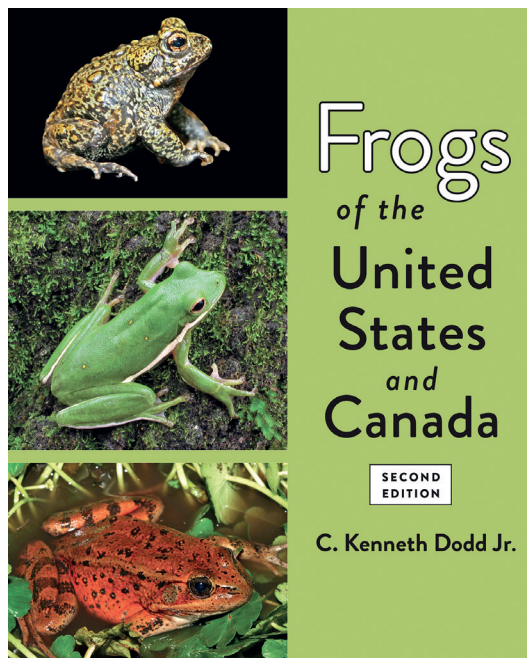


Dodd, C. K. Jr. 2023. **Frogs of the United States and Canada**. Second Edition. Johns Hopkins University Press, Baltimore, Maryland, USA (www.press.jhu.edu). xxxiv + 954 pp.

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The second edition of the award-winning *Frogs of the United States and Canada* is a remarkable compilation of thousands of research articles, books, agency reports, dissertations, and other sources that have been published on the frogs of these two countries. At almost a thousand pages, it remains the most complete work ever written about frogs from these two countries. This book is an essential starting place to gain a comprehensive understanding of the 106 frog species (and the eight introduced species) that occur north of the United States–Mexican border.

The 23-page introduction to the book is an excellent overview of nearly all aspects of the biology of frogs. It begins with a basic description of frog morphology, including line drawings that show the major characteristics of the basic frog body plan. Detailed drawings of the hind feet describe differences among frogs, toads, and hylids (treefrogs), as well as the keratinous spades used for digging by spadefoots (*Scaphiopus*, *Spea*). Other illustrations depict frogs in axillary amplexus and the common types of eggs (masses or clumps, surface films, and strings). A section on anuran evolution describes early evolution from the time that vertebrates left the water to more recent discoveries of morphological changes leading to modern frogs. Details of eggs and egg masses, skin and its functions, tadpole morphology, behavior, the use of pheromones, vocalizations, and habitats provide an overview of these amazing animals. A section on anuran conservation reviews amphibian declines and their possible causes, including diseases, habitat loss, especially wetlands, and the consequences of exposure to many pesticides and toxins produced by the ever-expanding human population.



A wonderful section in the introduction covers frogs as recurring subjects in human culture. Color photographs and illustrations include items from Dodd's collection as well as from various museums. The role of frogs in mythology of indigenous peoples is detailed, and several examples are given from Marty Crump's excellent book on this topic (Crump 2015). The number of examples of the use of frogs, toads, and tadpoles in all sorts of objects such as stamps, coins, jewelry, and as mascots for companies (i.e., Toad Hollow Vineyards) depict the various ways that different cultures have interacted with frogs. Three websites are given in this section for those interested in further information; however, I was unable to access two of them. The website given to access information about the relationship of frogs with the peoples of the Tlingit Nation in Alaska did not work, but I found relevant information by going to www.akherpsociety and following links therein, and also by going to Kiks.adi, a site given in the book. On the latter site, while not obvious, clicking on the black-and-white frog

totem photograph on this page leads to a site with colored photographs and the history and locations of other frog totems. The website listing the various uses of and stories about frogs in other indigenous cultures was also no longer extant, but searching for frog legends and mythology of individual tribes revealed numerous websites with extensive information on these topics.

The section “Measurements, Precision, and Generalizations” in the introduction will be useful for anyone conducting research on frogs. Dodd notes that his reading of thousands of research papers led to the realization that researchers have been imprecise in their use of terminology, often leading to confusion about various topics. For example, calling and breeding (oviposition) are different; male frogs of a particular species may call for months, but oviposition may occur only sporadically or infrequently. Breeding season may be assumed to occur continuously if calls are heard in different seasons, when in fact, some species at the same locality have distinct breeding periods in different seasons (Caldwell 1986). Other concepts that can be confused include clutch size/fecundity and time to sexual maturity/larval duration. Dodd cautions researchers to be aware of imprecise terminology. Other misconceptions arise when generalizations made at one location are assumed to be the same as in populations in other regions. A host of variables may affect what populations of the same species do at different latitudes. The classic example is the American bullfrog, *Lithobates catesbeianus*, which has large tadpoles that take 2–3 years to metamorphose in northern latitudes but may only require one year to transform in southern localities.

Other sections in the introduction include one on etymology, which gives the derivation of the generic names of the 23 genera represented in the book. For those seeking additional reading or reference material, an extensive list of sources includes 25 books geared to specific topics related to frogs, such as amphibian declines,

conservation, habitat management, and tadpole identification and biology. Various internet sites, state atlases, some of which are online, and sources for frog calls are provided. Abbreviations used throughout the book are listed.

The major part of the book is composed of species accounts of the 106 native species and the eight introduced species in the United States and Canada. Each account typically includes 18 sections, in addition to other sections that are relevant to specific species. For example, a fascinating section on the commercial use of the American Bullfrog, *Lithobates catesbeianus*, explains how huge numbers of bullfrogs have been introduced all over the world for frog farming and the massive monetary incentives involved. Each section in the species accounts summarizes what is currently known about the topic and cites extensive relevant literature, in addition to pointing out areas where nothing is known about a particular topic. The sections in the accounts include the following:

Nomenclature: Recent molecular analyses have resulted in much debate and confusion about which generic names should be applied to various lineages and how phylogenetic lineages should be named. Generally, the book follows the online website *Amphibian Species of the World* maintained by the American Museum of Natural History. Common names for all species are given in English (Crother 2017), in French for species in Canada (Green 2012), and in Hawaiian for the introduced species in Hawai‘i (McKeown 1996). **Etymology:** In addition to the etymology of genera included in the introduction (see above), the etymology of specific names is included in the accounts. **Identification:** Dodd notes that the book is not intended to be a field guide (and at a weight of over 5 pounds, the book would not be suitable for carrying in a backpack). However, in addition to a key to the genera of the frogs in the U.S. and Canada provided in the introduction, the verbal descriptions, photographs, and range maps given in each species account can be relied on to identify adults of most species. As a further aid,

field guides and internet atlases are available for many states in the U.S. Dodd correctly points out that identification of tadpoles is an “art form,” so no attempt is made to describe them in detail, i.e., listing number of tooth rows or other characters of the oral disc, for example. The excellent tadpole photographs in each account, coupled with the range and season will aid in tadpole identification. Altig and McDiarmid (2015) have written a comprehensive handbook with keys to eggs and tadpoles of the United States and Canada. **Distribution:** Maps have been updated based on the primary literature and the latest field guides. Each account presents extensive references regarding distribution. **Fossil Record:** Although little information is available in general for most frog species, the known information is summarized. **Systematics and Geographic Variation:** Evolutionary relationships are given, typically including the clade or species group for each species. Differences among populations, hybridization, color morphs, and other relevant topics are covered. **Adult Habitat; Terrestrial and Aquatic Ecology; Breeding Sites or Oviposition Sites:** These sections describe what is known about the macroenvironment, microenvironment, and the characteristics of the breeding sites. Oviposition sites are described for species that deposit eggs on land. **Calling Activity and Mate Selection:** Aspects of calls, timing of arrival at breeding sites by males and females, reproductive success related to call rates and male size, and many other topics are covered in detail. **Reproduction:** Frog species differ widely in the timing and length of the breeding season, weather patterns that initiate breeding, clutch size, whether eggs are deposited as small packets, large masses, strings, etc., size at hatching, and many other aspects of reproduction. Dodd notes that detailed information is lacking on nearly all these variables for most species. Long-term natural history studies at multiple locations on all species are encouraged. **Larval Ecology:** Length of larval period, size at metamorphosis, the influence of food availability on growth, and

tadpole response to predators are addressed.

Diet: Information about both adult and tadpole diets is given. Diets of most adult frogs are composed of various invertebrates, especially insects, whereas most, but not all, tadpoles graze on algae and detritus. **Predation and Defense:**

An extensive literature on these topics shows that primary predators of many frogs are other vertebrates, especially birds and snakes, whereas eggs and tadpoles are typically preyed on by fish and aquatic invertebrates. A variety of escape behaviors are used by frogs, including diving or burrowing in mud, distasteful skin secretions, and defensive calls. Defense mechanisms used by tadpoles against predaceous fish or aquatic invertebrates include crypsis, timing of breeding, for example, during cold weather when fewer aquatic insects are active, noxious secretions, and formation of large schools. **Population Biology:** Research on aspects of population biology varies widely, from estimates of population size, whether individuals are annuals or long-lived, growth rates, timing of sexual maturity, and sex ratios. **Community Ecology:**

Competition among species, habitat preferences in overlapping species, competitive advantages of larvae of one species causing decline of another species, and mesocosm experiments with larvae are among the topics discussed. **Diseases, Parasites, and Malformations:** Frogs are susceptible to bacterial, viral, and fungal infections, as well as infections caused by other protozoans and invertebrates. Chytridiomycosis (Bd) is discussed in detail because of its role in frog declines around the world. The history of the disease is mentioned in one account, noting that the fungus was found in the Southern Leopard Frog, *Lithobates sphenoccephalus*, in Illinois in 1888. Nematodes, trematodes, and cestodes are other organisms that cause malformations in adult frogs and tadpoles.

Susceptibility to Potential Stressors: Frogs are exposed to a variety of stressors, including numerous pesticides and other chemicals, fertilizers such as nitrates and nitrites, UV radiation, and pH. Metals such as cadmium,

mercury, lead, and arsenic are also present in the environment where frogs live and breed. In some cases, toxins from introduced plants can be harmful to tadpoles. Some species have been examined extensively, typically because of their large ranges and population size, whereas little or nothing is known about other species. **Status and Conservation:** Many variables affect the status of frogs throughout their ranges, including the above-mentioned stressors, the effects of development, habitat destruction, roads that are hazardous during breeding migrations, and even nonnative plants. In one case, the Northern Leopard Frog, *Lithobates pipens*, is thought to have disappeared from a large portion of its northern range because fisheries departments introduced predaceous fish for sport fishing into farm ponds and other types of fishless habitats used by frogs. Individual states and other agencies list the status of frogs in their areas; researchers and others should check these listings before planning to work with any frog species.

Reading through the accounts reveals how much is known for certain widespread species, and how little is known for other species, which is generally but not always correlated with a limited range size in the latter. For example, 25 pages in the book are devoted to the American Toad, *Anaxyrus americanus*, 27 pages are devoted to the widespread American Bullfrog, and 15 pages and 12 pages, respectively, to the morphologically identical Cope's Gray Treefrog, *Dryophytes chrysoscelis*, and the Gray Treefrog, *Dryophytes versicolor*. In contrast, the three species of *Eleutherodactylus*, which primarily occur in southern parts of Texas, have about two pages devoted to each species. A primary outcome of having so much information summarized in one place is that this great source of knowledge leads one to realize that further research is needed in nearly every area. For those who are interested in particular topics, i.e., predation, feeding, reproduction, conservation, etc., reading through those sections in sequence throughout the book provides an excellent overview of the literature and suggests numerous

ideas for further research. Even though the book is specifically about species in the U.S. and Canada, the numerous topics addressed in this book apply to frogs in any part of the world and thus will be a valuable resource for researchers everywhere.

Each species account is liberally sprinkled with excellent color photographs taken by the author as well as many other herpetologists. Every account has a well-designed line drawing depicting the range. Of course, frog populations may occur unevenly based on how suitable habitat is distributed. Readers may want to consult other websites for details of distribution, for example iNaturalist, which shows point locations for frogs photographed and identified by this community of researchers and naturalists. The photographs for each account in the book include at least one, and sometime 3 or 4, photographs of adult frogs, individual or sometimes aggregations of tadpoles, and typical breeding habitats. In addition, line drawings of the heads of 11 of the 25 species of toads allow easy comparisons of the postorbital and cranial crests and parotoids, characters frequently used for identification in these species. Many accounts have photographs of eggs, egg masses, or egg strings (toads), and some show amplexing pairs or adult color morphs. The unusual behavior of foot-flagging is depicted in the account of the Blanchard's Cricket Frog, *Acris blanchardi*. While the book is beautifully illustrated, if I had to choose an additional illustration or two to include, phylogenetic trees depicting the relationships of the 106 species would be a valuable addition given the recent proliferation of molecular studies.

The literature alone takes up 156 pages (approximately 16%) of the book. Over 8500 citations include nearly all publications about U.S. and Canadian frogs. References extend from 1664 to 2021, when the book went into publication. Most references are from the late 1900s and 2000s, but numerous new references have been added to the literature since the publication of the first edition. Although I did

not count the number of new references in all 156 pages of this edition, a rough estimate is that at least 12–14% of the references are new since the first edition was published ten years ago. Despite the extensive amount of knowledge this literature represents, the author notes in at least two places his concern about how little we still know about frogs. Because our emphasis has shifted from natural history to genetics, meta-analyses, and experimental studies, all of which generate research funding, we still have much to learn about the basic biology of frogs. In the account on the Northern Leopard Frog, *Lithobates sphenoccephalus*, for example, which is one of the most extensive accounts, we are deficient in knowledge of its longevity, sex ratios, population size and class structure, clutch size variation, and other aspects of its biology. I am certain that this situation prevails for most species. Other researchers have lamented the lack of natural history data for both amphibians and reptiles (Greene 1986, Vitt 2013, and see *Amphibian Species of the World*, Curator's blog, 30 November 2018).

I highly recommend reading the Preface to the first edition (reprinted in the second edition) and the Preface in this edition. Both give insights into Dodd's motivation for writing this book and aspects of his early life that led to the study of biology. Many of us would agree with his statement that nothing is more fascinating than the evolution of life. Dodd also mentions being drawn to the silence of nature, with which I would agree, but I would also point out that nothing is more thrilling than the raucous sound of a frog chorus. In addition, I greatly appreciate the author's frank assessment of his values and feelings about the present state of the world. His concern about whether we humans will begin to understand our interconnectedness with the biodiversity, the ecosystems, and the climate of the world before it is too late is a concern we should all share.

Marion Lovene Griffey's beautiful and moving poem "In the Eyes of a Toad," graced the frontal matter of the book. Given the

propensity of humans to engage in all manner of creative activities, I am certain many herpetologists and others have been moved to write about, sculpt, or paint frogs and toads because of their beautiful eyes, colorful patterns, and unique forms. Thinking of poetry reminded me of a delightful poem about toads written by the late Charles C. Carpenter (Caldwell and Vitt 2004). For those interested in reading more poetry inspired by frogs and toads, I highly recommend Jill Carpenter's anthology of 86 poems and short prose featuring amphibians (Carpenter 1998; out of print but hopefully will continue to be available on Amazon).

In summary, the wealth of information synthesized for each of the 106 native frog species in the U.S. and Canada is overwhelming. It is safe to say that Dodd has met and surpassed his goals for writing this book. The book will be an essential reference for anyone interested in frogs for many years into the future. The book should be a mandatory addition to school, university, and public libraries. Not only professional herpetologists, but also beginning graduate students in herpetology and many related fields, resource managers, naturalists with an interest in biodiversity and conservation, and those who are just fascinated with frogs and toads will find this book indispensable.

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Janalee P. Caldwell

Sam Noble Museum, University of Oklahoma,
Norman, OK 73072, USA.
E-mail: caldwell@ou.edu