Plants of Oceanic Islands

Evolution, Biogeography, and Conservation of the Flora of the Juan Fernández (Robinson Crusoe) Archipelago

Bringing together results from over 30 years of research on the Juan Fernández Archipelago off the coast of Chile, this book offers comprehensive coverage of the plants of these special islands. Despite its remote setting in the southeastern Pacific Ocean, the Juan Fernández Archipelago is in many ways an ideal place to ask and attempt to answer basic questions regarding the evolution of vascular plants in an oceanic island environment. By building on a firm taxonomic base for the flora, a new level of understanding regarding evolution, biogeography, and conservation of the plants is presented. This book is an extensive investigation of the origin and evolution of the flora of an oceanic archipelago, and it serves as a valuable resource for researchers and scholars of island biology as well as for conservation biologists worldwide.

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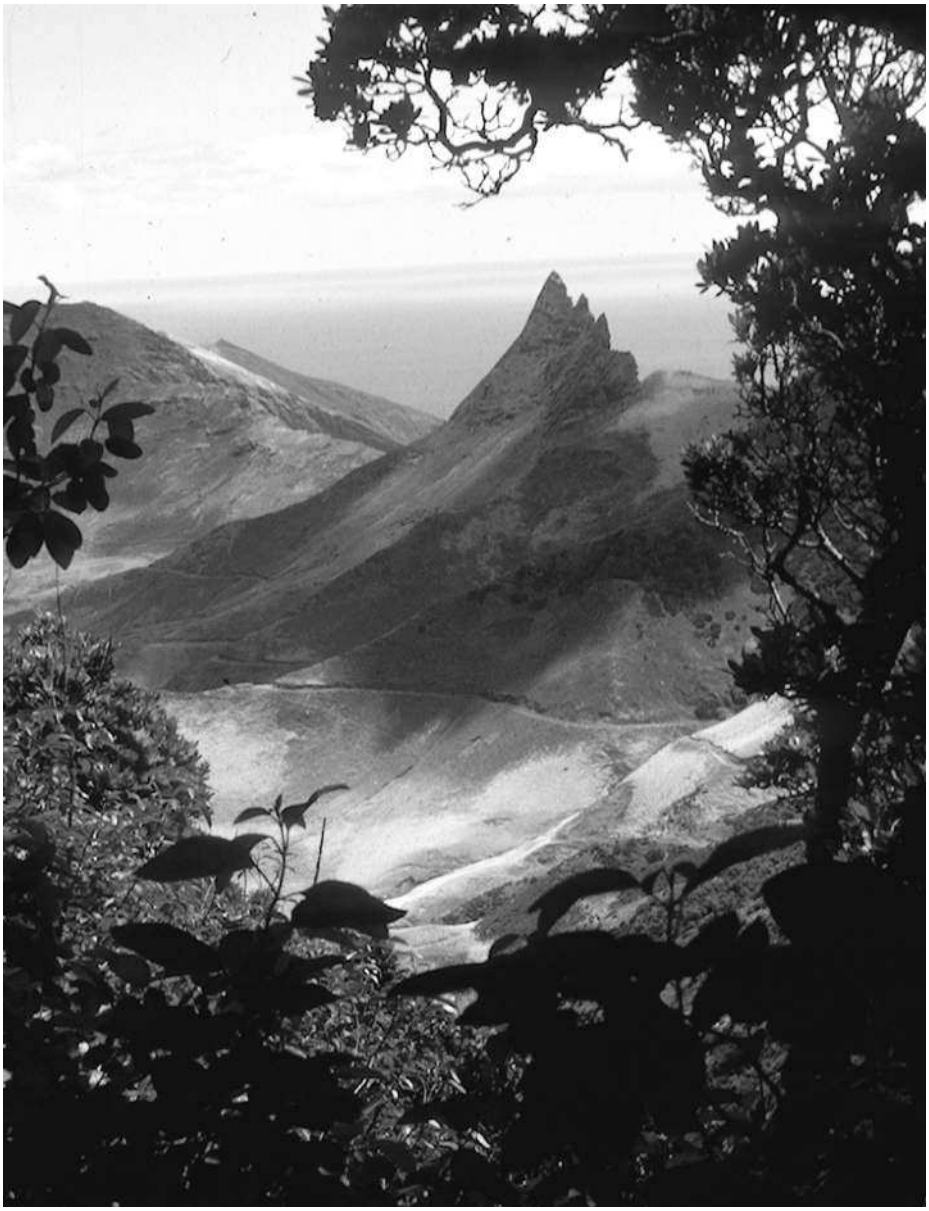

Panoramic view of Tres Picos on Robinson Crusoe Island, Juan Fernández Archipelago.

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In Memoriam

Professor Clodomiro Marticorena Pairoa
1929–2013

Critical, extremely intelligent, deeply insightful, a true friend and supporter of those he valued, expert in botanical nomenclature and bibliography, dedicated to understanding the Chilean flora, builder of the Herbarium of the University of Concepción, enthusiastic advocate of the Juan Fernández Project, co-leader of our first expedition to the archipelago in 1980, and co-author of many of our publications. We miss him for all these exceptional qualities.

We dedicate this book to past and present Corporación Nacional Forestal (CONAF) administrators, guides, and associates, without whose constructive help and friendship we never would have been able to carry out successful research in the Juan Fernández Islands.

Administrators

Bernardo Ackermann
Gastón González
Iván Leiva Silva

Guides and associates

Alfonso Andauer Schiller
Jorge Angulo Andonie
Guillermo Araya Arredondo
Danilo Arredondo Contreras
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Eduardo Paredes López
Aldo Recabarren Green
Teodoro Rivadeneira Recabarren
Ramón Schiller Recabarren

Representative CONAF guides who have helped us on many research expeditions to the Juan Fernández Archipelago. Left to right: Oscar Chamorro, Ramón Schiller, Guillermo Araya, Esteban Charpentier, and Bernardo López.

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Preface

This book has derived from numerous research discussions and expeditions over a period of more than 35 years, beginning in February of 1977. Tod F. Stuessy traveled to Chile for research discussions with Mario Silva O., professor in the Department of Botany of the Universidad de Concepción. The initial idea was to develop a joint research project on patterns and processes of speciation in the genus *Chaetanthera* (Mutisieae, Asteraceae) in the high Andes of southern South America. For a number of practical reasons, it was decided to develop another cooperative research program focused on the Juan Fernández (Robinson Crusoe) Islands, which belong to Chile. Silva was enthusiastic, and the principal taxonomist in the Department of Botany, Professor Clodomiro Marticorena, was also interested in a possible collaboration. A decision was made to develop an evolutionarily oriented project in the archipelago.

From the outset, an important concept for our research in the islands was that it must be internationally collaborative, involving Chilean botanists as well as those from the United States, Europe, and elsewhere. We have viewed this project as a means not only of advancing scientific understanding of the archipelago, justifiable enough in its own right, but also as a mechanism for educational development on all sides. Three Ph.D.'s have been completed in the project, two at The Ohio State University (Patricia Pacheco and Hugo Valdebenito) and one at the Universidad de Concepción (Eduardo A. Ruiz, who also spent research time at Ohio State). Five postdoctoral fellows have participated (Carlos M. Baeza, Gabriel Bernardello, Patricio López-Sepúlveda, Roger Sanders, and Ulf Swenson) plus dozens of students and technicians.

This book now complements several other recent volumes that, taken together, tell much about the Juan Fernández Archipelago. Especially useful for overviews of the islands and their history, culture, and people is the lavishly illustrated *La Isla de Robinson Crusoe* by Patricio Arana (2010). A smaller book, but also useful, is *Les îles de Robinson* by Philippe Danton et al. (1999), which provides a nice introduction and overview of the islands. As for the flora of the archipelago, Philippe Danton and collaborators have contributed an introduction to *Wild Plants of Robinson Crusoe Island* (2004; trilingual, also in Spanish and French) and now the comprehensive *Monografía de las Plantas Vasculares del Archipiélago Juan Fernández, Chile* (Danton and Perrier 2017). Our new book builds on the taxonomic base of understanding of plants of the archipelago by summarizing their evolution, biogeography, and conservation. With these combined new references, a new level of knowledge about the islands and their fascinating plant life has been achieved.

A note on figure citations in this book is in order. Black and white figures are contained within each chapter, but all color figures have been placed between pages 108 and 109. These figures all carry the prefix "C," for example, Fig. C1, Fig. C2, etc., and they are so cited throughout all chapters of the text.

On a personal level, we have found in these small islands a special world of wild and human nature. People living in isolated corners of our planet tend to reach out easily to visitors, and this is completely the case in the Juan Fernández Islands. We stress the friendship offered by the CONAF guides, to whom we dedicate this book. This volume belongs to them for making it all possible in the first place. We have profited immensely from our involvement with these islands, and we hope that readers will also derive inspiration from them.

Acknowledgments

It is with pleasure, and a profound sense of personal debt, that we acknowledge the help and support of many individuals and institutions over the past thirty-five years. These have been fundamental in aiding our efforts to understand the evolution and biogeography of the plants of the Juan Fernández Islands.

We give thanks to Mario Silva O., professor emeritus at the University of Concepción. It was his strong enthusiasm for the Juan Fernández project that led to its initial development and eventually the production of this book. On numerous occasions, Mario was the person who found the solution to some crisis, whether it be financial, administrative, or political. He was also the head of phytochemical investigations in the islands and was one of the general scientific leaders of the entire project for many years.

We thank the foundations that have provided the financial basis for our 12 expeditions to the islands plus many laboratory investigations: the US National Science Foundation (from International Programs and Systematic Biology), the National Geographic Society, the Österreichische Nationalbank Jubiläumsfond, The Austrian Science Fund (FWF), and the Armand G. Erpf Fund, Inc.

Thanks go to the following institutions for additional financial support: The Ohio State University, the Los Angeles County Museum of Natural History, the University of Vienna (Austria), the University of Concepción (Chile), the Department of Ecology and Evolutionary Biology and Research Foundation of the University of Connecticut, and CONICET and the Universidad Nacional de Córdoba (Argentina).

We very much appreciate the numerous leaves of absence from teaching and administrative duties granted to many of us, which made it possible to carry out the field work required for such an undertaking during 1980 (two trips), 1984, 1986, 1990, 1991, 1995, 1996, 1999, 2000, 2010, and 2011. These research leaves were generously provided by the University of Concepción, The Ohio State University (Columbus), the University of Connecticut (Storrs), the Universidad de Córdoba (Argentina), the Los Angeles Museum of Natural History, and the University of Vienna.

We thank the Corporación Nacional Forestal (CONAF) of Chile, which provided permits to visit, investigate, and collect in the islands. Our research in the Juan Fernández Archipelago would not have been accomplished without the consistent logistic help and administrative support of several chiefs of the Robinson Crusoe National Park: Bernardo Ackermann, Gastón González, and Ivan Leiva. We also thank the park guides (especially Alfonso Andauer, Jorge Angulo, Danilo Arredondo, Guillermo Araya, Oscar Chamorro, Bernardo López, Manuel Recabarren, and Ramón

Schiller), without whose invaluable assistance our work would have been impossible (see Dedication). Our sense of indebtedness to them is very sincere and deep.

We also acknowledge the following Chilean institutions: the Servicio Aeronáutico de Chile for allowing us to use one of their houses to sleep, eat, and carry out research during two expeditions; the Armada de Chile for help with logistic support in getting supplies to the archipelago; and the Servicio Meteorológico (especially Osvaldo Jara and Alex Meneses) for assistance with activities in San Juan Bautista.

The field and laboratory research described in this book has been accomplished with the participation of many students, associates, colleagues, and friends. We are particularly indebted to Pedro Aqueveque, Jorge Arriagada, Luis Letelier, Daniela Bacho, Leonardo Gaete, Alejandro Gatica, Fidelina González, Ana María Humaña, Héctor Ibarra, Paula Kivinen, Gabriele Kottirsch, Richard Jensen, Thomas Lammers, Alejandro Landero, Oscar Matthei, Patricio Novoa, Patricio Peñailillo, Oscar Parra, Richard Roederer, Mauricio Rondanelli, Roger Sanders, Jaime Sepúlveda, Alan Stuessy, Patricia Stuessy, Eric Tepe, Eduardo Ugarte, and Delbert Wiens. Assistance in San Juan Bautista was provided by José M. Gutiérrez, Juanita López, Jorge Palomino, and Valeria Salzmann.

Support was also generously provided by many specialists. The University of Connecticut greenhouse staff, led by Clinton Morse and assisted by Matt Opel, did an excellent job of growing and caring for a number of difficult and unusual plants. Conley McMullen, Warren Wagner, and Steve Weller provided comparative data and many useful comments in the development of Chapter 12. Alicia Marticorena located errors and omissions from the lists of taxa in Chapter 5. John McNeill, with input from Werner Greuter, Kanchi Gandhi, and Paul Rijckevorsel, provided expert nomenclature help in sorting out the proper name of *Erigeron fernandezia*. Mark Carine alerted us to the early collections of George Handisyd, and Charlie Davis aided with interpreting Sloane's handwriting. Andrés Moreira Muñoz directed our attention to the unpublished geological thesis by Astudillo M. John Freudenstein provided assistance in digitization of the figures for the book. John Frederick made helpful critical comments on the manuscript and prepared the indices, for which he received technical guidance from the reference staff of the Upper Arlington (Ohio) Public Library. Also important was the sophisticated electrical expertise provided by Sr. Juan Ghivarello, without whose contributions the isozyme runs on the islands would have been nearly impossible.

Most of the photographs in this book were taken by the editors and authors as follows: Gregory Anderson (frontispiece, dedication, and Fig. C39); Gabriel Bernardello (Figs. 2.3F, C72, and C77); Daniel Crawford (Fig. C41); Josef Greimler (Figs. 7.5A, 8.5, 8.9, C8, C10, C11, C23, C33, C75, C80, C85, C87, C93, C95, C111, C116, C117, and C121; Patricio López-Sepúlveda (Figs. C20, C83, and C90); Roberto Rodríguez (Figs. C7, C12, and C24); and Ulf Swenson (Fig. 9.5B). Patricio Novoa, a participant on the 2011 expedition to Alejandro Selkirk Island (Novoa 2015), also generously contributed images of ferns (Figs. C17, C18, C19, C22, and C25). Alicia Marticorena provided the photograph of her father, Clodomiro Marticorena, and Otto Solbrig allowed us to use photographs of *Ochagavia elegans* and *Robinsonia masafuerae* (Figs. C31, C66, and C67), plus his portrait (Fig. 2.1H), taken on the 1965 US-Chile expedition. All

other photos were taken by Tod F. Stuessy. Gilbert Ortiz drafted Figs. 7.1, 7.2, 10.1–10.9, 13.1, 13.2A–X, 14.2, 14.3, and 15.1–15.6 and the maps in Appendix 1, and Patricio López-Sepúlveda prepared Fig. 1.1.

The portraits of botanists in Fig. 2.1 have been cropped or modified from the following sources: A, original oil painting by Sir Thomas Lawrence in the National Portrait Gallery, London; B, Delprete et al. (2002: 625); C, Aguirre de Maino (1981: 332); D, Fürstenberg (1906: frontispiece); E, Moseley (1892: frontispiece); F and G, from photographs in the Department of Botany, Universidad de Concepción, Chile; H, Otto Solbrig, unpublished; I, Paulo de T. Alvim, in Heusser (1977: 248), ©1977, The New York Botanical Garden.

Permissions have been granted to republish figures that originally appeared in journals or books. We gratefully thank the following persons and institutions: Frontispiece, *American Journal of Botany*; Fig. 2.1B, Piero Delprete; Fig. C45, *Systematic Botany* (American Society of Plant Taxonomists); Fig. 3.1, *Science*; Figs. 3.3 and 3.4, the Geological Society; Figs. 3.5 and 3.6, *Opera Botanica* (now *Nordic Journal of Botany*); Fig. 4.4, Hugo Romero; Fig. 4.5, Andrés Moreira-Muñoz and Springer; Figs. 8.2, 8.3, 8.4, and C63, *Aliso*; Figs. 14.1 and 17.1, Taylor & Francis; Fig. 17.2, Robert Whittaker, *Journal of Biogeography*, and John Wiley; Figs. C88 and C104, University of Hawaii Press; Figs. 16.1 and 16.2, *Canadian Journal of Botany* (© 2008, Canadian Science Publishing or its licensors).

Finally, we are very appreciative of the skill and experience of Sr. Santiago Figueroa, seasoned pilot formerly of the Lineas Aéreas Robinson Crusoe, who safely carried us through some not always perfect weather to and from the islands on so many different trips.