Diversity and Function in Mangrove Ecosystems

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Diversity and Function in Mangrove Ecosystems

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Contents

Preface

The tropical coastal mangrove forest, once considered to be an inhospitable insect-infested swamp, the pariah among ecosystems, but paradise for the developer, has taken a new image in recent years. Growing awareness of its role in the intricate web of marine life, its value as a natural resource for local populations and the protection it affords to easily eroded coastlines, has contributed to a surge of interest, both scientific and lay. Nevertheless, our knowledge of the evolution and functioning of these ecosystems remains superficial and substantial gaps in our understanding can be identified. An inadequate comprehension of the interrelationships between ecosystem functioning and the diversity and evolution of it's component parts has surely been the cause of disasters in rehabilitation of degraded mangrove ecosystems, or in afforestation of new lands. It is recognized that mangrove forests are being degraded and lost at an alarming rate, leading to local social and economic distress and to calls for conservation efforts by the international community. These concerns emphasize the need for future focused research directions.

Several earlier publications have arisen from symposia dedicated to mangrove research. However, the pace of advances in research techniques in recent years has opened up opportunities to revisit earlier questions and to develop new areas of inquiry. Notable here are the advances in molecular biology, that offer opportunities for a more profound knowledge of biosystematics of mangrove taxa, of species genetic architecture, of physiological processes and of biotechnological potential. Advances in imaging technology have revolutionized methods in vegetation cartography and temporal assessment of vegetation dynamics, allowing remote monitoring of the effects of local and global environmental change. Field ecology has been brought increasingly into the laboratory, where controlled cause and effect relationships can be compared with *in vivo* conditions. A revolution in thinking about biodiversity has led to debate on conservation and sustained ecosystem management, opening up the biological dimension to include the social.

Because of these advances, it was considered timely to bring together specialists in mangrove research to review present and future research. Two symposia were held at Toulouse, France. In July 1997 about 50 scientists from all continents with important mangrove resources participated in a symposium entitled "Mangrove Ecosystems: Biodiversity, Functioning, Restoration and Management". This was followed in July 1998 by a second meeting entitled "Recent Advances and Future Trends in Mangrove Research: Biodiversity, Genetics, Evolutionary Biology and Restoration". This special issue of the journal Hydrobiologia includes a selection of the papers that were presented at the two meetings. It should be considered an important contribution, though necessarily incomplete, covering various aspects of the mangrove ecosystem appropriate for the scientific community as well as being a useful source for wetland management.

At the end of the second meeting the participants convened as an *ad hoc* working group to identify priority areas for future research. Professor Colin Field, Dr Daniel Imbert and Professor Peter Saenger presented overviews of gaps in knowledge of mangrove ecosystems and recommended future research efforts. Professor Samuel Snedaker took responsibility for leading the group discussion that resulted in the statement "The Future of Mangrove Research".

It is my pleasure as organizer of the symposia to thank all participants. My gratitude is extended to Director F. Blasco for scientific collaboration and for organizing financial support from the following sponsors: Centre National de la Recherche Scientifique (CNRS), Université Paul Sabatier, Toulouse, Région Midi-Pyrénées. My thanks also go to Kluwer Academic Publishers and Editor-in-Chief, Professor H. Dumont, University of Ghent, Belgium for agreeing to publish the Proceedings as a special volume in Hydrobiologia.

PROFESSOR RICHARD S. DODD
Guest Editor

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The future of mangrove research

The Working Group represented ongoing research activities in Africa, Asia, Australia, the Middle East, and the Americas. During the course of the three-day symposium, prepared presentations were made on mangrove biodiversity, mangrove genetics, the evolutionary biology of mangroves, and the rehabilitation and restoration of degraded mangrove areas. Subsequent discussions on the various topics revealed a notable lack of a global consensus or unifying focus on the future of mangrove research. Whereas the lack of a global consensus might not limit new advances in mangrove research, the Group strongly felt that a common focus would promote interdisciplinary initiatives, accelerate research in promising areas, and lay a basis for enhanced global collaboration. Accordingly, the assembled Group convened as an *ad hoc* working Group to define future mangrove research priorities as well as operational research-support needs that are required to promote and sustain research in the priority areas. The resulting consensus is summarized below:

Molecular and evolutionary biology of mangrove systems

In terms of basic mangrove research, the Group recognized that work on the molecular biology of these tropical vascular halophytes lags far behind similar work being done on economic crop species and certain plant models, such as Arabidopsis. The principal research needs elaborated by the Group emphasized mangrove genetics, e.g., evolutionary phylogenetic relationships, genomic imprinting, transfer RNA mechanisms, germ plasm and transgenic research. Equally far behind researchers working in non- mangrove forest habitats is research on the evolutionary biology of mangrove systems. Although a large field in itself, the Group placed specific research priority on plant–plant and plant–animal co-evolution, e.g. the co-evolution of epiphytes such as orchids and bromeliads and their mangrove hosts with emphasis on inter-species physiological relationships, and the role of mangrove animal species in the evolution of mangrove systems.

Mangrove system dynamics

Superficially, the gross physiognomy of mangrove forests appears no different than other low-elevation tropical forests in similar climates. Mangroves, however, are adapted to very different habitat conditions, including but not limited to sediment anoxia, salinity, a marine-tide driven hydrology, and severe cyclonic events that help to create a highly dynamic geomorphic setting. Although mangroves appear superbly adapted, each of these factors also act as stressors that modify mangrove forest dynamics. To achieve a better understanding of the dynamics of this unique coastal forest system, the Group agreed that future research should focus on both short-term processes (e.g., colonization strategies, mechanisms of adaptation to stress, habitat-controlled inter-species interactions) and long-term processes (e.g., the structuring role of catastrophic disturbances, and mangrove community responses to accelerating changes in sea level, ultraviolet radiation, and the composition of atmospheric gases). Because mangrove forest dynamics operate on differing temporal and spatial scales, advanced techniques in remote sensing were considered to be the principal tool that integrates diverse research interests.

The human dimension

Throughout recorded history, mangrove systems have provided a subsistence base for people living in the tropical coastal zone. Over recent decades, however, this forest system has been increasingly exploited for commercial gain (e.g., intensive harvesting of wood products, large-scale conversion to agriculture and human settlement, and the

controversial conversion or mangrove areas to problematic mariculture). Consequently, large areas worldwide are highly degraded and stand in need of rehabilitation and restoration. In this regard, there is a demonstrable paucity of social science research in mangrove areas particularly in the context of how local people are affected by the loss of mangrove habitats and resources. Since the extent and rate of loss are largely unknown, the Group gave high priority to enhanced global and regional monitoring using GIS mapping techniques. With regard to degraded areas, the Group identified several key research questions that need to be aggressively addressed. These are: (1) What factors lead to success versus failure in mangrove rehabilitation and restoration projects? (2) Can the introduction of "new" mangrove species facilitate the restoration of barren coastal habitats? (3) How can biodiversity be optimized relative to efforts to enhance forest productivity? (4) Since resource economists have variously valued mangrove habitats in the range of US$ 25,000–75,000 per hectare in terms of the natural services they provide, how can rehabilitation and restoration efforts be modified to maximize the economic benefit to local peoples?

Operational research-support

Finally, the Group recognized that these future trends in mangrove research will require enhanced global communication and cooperation among mangrove researchers. To achieve this, the Group recommended the establishment of an international internet web site that will provide an entré into the published and grey literature, advice on preferred methodologies in mangrove research and valuation methods, and opportunities for inter-personal networking among mangrove researchers. The inclusion of an all- encompassing internet mangrove data base was largely dismissed because of the generic absence of input-data quality control and the validation of the research that generated the input data. However, a modified database that focused exclusively on specific topics (e.g., mangrove area maps, species descriptions along with diagnostic color photographs) would have broad appeal to the general public as well as mangrove researchers.

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