

# THE CONCEPT OF EFFECTIVE RECOMBINATION RATE AND ITS APPLICATION IN SPECIATION THEORY

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The goal of this study is to develop a unifying theoretical framework to quantify the strength of reproductive isolation. We propose the use of the "effective recombination rate," which measures how fast associations of genes are broken by interlocus recombination. Applying the well-established theory of the effective migration rate, we derive two techniques to investigate the effective recombination rate in models of speciation: the weak migration approximation for parapatric scenarios and the weak recombination approximation for sympatric scenarios. We illustrate the use of these two methods by two examples each: (1) single-locus genetic incompatibility and (2) two-locus genetic incompatibility for the first method, and (3) assortative mating and (4) assortative mating combined with disruptive selection for the second method. An advantage of the effective recombination rate over previous approaches is that it integrates gene flow in both directions into a single index measuring the strength of isolation. This enables straightforward comparisons of speciation scenarios with the same or different geographic histories. The method also allows us to evaluate the relative contributions of F2 hybrid deficiency or linkage between multiple barriers in reproductive isolation.

**KEY WORDS:** Effective migration rate, gene flow, isolating barrier, linkage disequilibrium, reproductive value.

Speciation is one of the fundamental evolutionary puzzles that Darwin essentially failed to address in the *Origin of Species* despite the title of the book. Not to mention empirical researchers (Coyne and Orr 2004; Widmer et al. 2009), this challenging problem intrigued many theoreticians (Turelli et al. 2001; Gavrillets 2004). They contributed numerous mathematical and simulation models, which revealed how species can diverge through various evolutionary mechanisms (Gavrillets 2003, 2004; Dieckmann et al. 2004). Speciation models are still increasing in number, continuously bringing novel ideas and renewing our understanding (e.g., Proulx and Servodio 2009; Barton and de Cara 2009; van Doorn et al. 2009). A consequence of this growth is "balkaniza-

tion" of the subject (Kirkpatrick and Ravigne 2002), which makes synthetic and unifying work important. A major problem in synthesis is, however, that many of the modeling studies focus on conditions for speciation to occur. Given the inherent complexity of speciation, it is usually difficult to extract analytical conditions for speciation from realistic models. Therefore, modelers often use computer simulations with limited parameter values. This makes comparisons between different studies difficult or impossible. Thus, it is an important question what aspect of speciation, if not "occurrence," we can focus on to get a more synthetic view.

We would like to direct attention to consequences of, rather than conditions for, reproductive isolation and speciation, that is,

# Speciation And The Recognition Concept Theory And Application

**Allen F. Sanborn**



## **Speciation And The Recognition Concept Theory And Application:**

**Speciation and the Recognition Concept** David M. Lambert, Hamish G. Spencer, 1995 Developed by Hugh E H Paterson in the 1970s the Recognition Concept of Species stressed the importance of the Specific Mate Recognition System SMRS and offered a view of species which was radically different from the traditional Isolation Concept Paterson held that new species were formed through incidental changes in the SMRS rather than being directly promoted In the two decades since Paterson first advanced his theory evolutionary biologists around the world have had the opportunity to use this approach in their work Speciation and the Recognition Concept is the first book to bring together a group of leading researchers to examine the relevance of Paterson's ideas today for this important topic in evolutionary biology Representing a wide variety of viewpoints the contributors explore the consequences of applying the concept to areas as diverse as the fossil record insect taxonomy the structure of mate recognition systems speciation models and the concept function in biology The Recognition Concept of species write the editors is important to biology because it represents an innovative approach to the resolution of the problem of biological diversity The concept is based upon an analysis of the logic and language of species studies Consequently it offers significant implications for ideas about the origin of species

**Evolutionary Genetics** R. S. Singh, Costas B. Krimbas, 2000-03-28 This book brings out the central role of evolutionary genetics in all aspects of its connection to evolutionary biology *Molecular Biology and Genetics of the Lepidoptera* Marian R. Goldsmith, Frantisek Marec, 2009-09-01 Numerous and charismatic the Lepidoptera is one of the most widely studied groups of invertebrates Advances in molecular tools and genomic techniques have reduced the need for large sizes and mass rearing and lepidopteran model systems are increasingly used to illuminate broad based experimental questions as well as those peculiar to butterflies Putting the spotlight on the second most numerous order of insects living today this book provides a summary of cutting edge studies of the Lepidoptera as an organism in and of itself and as model systems Leading researchers discuss symbiosis genomes sex determination natural products ecophysiology sensory systems pest control the sterile insect technique immunity and evolution development Understanding the biology and genetics of butterflies and moths may lead to new species selective methods of control saving billions of dollars in pesticide use and protecting environmental and human health making the sections on pest control and the sterile insect technique extremely important

*Vital Apologetic Issues* Roy B. Zuck, 2012-12-01 Vital Apologetic Issues Vital pertaining to life essential of critical importance Apologetic a systematic defense of the authenticity and authority of Christian truth Issues a point or matter the decision of which is of special or public importance When it comes to giving a reasoned defense of one's faith just knowing definitions isn't enough It helps to have reliable guidance through the critical issues of apologetics such as philosophical questions regarding the Christian faith or biblical reliability Vital Apologetic Issues Examining Reason and Revelation in Biblical Perspective draws upon the insights and study of numerous evangelical scholars and writers to address crucial

questions in the field of Christian apologetics Some of the chapters included are The Nature and Origin of Evil by Robert Culver Biblical Naturalism and Modern Science by Henry M Morris Ebla and Biblical Historical Inerrancy by Eugene H Merrill Theological Problems with Theistic Evolution by David H Lane Christian readers church leaders and pastors will appreciate the insight and guidance of Vital Apologetic Issues

Catalogue of the Cicadoidea (Hemiptera: Auchenorrhyncha) Allen F. Sanborn, 2013-10-31 This is the third in a series of catalogs and bibliographies of the Cicadoidea covering 1981 2010 The work summarizes the cicada literature providing a means for easy access to information previously published on a particular species or to allow researchers the ability to locate similar work that has been published on other species A total of 2 591 references are included in the bibliography The book is a source of biological and systematic information that could be used by zoologists entomologists individuals interested in crop protection and students studying entomology as well as anyone interested in cicadas or who require specific information on the insects Each genus species is identified with the reference the page number any figures if applicable the topics covered by the reference any synonymies and any biogeographic information mentioned for the species in the individual reference An added benefit to the catalog is that it is the first complete species list for the Cicadoidea including all synonymies and new combinations through 2012 Provides nearly four times the number of references of the previous catalog demonstrating the explosion of data since that time Contains all references found that mention a genus or species name in the work Includes more than 300 additional references that were not in the two previous works on this subject Features the first complete species list for the Cicadoidea including all synonymies

**The Phenomenon of Teilhard** David H. Lane, 1996 New Age writer of the popular Aquarian Conspiracy Marilyn Ferguson observed that many of the leading lights of the New Age movement claim Teilhard as one of the most influential persons in their lives Other influences acknowledged include C G Jung Aldous Huxley Swami Muktananda Thomas Merton Werner Erhard and Maharishi Yogi Indeed of the 185 New Age leaders surveyed Teilhard was the most frequently mentioned of any person who had most influenced their thinking If this is the case then if we are to understand the New Age movement properly it behooves us to take a careful and critical look at Teilhard de Chardin David Lane has done precisely this in a clear well documented and penetrating way In this crucial book David Lane lays bare the philosophical theological and scientific failures of Teilhard s New Age enterprise In a highly documented and insightful scrutiny of Teilhard s cosmic evolution Lane unveils the apostate Christian roots of one of the most important forerunners of the New Age movement This is one of the most significant and serious treatments of the modern roots of the New Age in print

Species, Species Concepts and Primate Evolution William H. Kimbel, Lawrence B. Martin, 2013-12-18 A world of categories devmd of spirit waits for life to return Saul Bellow Humboldt s Gift The stock in trade of communicating hypotheses about the historical path of evolution is a graphical representation called a phylogenetic tree In most such graphics pairs of branches diverge from other branches successively marching across abstract time toward the present To

each branch is tied a tag with a name a binominal symbol that functions as does the name given to an individual human being On phylogenetic trees the names symbolize species What exactly do these names signify What kind of information is communicated when we claim to have knowledge of the following types Tetonia mathewzi was ancestral to Pseudotetonia ambiguus The sample of fossils attributed to Homo habilis is too variable to contain only one species Interbreeding populations of savanna baboons all belong to Papio anubis Hylobates lar and H pileatus interbreed in zones of geographic overlap While there is nearly universal agreement that the notion of the species is fundamental to our understanding of how evolution works there is a very wide range of opinion on the conceptual content and meaning of such particular statements regarding species This is because oddly enough evolutionary biologists are quite far from agreement on what a species is how it attains this status and what role it plays in evolution over the long term

Principles of Human Evolution Robert Andrew Foley, Roger Lewin, 2013-05-03 Principles of Human Evolution presents an in depth introduction to paleoanthropology and the study of human evolution Focusing on the fundamentals of evolutionary theory and how these apply to ecological molecular genetic paleontological and archeological approaches to important questions in the field this timely textbook will help students gain a perspective on human evolution in the context of modern biological thinking The second edition of this successful text features the addition of Robert Foley a leading researcher in Human Evolutionary Studies to the writing team Strong emphasis on evolutionary theory ecology and behavior and scores of new examples reflect the latest evolutionary theories and recent archaeological finds More than a simple update the new edition is organized by issue rather than chronology integrating behavior adaptation and anatomy A new design and new figure references make this edition more accessible for students and instructors New author Robert Foley leading figure in Human Evolutionary Studies joins the writing team Dedicated website [www.blackwellpublishing.com/lewin](http://www.blackwellpublishing.com/lewin) provides study resources and artwork downloadable for Powerpoint presentations Beyond the Facts boxes explore key scientific debates in greater depth Margin Comments indicate the key points in each section Key Questions review and test students knowledge of central chapter concepts and help focus the way a student approaches reading the text New emphasis on ecological and behavioral evolution in keeping with modern research Fully up to date with recent fossil finds and interpretations integration of genetic and paleoanthropological approaches

**Parental Care: Evolution, Mechanisms, And Adaptive Significance**, 1996-11-18 Advances in the Study of Behavior presents its first thematic volume focusing on the physiological and behavioral mechanisms underlying parental care The book discusses parental care both within and across taxa with coverage of invertebrates and early vertebrates fishes amphibians reptiles mammals birds and nonhuman primates A running theme throughout the chapters shows that parental care is anchored to the ecology reproductive physiology and embryonic development of a species Coverage also includes mechanisms of parental care including analysis of the stimuli that parents respond to and how parental care is initiated maintained and terminated Individual differences within species are also

explored examining stable differences in maternal style how they arise and the consequences for both mother and infant

**Darwin and the Nature of Species** David N. Stamos, 2012-02-01 Since the 1859 publication of *On the Origin of Species* the concept of species in biology has been widely debated with its precise definition far from settled And yet amazingly there have been no books devoted to Charles Darwin's thinking on the term until now David N Stamos gives us a groundbreaking historical reconstruction of Darwin's detailed yet often misinterpreted thoughts on this complex concept Stamos provides a thorough and detailed analysis of Darwin's extensive writings both published and unpublished in order to reveal Darwin's actual species concept Stamos argues that Darwin had a unique evolutionary species concept in mind one that was not at all a product of his time Challenging currently accepted views that believe Darwin was merely following the species ascriptions of his fellow naturalists Stamos works to prove that this prevailing nominalistic view should be overturned This book also addresses three issues pertinent to the philosophy of science the modern species problem the nature of concept change in scientific revolutions and the contextualist trend in professional history of science

**Evolution of the House Mouse** Miloš Macholán, 2012-07-19 A detailed review of the evolutionary context necessary to interpret patterns and processes in the age of mouse genomics

**The Evolution of Agency and Other Essays** Kim Sterelny, 2001 This book presents a collection of linked essays written by one of the leading philosophers of biology Kim Sterelny on the topic of biological evolution The first half of the book explores most of the main theoretical controversies about evolution and selection Sterelny argues that genes are not the only replicators non genetic inheritance is also extremely important and is no mere epiphenomenon of gene selection The second half of the book applies some of these ideas in considering cognitive evolution Concentrating on the mental capacities of simpler animals rather than those of humans Sterelny argues for a general distinction between detection and representation and that the evolution of belief like that of representation can be decoupled from the evolution of preference These essays some never before published form a coherent whole that defends not just an overall conception of evolution but also a distinctive take on cognitive evolution

**The Handbook of Historical Linguistics** Brian Joseph, Richard Janda, 2008-04-15 The Handbook of Historical Linguistics provides a detailed account of the numerous issues methods and results that characterize current work in historical linguistics the area of linguistics most directly concerned with language change as well as past language states Contains an extensive introduction that places the study of historical linguistics in its proper context within linguistics and the historical sciences in general Covers the methodology of historical linguistics and presents sophisticated overviews of the principles governing phonological morphological syntactic and semantic change Includes contributions from the leading specialists in the field

**Autecology** Gimme H. Walter, Rob Hengeveld, 2014-04-24 This book spells out the theoretical structure methodology and philosophy of the science of autecology The autecological approach focuses on the interactions of individual organisms and their species specific adaptations with the spatio temporal dynamics of their environment as a basis for interpreting patterns of diversity and abundance in nature

Acoustic Communication in Insects and Anurans H. Carl Gerhardt, Franz Huber, 2002-07-15 Walk near woods or water on any spring or summer night and you will hear a bewildering and sometimes deafening chorus of frog toad and insect calls How are these calls produced What messages are encoded within the sounds and how do their intended recipients receive and decode these signals How does acoustic communication affect and reflect behavioral and evolutionary factors such as sexual selection and predator avoidance H Carl Gerhardt and Franz Huber address these questions among many others drawing on research from bioacoustics behavior neurobiology and evolutionary biology to present the first integrated approach to the study of acoustic communication in insects and anurans They highlight both the common solutions that these very different groups have evolved to shared challenges such as small size ectothermy cold bloodedness and noisy environments as well as the divergences that reflect the many differences in evolutionary history between the groups Throughout the book Gerhardt and Huber also provide helpful suggestions for future research *Insect Sounds and Communication* Sakis Drosopoulos, Michael F. Claridge, 2005-11-02 While we may have always assumed that insects employ auditory communication our understanding of it has been impeded by various technical challenges In comparison to the study of an insect's visual and olfactory expression research in the area of acoustic communication has lagged behind Filling this void *Insect Sounds and Communication* is the *Defining Species* John S. Wilkins, 2009 This book was listed as a CHOICE Outstanding Academic Title in 2011 *Defining Species* A Sourcebook from Antiquity to Today provides excerpts and commentary on the definition of species from source material ranging from the Greeks through the middle ages to the modern era It demonstrates that the logical meaning of species is in direct contrast to the use of kind terms and concepts in natural history and biology and that the myth that biologists or natural historians were ever essentialists about kinds is mistaken *Species* John S. Wilkins, 2009-09-08 The complex idea of species has evolved over time yet its meaning is far from resolved This comprehensive work takes a fresh look at an idea central to the field of biology by tracing its history from antiquity to today John S Wilkins explores the essentialist view a staple of logic from Plato and Aristotle through the Middle Ages to fairly recent times and considers the idea of species in natural history a concept often connected to reproduction Tracing generative conceptions of species back through Darwin to Epicurus Wilkins provides a new perspective on the relationship between philosophical and biological approaches to this concept He also reviews the array of current definitions *Species* is a benchmark exploration and clarification of a concept fundamental to the past present and future of the natural sciences **Insect Pheromone Research** R.T. Carde, A.K. Minks, 2012-12-06 This book contains the proceedings of the First International Symposium on Insect Pheromones which was held at Wageningen The Netherlands from March 6 to March 11 1994 Eighty participants from 17 countries attended the symposium which turned out to be a unique forum for the exchange of the latest worldwide findings on insect pheromones an opportunity to discuss and debate unsettled issues and a mechanism to define new directions in pheromone research and foster interdisciplinary collaborations The meeting

comprised five sessions representing the breadth of disciplinary interest in pheromones a typical characteristic of this research area In the sessions the following topics were presented 1 control of pheromone production organized by W L Roelofs 2 sensory processing of pheromone signals T L Payne 3 neuroethology of pheromone mediated responses T C Baker 4 use of pheromones in direct control A K Minks and R T Card6 and 5 evolution of pheromone communication c LOfstedt All sessions started with a series of 30 minute lectures after which ample time was reserved for discussion In each session some participants were asked to serve as discussants and to initiate and stimulate discussion and a rapporteur was recruited to make notes of these discussions and to summarize the general trends emerging from the session The general program ming of the symposium was in the hands of R T Carde A K Minks and T L Payne

**Species Concepts and Phylogenetic Theory**

Quentin D. Wheeler, Rudolf Meier, 2000-06-22 No question in theoretical biology has been more perennially controversial or perplexing than What is a species Recent advances in phylogenetic theory have called into question traditional views of species and spawned many concepts that are currently competing for general acceptance Once the subject of esoteric intellectual exercises the species problem has emerged as a critically important aspect of global environmental concerns Completion of an inventory of biodiversity success in conservation predictive knowledge about life on earth management of material resources formulation of scientifically credible public policy and law and more depend upon our adoption of the right species concept Quentin D Wheeler and Rudolf Meier present a debate among top systematic biology theorists to consider the strengths and weaknesses of five competing concepts Debaters include 1 Ernst Mayr Biological Species Concept 2 Rudolf Meier and Rainer Willmann Hennigian species concept 3 Brent Mishler and Edward Theriot one version of the Phylogenetic Species Concept 4 Quentin Wheeler and Norman Platnick a competing version of the Phylogenetic Species Concept and 5 E O Wiley and Richard Mayden the Evolutionary Species Concept Each author or pair of authors contributes three essays to the debate first a position paper with an opening argument for their respective concept of species second a counterpoint view of the weakness of competing concepts and finally a rebuttal of the attacks made by other authors This unique and lively debate format makes the comparative advantages and disadvantages of competing species concepts clear and accessible in a single book for the first time bringing to light numerous controversies in phylogenetic theory taxonomy and philosophy of science that are important to a wide audience Species Concepts and Phylogenetic Theory will meet a need among scientists conservationists policy makers and students of biology for an explicit critical evaluation of a large and complex literature on species An important reference for professionals the book will prove especially useful in classrooms and discussion groups where students may find a concise lucid entr e to one of the most complex questions facing science and society



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