

## Coexistence: The Ecology and Evolution of Tropical Biodiversity

By Jan Sapp. 2016. Oxford University Press. 275 pages, 49.95 USD, Cloth.

*Coexistence: The Ecology and Evolution of Tropical Biodiversity* is a fascinating chronology and reconstruction of the history of the science of tropical ecology in the Western Hemisphere. The book is framed as a history of the Smithsonian Tropical Research Island (STRI) on Barro Colorado Island in the Lago Gatun of the Panama Canal, but it also provides a broad history of the theories, debates, and research surrounding the evolution and maturing of tropical ecology. The author skillfully weaves in the development and evolution of theories related to tropical diversity (forests and corals) and why so many species can coexist in tropical ecosystems. At its essence, the debate is about how 50% of the global plant and animal species diversity can coexist on only 2% of the planet's area. At one level, the book would seem narrowly focussed on essentially how scientists attempted to explain how many species could occupy the same habitat in tropical ecosystems (both tropical forests and marine coral reefs). But at another level the book is a fascinating chronology of the development and maturing of science through the proposal and subsequent refuting of many competing hypotheses. The establishment and development of the STRI is used as a template for explaining the much broader evolution of tropical forest and marine ecology.

While both scientists and lay readers may now accept tropical ecology as a given and accepted sphere of ecology, this was not always the case. At one time it was assumed that principles of temperate forest ecology, where the earliest scientific strides had been made, would directly apply to the tropics. It is interesting how much of the early field of ecology was based upon research in temperate regions, and how strongly that influenced initial theories of tropical ecology.

The initial tropical research station in the isolated Panamanian rainforest which became the STRI was the first one established for the express purpose of studying tropical natural history rather than applied agricultural research. Major marine research on both Atlantic and Pacific marine coral ecosystems also evolved out of this research initiative. This provided the unique opportunity to study fish community structure and ecology in two totally different marine ecosystems, separated by major geologic events in the past and yet only 65 km apart.

A dizzying and competing sequence of theories has been developed to explain tropical biodiversity. The author has done a masterful job of explaining the scientific complexities of the various theories of tropical ecology and evolution that led to the establishment of the research station, and how those theories and concepts evolved through time in a manner true to the science and yet understandable and interesting to the lay person. Like a skilful mystery writer, the author leads us from one potential hypothesis to another, building

up the basis for the theory, the subsequent research to prove or disprove the hypothesis, the scientific debates and arguments, and the inevitable refinement and alternative hypothesis that took its place, leading to the book's final analysis and conclusions.

The author has an impressive grasp of scientific literature from a diverse range of fields and portrays an amazing understanding of scientific principles and processes. As one example, his grasp of biological, evolutionary, and geological history was evident in the succinct summary of processes leading to the mass extinction of marine species that resulted from the geological closure of the seaway and the creation of the Panamanian isthmus.

While the title may suggest a book with a rather limited target audience, it is a fascinating and very compelling story of interest to scientists and lay readers alike. The author obviously did a great deal of meticulous research, scrutinizing scientific publications, letters, research notes, chronicled archives of the research institute, popular articles, and personal interviews. These are skillfully and seamlessly woven into a fascinating chronology of the parallel evolution of the Barro Colorado Island field station and tropical ecology as a scientific field. In its 275 pages, 50 devoted to scientific references. Almost every fact noted has an accompanying reference. I found myself repeatedly flipping back to the reference section simply out of curiosity to see what the source could be of yet another interesting nugget of tropical science history.

Some of the early history is especially fascinating, detailing the vision, boldness, and courage that brought the concept of the Barro Colorado reserve to life. There are fascinating stories of the early unique research scientists and their often-fractious relationships. The stories are accompanied by grainy black and white photos that add to the historical perspective. The impacts of history and politics on science, sometimes in totally unforeseen ways, provided interesting insights. These included the role of construction of the Panama Canal on the stimulation of interest in tropical research, and the effects of the American invasion of Panama. The book provides fascinating insights into the canal's history, such as the very serious proposal to use nuclear devices to create a sea-level canal rather than a series of freshwater locks, and the kidnapping of marine research scientists during the Panamanian invasion.

There are many interesting elements to the gradual maturing of tropical ecology as a scientific discipline, which the author carefully researched and clearly and succinctly described. Tropical research innovated and initiated the use of canopy towers to study all manner of scientific questions without disturbing the flora or fauna, eventually leading to a global network of tropical canopy towers. Another initiative was the develop-

ment of large, permanent study plots which, despite all the debate about the source and status of tropical diversity, no one had previously thought to establish. This eventually led to the creation of a global, interlinked network, which is proving useful to current research on the effects of climate change.

As well as detailing the development and evolution of the research station, and almost as an aside, the book objectively and without comment describes the parallel evolution of growing gender parity on the island over the decades. In the early years women were not permitted on the island, for fear of proving a distraction, and children and families were discouraged. Eventually female scientists came into their own, initially assisting with their husbands' research, often as unpaid research assistants, and later as fully independent and autonomous research scientists.

Author Jan Sapp is a Professor of Biology and History at Toronto's York University, but, not surprisingly, this book on tropical ecology has few references to Canada. References I noted related to the Welland Canal, which allowed Sea Lamprey (*Petromyzon marinus*) into the upper Great Lakes, an example of ecological implications with parallels to what was proposed in Panama, and a reference to a McGill biologist's reviewing of Stephen Hubbell's book on neutral theory.

*Coexistence* provides a fascinating and comprehensive overview of the evolution of tropical forest and marine ecology and their rapidly expanding research sphere. For the most part it is tightly researched and

edited, and almost no distracting typographic or spelling errors were noted. However, it does suffer from a few minor inconveniences at the micro scale. The need to convert between Imperial and metric measures was a minor annoyance. The first hint that the book was losing its tight editorial focus came in Chapter 9, when three references in as many pages were made to the portending canal treaties that would terminate the Canal Zone in 1979. A few other duplicate references to historical facts were scattered throughout the text, where notable facts appeared to have been collected and inadvertently inserted twice. Unfortunately, the same level of detail that went into the research and writing did not go into making optimal use of the interesting and informative historical photos. While these black and white photos helped the reader to envision the historical period, their placement and use was at times distracting and almost haphazard. The figure was often not placed with the first reference to the subject matter, and often the content of the photo and the textual reference were only tangentially related.

This is a meaty book that cannot be read quickly but must be contemplated and absorbed. Although it is focussed primarily on tropical ecology, it is also a fascinating chronology of a detailed and skillfully researched scientific history that both scientists and lay readers can learn from and enjoy.

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