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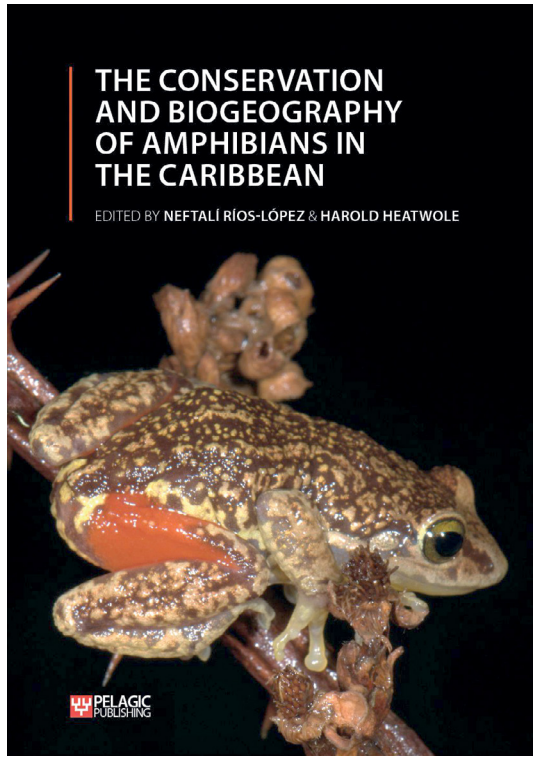

I was happy to receive a copy of this book on a subject of great interest to me. Most of the chapters are well written and I like that it has a large representation of resident Caribbean herpetologists among the contributors. However, I was disappointed about two major aspects of this book. First, the title is misleading because there is almost no biogeography aside from the first chapter on island biogeography theory, inapplicable to species covered in the book. Secondly, two chapters covering more than one-third of the book, and authored and coauthored by one of the editors, Ríos-López, express opinions that I find harmful to conservation efforts. I will elaborate on these problems below.

Except for the first chapter written by the editors, each one covers an island, island group, or country in the Caribbean region: Bahamas and Turks and Caicos islands, Cuba, southwestern Caribbean islands, Jamaica, Haiti, Dominican Republic, Puerto Rico and the Virgin Islands, Lesser Antilles, Aruba-Curaçao-Bonaire, Venezuelan islands, Trinidad and Tobago, and the Bocas del Toro Archipelago. The last are barrier islands of Panama recently connected to the mainland, with insufficient time for speciation and endemicity. Researchers studying biodiversity and biogeography usually exclude such barrier islands from the definition of the Caribbean islands (Hedges *et al.* 2019).

Heatwole, in his preface, says that the book "looks backward in assessing how the amphibian fauna of particular Caribbean regions came to be what they are." However, the rich biogeographic literature of Caribbean amphibians is largely missing from the book, except for occasional brief references in chapters. The "biogeography" in the title relates to the first chapter where the editors discuss the historical development of "island biogeography theory" (MacArthur and Wilson 1963), which is not a theory designed to look backward, but rather to predict the number of equilibrium species given the intersection of the immigration and extinction rate curves. While an important stepping-stone for other ideas, and notwithstanding the subsequent addition of other parameters, it is inapplicable to many islands and archipelagos in the world (Brown and Lomolino 2000). Although it might be applicable to some groups with high immigration rates, the vast majority of amphibian species on Caribbean islands evolved in-situ and did not immigrate across water. For example, a single landfrog colonized Jamaica in the Miocene

and subsequent speciation within the island led to the 17 native species today (Hedges 1989). To look backward and discover the history of a species or group, biogeographers instead use a diversity of data sources including phylogeny, times of divergence, ocean currents, geology, and the fossil record.

The Bahamas archipelago has low levels of diversity but many islands. Reynolds does a nice job of covering the three native species, one of which is endemic, and seven non-native species. Their distribution can be complex, as exemplified by *Eleutherodactylus planirostris,* which is a native species on some islands but introduced on others. The 112-page chapter that covers the 69 native species of Cuban amphibians, by Díaz and colleagues, is the most comprehensive in the book. It summarizes just about everything that is known on the subject in an accessible way. It is especially important to get the electronic version of this chapter to enjoy the color photos, because they did not print well in the book. The next chapter is on the amphibians of the "southwestern Caribbean islands," places with few species, by Heatwole and Sunyer. The chapter on Jamaica by Stephenson and Wilson is a brief summary of the 21 native and 4 introduced species of anurans. It concludes with a discussion of the threats facing those species, with deforestation being the primary threat. Jamaica is a green island largely from its high rainfall, but the green appearance is mostly from introduced species of plants, not primary forest.

The chapter on Haiti by Ríos-López, is one of two that I consider problematic in this book. I say this for several reasons. Unlike most of the chapters that are focused and well structured, this one and the one on the Puerto Rican archipelago (see below) are unfocused and long-winded. They include a large amount of unnecessary text such as details of the history of the taxonomic literature of limited use (and with misunderstandings), and a long compilation of museum collection records that are not useful for the intended purpose. On the other hand, important things like the evolutionary history of the species and their historical biogeography are lacking. In covering species threats in Haiti, a full page is devoted to an introduced toad that doesn't even co-occur with most Haitian amphibian species, but only a few sentences are devoted to the near total (> 99%) destruction of primary forest habitat in Haiti, which is the single most-important conservation threat to the amphibians (Hedges *et al.* 2018). Moreover, the author voices opinions that are incorrect and I will elaborate on these in the next few paragraphs.

First, Ríos-López promotes the idea that the period of discovery of new species is over, and that research should change focus from systematics to ecology in Haiti as he claims it already has elsewhere in the Caribbean. For support, he quotes from a 1999 article by the late Ernest Williams who predicted, after the publication of Schwartz and Henderson's 1991 book, that the period of "collection and description has come to an end" in the Caribbean islands for amphibians and reptiles. However, that prediction never came true, as evidenced by the taxonomic literature and databases. Of the 1,022 currently described species of amphibians and reptiles on Caribbean islands (Hedges 2023), 166 species (16% of the total) have been described since 1991, 34 of those being amphibians (14% of the 246 species of amphibians). In addition, many new species are not yet described. For example, I am aware of more than 50 new species of amphibians from just one island in the process of description. That is approximately the same number of species of amphibians, from all islands, that the late Albert Schwartz described in his long career, just to give an idea of the workload facing taxonomists today. Fortunately, there are herpetologists on Caribbean islands and in other countries who will continue to discover and describe species, and train students. Therefore, young scientists should not be discouraged from choosing any research area in herpetology. In addition, there is large overlap in the fields of systematics and ecology, so it is divisive to treat them in this way. Both areas make strong contributions to conservation biology.

Secondly, Ríos-López conducts "armchair taxonomy" by drawing new taxonomic conclusions from comparison of past articles rather than the normal procedure, followed by authors of other chapters in the book, of accepting the most recent revisions of taxonomic experts. The problem with doing armchair taxonomy is that species names are not always backward compatible. For example, a species listed in a paper 30 years ago may be three species today, and therefore have a more restricted range. In addition, taxonomists frequently correct identifications of museum specimens mentioned in earlier papers. Furthermore, distribution maps often change over time. Second-guessing all of the complex decisions made by taxonomists through history, who examined specimens and often saw the animals in life, and may have other supporting data, will invariably lead to errors, which is what happened in this chapter. In just one case, Ríos-López misinterpreted a range polygon from an early (now-superseded) Red List account of *Eleutherodactylus hypostenor* that slightly overlapped the Haitian border because a range buffer was applied, as is recommended by the IUCN. After much discussion of this in the text, he concluded, incorrectly, that the species was originally native to Haiti and is now extirpated from that country because the recent Red List map clips the range at the border with Haiti. In another case, he devotes a page and a half to the taxonomic history of a single species, *E. chlorophenax,* questioning its status as a valid species but overlooking the two most-recent articles, both treating it as valid (Hedges *et al.* 2018, 2019). Ríos-López mentions that "profound consequences on conservation efforts" can result from the discrepancies he finds, but, instead, this is an overanalysis of the normal dynamic process of taxonomy that continually builds and improves on past work.

Lastly, Ríos-López laments over the apparent absence of ecological studies of Haitian amphibians but overlooked that a large study (Hedges *et al.* 2018) that he cites for other reasons included such work pertaining directly to amphibian conservation. In that study, we showed that mountains with primary forest had significantly higher numbers of species of amphibians and reptiles than mountains without primary forest, which means that rare primary forest is critical for species diversity. We also included data on 16 new Haitian species of amphibians, showing that Haiti has a much higher species diversity of amphibians than currently believed. Instead, Ríos-López stated that, since 2009 "we still lack a great deal of valuable information for the conservation and management of virtually all species of anurans in Haiti." However, it was this research on amphibians, after 2009, that directly led to the creation of three national parks in the country (Grand Bois, Deux Mamelles, and Grande Colline) and why I created, with Philippe Bayard, *Haiti National Trust* in 2015 (Mayer 2019, Moore and Hedges 2021, Hance 2022, Haiti National Trust 2023). Ríos-López offers a simplistic solution to saving Haiti's biodiversity by claiming deforestation will only stop when "the subsistence needs of Haitians are fulfilled by effective socioeconomic and educational policies," and not by "regulation" (e.g., protected areas). However, international aid programs have addressed the subsistence needs of Haitians for years and that is not progressing fast enough to save the country's biodiversity. Instead, modern conservation practice involves multiple strategies, including, but not limited to, providing socioeconomic and educational activities for local communities, managing protected areas (park guards, etc.), removing introduced species, and reforesting with native trees (Haiti National Trust 2023).

The chapter on the Dominican Republic, by Incháustegui and Díaz, covers the 47 species of anurans in that country. They note that the number of species has increased recently through discovery of new species, which contradicts the claim of Ríos-López (Haiti chapter) that the period of discovery has ended. Also compared with the Haiti chapter, Incháustegui and Díaz

provide a better description of forest change through time, and the importance of climate change as a threat. The only mistake I noticed in the chapter, a minor one, is that they mention Jamaica is the only other country among Caribbean islands, besides the Dominican Republic, with elevations > 2000 m, overlooking those high mountains in Haiti.

The chapter on Puerto Rico and the Virgin islands, written by Ríos-López and colleagues, covers 30 species of anurans, including 21 native species. This is the other problematic chapter in the book, besides that on Haiti. It is more than five times as long as the one on the Dominican Republic yet it covers fewer species, primarily because of wordiness. Like the chapter on Haiti, it includes unnecessary details of the taxonomic and other literature, and long quotations. At the same time, it lacks basic things like the evolutionary history of the species and their biogeography, topics with a rich literature. As with Haiti, it includes misunderstanding of taxonomic practice. For example, the initial lack of recognition of the toad genus *Peltophryne* had nothing to do with monophyly. Its recognition would have rendered *Bufo* as paraphyletic. It was not until the latter genus was revised that the former genus could be recognized. For the sake of brevity, I will skip over other minor errors and focus on three major problems of concern to conservation in this chapter.

Firstly, Ríos-López and colleagues advocate conservation complacency and go further by putting a positive spin on the near total annihilation of primary forest in Puerto Rico. Much of the original forest was cut down in the nineteenth and early 20th centuries, followed by secondary regrowth that included many introduced species. Today, the most abundant tree in Puerto Rico, *Spathodea campanulata,* is African in origin and ranks in the top 100 of IUCN's worst invasive species on the planet. Oddly, Ríos-López and colleagues depict such habitat change as a "natural adaptive response" to produce "novel ecosystems which can represent reference ecosystems for future generations, and as such they may have a greater conservation value than is frequently acknowledged." I disagree. Ecological studies show that species are impacted negatively or lost when tropical primary forest is destroyed and replaced with secondary forest (reviewed in Alroy 2017, Hedges *et al.* 2018). It may not be possible to bring back the primary forest of the entire island, but conservation efforts should focus on protecting and expanding the pockets of primary forest that remain, including control and removal of invasives even if it is a slow and difficult process.

Secondly, Ríos-López and colleagues blame scientific collecting on the demise of Puerto Rican species of amphibians (e.g., *Eleutherodactylus eneidae, E. karlschmidti,* "among others") as opposed to the more likely and logical causes such as massive deforestation, invasive diseases, and invasive predators. The only supporting data presented by them are numbers of specimens of those species in museum collections, which show that only a few hundred individuals were collected across all years, tiny numbers for small species of vertebrates. Population data are rare, but one species in Puerto Rico, *Eleutherodactylus coqui,* is well studied and its density is roughly 5,000 per hectare (Stewart and Pough 1983) which translates to over 4 billion individuals of that species living on the island at one time. The distribution of *E. karlschmidti* was about one-tenth that of *E. coqui* (IUCN SSC Amphibian Specialist Group 2021a). Given that, and assuming (conservatively) that it had a much lower density as well, say 10% of *E. coqui,* there still would have been millions of *E. karlschmidti* throughout its range, and even more of *E. eneidae,* which had a larger range (IUCN SSC Amphibian Specialist Group 2021b). Moreover, scientists never took individuals from throughout the estimated ranges of those species, on every hill and valley, as would an invasive predator. For those reasons and others (Hedges and Thomas 1991), scientists logically could not have been responsible for the decline or disappearance of those or other species.

Thirdly, Ríos-López and colleagues make a surprising defense of another of IUCN's worst invasive species on the planet, the Small Indian Mongoose (*Urva auropunctata*). That species caused the extinction of many endemic reptiles on Caribbean islands soon after it was introduced in the late nineteenth century. The spread of the mongoose and disappearance of skink species on the same islands was so close in time that a cause-and-effect relationship is inescapable (Hedges and Conn 2012). Amphibians are mostly nocturnal and many climb trees, two behaviors that make them less likely to be mongoose prey. Nonetheless, the mongoose could prey on terrestrial species of amphibians, whether those species are diurnal or not. In addition, native frogs (*Eleutherodactylus*) have been found in the stomach contents of mongooses. Ríos-López and colleagues devote many pages of their chapter, including an appendix, to the mongoose literature, concluding that the IUCN Redlist "must omit the mongoose as a threat." They ask the question "what is it about the mongoose that leads authors to keep including it as a significant threat for amphibians?" The answer is simple: multiple published studies have found native amphibians in mongoose stomachs. This makes the mongoose a threat to amphibians, even if it is a small proportion of the diet (they acknowledge that some studies record up to 25% of prey as amphibians). Ríos-López and colleagues try hard to minimize the percentage of frogs in mongoose stomachs, by summarizing the data in different ways (e.g., items versus prey type) without realizing that it is not the exact percentage but the fact they eat frogs that makes them a threat. Even if the percentage is as low as 1%, as they claim, mongooses, which have been estimated to number more than 2 million on Puerto Rico, will probably eat any frog they encounter rather than ignoring 99 frogs before they decide to eat one. The fact that most ground-dwelling amphibians in the Puerto Rico region (e.g., *Eleutherodactylus karlschmidti, E. richmondi, E. lentus, Peltophryne lemur*) have either experienced declines or disappeared, including those in otherwise undisturbed forest, indicates that predation by the mongoose could be the cause. This is further supported by the fact that the mongoose, originally in lowland areas, invaded upland forested habitats after 1951 (Pimentel 1955) and before 1993 (Viella 1998), coincident with declines of initially the lowland species (*P. lemur*) followed by the upland forest-dwelling species (*E. karlschmidti, E. richmondi, E. lentus*). Even Schmidt suggested that the mongoose was responsible for the decline of *P. lemur* a century ago. Authors of other chapters in this book (Incháustegui and Díaz, Powell and Henderson, and Auguste and colleagues) also agree with me that the mongoose is a continuing threat to amphibians.

The next chapter, by Powell and Henderson, covers 10 native species of amphibians of the Lesser Antilles and an assortment of introduced species. It is welcome relief in being well-organized and clearly written, with information that one would expect, such as relationships of each species and their natural history, besides a conservation section. A species described a few months ago, *Eleutherodactylus montserratae,* did not make it into the chapter in time. The authors include a detailed distribution list as an appendix.

The following two chapters cover species in the Southern Antilles. The chapter on the ABC islands (Aruba, Curaçao, and Bonaire) was written by Van Buurt and includes one native and several introduced species to these dry islands. Heatwole contributes a short chapter on "amphibians of the Venezuelan islands," but only Margarita Island, close to the mainland and separated by shallow water, has amphibians (5 species). The chapter on Trinidad and Tobago, written by Auguste and colleagues, covers 35 amphibian species. Nearly all (30 species) also occur outside of the islands and are Least Concern (Redlist status), reflecting the close proximity of Trinidad and Tobago to the mainland. The final chapter by Galeano and colleagues is on the Bocas del Toro Archipelago, which are some barrier islands more-or-less

integrated into the coastline of northwestern Panama. There are 37 species including anurans and salamanders. My only criticism of this chapter is the editorial decision to include it with Caribbean islands instead of with the volume on Middle America where it belongs from a geographic standpoint.

In summary, this book includes some excellent chapters but most herpetologists will not find it a useful long-term reference. Considering that it largely omits biogeography, despite the word in the title, the book is mostly about dynamic topics such as taxonomy, distribution, and conservation, where one can find more up-to-date information in databases (e.g., IUCN Redlist). A few chapters go beyond those topics and they will be longer lasting as reference sources. For that reason, and considering the reduced quality of the printed photos and figures, I would recommend finding electronic copies of chapters of interest rather than purchasing the book.

There is also the major issue of the two long-winded chapters on Haiti and the Puerto Rican archipelago, comprising one-third of the book and written and co-written (respectively) by the senior editor, Ríos-López. They stand out from others in their expression of opinions contrary to many in the conservation community. *Should young herpetologists avoid a career in systematic research because that area is declining?* Of course not, because the scientific literature shows it to be an active research area. *Should we embrace and praise the conservation value of secondary forests that are full of introduced species?* No, they are bad for biodiversity so we should remove those introduced species and expand and restore original forests. *Did systematists accelerate the decline of amphibian species in the Caribbean or cause their extinction?* No, the individuals sampled represent a miniscule fraction of the total of each species so that claim is illogical. *Is the introduced mongoose harmless to native amphibians?* No, it is a threat because it eats native frogs and it possibly led to the decline and extinction of several amphibian species. To conclude this review, I must say that I am saddened to see such opinions published in this book that are potentially harmful to the conservation of Caribbean amphibians.

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