Biotic Evolution and Environmental Change in Southeast Asia

The flora and fauna of Southeast Asia are exceptionally diverse. The region includes several terrestrial biodiversity hotspots and is the principal global hotspot for marine diversity, but it also faces the most intense challenges of the current global biodiversity crisis.

Providing reviews, syntheses and results of the latest research into Southeast Asian earth and organismal history, this book investigates the history, present and future of the fauna and flora of this bio- and geodiverse region. Leading authorities in the field explore key topics including palaeogeography, palaeoclimatology, biogeography, population genetics and conservation biology, illustrating research approaches and themes with spatially, taxonomically and methodologically focused case studies. The volume also presents methodological advances in population genetics and historical biogeography. Exploring the fascinating environmental and biotic histories of Southeast Asia, this is an ideal resource for graduate students and researchers as well as for environmental NGOs.

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The Systematics Association

Special Volume Series

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The Systematics Association promotes all aspects of systematic biology by organising conferences and workshops on key themes in systematics, running annual lecture series, publishing books and a newsletter, and awarding grants in support of systematics research. Membership of the Association is open globally to professionals and amateurs with an interest in any branch of biology, including palaeobiology. Members are entitled to attend conferences at discounted rates, to apply for grants and to receive the newsletter and mailed information; they also receive a generous discount on the purchase of all volumes produced by the Association.

The first of the Systematics Association’s publications The New Systematics (1940) was a classic work edited by its then-president Sir Julian Huxley. Since then, more than 70 volumes have been published, often in rapidly expanding areas of science where a modern synthesis is required.

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Biotic Evolution and Environmental Change in Southeast Asia

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Foreword

Surely there is nowhere more exciting – or more daunting – than Southeast Asia to demonstrate that the past is the key to understanding the nature of our world. There is a vast complexity in the multiple physical and biological processes that have formed what we see today. The region comprises islands large and small, islands new and old, islands that once were mainland, and highlands that used to be islands. There are both young and ancient rocks, forming staggeringly beautiful limestone towers and picture-book volcanoes. Over eons the parcels of land have moved vertically and horizontally, their climates have changed, their coastlines have been stranded and inundated, and their coral reefs have bloomed and died. There are places that experience deluges of rain, and places that know the harshness of long droughts. The region is bathed in a warmth that can support year-round, vigorous growth. There are caves whose speleothems capture within them the details of former climates, and the gentle showering of pollen from the changing constituents of the vegetation is preserved in swamps. The region has seen successive waves of people introducing diverse cultures, languages and behaviours, modifying the environment to their needs as they travelled. And it has an abundance and diversity of animals and plant life, which has long attracted scientists to collect and to observe them in their natural state. Doing this, scientists have for many years noticed and endeavoured to explain the patterns in the distribution of those species that most captured their interest.

It is the revelations from the latest research on these patterns that this book discusses. I find it very exciting to read how much our understanding has improved and deepened over the last few decades and to see the increasing integration of the geological and biological sciences in pursuit of a common desire. It is not just the sheer intellectual endeavour undertaken to produce this book which impresses, but also the application of novel molecular approaches to phylogenies in a variety of groups, the use of powerful, new statistical techniques, and the comparisons among diverse datasets which, but for this book, might remain on separate bookshelves.
FOREWORD

The region has been dubbed by some a ‘natural laboratory’ for biogeography, but this is hardly appropriate given the enormous, relentless, landscape-level changes that are happening as a consequence of political expediency, perverse incentives and poorly-enforced laws. I know the anguish of trying to find even a remnant of biologically intriguing forest battered, cut and burned out of existence to establish the serried matrices of oil palm plantations. Such vast swathes of crops now cover the region, that the detail of distribution patterns for many species is no more than conjecture. Of course, as if this were not enough, we are having to contend with the changes in climate, aggravated by land-use change, which are adding new pressures to the remaining natural ecosystems. While the world continues to argue about mechanisms for mitigation to pull us back from the brink, strategies for adaptation are needed, and understanding the origins of the natural features of the region and how they have changed could help us to fashion plans for the future.

One can easily be lulled into thinking that the increasingly sophisticated mapping associated with the various global species datasets reflects a close-to-perfect knowledge. In fact, there is a great deal of assumption and educated guesswork involved, often using out-of-date data. There appears to be a lot of biological research going on, but – even 160 years after Wallace arrived in the region – there is still a real need for careful collecting, inventory work and careful molecular and more traditional taxonomy. In my experience, when collections are made almost anywhere in the region in fairly natural habitats, new species are found, as are new records of known species which give fresh insights into their ecological preferences and add weight (or otherwise) to explanatory hypotheses on their distributions.

Despite the intense scholarship exhibited in this book, there is little doubt that there will eventually be a need for another similar volume that will recount yet more advances in the geology and biology of Southeast Asia, and in increasingly comprehensive ways to interpret the findings. I hope that this wide-ranging and detailed book will inspire a new cohort of scientists to further, deepen and reassess the corpus of knowledge laid out so clearly within its pages.

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Preface

This Systematics Association Special Volume was prompted by the organisation and staging of a conference held at Royal Holloway, University of London, in September 2009: Southeast Asian Gateway Evolution (SAGE), 2009. The meeting was organised by geologists at Royal Holloway, University of London, and biologists (palaeontologists and neontologists) at the Natural History Museum, London, who shared an interest in Southeast Asia. The region is megadiverse biologically, and of unparalleled tectonic activity and complexity. The region is the focus of the highest levels of marine biodiversity globally, and in terms of terrestrial biota it is an almost continuous patchwork of 5 of the 35 or so global hotspots. The geological history of the region has undoubtedly had substantial impact on the biodiversity, and the distribution and evolutionary relationships of organisms in space and time has informed reconstructions of the geological history.

The meeting attracted 150 scientists, who together presented 85 talks and 50 posters, and it was a great success. Scientists today spend much of their time working in fairly narrowly focused topics or, even if conducting relatively broad studies, working within narrow paradigms and ways of communicating. The organisers hoped that delegates would benefit from scientific exchange beyond their areas of expertise, but scope for detailed interaction between biologists and geologists was patchy. The majority of the biologists attending were working in biogeography, systematics and evolution; the majority of the geologists in structural geology. The lexicons of each tribe were largely non-overlapping. The interest in geology for most of the biologists was restricted to a desire to see accurate reconstructions of the disposition of land masses through time in order to direct and/or test hypotheses of biotic evolution, and if the geologists had a professional interest in the biology, then this was largely in key fossils or historical biogeographic data that could similarly assist palaeogeographical reconstructions. Many delegates still benefited from the mixed attendance – if only to gain some insights into the language, working methods and outlook of relevant but distant disciplines. There were also several more obviously integrative or cross-disciplinary presentations.
This volume is not a conference proceedings in the usual sense, but instead a collection of chapters inspired by topics covered by and themes running through many of the more biological aspects of the meeting. Some of the authors of contributions included here were unable to attend the SAGE 2009 meeting, but were recruited because the editors were looking to assemble a collection of works that covered a range of topics that seemed to us to be particularly relevant. The contributions vary from substantial syntheses or reviews, to more tightly focused case studies that illustrate particular advances and/or approaches that will have a broader relevance. We draw attention to a parallel volume on the more geological aspects, published in 2011 as Special Publication 355 of the Geological Society of London and edited by Robert Hall, Mike Cottam and Moyra Wilson: The SE Asian Gateway: History and Tectonics of Australia–Asia Collision. Readers might also note that a SAGE 2013 meeting is planned for Berlin, Germany.

We are very grateful to our colleagues in the SE Asia Research Group at Royal Holloway for undertaking the majority of the SAGE 2009 meeting organisation, especially Mike Cottam, Robert Hall and Simon Suggate. Funding for the SAGE meeting was provided by Royal Holloway’s Southeast Asia Research Group, The Geological Society of London, The Systematics Association, The Linnean Society and the Malacological Society of London. Help and advice in producing the volume was provided by several people, including Dominic Lewis, Zewdi Tsegai, Megan Waddington (all CUP) and Alan Warren (former Editor in Chief, the Systematics Association). The editors are extremely grateful to the expert reviewers of each chapter, those anonymous as well as Alexandre Antonelli, William Baker, Celine Becquet, Elizabeth Bennett, Ben Cook, Gathorne Cranbrook, Michael Crisp, Martin Haase, Bert Hoeksema, Hugh Kirkman, Robert Morley, Arne Nolte, Timothy Page, Toby Pennington, Dinarzarde Raheem, David Reid, Isabel Sanmartín, Menno Schilthuizen, Matt Struebig, Richard Thomas, Harold Voris, Peter van Welzen, Clive Wilkinson and Henk Wösten. We thank Burt Jones and Maurine Sherlock for use of the cover image and Elena Perez for producing the index. Finally, we thank all 49 contributing authors to the book, several of whom also peer-reviewed other chapters. We encourage all readers to support the activities of the Systematics Association (www.systass.org).

Please note that the contributors have made abstracts (in English and in Bahasa Indonesia) of chapters freely available on the internet at: www.cambridge.org/9781107001305

Translations of abstracts were produced by Evy Arida, Museum Zoologicum Bogoriense, Java, Indonesia, with help from Fauzie Hasibuan, Geological Agency of Indonesia, Bandung, Java, Indonesia.
Cover image
The cover image encapsulates some of the diverse topics of our original meeting and this volume. The photograph was taken off Wagmab Island, Southeast Misool, Raja Ampat, Papua, Indonesia. The bommie of the fringing reef flat in the foreground comprises several corals, including species of *Pocillopora, Acropora, Favia, Goniastrea* and massive and finger forms of *Porites*. Other animals here include the damselfish *Dascyllus melanurus* and *Chrysiptera cyanea*, the starfish *Linckia laevigata* and giant clam *Hippopus hippopus*. In the background is typical coastal limestone vegetation of northern New Guinea, likely including species of common genera such as *Diospyros, Syzygium* and *Ficus*. The exposed rocks are Eocene–Oligocene limestones of the Zaag Limestone Formation, part of the largely undeformed Australian passive margin in the Bird’s Head of western New Guinea that borders the Banda region of eastern Indonesia.