling performance, and the substrates that fuel calling. Gerhardt and Schwartz (Chapter 7) review the tuning of the auditory system and how well this corresponds to the behavioral preferences of females. Hödl and Amézquita (Chapter 10) review visual signals produced by anurans and provide a preliminary examination of the ecological correlates of visual signaling. Waldman (Chapter 15) discusses kin recognition in anurans, with emphasis on his work on inbreeding avoidance in American toads (*Bufo americanus*). Most of these review chapters offer new insights into the their respective subjects.

Six chapters focus primarily on the work of the author or authors. Narins (Chapter 6) describes experiments investigating the effect of temperature on the anuran auditory system of several species; this chapter bears the closest resemblance of any to a journal article. Ryan and Rand (Chapter 8) describe their research on the call characteristics of male túngara frogs (*Physalaemus pustulosus*) that influence recognition and discrimination by females. Brenowitz, Rose, and Adler (Chapter 11) review their work on plasticity in the calling behavior of the Pacific treefrog (*Pseudacris regilla*) and the neural processing underlying responses to pulse repetition rates. Kelley, Tobias, and Horng (Chapter 12) report on a variety of aspects of communication by *Xenopus laevis*, including the function of calling, the mechanism of vocal production, and sexual dimorphism in the auditory system. Giacoma and Castellano (Chapter 15) describe variation at several different levels (from within bout to among populations) in calling behavior of toads of the *Bufo viridis* complex. Márquez and Bosch (Chapter 16) review their studies on communication and mate choice in midwife toads (*Alytes obstetricans* and *Alytes cisternasii*). Despite a focus on their own work, all of these authors relate their work to broader questions concerning anuran communication.

Three chapters focus on methodological issues or approaches to the study of anuran communication. Littlejohn (Chapter 9) reviews how temporal properties of anuran acoustic signals can be described and how such properties vary within and between species. Phelps (Chapter 13) discusses the use of neural networks for understanding communication and his studies using neural networks to examine the influence of history on receiver biases. Schwartz (Chapter 14) describes how computers can be used to

create sophisticated experiments for understanding vocal interactions among males.

The three remaining chapters offer three additional styles. Emerson (Chapter 4) proposes a model (the Energetics-Hormone Vocalization Model) that links both interspecific and intraspecific variation in calling behavior to among-male variation in hormone levels. The two chapters in the Introduction are especially interesting. The first, by Mary Jane West-Eberhard, discusses the importance of taxon-centered research, that is, research focused on a group of organisms rather than a theoretical area. West-Eberhard's discussion of how to choose a study organism and study question should be of great interest to any doctoral student in the throes of deciding on a project. The second chapter, by Rand, traces the history of the study of anuran communication from 405 B.C. to 1980 from four perspectives: concepts and questions addressed, technological breakthroughs, important people and institutions, and academic disciplines that contributed to the study of anuran communication. True to his own history as a mentor of others, Rand points out numerous unanswered questions (yet another goldmine for doctoral students).

The diversity of approaches and styles reveals the strength of this volume: it provides a snapshot of the diversity of research currently aimed at unraveling anuran communication. One gains a sense of the types of questions being asked, the disciplines involved, the methodologies used, and the areas that await investigation. The book also provides readers an opportunity to see the connections between disciplines, questions, and approaches. In a few cases, the connections are made explicit, but for the most part, the chapters are meant to stand alone, and readers will have to forge their own connections. Luckily, this book provides ample raw material.

Although a substantial number of the chapters of this book are reviews, this book is not an introduction to anuran communication, nor is it a textbook on the subject. Most chapters require background knowledge of concepts or terminology. In general, the chapters are well-written, and the figures and tables are helpful, although a few figures were difficult to read or had incomplete legends. Each chapter contained its own list of references, which in most cases were quite extensive (averaging about 80 per chapter). This book is a must for anyone interested in anuran communication, especially for those interested in the current state of the discipline. It is a fitting tribute to Rand, bringing together, as Rand has done so well, different

authors with different approaches, methodologies, and viewpoints.

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