

Status of mangrove research in Latin America and the Caribbean(*)

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- **Abstract:** For those in the eastern hemisphere, the most striking characteristic of New World mangroves must be their low diversity. However, this apparent simplicity is deceptive, New World mangrove species are extraordinarily plastic in their adaptations to their environment. On a geographic basis mangroves attain their greatest development where rainfall and tidal subsidies are abundant. These conditions occur in the northwest part of South American continent and on the eastern seaboard, south of the Gulf of Paria (Venezuela) to São Luís, in Brazil. In the 1970's events related to the developing environmental movement in the United States led to a marked interest in these systems, their ecology and management, pointing out the ecological role of mangroves as sources of organic matter to estuarine food webs. The economic recession of the 80's and its impact on funding agencies, both national and international, and changing national priorities have dramatically curtailed scientific research. Research in the region is now almost totally supported by local institutions. The alarming rate at which mangroves are being destroyed in the region requires that prompt action be taken to develop a regional program such as the one recommended in the UNESCO Cali 1978 meeting, capable of fostering and supporting ecosystemic research, the development and compilation of management guidelines and the training of scientific personnel, resource managers, and providing for public environmental education. These guidelines and strategies for effective management of a complex resource can only be developed through research.
- **Descriptors:** Mangrove swamps, Geographical distribution, Historical account, Research programmes, Latin America.
- **Descritores:** Manguezais, Distribuição geográfica, Avaliação histórica, Programas de pesquisa, América Latina.

Introduction

From earliest colonial times, mangrove forests captured the attention of New World explorers, settlers and naturalists. Coming from temperate coastal landscapes dominated by herbaceous marshes, they were fascinated by these remarkable trees with the ability to grow in seawater, forming impressive and often impenetrable mazes of aerial roots. They soon discovered that these plants yielded useful products like timber,

firewood and bark for tanning leather. In contrast to the indigenous populations that had lived, fished and made use of these forests for millenia without drastic alterations, New World settlers initiated dramatic changes that ultimately have led to the depletion or degradation of the resource. In fact, as early as 1760, the cutting of mangroves for fuel wood in some provinces of colonial Brazil had reached such proportions that it had become difficult to obtain bark for tannins, causing its price to rise sharply. As a result, the King of Portugal, Dn. José, had to issue a proclamation ordering that only debarked trees could be used as fuelwood. Violators faced fines and incarceration.

Unfortunately, in spite of this early rudimentary attempt to manage for multiple uses, New World mangrove resources have not been historically regarded as valuable or important. In fact, they have been and are unfortunately still considered obstacles to economic development or as lands suitable for reclamation. The

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only perceived value is often their real estate value (after filling), especially in highly prized coastal areas.

In this paper we will give a brief overview of some characteristics of New World mangroves and their environment, specifically those related to their management, and will review some of the efforts that have been made in Latin America to foster regional research.

New World mangroves and their environment

For those in the eastern hemisphere, the most striking characteristic of New World mangroves must be their low species richness. Old World areas have a very large number of species (more than 40) when compared to the species poor New World mangroves (less than 10). Although these numbers may change depending upon which species are considered "true" mangroves or "major species", certainly this difference is of great interest because of its many implications for research and management. However, this apparent simplicity is deceptive, since mangrove species are extraordinarily malleable in their adaptations to their environment. In fact, the varied responses of these few species to local patterns of tidal and terrestrial drainage influence led Lugo & Snedaker (1974) to develop a classification system based on the observation that where mangrove stands share similar environmental conditions they attain similar levels of structural development and function. This accommodation to local conditions results in a high diversity of forest types in spite of their floristic simplicity, because of the diversity in growing conditions over their geographic range. Even in a given area, microtopographic features may be reflected in changes in plant structure.

On a geographic basis New World mangroves attain their greatest development where rainfall and tidal subsidies are large. They develop best in equatorial areas influenced by the intense convective activity within the Intertropical Convergence Zone and subjected to mesotidal or macrotidal regimes (mesotidal 2-4 m, macrotidal > 4 m; Davies, 1964). These conditions (annual rainfall > 2000 mm, tidal amplitudes > 2 m) occur in the northwest part of the South American continent (northern Ecuador, Pacific coast of Colombia and southern Panama) and on the eastern seaboard of the continent south of the Gulf of Paria (Venezuela) to São Luís in Brazil. It is in this moist and dynamic region where the greatest mangrove development occurs. Red mangrove (*Rhizophora*) forests attaining 40-50 m in height and more than 1 meter in diameter have been reported in northern Ecuador (Acosta-Solis, 1959), and in the Pacific coast of Colombia (Lamb, 1959). Another area of intense dynamism and mangrove development is found along the coasts of Suriname, French Guiana and the northern part of Brazil, north of the mouth of the Amazon. Extraordinarily well developed black mangrove (*Avicennia*) forests are typical of this coast. Stands reach 30 m in height and diameters of 50-70 cm are common at the island of Maracá, about 2 degrees north of the equator (Schaeffer-Novelli *et al.*, 1988). Interestingly enough, mangrove development and coverage near the delta of the Amazon river is restricted because of the

overwhelming fresh water discharge and intense tidal and wave energies.

The belt of greatest mangrove development is roughly restricted to within 10 degrees of the equator except on the Pacific coast of South America, where the cold Humboldt Current suppresses convective activity and creates extremely desiccating conditions. The terminus of mangrove forests on this coast lies at the mouth of the Tumbes river barely 03°48' south of the equator. Isolated mangroves occur further south (to about 5°30'S) but conditions along the remainder of this barren coast are not conducive to mangrove establishment or development. On the Atlantic side, on the other hand, mangroves develop as far as 28°30'S along the Brazilian coast, where they eventually become limited by low temperatures and sporadic frost events. Mature red mangroves at their latitudinal Southern limit barely reach 1 meter tall, but black mangroves still reach more than 8 meters in height at Laguna (28°30'S). In fact the landscape here is dominated by herbaceous vegetation (*Spartina*) with scattered and isolated white mangrove (*Laguncularia*) clumps.

On the Latin America northern hemisphere mangroves reach 31°N near Puerto Lobos, Gulf of California. On the Gulf coast of Florida they reach 30°24'N, whereas on the Atlantic coast they reach 29°54'N, and on the Bermuda island they occur at 32°N.

Mangrove research in Latin America

We can divide the study of Latin American mangroves into three stages: an early phase consisting of the narratives of the first visitors to the region (Oviedo, 1526; Souza, 1971) and others, followed by the more detailed observations of well known naturalists from the latter part of the 19th and early 20th centuries such as Eggers (1892), Schimper (1903) and others who provided the first detailed scientific accounts of mangrove systems in the New World. Finally, in this century we find more detailed local studies such as the description of the mangroves of Santos by Luederwaldt (1919), and Cananéia (Gerlach, 1958) in Brazil, the description of the mangroves of the Pacific coast of Colombia by West (1956), the review of mangrove biology by Cuatrecasas (1958), the description of Ecuadorian mangroves by Acosta-Solis (1959) and the ecophysiological studies of Pannier (1959, 1962), Pannier & Rodriguez (1967) in Venezuela, and in Brazil by Lamberti (1969). Thom (1967), in his studies of the mangroves of the Tabasco delta (Mexico), stressed the importance of physiography and impinging geomorphic processes on the development of mangrove communities.

In the 1970's, events related to the developing environmental movement in the United States and research by Heald (1969) and Odum (1970) pointing out the ecological role of mangroves as sources of organic matter to estuarine food webs, led to a marked interest in these systems, their ecology and management. Lugo, Snedaker and associates produced many important papers related to ecology, productivity, decomposition and transport of detritus, papers too numerous to cite here but well known to mangrove researchers everywhere.

Noteworthy, however, is the review on the ecology of mangroves by Lugo & Snedaker (1974). Pool *et al.* (1977) made the first comparative structural study of mangrove forests in Florida, Puerto Rico, Mexico and Costa Rica. This interest quickly trickled to the South American region, mainly through the efforts of the UNESCO Regional Office in Latin America (ROSTLAC), which, recognizing the importance of mangrove research and conservation in the area, sponsored in December 1978 a Symposium on the Scientific Aspects and Human Impact on the Mangrove Ecosystem. Thirty one papers were presented in this important symposium (UNESCO/ROSTLAC, 1980). UNESCO/ROSTLAC also sponsored the publication of an introduction to mangrove ecology (Cintrón & Schaeffer-Novelli, 1983). This publication is in the Spanish language and is directed to students and resource managers in Latin America.

It appeared for a while that the recognition of mangroves as valuable resources would result in the sponsorship of vigorous research and the development of plans for sustainable and multiple use of mangrove forest resources. This would have contributed to the rational use of a historically abused and poorly understood resource. Unfortunately this was not to be. The economic recession of the 80's and its impact on funding agencies, both national and international, and changing national priorities have dramatically curtailed scientific research. The lack of external funding has also prevented regional coordination and as a result most of South and Central American countries lack active ongoing research on their mangrove forests. Research throughout the region lacks cohesiveness and coordination.

Current research

Research in the regions is now almost totally supported by local governments and educational institutions. Probably the most active research centers are the National Autonomous University of Mexico (UNAM), and the University of São Paulo (Brazil). In 1981 the United Nations Development Programme (UNDP) sponsored a project for the characterization of the mangroves of Venezuela and Trinidad. This project, carried out by the Ministry of the Environment and Natural Resources in Venezuela, has been completed but remains unpublished. In Trinidad, Ramcharan *et al.* (1982) prepared an inventory of the coastal wetlands of Trinidad and Tobago. The need for the integrated management of coastal systems in the Caribbean led to the organization in 1982 of a workshop on the interactions between coral reefs, seagrass beds and mangroves (UNESCO, 1983a). Among the recommendations of this workshop is that research efforts must involve the region's scientific resources and must have as one of its goals the strengthening of its scientific and management capability. More recently (1984), the Organization of American States supported a regional study in which Brazil, Suriname, Colombia, Mexico, and the Dominican Republic participated. As part of this project a training course was held in Puerto Rico in 1986. However, budget cuts in the OAS dramatically curtailed the original scope of this project and its most important objectives will

remain unattained. In support of this regional study, Cintrón & Schaeffer-Novelli (1985) reviewed the available structural data for mangroves and described patterns in stand development and relationships between structural and functional characteristics. For the workshop held in Puerto Rico a mangrove methods manual was prepared (Schaeffer-Novelli & Cintrón, 1986) for the uniform description of structural parameters in the regional study. This manual is an enlarged version of a chapter previously included in the UNESCO manual on mangrove methodology (Cintrón & Schaeffer-Novelli, *in* UNESCO, 1984).

Mangrove systems are complex. Although many studies are available we still do not understand many basic processes, responses and restoration mechanisms. Mangrove projects in the region must adopt a system level approach duly recognizing that ecosystem problems are interdisciplinary and require integration. Long-term studies must be initiated to assess natural and man induced changes as well. These studies will require intra and inter institutional linkages and close cooperation among researchers in the region. Certainly some regional mechanism will be needed to provide coordination and avoid duplication of efforts. The UNESCO/COMAR/COSALC project may be an instrument to reach this goal if funding is made available and can be directed to mangrove studies as recommended by the Research and Training Group (RTG) at the COSALC project meeting of November 1982 in Venezuela (UNESCO, 1983b). Similarly, national centers for coordination will be required. In the report of the seminar organized in Cali, Lugo (*in* UNESCO, 1979) suggested the elements of a regional project for research in Latin American mangroves. His recommendations are still valid and should be given serious consideration.

Strategy for action

The alarming rate at which mangroves are being destroyed in the region requires that prompt actions be taken to develop a regional program such as the one recommended in the UNESCO Cali meeting, capable of fostering and supporting ecosystemic research, the development and compilation of management guidelines and the training of scientific personnel, resource managers, and providing for public environmental education. The great malleability and accommodation to site factors exhibited by mangroves creates a requirement for management strategies that are site specific. These guidelines and strategies for effective management of a complex resource can only be developed through research, and only through research can we hope to learn to conserve these valuable coastal resources.

Resumo

Os manguezais do Novo Mundo são bem menos ricos em espécies vegetais que os do Velho Mundo. Entretanto, essa simplicidade é apenas aparente, pois as espécies de mangue são extraordinariamente maleáveis quanto às suas adaptações ao ambiente. Geograficamente, os manguezais atingem seu máximo desenvolvimento

estrutural onde os subsídios das precipitações pluviais e das marés são maiores. Essas condições ocorrem na costa NW do Continente Americano e da porção oriental do litoral da Venezuela (Golfo de Paria) até São Luís, no Maranhão (Brasil).

O interesse pelo estudo e manejo do ecossistema manguezal ocorrido na década de 1970, destacou a função ecológica do sistema como fonte de matéria orgânica para a cadeia alimentar estuarina.

A recessão dos anos 80 marcou uma dramática redução dos fundos para pesquisa, tanto nacionais como internacionais. Atualmente os projetos de pesquisa são sustentados, praticamente, por recursos institucionais locais.

As elevadas taxas de destruição dos manguezais na região exigem ações decisivas dos órgãos competentes, incluindo apoio à pesquisa, desenvolvimento de planos de manejo e formação de recursos humanos, além da organização de programas de educação ambiental. Essas metas somente serão atingidas através de projetos de pesquisa bem estruturados.

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