

# Evolutionary and ecological trends in the Neotropical cycad genus *Dioon* (Zamiaceae): An example of success of evolutionary stasis

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## Abstract

Cycads represent an example of the success of evolutionary stasis. Despite their early origin, they survived multiple events of mass extinction and diversified in modern tropical ecosystems during the Cenozoic without major changes in their morphology. What factors have allowed their persistence and diversification despite their conservative nature? We reviewed documentation on the micro- and macro-evolutionary processes involved in the diversification of the Neotropical genus *Dioon*. *Dioon* comprises 18 species from varied habitats in Mexico and Honduras, and serves as a model to understand the patterns of cycad diversification. Here, we synthesize evidence reached from different fields, especially biogeography, phylogenetics, population ecology, and speciation, to propose a mechanism that can explain the current patterns of biodiversity in *Dioon*. At the macroevolutionary scale, a Paleogene origin for *Dioon* is more likely than an alternative hypothesis of a Neogene origin. *Dioon* lineages have dispersed along with the expansion of tropical forests throughout main mountain chains. Subsequently, climate change, and particularly aridification, promoted the fragmentation of the tropical forests, allowing the main *Dioon* clades to evolve in isolation at distinct biogeographic regimes. At the microevolutionary scale, low seed dispersal capability, stochastic demographic processes, and niche conservatism restrict the lineages to isolate themselves at narrow habitats, promoting local adaptation in populations. Local adaptation seems to be a process achieved through many generations under stabilizing selection. Altogether, these processes shaped the diversification in *Dioon*. This review attempts to stimulate further research on cycads and other biological groups that have diversified despite their apparent evolutionary stasis.

José Said Gutiérrez-Ortega is the recipient of the ninth Young Scholar Award of the Ecological Society of Japan (ESJ Suzuki Award).

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# Evolutionary Trends In The Neotropical O

**Elvira Hörandl, Natascha D.  
Wagner, Karol Marhold, Christoph  
Oberprieler**



## **Evolutionary Trends In The Neotropical O:**

**Evolutionary Trends in Flowering Plants** Armen Leonovich Takhtadzhian, 1991 Takhtajan one of the foremost authorities on flowering plant evolution has brought together from the literature and his own studies interpretations of the origin and evolution of various vegetative and reproductive parts of flowering plants Starting with growth habit he continues through leaf and stem structure including the origin of vessels sieve tubes and rays to flowers After tracing the possible origin of the flower he discusses in detail the sepals petals stamens and carpels accounting for their variations in number of parts fusion position and structure The evolution and origin of the micro and megagametophytes and the development of triple fusion are considered The book ends with the developmental sequence of the fruit and seed types Each chapter has its own extensive bibliography Takhtajan has produced a book that will be essential in the library of any college where plant evolution is considered C T Mason Jr University of Arizona Choice Reviews [Origin and Evolution of Caribbean Mangroves](#) Valenti Rull, 2024-05-22 This book provides a comprehensive detailed and coherent spatio temporal account of Caribbean mangrove evolution from its evolutionary origins to the present that is not available for any mangrove region in the world Mangroves are intertidal wetland forests that play a crucial role in the maintenance of terrestrial and marine biodiversity and in the functioning of global biogeochemical cycles especially the carbon cycle These ecosystems dominate the tropical subtropical coasts of all continents and are among the most threatened ecosystems in the world This book combines all temporal scales from the geological to the ecological to provide an integrated picture of mangrove history and the natural and anthropogenic drivers of ecological and evolutionary change This may be useful not only for understanding the current ecological status of these emblematic ecosystems but also for informing their conservation in the face of ongoing global change

**The Behavior, Ecology and Evolution of Cichlid Fishes** Maria E. Abate, David L.G. Noakes, 2021-09-19 This volume constitutes the most recent and most comprehensive consideration of the largest family of bony fishes the Cichlidae This book offers an integrated perspective of cichlid fishes ranging from conservation of threatened species to management of cichlids as invasive species themselves Long standing models of taxonomy and systematics are subjected to the most recent applications and interpretations of molecular evidence and multivariate analyses and cichlid adaptive radiations at different scales are elucidated The incredible diversity of endemic cichlid species in African lakes is revisited as possible examples of sympatric speciation and as serious cases for management in complex anthropogenic environments Extreme hydrology and bathymetry as driver of micro allopatric speciation is explored in the African riverine hotspot of diversity of the lower Congo River Dramatic new molecular evidence draws attention to the complex taxonomy and systematics of Neotropical cichlids including the crater lakes of Central America Molecular genetics genomics imaging tools and field study techniques assess the roles of natural sexual and kin selection in shaping cichlid traits and beyond The complex behavioral adaptations of cichlids are considered from a number of sub disciplines including sensory biology neurobiology development

and evolutionary ecology Most importantly this volume puts forth a wealth of new interpretations explanatory hypotheses and proposals for practical management and applications that will shape the future for these remarkable fishes in nature as well as their use as models for the study of biology

**Amazonia: Landscape and Species Evolution** Carina Hoorn, Frank Wesselingh, 2011-09-26 The book focuses on geological history as the critical factor in determining the present biodiversity and landscapes of Amazonia The different driving mechanisms for landscape evolution are explored by reviewing the history of the Amazonian Craton the associated sedimentary basins and the role of mountain uplift and climate change This book provides an insight into the Meso and Cenozoic record of Amazonia that was characterized by fluvial and long lived lake systems and a highly diverse flora and fauna This fauna includes giants such as the ca 12 m long caiman *Purussaurus* but also a varied fish fauna and fragile molluscs whilst fossil pollen and spores form relics of ancestral swamps and rainforests Finally a review the molecular datasets of the modern Amazonian rainforest and aquatic ecosystem discussing the possible relations between the origin of Amazonian species diversity and the palaeogeographic palaeoclimatic and palaeoenvironmental evolution of northern South America The multidisciplinary approach in evaluating the history of Amazonia has resulted in a comprehensive volume that provides novel insights into the evolution of this region

**Morphological Evolution, Adaptations, Homoplasies, Constraints, and Evolutionary Trends** Rui Diogo, 2004-01-11 The major aim of this work is to help clarify the interrelationships of catfishes with major implications on the study of the general evolution of these fishes A great part of this work therefore deals with a cladistic analysis of catfish higher level phylogeny based on extensive morphological data in which are included some terminal taxa not Systematics, Evolution, and Ecology of Melastomataceae Renato Goldenberg, Fabián A. Michelangeli, Frank Almeda, 2022-07-20 This book presents a synthesis of critical new information for the Melastomataceae one of the ten richest families among flowering plants with over 5 800 species that has its diversity highly concentrated in tropical or subtropical areas It describes the family's global diversity and distribution and summarizes recent advances in systematics evolution biogeography reproductive biology and ecology

*Recent Trends in Cytogenetic Studies* Padma Tirunilai, 2012-03-02 *Recent Trends in Cytogenetic Studies Methodologies and Applications* deals with recent trends in cytogenetics with minute details of methodologies that can be adopted in clinical laboratories The chapters deal with basic methods of primary cultures cell lines and their applications microtechnologies and automations array CGH for the diagnosis of fetal conditions approaches to acute lymphoblastic and myeloblastic leukemias in patients and survivors of atomic bomb exposure use of digital image technology and using chromosomes as tools to discover biodiversity While concentrating on the advanced methodologies in cytogenetic studies and their applications authors have pointed out the need to develop cytogenetic labs with modern tools to facilitate precise and effective diagnosis to benefit the patient population

**Evolutionary Biology - Concepts, Molecular and Morphological Evolution** Pierre Pontarotti, 2010-08-24 The annual Evolutionary Biology Meetings in Marseille aim to

bring together leading scientists promoting an exchange of state of the art knowledge and the formation of inter group collaborations This book presents the most representative contributions to the 13th meeting which was held in September 2009 It comprises 21 chapters which are organized into the following three categories Evolutionary Biology Concepts Genome Molecular Evolution Morphological Evolution Speciation This book offers an up to date overview of evolutionary biology concepts and their use in the biology of the 21st century The Role of Rivers in the Origins, Evolution, Adaptation, and Distribution of Biodiversity Luciano N. Naka, Fernanda P. Werneck, Maria W. Pil, Neil Rosser, Jean Boubli, 2022-10-13

*Evolution and Biodiversity of Wild Polyploids* Elvira Hörandl, Natascha D. Wagner, Karol Marhold, Christoph Oberprieler, 2021-09-28 **Molecular Evolution and Adaptive Radiation** Thomas J. Givnish, Kenneth J.

Sytsma, 2000-05-08 This volume surveys advances in the study of adaptive radiation showing how molecular characters can be used to analyze the origin and pattern of diversification within a lineage in a non circular fashion *The Role of Flower Color in Angiosperm Evolution* Montserrat Arista, Eduardo Narbona, Justen Whittall, Mani Shrestha, Maria Gabriela Gutierrez Camargo, 2021-11-05 **Frontiers in Ecology and Evolution 2020 Highlights** Mark A. Elgar, 2021-02-26 If nothing else

2020 reminded us that whether we like it or not human society forms part of a broader ecological community that includes species with management challenges My experience in Melbourne highlighted how environmental threats to humanity are best managed when governments adopt evidence based strategies that might also require incentives for human cooperation Fundamental research ranging from quantitative natural history to broader insights about ecological and evolutionary processes invariably forms the backbone of such evidence The collection of papers in this 2020 Highlights eBook represents a sample of articles in Frontiers in Ecology and Evolution that contribute to our collective wisdom in the discipline and generated sizeable interest among our readers We hope you also find them interesting *Introduction to Plant Population Biology* Jonathan Silvertown, Deborah Charlesworth, 2009-04-01 This completely revised fourth edition of Introduction to Plant Population Biology continues the approach taken by its highly successful predecessors Ecological and genetic principles are introduced and theory is made accessible by clear accurate exposition with plentiful examples Models and theoretical arguments are developed gradually requiring a minimum of mathematics The book emphasizes the particular characteristics of plants that affect their population biology and evolutionary questions that are particularly relevant for plants Wherever appropriate it is shown how ecology and genetics interact presenting a rounded picture of the population biology of plants Topics covered include variation and its inheritance genetic markers including molecular markers plant breeding systems ecological genetics intraspecific interactions population dynamics regional dynamics and metapopulations competition and coexistence and the evolution of breeding systems and life history An extensive bibliography provides access to the recent literature that will be invaluable to students and academics alike Effective integration of plant population ecology population genetics and evolutionary biology The new edition is thoroughly revised and now includes molecular techniques

The genetics chapters have been completely rewritten by a newco author Deborah Charlesworth Evolutionary Paleobiology James W. Valentine,1996-12-15 Representing the state of the art in evolutionary paleobiology this book provides a much needed overview of this rapidly changing field An influx of ideas and techniques both from other areas of biology and from within paleobiology itself have resulted in numerous recent advances including increased recognition of the relationships between ecological and evolutionary theory renewed vigor in the study of ecological communities over geologic timescales increased understanding of biogeographical patterns and new mathematical approaches to studying the form and structure of plants and animals Contributors to this volume a veritable who s who of eminent researchers present the results of original research and new theoretical developments and provide directions for future studies Individually wide ranging these papers all share a debt to the work of James W Valentine one of the founders of modern evolutionary paleobiology This volume s unified approach to the study of life on earth will be a major contribution to paleobiology evolution and ecology

**Living in a Dynamic Tropical Forest Landscape** Nigel Stork,Stephen M. Turton,2009-01-26 This book brings together a wealth of scientific findings andecological knowledge to survey what we have learned about the Wet Tropics rainforests of North Queensland Australia This interdisciplinary text is the first book to providesuch a holistic view of any tropical forest environment includingthe social and economic dimensions The most thorough assessment of a tropical forest landscape todate Explores significant scientific breakthroughs in areasincluding conservation genetics vegetation modeling agroforestryand revegetation techniques biodiversity assessment and modeling impacts of climate change and the integration of science innatural resource management Research achieved in part due to the Cooperative ResearchCentre for Tropical Rainforest Ecology and Management theRainforest CRC Written by a number of distinguished internationalexperts contains chapter summaries and section commentaries The Ecology and Evolution of Heliconius Butterflies Chris D. Jiggins,2017-01-27 The Heliconius butterflies are one of the classic systems in evolutionary biology and have contributed hugely to our understanding of evolution over the last 150 years Their dramatic radiation and remarkable mimicry has fascinated biologists since the days of Bates Wallace and Darwin The Ecology and Evolution of Heliconius Butterflies is the first thorough and accessible treatment of the ecology genetics and behaviour of these butterflies exploring how they offer remarkable insights into tropical biodiversity The book starts by outlining some of the evolutionary questions that Heliconius research has helped to address then moves on to an overview of the butterflies themselves and their ecology and behaviour before focussing on wing pattern evolution and finally speciation Richly illustrated with 32 colour plates this book makes the extensive scientific literature on Heliconius butterflies accessible to a wide audience of professional ecologists evolutionary biologists entomologists and amateur collectors **Phylogeny and Evolution of the Angiosperms** Douglas Soltis,Pamela Soltis,Peter Endress,Mark Chase,Steven Manchester,Walter Judd,Lucas Majure,Evgeny Mavrodiev,2018-01-24 Although they are relative latecomers on the evolutionary scene having emerged only 135 170 million years ago angiosperms or flowering

plants are the most diverse and species rich group of seed producing land plants comprising more than 15 000 genera and over 350 000 species Not only are they a model group for studying the patterns and processes of evolutionary diversification they also play major roles in our economy diet and courtship rituals producing our fruits legumes and grains not to mention the flowers in our Valentine s bouquets They are also crucial ecologically dominating most terrestrial and some aquatic landscapes This fully revised edition of *Phylogeny and Evolution of the Angiosperms* provides an up to date comprehensive overview of the evolution of and relationships among these vital plants Incorporating molecular phylogenetics with morphological chemical developmental and paleobotanical data as well as presenting a more detailed account of early angiosperm fossils and important fossil information for each evolutionary branch of the angiosperms the new edition integrates fossil evidence into a robust phylogenetic framework Featuring a wealth of new color images this highly synthetic work further reevaluates long held evolutionary hypotheses related to flowering plants and will be an essential reference for botanists plant systematists and evolutionary biologists alike

**A Primer of Life Histories** Jeffrey Alexander Hutchings,2021 This accessible primer encompasses the basic concepts theories and applied elements of life history evolution

**Bryophytes** Matt von Konrat,2010

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