

## MICROBIAL COMMUNITY ECOLOGY

## Function over phylogeny

Analysis of bacterial communities inhabiting water ‘tanks’ in the foliage of tropical bromeliads reveals a surprising similarity in their metabolic capacity, despite large variation in microbial taxa.

Sean M. Gibbons

In the macroscopic world, grasslands, forests, and deserts have different species compositions on different continents. These geographically separated ecosystems all contain primary producers, herbivores, and carnivores in roughly equal proportion. However, the taxonomic identities of these organisms are different (redwoods in North America, kangaroos in Australia, tigers in Asia). The reasons for these differences are historical. Species evolved independently in each isolated region to fill the available ecological roles. Thus, ecosystem function is conserved while species identities vary.

In this issue, Louca *et al.* report that aquatic microbial community assembly is non-random and can be better predicted by inferred functional characteristics than by species composition<sup>1</sup>. This result mirrors what we see in macrosystems, but unlike macroorganisms the authors found no evidence of dispersal limitation, where more similar communities are generally found closer together in the environment. In the absence of dispersal limits, what alternative ecological models could explain this observed variability in species composition?

Distinguishing between alternative models of community assembly requires independent replicate ecosystems. Louca *et al.* investigate microbial communities associated with the bromeliad *Aechmea nudicaulis* randomly distributed around 20 hectares of the Jurubatiba National Park in Brazil. Bromeliads are tropical plants, many of which store water in the base of overlapping leaves at their centre known as the ‘tank’, where rainfall and detritus collect (Fig. 1a).

To assess microbial community composition, the authors extract and sequence total community DNA from the tanks, each of which they find have similar physical and chemical properties across the sampling area. By assigning sequences to functional groups based on a manually curated database that maps taxonomic identities to metabolic traits, they find that the functional structure of the bromeliad communities is remarkably stable, despite

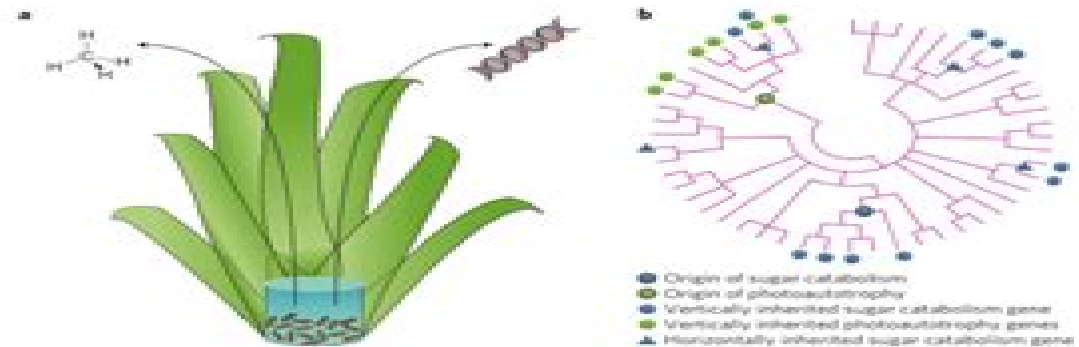
high taxonomic variability between tanks. This lack of conservation between taxonomy and functional traits is likely due to horizontal gene transfer (gene swapping between unrelated organisms)<sup>2</sup>, which is quite common in bacteria (Fig. 1b).

While functional consistency across replicate environments suggests non-random community assembly, this lack of taxonomic consistency could be due to random demographic processes like dispersal limitation. However, they find no strong relationship between taxonomic dissimilarity and geographic distance. This implies that dispersal limitation is not responsible for the taxonomic variability between bromeliads’ tank communities.

This result fits well with recent work showing the cosmopolitan distribution of aquatic microorganisms<sup>3–5</sup>. An alternative explanation for taxonomic turnover across replicate environments could be the influence of priority effects, where the initial colonization and growth of

one taxon excludes the establishment of another functionally similar organism. Priority effects have previously been shown to impact the dominance of genetically identical strains expressing different coloured fluorescent proteins in simple microbial ecosystems<sup>6</sup>. In this context, as a new bromeliad grows and forms its tank, those bacteria that happen to colonize first would hit the jackpot, filling the available niche space.

Finally, minor physicochemical differences between bromeliad tanks could also drive taxonomic variability, tipping the competitive scale ever so slightly between different microorganisms that inhabit a similar metabolic niche. This latter hypothesis seems unlikely, as the authors find that less than 5% of the community variance could be explained by measured environmental factors — though it is of course possible that unmeasured environmental variables may be responsible for the observed species heterogeneity.



**Figure 1 |** Aquatic microbial communities inhabiting bromeliad ‘tanks’. **a**, The bromeliad *Aechmea nudicaulis* (green) collects rainwater (blue) and detritus (brown) in a ‘tank’ formed by overlapping leaves in the centre of the plant, from which total community DNA is sequenced and physicochemical conditions are characterized. **b**, Simple traits encoded by a single gene (like sugar catabolism) are easily transferred. More complex traits that require many genes (like photoautotrophy) are restricted to the clades where they arose (for example cyanobacteria). This tree is purely illustrative and does not represent real phylogenetic data. Panel **b** adapted from ref. <sup>7</sup>, Elsevier.

# Phylogenies And Community Ecology

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## **Phylogenies And Community Ecology:**

**Phylogenies in Ecology** Marc W. Cadotte, T. Jonathan Davies, 2016-08-09 *Phylogenies in Ecology* is the first book to critically review the application of phylogenetic methods in ecology and it serves as a primer to working ecologists and students of ecology wishing to understand these methods. This book demonstrates how phylogenetic information is transforming ecology by offering fresh ways to estimate the similarities and differences among species and by providing deeper evolutionary based insights on species distributions, coexistence and niche partitioning. Marc Cadotte and Jonathan Davies examine this emerging area's explosive growth, allowing for this new body of hypotheses testing. Cadotte and Davies systematically look at all the main areas of current ecophylogenetic methodology: testing and inference. Each chapter of their book covers a unique topic, emphasizes key assumptions and introduces the appropriate statistical methods and null models required for testing phylogenetically informed hypotheses. The applications presented throughout are supported and connected by examples relying on real world data that have been analyzed using the open source programming language R. Showing how phylogenetic methods are shedding light on fundamental ecological questions related to species coexistence, conservation and global change, *Phylogenies in Ecology* will interest anyone who thinks that evolution might be important in their data.

**Phylogenetic Ecology** Nathan G. Swenson, 2019-11-22 Over the past decade, ecologists have increasingly embraced phylogenetics, the study of evolutionary relationships among species. As a result, they have come to discover the field's power to illuminate present ecological patterns and processes. Ecologists are now investigating whether phylogenetic diversity is a better measure of ecosystem health than more traditional metrics like species diversity, whether it can predict the future structure and function of communities and ecosystems, and whether conservationists might prioritize it when formulating conservation plans. In *Phylogenetic Ecology*, Nathan G. Swenson synthesizes this nascent field's major conceptual, methodological and empirical developments to provide students and practicing ecologists with a foundational overview. Along the way, he highlights those realms of phylogenetic ecology that will likely increase in relevance, such as the burgeoning subfield of phylogenomics, and shows how ecologists might lean on these new perspectives to inform their research programs.

**Community Ecology** Gary George Mittelbach, Brian J. McGill, 2019 *Community ecology* has undergone a transformation in recent years, from a discipline largely focused on processes occurring within a local area to a discipline encompassing a much richer domain of study, including the linkages between communities separated in space, metacommunity dynamics, niche and neutral theory, the interplay between ecology and evolution, eco-evolutionary dynamics, and the influence of historical and regional processes in shaping patterns of biodiversity. To fully understand these new developments, however, students continue to need a strong foundation in the study of species interactions and how these interactions are assembled into food webs and other ecological networks. This new edition fulfills the book's original aims, both as a much needed up-to-date and accessible introduction to modern community ecology and in identifying the important questions that are yet to be

answered This research driven textbook introduces state of the art community ecology to a new generation of students adopting reasoned and balanced perspectives on as yet unresolved issues Community Ecology is suitable for advanced undergraduates graduate students and researchers seeking a broad up to date coverage of ecological concepts at the community level

**Theoretical Approaches to Community Ecology** Luís Borda-de-Água, Paulo A. V. Borges, John Maxwell Halley, 2022-02-18

Niche Evolution and Phylogenetic Community Paleoeecology of Late Ordovician Crinoids Selina R. Cole, David F. Wright, 2022-05-26 Fossil crinoids are exceptionally suited to deep time studies of community paleoecology and niche partitioning By merging ecomorphological trait and phylogenetic data this Element summarizes niche occupation and community paleoecology of crinoids from the Bromide fauna of Oklahoma Sandbian Upper Ordovician Patterns of community structure and niche evolution are evaluated over a 5 million year period through comparison with the Brechin Lagerstätte Katian Upper Ordovician The authors establish filtration fan density food size selectivity and body size as major axes defining niche differentiation and niche occupation is strongly controlled by phylogeny Ecological strategies were relatively static over the study interval at high taxonomic scales but niche differentiation and specialization increased in most subclades Changes in disparity and species richness indicate the transition between the early middle Paleozoic Crinoid Evolutionary Faunas was already underway by the Katian due to ecological drivers and was not triggered by the Late Ordovician mass extinction

**Tropical Forest Community Ecology** Walter Carson, Stefan Schnitzer, 2011-08-31 Historically tropical ecology has been a science often content with descriptive and demographic approaches which is understandable given the difficulty of studying these ecosystems and the need for basic demographic information Nonetheless over the last several years tropical ecologists have begun to test more sophisticated ecological theory and are now beginning to address a broad array of questions that are of particular importance to tropical systems and ecology in general Why are there are so many species in tropical forests and what mechanisms are responsible for the maintenance of that vast species diversity What factors control species coexistence Are there common patterns of species abundance and distribution across broad geographic scales What is the role of trophic interactions in these complex ecosystems How can these fragile ecosystems be conserved Containing contributions from some of the world's leading tropical ecologists Tropical Forest Community Ecology provides a summary of the key issues in the discipline of tropical ecology Includes contributions from some of the world's leading tropical ecologists Covers patterns of species distribution the maintenance of species diversity the community ecology of tropical animals forest regeneration and conservation of tropical ecosystems

Functional and Phylogenetic Ecology in R Nathan G. Swenson, 2014-03-26 Functional and Phylogenetic Ecology in R is designed to teach readers to use R for phylogenetic and functional trait analyses Over the past decade a dizzying array of tools and methods were generated to incorporate phylogenetic and functional information into traditional ecological analyses Increasingly these tools are implemented in R thus greatly expanding their impact Researchers getting started in R can use

this volume as a step by step entryway into phylogenetic and functional analyses for ecology in R More advanced users will be able to use this volume as a quick reference to understand particular analyses The volume begins with an introduction to the R environment and handling relevant data in R Chapters then cover phylogenetic and functional metrics of biodiversity null modeling and randomizations for phylogenetic and functional trait analyses integrating phylogenetic and functional trait information and interfacing the R environment with a popular C based program This book presents a unique approach through its focus on ecological analyses and not macroevolutionary analyses The author provides his own code so that the reader is guided through the computational steps to calculate the desired metrics This guided approach simplifies the work of determining which package to use for any given analysis Example datasets are shared to help readers practice and readers can then quickly turn to their own datasets

**The Princeton Guide to Ecology** Simon A. Levin, Stephen R. Carpenter, H. Charles J. Godfray, Ann P. Kinzig, Michel Loreau, Jonathan B. Losos, Brian Walker, David S. Wilcove, 2012-09-30 The Princeton Guide to Ecology is a concise authoritative one volume reference to the field s major subjects and key concepts Edited by eminent ecologist Simon Levin with contributions from an international team of leading ecologists the book contains more than ninety clear accurate and up to date articles on the most important topics within seven major areas autecology population ecology communities and ecosystems landscapes and the biosphere conservation biology ecosystem services and biosphere management Complete with more than 200 illustrations including sixteen pages in color a glossary of key terms a chronology of milestones in the field suggestions for further reading on each topic and an index this is an essential volume for undergraduate and graduate students research ecologists scientists in related fields policymakers and anyone else with a serious interest in ecology Explains key topics in one concise and authoritative volume Features more than ninety articles written by an international team of leading ecologists Contains more than 200 illustrations including sixteen pages in color Includes glossary chronology suggestions for further reading and index Covers autecology population ecology communities and ecosystems landscapes and the biosphere conservation biology ecosystem services and biosphere management

**Ecology and Recovery of Eastern Old-Growth Forests** Andrew M. Barton, William S. Keeton, 2018-11-08 The landscapes of North America including eastern forests have been shaped by humans for millennia through fire agriculture hunting and other means But the arrival of Europeans on America s eastern shores several centuries ago ushered in the rapid conversion of forests and woodlands to other land uses By the twentieth century it appeared that old growth forests in the eastern United States were gone replaced by cities farms transportation networks and second growth forests Since that time however numerous remnants of eastern old growth have been discovered meticulously mapped and studied Many of these ancient stands retain surprisingly robust complexity and vigor and forest ecologists are eager to develop strategies for their restoration and for nurturing additional stands of old growth that will foster biological diversity reduce impacts of climate change and serve as benchmarks for how natural systems operate Forest ecologists William Keeton and Andrew Barton bring

together a volume that breaks new ground in our understanding of ecological systems and their importance for forest resilience in an age of rapid environmental change This edited volume covers a broad geographic canvas from eastern Canada and the Upper Great Lakes states to the deep South It looks at a wide diversity of ecosystems including spruce fir northern deciduous southern Appalachian deciduous southern swamp hardwoods and longleaf pine Chapters authored by leading old growth experts examine topics of contemporary forest ecology including forest structure and dynamics below ground soil processes biological diversity differences between historical and modern forests carbon and climate change mitigation management of old growth and more This thoughtful treatise broadly communicates important new discoveries to scientists land managers and students and breathes fresh life into the hope for sensible effective management of old growth stands in eastern forests

*The causes and consequences of microbial community structure* Diana Reid Nemergut, Ashley Shade, Cyrille Violle, 2015-01-22 The causes and consequences of differences in microbial community structure defined here as the relative proportions of rare and abundant organisms within a community are poorly understood Articles in *The Causes and Consequences of Microbial Community Structure* use empirical or modeling approaches as well as literature reviews to enrich our mechanistic understanding of the controls over the relationship between community structure and ecosystem processes Specifically authors address the role of trait distributions and tradeoffs species species interactions evolutionary dynamics community assembly processes and physical controls in affecting who's there and what they are doing

*Neotropical Diversification: Patterns and Processes* Valentí Rull, Ana Carolina Carnaval, 2020-03-30 This book provides a comprehensive overview of the patterns of biodiversity in various neotropical ecosystems as well as a discussion on their historical biogeographies and underlying diversification processes All chapters were written by prominent researchers in the fields of tropical biology molecular ecology climatology paleoecology and geography producing an outstanding collection of essays synthetic analyses and novel investigations that describe and improve our understanding of the biodiversity of this unique region With chapters on the Amazon and Caribbean forests the Atlantic rainforests the Andes the Cerrado savannahs the Caatinga drylands the Chaco and Mesoamerica along with broad taxonomic coverage this book summarizes a wide range of hypotheses views and methods concerning the processes and mechanisms of neotropical diversification The range of perspectives presented makes the book a truly comprehensive state of the art publication on the topic which will fascinate both scientists and general readers alike

Modern Phylogenetic Comparative Methods and Their Application in Evolutionary Biology László Zsolt Garamszegi, 2014-07-29 Phylogenetic comparative approaches are powerful analytical tools for making evolutionary inferences from interspecific data and phylogenies The phylogenetic toolkit available to evolutionary biologists is currently growing at an incredible speed but most methodological papers are published in the specialized statistical literature and many are incomprehensible for the user community This textbook provides an overview of several newly developed phylogenetic comparative methods that allow to investigate a broad array of questions on how phenotypic

characters evolve along the branches of phylogeny and how such mechanisms shape complex animal communities and interspecific interactions The individual chapters were written by the leading experts in the field and using a language that is accessible for practicing evolutionary biologists The authors carefully explain the philosophy behind different methodologies and provide pointers mostly using a dynamically developing online interface on how these methods can be implemented in practice These conceptual and practical materials are essential for expanding the qualification of both students and scientists but also offer a valuable resource for educators Another value of the book are the accompanying online resources available at <http://www.mpcm-evolution.com> where the authors post and permanently update practical materials to help embed methods into practice

**Lianas, Ecosystems, and Global Change** Geertje M. F. Van Der Heijden, Félicien Meunier, Stefan A. Schnitzer, 2023-03-07 *Ecology, Systematics, and the Natural History of Predaceous Diving Beetles (Coleoptera: Dytiscidae)* Donald A. Yee, 2023-01-01 The 2nd edition of this comprehensive book provides one of the most complete overviews of the aquatic beetles in the family Dytiscidae also known as predaceous diving beetles Dytiscids constitute one of the largest families of freshwater insects with approximately 4 650 named species that come in a variety of sizes colors and habitat affinities Although dytiscid adults and larvae are ubiquitous throughout a variety of aquatic habitats and are important predators on other aquatic invertebrates and vertebrates there are no compilations that have focused on summarizing the knowledge on aspects of their ecology systematics and biology Chapters in this book summarize hitherto scattered topics including their anatomy and habitats chemical and community ecology phylogenies and larval morphology including chaetotaxy sexual systems predation dispersal conservation and cultural and historical aspects The 2nd edition offers updates on the newest scientific findings on dytiscids and also includes a new chapter on the subterranean fauna from Australia The information in this new edition is potentially beneficial to anyone working in aquatic systems where dytiscids are an important part of the food web Moreover readers will gain a greater appreciation of dytiscids as model organisms for investigations of fundamental principles derived from ecological and evolutionary theory Contributed chapters are by authors who are actively engaged in studying dytiscids and each chapter provides color photos and future directions for research

**Evolutionary Community Ecology** Mark A. McPeck, 2017-08-29 Evolutionary Community Ecology develops a unified framework for understanding the structure of ecological communities and the dynamics of natural selection that shape the evolution of the species inhabiting them All species engage in interactions with many other species and these interactions regulate their abundance define their trajectories of natural selection and shape their movement decisions Mark McPeck synthesizes the ecological and evolutionary dynamics generated by species interactions that structure local biological communities and regional metacommunities McPeck explores the ecological performance characteristics needed for invasibility and coexistence of species in complex networks of species interactions This species interaction framework is then extended to examine the ecological dynamics of natural selection that drive coevolution of interacting species in these

complex interaction networks The models of natural selection resulting from species interactions are used to evaluate the ecological conditions that foster diversification at multiple trophic levels Analyses show that diversification depends on the ecological context in which species interactions occur and the types of traits that define the mechanisms of those species interactions Lastly looking at the mechanisms of speciation that affect species richness and diversity at various spatial scales and the consequences of past climate change over the Quaternary period McPeck considers how metacommunity structure is shaped at regional and biogeographic scales Integrating evolutionary theory into the study of community ecology

Evolutionary Community Ecology provides a new framework for predicting how communities are organized and how they may change over time

**Birds of Prey** José Hernán Sarasola, Juan Manuel Grande, Juan José Negro, 2018-06-30 This book will provide the state of the art on most of the topics involved in the ecology and conservation of birds of prey With chapters authored by the most recognized and prestigious researchers on each of the fields this book will become an authorized reference volume for raptor biologists and researchers around the world

**Phylogenetic Signal in Ecological Community Responses to Environmental Variability** Matthew R. Helmus, 2008 *Insect Communities: Diversity Patterns and their Driving Forces* Ai-Bing Zhang, Xin Zhou, Shu-Jun Wei, Jian Zhang, Yasuoki Takami, Gengping Zhu, 2023-03-17

Biodiversity and Biogeographic Patterns in Asia-Pacific Region I: Statistical Methods and Case Studies Youhua Chen, 2015-07-15 This brief book is dedicated to the quantitative analyses and systematic discussion of spatial biodiversity and biogeographic patterns in the Asia pacific region comprised of China India and adjacent countries The book is split into two sections The first section presents readers with detailed statistical methods to conduct spatial macro biodiversity and biogeography analyses Step by step instructions on how to perform these statistical methods by using the statistical program R are also provided In the second part different quantitative case studies are presented covering several topics including phylogenetics spatial statistics multivariate statistics and ecological genomics Each case study concludes with a detailed interpretation of the quantitative results and how these results are relevant to local and regional ecological processes This reference is suitable for academics interested in biostatistics biodiversity and ecological studies specific to the Asia Pacific region and China

Origin of Tropical Diversity: From Clades to Communities James Edward Richardson, R. Toby Pennington, 2017-01-12 In this volume we aimed to assess progress in determining the processes by which current patterns of tropical biodiversity were established and are maintained Tropical regions are highly species rich and we present studies that have improved our understanding of the generation of that diversity at local regional and global scales We demonstrate how diverse fields from molecular phylogenetics phylogeography palaeontology and palaeoecology continue to improve our understanding of the natural history of the tropics



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## **Table of Contents Phylogenies And Community Ecology**

1. Understanding the eBook Phylogenies And Community Ecology
  - The Rise of Digital Reading Phylogenies And Community Ecology
  - Advantages of eBooks Over Traditional Books
2. Identifying Phylogenies And Community Ecology
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Phylogenies And Community Ecology
  - User-Friendly Interface
4. Exploring eBook Recommendations from Phylogenies And Community Ecology
  - Personalized Recommendations
  - Phylogenies And Community Ecology User Reviews and Ratings
  - Phylogenies And Community Ecology and Bestseller Lists
5. Accessing Phylogenies And Community Ecology Free and Paid eBooks

- Phylogenies And Community Ecology Public Domain eBooks
- Phylogenies And Community Ecology eBook Subscription Services
- Phylogenies And Community Ecology Budget-Friendly Options
- 6. Navigating Phylogenies And Community Ecology eBook Formats
  - ePub, PDF, MOBI, and More
  - Phylogenies And Community Ecology Compatibility with Devices
  - Phylogenies And Community Ecology Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Phylogenies And Community Ecology
  - Highlighting and Note-Taking Phylogenies And Community Ecology
  - Interactive Elements Phylogenies And Community Ecology
- 8. Staying Engaged with Phylogenies And Community Ecology
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Phylogenies And Community Ecology
- 9. Balancing eBooks and Physical Books Phylogenies And Community Ecology
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Phylogenies And Community Ecology
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Phylogenies And Community Ecology
  - Setting Reading Goals Phylogenies And Community Ecology
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Phylogenies And Community Ecology
  - Fact-Checking eBook Content of Phylogenies And Community Ecology
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

### 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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






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