International Symposium on

THE ECOLOGY OF MANGROVES AND RELATED ECOSYSTEMS

24 - 30 September, 1990

Mombasa, KENYA

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PROGRAMME

MONDAY, 24 SEPTEMBER

08.30-10.30 **Registration - Poster display**

10.30-11.00 **OPENING SESSION**

Prof. V. Jaccarini, Chairman Organizing Committee
Mr. E. Okemwa, Director KMFRI
Prof. R.W. Mwangi, Chairman Dept. Zoology-Nairobi
Ministry of Research, Science & Technology

STATUS, PRIMARY PRODUCTIVITY AND TAXONOMY OF MANGROVES, SEAGRASSES AND ALGAE

Chairman: **V. Jaccarini**

11.00-12.00 **A. Semesi** (plenary session 1)
The mangrove forest reserves of mainland Tanzania

12.00-14.00 LUNCH

14.00-14.20 **P.O. Gang & J.L. Agatsiva**
The current status of mangroves along the Kenyan coast: a case study of the Mida creek mangroves based on remote sensing

14.20-14.40 **K. Naskar**
Status of the Sundarbans mangrove forests of India and its ecological stresses

14.40-15.00 **J. Azariah, H. Azariah & S. Gunasekaran**
Structure and species distribution in Coringa mangrove forest, Godavary Delta, Andhra Pradesh, India

15.00-15.20 **M.D. Amarasinghe & S. Balasubramaniam**
Structural properties of two types of mangrove stands on the North-Western coast of Sri Lanka

15.20-15.40 COFFEE/TEA BREAK

Chairman: **E. Martens**

15.40-16.00 **J.A. Jiménez**
Dynamics of a mangrove forest along a flooding gradient

16.00-16.20 **F.W. Fong**
Some ecological aspects of the establishment and spread of Nypa fructicans Wurmb.

16.20-16.40 **Ph. Polk & K. Delbeke**
The Kenyan-Belgian Project in Marine Science

18.30-20.00 **WELCOME RECEPTION**

TUESDAY, 25 SEPTEMBER

Chairman: **W. Kudoja**

08.30-08.50 **M. Couto & J.C. Hatton**
The effect of coastline changes on mangrove community structure, Portuguese Island, Mozambique

08.50-09.10 **R. Ruwa**
Impacts on mangroves and crabs in creek and fringe mangrove vegetation due to disturbances at the Kenyan coast

09.10-09.30 **M.D. Amarasinghe & S. Balasubramaniam**
Net primary productivity of two mangrove forest stands on the North Western coast of Sri Lanka

09.30-09.50 **M.D. Fortes**
Mangroves and seagrass connections - A status report from the ASEAN perspective

09.50-10.10 **A. Semesi**
Seagrass beds from selected sites along the coast of Tanzania

10.10-10.30 COFFEE/TEA BREAK

Chairman: **M. Vannini**

10.30-10.50 **E. Coppejans**
The seagrass and associated macroalgal vegetation of Gazi Bay (Kenya)

10.50-11.10 **D. Prasad**
Seasonal studies on the biomass and chemical composition of seagrasses from the Hellshire coast of Jamaica

11.10-11.30 **M.D. Fortes**
Comparative analysis of seagrass structure and productivity in the ASEAN region

11.30-11.50 **L. Kannan & K. Vasantha**
Phytoplankton of the Pitchavaram mangrove area, Southeast coast of India: species composition and population density

12.00-14.00 LUNCH

CONSUMERS IN MANGROVE ECOSYSTEMS

Chairman: **A. Semesi**

14.00-15.00 **M. Vincx & S. Van Hove** (Plenary Session 2)
The ecology of meiofauna in mangroves: a review or only a start ?

15.00-15.20 **J.G. Mutwiri**
Preliminary observations on the littoral-benthic meiofauna in a mangrove ecosystem of the Kenyan coast with special reference to the harpacticoid copepods (Crustacea)

15.20-15.40 **N. Revis & E. Okemwa**
The zooplankton composition in a mangrove creek during a tidal cycle

15.40-16.00 **M.K.W. Osore**
A note on the variation of zooplankton population distribution and diversity in a mangrove creek system Gazi, Kenya

16.00-16.20 COFFEE/TEA BREAK

16.20-16.40 **M. Vincx & S. Van Hove**
Study of the meiobenthos in five mangrove vegetation types in Gazi Bay, Kenya

16.40-17.00 **R. Borger & N. Revis**
Study of the zooplankton during a tidal cycle in Gazi creek, Kenya

17.00-18.30 POSTER SESSION

M. Vincx & P. Van Avermaet
Meiofauna from seagrassbeds near mangroves in Kenyan coastal biotopes

W.M. Muya & E. Martens
Gill morphometry and desiccation tolerance in supratidal and intertidal fiddler crabs

V. Selvam & J. Azariah
Diurnal variation in the physico-chemical properties and primary production in the interconnected marine, mangrove and fresh water biotopes of Kakinada coast, Andhra Pradesh, India

F.W. Fong
The local resource utilization of Nypa fruticans Wurmb. in Malaysia

D. Prasad
Seasonal variation in the chemical composition of benthic macroalgae on the South coast of Jamaica

W. Giesen & K. Van de Kerkhof
The effects of river discharges on a coral reef ecosystem near Malindi, Kenya

K. Padmakumar & K. Ayyakkannu
Antibiotic activity of mangroves

S.A. Robertson
The coast forest survey project in Kenya

M.H.A. Shete
East African Wildlife Society

WEDNESDAY, 26 SEPTEMBER

Chairman: **M.A. Ngoile**

08.30-09.30 **D.J. Macintosh** (Plenary Session 3)
Current status of research on consumer organisms in Southeast Asian mangroves

09.30-09.50 **A.M. Ellison & E.J. Farnsworth**
Mangrove-root epibionts: patterns of distribution and abundance, and effects on mangrove root growth in Belizean mangals

09.50-10.10 **J.F. Tack, E. Vanden Berghe & Ph. Polk**
Size of the mangrove oyster (Crassostrea cucullata, Ostreidae), in a mangrove creek (Gazi, Kenya) in relation to environmental parameters

10.10-10.30 **E. Vanden Berghe, J.F. Tack & Ph. Polk**
Variations of form of Crassostrea cucullata as related to environmental parameters

10.30-10.50 COFFEE/TEA BREAK

Chairman: **K. Delbeke**

10.50-11.10 **M. Vannini, F. Gherardi & F. Micheli**
Ecological notes on Mida creek (Kenya) decapod crustaceans

11.10-11.30 **A. Oluoch & V. Jaccarini**
Distribution and abundance of brachyuran Decapoda (Ocypodidae and Grapsidae) in Gazi mangrove swamp, Kenya

11.30-11.50 **C.A. Muhando**
Some of the factors affecting the distribution and abundance of the mangrove crab Uca lactea (Milne Edwards) in the Kunduchi mangrove creeks, Dar Es Salaam, Tanzania

11.50-12.10 **J.N. Kasyi, E. Martens & W. Kudoja**
Relative growth and diet composition in the mud crab Scylla serrata

12.10-12.30 **A. Sivakumar & K. Kathiresan**
Biodeterioration of mangroves by wood borers and their control

12.30-14.30 LUNCH

CORAL REEF ECOSYSTEMS

Chairman: **E. Okemwa**

14.30-15.30 **T. Done** (Plenary Session 4)
Phase shifts in coral reef communities and their ecological significance

15.30-15.50 **J. Mutere**
A taxonomic and ecological study of scleractinian corals on the Kenyan reef flats

15.50-16.10 **J.D. Woodley**
The incidence of hurricanes on the North coast of Jamaica since 1870: are the classic reef descriptions atypical ?

16.10-16.30 COFFEE/TEA BREAK

Chairman: **J. Azariah**

16.30-16.50 **G. van der Velde, C. den Hartog, M.W. Gorissen, T. van 't Hoff & G.J. Meijer**
Importance of the Lac-lagoon on Bonaire (Netherlands Antilles) for reef fishes

16.50-17.10 **P.A. DeGeorges**
Land-based pollution and its impact on coral reefs and related ecosystems in the Caribbean

17.10-17.30 **M. Samoilys**
Abundance and species richness of coral reef fish on the Kenyan coast: the effects of protective management and fishing

17.30-17.50 **P. Pissierssens**
Regional Cooperation in Scientific Information Exchange in the W.Indian Ocean Region, RECOSCIX-WIO Project

THURSDAY, 27 SEPTEMBER

NUTRIENT CYCLING, CHEMICAL AND PHYSICAL PROCESSES

Chairman: **M. Ntiba**

08.30-09.30 **E. Wolanski** (Plenary Session 5)
Hydrodynamics of tropical coastal marine systems: mangrove swamps and coral reefs

09.30-09.50 **H. Onyango**
A residual circulation model of Gazi creek, Kenya

09.50-10.10 **J. Francis**
Physical processes in the Rufiji Delta and their possible implications on the mangrove ecosystem

10.10-10.30 **M.A. Hemminga**
Seagrass meadows as traps of seston and dissolved nutrients

10.30-10.50 COFFEE/TEA BREAK

Chairman: **T. Done**

10.50-11.10 **V. Selvam & J. Azariah**
Spatial and temporal variations in dissolved inorganic nutrients and phytoplankton production in the Muthupet mangrove lagoon, Tamil Nadu, India

11.10-11.30 **M.A. Amakiri**
Some microbial, physical and chemical characteristics of the mangrove ecosystem in Nigeria

11.30-11.50 **S. Gunasekaran, J. Azariah & H. Azariah**
Mineral distribution in the deltaic soil of mangrove forest Cauvery Basin, Tamil Nadu, India

11.50-12.10 **F.M. Chale**
Degradation of mangrove leaf litter under aerobic conditions

12.10-12.30 **N.O. Isirimah, R.P. Gambrel, F.O.C. Harry, A.G. Ojanuga & G. Gichiru**
Variations in the concentration of some nutrients and other elements in manganese dioxide and calcium carbonate ameliorated acid sulphate soil-water oxygenated closed system

12.30-14.00 LUNCH

Chairman: D. Prasad

14.00-14.20 **R. Mohanraju & R. Natarajan**
Methane production in the mangrove sediments of Kodiakkarai

14.20-14.40 **R.J. Uncles, J.E. Ong & W.K. Gong**
Observations and analysis of a stratification-destratification event in a tropical estuary

14.40-15.00 **M.M. Nguli**
Some hydrographic characteristics in Tudor Mangrove creek system

15.00-17.30 **Visit to Kenya Marine & Fisheries Research Inst. and RECOSCIX-WIO Project**

FRIDAY, 28 SEPTEMBER

FISHERY BIOLOGY AND MARICULTURE

Chairman: A. Oluoch

08.30-08.50 **A. Sasekumar, V.C. Chong, M.U. Leh & R. D'Cruz**
Mangroves as a habitat for fish and prawns

08.50-09.10 **A.Yanez-Arancibia & A.L. Lara-Dominguez**
Mangroves-seagrasses interactions as critical habitats for estuarine nekton assemblages and life-cycles, Mexico

09.10-09.30 **M.J. Ntiba & V. Jaccarini**
Evidence for definite spawning seasons in a tropical fish: the spawning cycle of the rabbit fish Siganus sutor of Kenya

09.30-09.50 **A. Getahun**
Food of a noted coral fish, Epinephelus chlorostigma (Pisces, Serranidae), from some coastal areas of the Ethiopian Red Sea

09.50-10.10 **E.O. Wakwabi & B.K. Okoth**
The feeding ecology of the juveniles of six fish species from the Gazi mangrove creek, Kenya

10.10-10.30 **V.M. Rasolofo**
Ecology and fisheries of penaeid shrimps in mangrove areas in Madagascar

10.30-10.50 COFFEE/TEA BREAK

Chairman: M.D. Fortes

10.50-11.10 **M.J. Ntiba & V. Jaccarini**
The effect of oocytic atresia on fecundity estimates of Siganus sutor of Kenyan marine inshore waters

11.10-11.30 **J. Rasowo**
Mariculture development in Kenya: alternatives to shrimp pond sitting in mangrove ecosystems

11.30-11.50 **L. Solorzano**
The mangroves and mariculture industry of Ecuador

11.50-12.10 **M. Mastaller & U. Helbing**
Fisheries and aquaculture management in mangrove areas of Northeastern Brazil

12.10-14.00 LUNCH

Chairman: M. Vincx

14.00-14.20 **M. Poznanski**
Feasibility for mariculture in mangrove systems: case study of an oyster culture in Gazi Bay

14.20-14.40 **G.C. Trono & A.O. Lluisma**
Biomass productions and carrageenan yields of four strains of carrageenophytes presently farmed on Danajon reef, Notrthern Bohol, Philippines

14.40-15.00 **G.M. Wamukoya**
Nutritional studies of Ulva fasciata Del. and Sargassum binderi Sond. from Mackenzie point, Mombasa, Kenya

15.00-15.20 **D. Prasad**
Genetic improvement of Gracilaria

15.20-15.30 COFFEE/TEA BREAK

15.30-18.30 **Visit to Mombasa Old Town**

SATURDAY 29 SEPTEMBER

POLLUTION OF COASTAL ECOSYSTEMS

Chairman: **E. Wolanski**

08.30-09.30 **A. Thorhaug** (Plenary Session 6)
Effects of various dispersants on tropical organisms: corals, mangroves, seagrass, tropical commercial fish in Jamaica

09.30-09.50 **R. Santhanam**
Influence of thermal effluents on the phytoplankton ecology of mangrove estuaries of Tuticorin, Southeast coast of India

09.50-10.10 **W.M. Kudoja**
Concentration of heavy metals in Anadara antiquata (Pelecypoda) from Ocean Road Beach, Tanzania

10.10-10.30 **D. Munga, J.G. Mutwiri & A.C. Yobe**
Preliminary observations on effects of oil spills on the mangrove ecosystem in Mombasa creeks

10.30-10.50 COFFEE/TEA BREAK

EXPLOITATION, CONSERVATION AND MANAGEMENT ASPECTS

Chairman: **E. Coppejans**

10.50-11.50 **P.K. Akiwumi** (Plenary Session 7)
Protection and management of marine and coastal areas within the framework of UNEP's Regional Seas Programme

11.50-12.10 **M.A.K. Ngoile & J.P. Shunula**
Status and exploitation of the mangrove and associated fishery resources in Zanzibar

12.10-12.30 **J. Katupotha**
Exploitation of mangrove and coral reef ecosystems of the West and South coasts in Sri Lanka

12.30-12.50 **J. Bauer**
Situation, conservation and management of mangrove ecosystems in Somalia

12.50-14.30 LUNCH

Chairman: J.D. Woodley

14.30-14.50 **J.K. Maheshwari**
Human uses and management implications of the mangrove ecosystem of India

14.50-15.10 **P. Bacon & G. Alleng**
The management of insular Caribbean mangroves in relation to site location and community type

15.10-15.30 **B.M. Musyoki**
Management of marine national parks and reserves in Kenya

15.30-15.50 **A.H. Moallin**
The exploitation of Somali coast ecosystem products and area conservation management aspects

16.10-16.30 COFFEE/TEA BREAK

Chairman: V. Jaccarini

16.30-16.50 **A. Thorhaug**
The restoration of mangroves and seagrass for increased fish nursery production

16.50-17.10 **D. Van Speybroeck**
Regeneration strategy of mangroves along the Kenyan coast: a first approach

17.10-17.30 **J. Azariah & V. Selvam**
Impact of the past management practices on the present status of the Muthupet mangrove ecosystem, Tamilnadu, India

17.30-17.50 **K.C. Hall & C. Amadou**
Experience with Rhizophora racemosa planted 1987-1989 from propagules on a mangrove rehabilitation site at Lower Allan town in Sierra Leone

17.50-18.10 **K. Kathiresan**
Biotechnology in mangrove afforestation

18.10-18.30 CLOSING SESSION

Prof. M. Hyder

SUNDAY, 20 SEPTEMBER

08.00-16.30 **EXCURSION: Watamu mangrove creek and Gedi at North coast**

OR

09.00-12.00 **EXCURSION: Bamburi fish farm and nature trail**

ABSTRACTS

STATUS, PRIMARY PRODUCTIVITY AND TAXONOMY OF MANGROVES, SEAGRASSES AND ALGEA.

DEVELOPING MANAGEMENT PLANS OF THE MANGROVE FOREST RESERVES OF MALINDI TANZANIA

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The mangroves of Tanzania are currently not being managed although they are legally gazetted as forest reserves.The management of this overexploited and under estimated natural resource rests with the Forest of Beekeeping Division in the Ministry of Natural Resources and Tourism.It is the Division's intention to conserve the mangroves of Tanzania,therefore steps are being taken to reach that goal.So far the Division through its established mangrove project, has done an inventory of all the mangroves of mainland Tanzania with the assistance of NORAD support.Aerial photography and ground checks were used to asses the state of all the mangrove reserves.Literature search and a socio-economic study was also undertaken.

The inventory revealed that the area covered by mangrove vegetation is 115,901 ha while the previous records indicate about 80,000 ha. If the bare saline areas, water bodies, and salt pans which are part of the mangrove reserves are included, the area amounts to 172,879 ha for the Tanzanian mainland. The mangrove reserves have already been mapped in 30 sheets. Some sheets are mapped using a scale of 1:25,000 while others are mapped in 1:50,000 scale. The maps show the vegetation types, the area of each vegetation type, and the stand density and height of each compartment.

The paper therefore presents the current state of the mangroves of Tanzania in respect to area, distribution and vegetation types. Included is a discussion on the strategy being used to develop the management plans of Tanzania.

THE CURRENT STATUS OF MANGROVES ALONG THE KENYAN COAST: A CASE STUDY OF THE MIDA CREEK MANGROVES BASED ON REMOTE SENSING

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Mangroves form a unique ecosystem of limited extent along the Kenyan coast that does warrant for their absolute protection from extinction if overexploited. Background information on the areal extent and status of these mangroves is limited. This makes the protection and management ultimately difficult.

A model study has been carried out on the Mida creek mangroves based on a double sampling approach starting with SPOT multispectral satellite imagery followed by ground measurements to come up with information on their status. The results reveal the current situation of these mangroves by species and utility. Their densities and distribution is also indicated. Other forms of land uses around and within these mangroves have also been established.

During this study, seven mangrove species were identified in Mida creek and these include: Avicennia marina, Bruguieria gymnorrhiza, Ceriops tagal, Rhizophora mucronata, Sonneratia alba, Zylocarpus granatum and Lumnitzera racemosa. This report therefore presents the utilization of each mangrove species and gives recommendations and suggestions on how to exploit the mangroves sustainably.

STATUS OF THE SUNDARBANS MANGROVE FORESTS OF INDIA AND ITS ECOLOGICAL STRESSES

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INDIA.

The fresh water flow from the upstream of the river Ganga is now reduced in comparison to the early 20th century; consequently the deltaic lands in this lower Ganga basin of the Sundarbans tidal forests are now almost disconnected from many of the tributaries of the Ganga. The reduced flow from the upstream has turned the tidal river water more saline, hampering the natural regeneration process of many important mangrove flora. Nowadays, there is an alarming of increase population pressure on the natural virgin mangrove forests severely affecting the natural regeneration process. Both the biotic and abiotic factors in this Sundarbans mangrove forests affected the natural regeneration process of the mangrove flora. At present only thirty true mangrove species and thirty halophytic mangrove associated flora are available in the tidal and intertidal mangrove forests of Sundarbans .The total area under the Sundarbans mangrove forests is only about 2300 km^2, out of 4266.6km^2 area within the forest boundary. The local people settled in the buffer zones of the Sundarbans are economically backward and the forest products, eg., fuel wood, timber, honey and wax, fish and prawn etc. are their sole income sources. The human activities in the forests have a very damaging effect on the mangrove vegetation. Therefore, afforestation programmes were undertaken to conserve this forest ecosystem. But such artificial afforestation practices have not shown much promising results. The pros and cons of the human interference on these ecosystems are discussed in the present paper.

STRUCTURE AND SPECIES DISTRIBUTION IN CORINGA MANGROVE FOREST, GODAVARY DELTA, ANDHRA PRADESH, INDIA.

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Coringa mangrove forest is located in the Godavary delta, Andhra Pradesh, India. The mangrove community consisted of more than 26 species of mangrove and other plants. The following three dominant mangrove plants, Avicennia marina, Exoecaria agallocha and Sonneratia apetala were found to be present on the banks of a major channel of the Godavary river running through the forest.

The present paper outlines the structure and species distribution of mangroves in the channel Nagathana Kalava. The area behind the belt consisting of Acanthus ilicifolius and Myriostachya whightiana is generally colonized by Excoecaria agallocha and Avicennia marina. The zone has been called the Avicennia and Excoecaria zone. Adjacent to this zone species like Aegiceras corniculatum, Avicennia officinalis and Rhizophora apiculata were the common species. In the flat-clayey soil, Saueda maritima and S. lumnitra species were found to grow. On the other hand, in areas of high elevation, devoid of inundation of tidal seawater during the high tidal period, species such as M. whightiana and Acanthus were found to colonize both the banks of the channels.

An analysis of species diversity, indicated a definite trend in the distribution of mangrove from the mouth of the estuarine region to the inland waters. The paper provides statistical analysis on the community structure of the mangrove stand.

The results on air-quality with reference to sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ammonia (NH_3) and suspended particle matter (SPM), have been presented. A few recommendation on the management of the mangrove ecosystem have been formulated.

STRUCTURAL PROPERTIES OF TWO TYPES OF MANGROVE STANDS ON THE NORTH-WESTERN COAST OF SRI LANKA

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Regional Research Centre
Kalpitiya, SRI LANKA

&

S. Balasubramaniam
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Mangrove stands in Puttalam lagoon and Dutch bay, two interconnected lagoons situated on the North-Western coast of Sri Lanka have been classified broadly into two groups, ie. estuarine and island/mainland-fringing stands. Structural diversity of six mangrove stands, representing the two types was studied in terms of floristic composition, density, basal area, mean stand diameter, tree height, standing above-ground biomass and leaf-area index . Rhizophora mucronata and Avicennia marina were dominant mangrove species in the area . Higher mean stand diameters for the mangrove stands in Puttalam lagoon indicated greater maturity than the estuarine mangrove stands in Dutch bay. Nevertheless, estuarine stands in Dutch bay were structurally more complex (complexity indices 8.11 - 22.7) than the island/mainland-fringing mangrove stands (complexity indices 1.38 - 6.78). Higher number of species present in the estuarine mangrove stands is the major element that contributes to the higher values for the complexity indices for those stands. This appears to mask the contribution of stand-age to the complexity of a mangrove stand. Therefore complexity indices alone may not be used to explain adequately the structural diversity among mangrove stands.

DYNAMICS OF A MANGROVE FOREST ALONG A FLOODING GRADIENT

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The occurrence of mangrove species in distinct monospecific zones is one of the most discussed themes of mangrove ecology. However, few experimental studies have been conducted to clarify this subject.

Structural and dynamic analysis were conducted, during a three year period, in three one-hectare plots located perpendicular to the flooding gradient, on the Pacific coast of Costa Rica.

Tree growth, morality and spatial distribution were evaluated in each plot for the two main species in the area (Avicennia bicolor and Rhizophora racemosa). Seedling dynamics and reciprocal planting experiments were conducted within and among the plots.

Species zonation within the study area appears to be regulated, primarily, by the depth of tidal inundation. However, tidal-depth is not the only factor related to inundation that is operative. A. bicolor is where it is because it tolerates drought and probably high soil salinity better than R. racemosa. It would flourish somewhat farther seaward in the absence of the R. racemosa. The extent to which A. bicolor can exploit the seaward end of its potential range is largely determined by the tidal sorting of R. racemosa propagules to somewhat below their physiological and competitive limit with respect to A. bicolor. Tidal sorting of propagules seems to be a quite finely tuned adaptation. It confines propagules to zones where they have the highest likelihood of contributing to another generation, by avoidance of intolerable physical environments on the one hand and physiologically benign environments where they are competitively inferior on the other hand.

SOME ECOLOGICAL ASPECTS OF THE ESTABLISHMENT AND SPREAD OF NYPA FRUTICANS WURMB.

"palm"

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Although Nypa fruticans Wurmb. occurs naturally in Asia and Oceania, it has been introduced into the coastal districts of West Africa. Nypa thrives further upstream of other mangrove species and, as a rule, forms narrow groves along water channels through which tides ebb and flow or fringes on the inland portions of mangrove forests. The diaspores of Nypa, referred to as the propagules, are characterised by the protruding plumular extensions from the end where the fallen fruits formerly adjoined the globose fruit head of the infructescence. The propagules float with the incoming tides so that establishment may be possible only at low tides or when stranded above the high tide. There were marked tendencies towards longer buoyancy in propagules floated in freshwater and dilute seawater than those floated in higher saline media from floatation experiments. The damaging effects of seawater was observed as early as the fourth week when some of the propagules began to shrivel and eventually succumbed to fungal attack. Transferring salt-soaked propagules to freshwater brought about higher percentages of survivors compared to continuous immersion in various seawater diluents. Propagule sources or populations were examined for their tolerance to salt in terms of buoyancy in salt water, appearance of first leaf initials, shoot extension and mortality. Each of these parameters were found to vary independently under the influence of increasing salt concentrations and there were no observable correlated trends. Seedling cohorts, transplanted and naturally established, at field sites were monitored for survival patterns. Results indicate that loss of propagules or seedlings was rapid at sea front sites. Death or loss could be caused by the physical effects of washout by wave action, requirement for freedom from inundation to anchor onto substrate or chronic stress due to high salinities. The morality rate constant q throughout the period of observation has been computed as 0.00556 where $q = 1 - e^b$ and the cohort half-liter (ln 0.5/b) as 12.16 weeks. With increasing distance form the estuary mouth salinity decreases, water depths vary monotonically over the tidal gradient and tidal disturbance is less influential in dislodging rooted seedlings. Depletion due to these physical factors is less devastating. The seedlings here achieved growth in height of just over a meter in about two years up to the sixth foliage leaf stage.

KENYA-BELGIUM AND EEC - PROGRAMME IN MARINE SCIENCES

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The Kenyan Belgian Project started in 1985. It aimed to make a linkage between equipment, training and research in marine science. It also linked Belgian experts with Kenyan Experts. After 5 years, research is going on in different fields of marine science such as hydrography, plankton, benthos, fisheries, fish physiology, algae and mariculture. Different ecosystems are investigated: mangroves, coral reefs, creeks and the Kenyan coastal zone. The Kenyan Belgian Project is supported by the regional UNESCO programme RECOSCIX - WIO and the Postgraduate training course on Fundamental and Applied Marine Ecology in Belgium. An extension of the project was recently established with the EEC project "Dynamics and Assessment of Kenyan Mangrove Ecosystems". This project involves interdisciplinary cooperation between the KMFRI, the University of Nairobi, The Netherland Institute for Hydrobiological Research, the University of Nijmegen, the Free University of Brussels and the State University of Gent. The international cooperation of the KMFRI will also, in the near future, be extended to participation in a regional UNEP programme on marine pollution.

We hope to extend the existing research programmes in East Africa and elaborate further cooperation researchers from the whole Indian region and Europe.

THE EFFECT OF COASTLINE CHANGES ON MANGROVE COMMUNITY STRUCTURE, PORTUGUESE ISLAND, MOZAMBIQUE

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Mangrove communities are an important vegetation component on Inhaca Island and the nearby Portuguese Island. These communities are undergoing constant change in response to changes in coastline configuration. The most dramatic geomorphological coastline changes are occurring on Portuguese Island as shown by a series of aerial photographs for 1958, 1967, 1985 and 1987. These changes resulted in the closure of the canal leading into the mangrove in 1987 thereby preventing regular exchange of sea water through tidal wash. The only entry of sea water into the mangrove is during occasional spring high tides when the sea manages to breach some adjacent low dunes. A further direct result is the dramatic decline of the area of the mangrove itself (Table 1).

Table 1. Changes in the area covered by mangrove on Portuguese Island between 1958 and 1989.

YEAR	AREA (ha)
1958	110.151
1968	73.866
1985	28.428
1989	26.240

Four woody mangrove species are found on Portuguese Island: Rhizophora muronata, Ceriops tagal, Brugiera gymonorhiza, (all three species belonging to the family Rhizophoraceae) and Avicennia marina (Verbenaceae). No clear zonation patterns are apparent though R. mucronata tends to occur predominantly along the edges of the former canal whilst A. marina occurs towards the outer margins of the mangrove.

Restricted transect and quadrat studies show clearly that selective death of C.tagal is occurring. Although, somewhat in contradiction, C.tagal also has the highest regeneration status. Mortality rates are much lower for the other three species although their regeneration status is also markedly reduced by comparison with a "non- stressed" mangrove on Inhaca Island (Table 2).

Table 2. A comparison of morality and regeneration status of the four woody species occurring in the mangroves of Portuguese Island ("stressed") and Inhaca Island ("non-stressed"). Differences of significance are between "stressed" and "non-stressed" situations (n.s. -not significant, ** = 0.001 < p < 0.001; ***= p<0.001; N= 20 3m x 3m quadrats).

	MORTALITY (%)			REGENERATION STATUS (%)		
	PORTUGUESE ISLAND	INHACA ISLAND	SIGN	PORTUGUESE ISLAND	INHACA ISLAND	SIGN
C.tagal	52.3	3.1	***	38.4	39.2	n.s
R. mucronata	35	12.1	**	19.0	50.2	**
B.gymnorhiza	2.4	2.6	n.s	0	40.1	***
A.marina	0	2.6	n.s	0	22	***

The herbaceous component is also undergoing marked changes. In contrast to similar mangroves on Inhaca Island, where the herbaceous component is sparse or absent the Portuguese Island mangrove is experiencing an invasive spread of halophytic herbs and grasses including Sesuvium portulacastrum, Chelonia diffusa, Arthrochnemum perenne and Sporobolus virginicus.

The morality and regeneration rates are discussed in the context of the known physiological and germination requirements of the individual species. Options for reversing these deleterious trends are considered.

IMPACT ON MANGROVES AND CRABS IN CREEK AND FRINGE MANGROVE VEGETATION DUE TO DISTURBANCES AT THE KENYAN COAST.

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In a macrotidal shore like of the Kenyan coast where the tidal range is about 4m, the distribution or zonation of both mangroves and crabs was related to height of shore level above tide datum. Based on the principal species, the mangrove zonation which was observed in creek mangroves was, in an upward shore direction, as follows: Sonneratia alba J.S., Rhizophora mucronata Lam., Ceriops tagal (perr.) C.B. Robinson, Avicennia marina (Forks:) Vierch. and Lumnitzera racemosa Willd. Going by the commonest genera of crabs occurring in mangroves, the genus Uca by comparison conspicuously occupied lower levels below the mean tide level (1.9m) than the genus Sesarma which occupied higher levels even above the highest spring tide water mark (4,0m) to the maritime environment.

At Ngomeni Prawn Farm, the changes in height of the shore due to excavations altered the horizontal sequence of crab distribution along the surface profile across the shore in the disturbed mangrove forest. However, it was noted that the various species of crabs still occurred in their preferred levels in relation to tide levels. It was observed that recolonization by mangrove was prolific and the trees were robust along the lower sides near the bottoms of the excavated channels that brought seawater into the ponds, but extremely poor at higher shore levels where the vegetation had been clear cut about a decade ago and left unused.

NET PRIMARY PRODUCTIVITY OF TWO MANGROVE FOREST STANDS ON THE NORTH-WESTERN COAST OF SRI LANKA

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Despite the high productivity of mangrove forests, data available hitherto indicate that the primary productivity of these ecosystems vary from one location to another. This paper presents the findings of the first ever study on the primary productivity of Sri Lankan mangroves.

Productivity studies were carried out from September, 1985 to August, 1987 in two mangrove stands, i.e. estuarine and island-fringing, in Dutch bay, a lagoon situated on the North - western coast of Sri Lanka. Net above-ground primary productivity was measured by monitoring litterfall and above-ground biomass increament. The average annual rate of litterfall in the estuarine and island-fringing mangrove stands are 588.14 $g_{-1}m^{-2}$ (approximately 6t ha^{-1}) and 407.33 gm^{-2} (approximately 4t ha^{-1}) respectively.The average annual rate of above - ground woody growth are 614.74 gm^{-2} (approximately 6 t ha^{-1}) in the estuarine stands and 286.8 gm-2 (approximately 3 t ha^{-1}) in the island - fringing mangrove stands. Hence estuarine mangrove stands record a higher annual rate of above-ground net primary production - NPP, (1207.88 $gm^{-2;}$ approximately 12 t ha^{-1}) than the fringing mangrove stands (694.22 $gm^{-2;}$ approximately 7 t ha^{-1}). The annual rate of NPP in the water-front zones of the stands (1300.47 gm^{-2} in the estuarine stands and 874.56 gm^{-2} in the fringing stands) are greater than those in the back - mangrove zones (1115.28 gm^{-2} in the estuarine stands and 513.88 gm^{-2} in the island - fringing stands). These variations may be attributed mainly to the differences in tidal flushing and influence of fresh water in the two localities.

MANGROVES AND SEAGRASS CONNECTIONS - A STATUS REPORT FROM THE ASEAN PROSPECTIVE

FAME.

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Mangroves and seagrass ecosystems are interlinked by functional processes which are incompletely known in the ASEAN region. There is, however, a growing awareness on the part of ASEAN marine scientists that a sound biological advice formulated through studies of interactions at the ecosystem level is needed in order to achieve sustainable use of mangrove/seagrass resources.

This study presents the major accomplishments and current activities of the ASEAN-Australia coastal living resources project. Its focus is an integrated effort to understand better and quantify the functional linkages between mangrove and seagrass ecosystems in the region.

Material exports, high interhabitat similarities, fish, crustacean, and epiphytic community composition, and integrated effects of perturbations provide strong evidence suggesting close functional linkages between mangroves and seagrass ecosystems in the region. Net export from mangroves to seagrass areas (20.1-142.3 g OM per ha) and from seagrass to nearshore habitats (0.92 - 5.54 g OM per sq. m) may provide significant energy input to local benthic energetics. High intersystem species overlap (fish, 27-52%; crustacean, 21-63%; algal epiphytes, 28%) implies close similarity in the magnitude of the principal environmental factors and niche provisions by the two habitats. The current and alarming but largely unquantified effects of both natural and man-induced stresses to these habitats in the region raise serious doubts as to their sustainability and recovery within this generation.

SEAGRASS BEDS FROM SELECTED SITES ALONG THE COAST OF TANZANIA

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The distribution of seagrass beds in Tanga, parts of Bagamoyo, Mafia and Dar Es Salaam area are presented. It was found that there is patchiness in distribution of seagrass beds along the coast. The most common species are Thalassodendron ciliatum, Thalassia hemprichii, Syringondium isotifolium, Cymodoceaa ssp and Halodule spp. Holophila spp. and Enhalus acroides are more restricted in distribution.

The biomass of the seagrasses and associated algae and macrofauna was assessed along two sites in Dar es Salaam. The averaged biomass of the seagrasses in the two sites in Dar es Salaam ranged from 187-3549.6 g per sq. meter and that of macrofauna ranged between 6.6-8.0 g per sq. meter. There is a significant difference in biomass for the different types of seagrasses within each site and also among the sites. Similarly, the biomass of macrofauna found in various types of seagrass beds was different and depended on the biomass of supporting seagrass and associated macroalgae and other environmental factors.

The importance of seagrass beds in productivity of nearshore waters is discussed.

THE SEAGRASS AND ASSOCIATED MACROALGAL VEGETATION OF GAZI BAY (KENYA)

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The seagrass and macroalgal vegetation of Gazi Bay (approximately, 50 km south of Mombasa) have been studied by means of 88 releves along 7 transects. Correlation between the distribution of the seagrasses and of some abiotic factors (particle size fractions, chemical composition of the substrate) are not well marked. Nevertheless a general zonation and succession of seagrasses could be established: 1. A transition zone between the mangrove and the seagrass beds is covered by Boodleopsis pusilla: 2. The pioneer association Halophine ovalis + Halodule wrightii forms low sandy bumps at the upper limit of the seagrass beds, but also occurs in the whole midlittoral where sand-layers have recently been accumulated (e.g. on coral platforms); 3. The climax vegetation of the interdial zone seems to be Thalassia hemprichii which sometimes is associated to Cymodocea rotunda and C. serrulata, certainly in deeper pools and close to low water mark; Halimeda opuntia, Gracilaria salicornia and G. corticata are also frequent in this vegetation type; 4. From MLWN downwards patches of monospecific Enhalus acoroides vegetation can also occur; 5. from MLWS down to approximately - 1m mixed meadows of Thalassia, Cymodocea serrulata, C. rotundata and Haodule uninervis are well developed; the seaweeds Halmeda macroloba and Avainvillea obscure are also typical for this zone: locally patches of Syringodium isoetifolium grow on small bumps and Halophila stipulaccea grows as a pioneer on bare sand: 6. From -1m downwards the whole lagoon is covered by homogeneous, monospecific Thalassodendron ciliatum meadows, locally replaced by Enhalus acoroides.

SEASONAL STUDIES ON THE BIOMASS AND CHEMICAL COMPOSITION OF SEAGRASSES FROM THE HELLSHIRE COAST OF JAMAICA

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Seagrasses from five different sites (Small Point Hellshire Bay, Half Moon Bay Two Sisters Bay and Wreck Bay) from the Hellshire Coast, south-southwest of Kingston harbour, Jamaica were studied for seasonal variation in their occurrence, biomass soluble carbohydrates, proteins and lipid content of the shoots. Of the three seagrasses encountered viz: Thalassia testudinum, Syringodium filiforme and Halodule wrightii, only Thalissia was observed throughout the year at all the sites. The biomass of this seagrass ranged between a high of 380 gm during July to a low of 48 gm during November, both recorded at Half Moon Bay. There was a general increase in the biomass after the rainy season indicating the influx of washed nutrients through the harbour into the Hellshire area. Soluble carbohydrates were generally low and did not exceed 25%. There was an inverse relationship between the carbohydrate content and the biomass. Inverse relationship was also found between the carbohydrate content and protein content at Two Sisters Bay, Half Moon Bay and Hellshire Bay while at the other two sites, the carbohydrate protein ratio was maintained nearly uniform throughout the year. Lipid content was generally high ranging between 6 and 16% of the dry weight but no clear pattern was evident. These results will be discussed in relation to other macrophytes, pollution, erosion and other problems of the Hellshire Coast of Jamaica.

COMPARATIVE ANALYSIS OF SEAGRASS STRUCTURE AND PRODUCTIVITY IN THE ASEAN REGION

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The structure and production rates of selected seagrass species from Indonesia, Malaysia, Thailand and the Philippines were compared using twinspan.

These countries of the ASEAN region belong to one phytogeographic province characterized by a high similarity in the species composition of their seagrass floras (Sorensen & CCs = 50-88%), as well as in the general spatial and temporal distribution of the communities. This may suggest high evolutionary affinity, characteristic patterns of climate, and high similarity in habitat conditions. However, leaf biomass (gDW per sq.m) in Enhalus acoroides (41.5-194), Thalassia hemprichii (11.2-148.4), Syringodium isoetifolium (0.3-30.8), Cymodocea rotundata (14.3-138.4), C. serrulata (5.3-118), and Halodule uninervis (1.9-38) differed significantly between the Philippines and Indonesia, suggesting site-specific community responses and/or differences in the procedures used. Production rates (gC per sq. meter per d) were 0.68 in E. acoroides, 0.15 in C. rotundata, and 0.13 in T. hemprichii. These values are comparatively lower than previously reported.

The need for more ecological studies an ASEAN seagrass systems is emphasized as a key to a better understanding of their functional role in the coastal environment of the region.

PHYTOPLANKTON OF THE PITCHAVARAM MANGROVE AREA, SOUTHEAST COAST OF INDIA: SPECIES COMPOSITION AND POPULATION DENSITY

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Species composition of phytoplankton of the Pitchavaram mangrove area was impressive. A total of 83 species were recorded from here. These comprised of 67 species of diatoms, 12 species of dinoflagellates, 3 species of blue greens and a single sppecies of green. The diatoms and dinoflagellates were the dominant groups; the former constituting 72% followed by the latter, constituting 14.46%. Autochthonous (temporary and permanent) and allochthonous species were also identified.

Phytoplankton population density exhibited a wide seasonal fluctuation recording maximum density (360 cells/l) during monsoon season and maximum density (784,320 cells/l) during summer season. Phytoplankton density showed a positive significant relationship with temperature, salinity, pH, dissolved oxygen and chlorophyll a and a negative significant relationship with bacterial and myco populations, phosphate, nitrate and silicate.

CONSUMERS IN MANGROVE ECOSYSYTEMS

THE ECOLOGY OF MEIOFAUNA IN MANGROVES: A REVIEW OR ONLY A START?

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The ecology of the benthos of mangrove ecosystems has attracted the attention of many marine biologists in last years, but so far, the meiofauna (metazoans less than 1 mm) has been largely ignored.

Less than 10 papers give quantitative information on the meiofauna of mangroves. Most previous meiofaunal studies describe taxonomic features of these animals; nevertheless, it will take several years to complete taxonomic work of these highly diverse, and endangered biotopes.

The ecological surveys (from Florida, Australia, Asia) show that the meiofauna - which is dominated taxonomically and numerically by nematodes - is abundant and fall within the range (10^5 to 10^7 ind./10 cm^2) reported for meiofauna from other intertidal habitats. This suggest their combined effects on nutrient re-cycling may be highly significant.

PRELIMINARY OBSERVATIONS ON THE LITTORAL-BENTHIC MEIOFAUNA IN A MANGROVE ECOSYSTEM IN THE KENYA COAST WITH SPECIAL REFERENCE TO THE HARPACTICOID COPEPODS (CRUSTACEA).

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The meiofauna community of an intertidal mangrove environment was studied for a 3-month period. The major taxa were identified.

The harpacticoid copepod (Crustacea) fauna was identified to the species level and the change in abundance was determined with change in depth. Five taxa were identified, Nematoda, Copepoda, Gastrotricha, Polychaeta and Turbellaria. Six families consisting of nine species of harpacticoid copepod fauna were identified.

There was a decrease in abundance with increase in depth. Results show that there is a discrete pattern of vertical distribution of harpacticoid copepod fauna.

THE ZOOPLANKTON COMPOSITION IN A MANGROVE CREEK DURING A TIDAL CYCLE

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A 24 hour cycle was carried out on 2 and 3 April 1985 at English Point, a near shore sampling site in Tudor Creek, Mombasa.

Zooplankton surface samples were taken every two hours with a 55 um mesh net. Salinity, surface temperature and oxygen content were measured.

Oxygen concentration and salinity fluctuated parallel with the tidal cycle. Temperature changed in function to the exposure to daylight.

The encountered zooplankton taxa were identified and Copepoda were identified to species. Copepoda comprised the major part of the total zooplankton. The Mollusca (Bivalvia and Gastropoda together) were the second most important group. Nearly all the encountered zooplankton taxa showed diel and tidal fluctuations. The zooplankton showed a density increase at 11.30 hrs and an even higher increase at 23.30 hrs, both halfway during the incoming tide. During daytime, a third zooplankton density peak is noted halfway during the outgoing tide. This peak is caused by an increase of Copepoda. Of the 25 copepod species encountered five were present throughout the 24 hours: Paracalanus crassirostris, Paracalanus aculeatus, Harpacticella sp., Oithona sp. and Microsetella norvegica.

A NOTE ON VARIATIONS OF ZOOPLANKTON POPULATION DISTRIBUTION AND DIVERSITY IN A MANGROVE CREEK SYSTEM GAZI, KENYA.

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Zooplankton population distribution was studied in relation to hydrographic conditions of pH, temperature and dissolved oxygen at Gazi creek during the earlier months of the North-East Monsoon.

Preliminary results show that there is a large diversity of zooplankton groups. Copepods make up the majority with an abundance of 80% to 90% of the total zooplankton population. Thirty five different groups of zooplankton have been identified at genus level so far and among them fifteen species of copepods. Although zooplankton is rich and abundant at Gazi, species number and abundance decrease up the creek, suggesting an ecological gradient. On average, a 25 ml of surface water sample from the creek mouth contained 951 individual zooplanktons whereas that from up the creek contained only 453. Similarly, the creek mouth had 9 dominant groups compared to only 4 up the creek. The surface temperature increased from 29.5 to 31.0 °C and dissolved oxygen from 4.93 to 5.25 mg/1 up the creek corresponding to the decrease in species number and abundance.

STUDY OF THE MEIOBENTHOS IN FIVE MANGROVE VEGETATION TYPES IN GAZI BAY, KENYA.

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The vertical distribution patterns of the meiofauna (smaller metazoans) within the sediment of five mangrove vegetation types in Gazi Bay is described in relation to environmental parameters such as sediment characteristics and nutrients.

The Avicennia marina bottoms consist of 95% sand (with a median grain size of the sand fraction ranging between 250 and 550 μm) and 5% silt. The meiofauna is dominated by the nematodes, with highest densities in the top cm of the sediment (700 ind./10 cm^2) and lower numbers in the deeper layers (200 ind./10 cm^2 in each centimeter). Ostracods, polychaetes and rotifers are important in numbers too. The total density is 3500 ind./10 cm^2.

The Bruguiera gymnorrhiza bottoms consist of 99% sand (median grain size between 250 and 360 μm) and less than 1% silt. The meiofauna is dominated by nematodes, with copepods, gastrotrichs and rotifers as subdominant. The vertical profile is characterized by the highest numbers between the third and the tenth centimeter within the bottom for nematodes (1240 ind./10 cm^2) and copepods (325 ind./10 cm^2). In total, 6700 ind./10 cm^2 of meiobenthic animals are found.

The Ceriops tagal bottoms are homogeneous sandy sediments (98%, median grain size between 300 and 360 μm) with a silt content less than 2%. The meiofauna consists mainly of nematodes, which have an even distribution along the vertical profile (around 200 ind./10 cm^2 per cm). The total density of the meiofauna is 2000 ind./10 cm^2.

The Rhizophora mucronata bottoms have more silt than the others (between 2 and 7% silt) and the median grain size is between 200 and 300 μm. The nematodes are the dominant group with an even distribution along the vertical profile. The total density of the meiofauna is 4000 ind./10 cm^2.

The Sonneratia alba bottoms consists of 2 and 8% silt with a median grain size between 300 and 630 μm. The meiofauna consists, except for the top centimeter, only of nematodes. The vertical profile of the meiofauna shows a clear decrease in numbers to the depth. The total density is 3000 ind./10 cm^2.

The biomass values of the nematodes are discussed in function of the density patterns with sediment depth. The root systems of the different mangrove vegetation types are very important in structuring the meiofauna

STUDY OF THE ZOOPLANKTON DURING A TIDAL CYCLE IN GAZI CREEK, KENYA.

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Three 24 hour cycles were carried out in August 1989 in Gazi Creek, Kenya Gazi Creek is a tidal mangrove Creek, situated South of Mombasa. Zooplankton samples were taken at 4 hour intervals.

The first part of the study includes density, diversity and respiration measurements of zooplankton during three 24 hours cycles. Abiotic parameters (salinity, temperature and oxygen saturation of the water) were measured at the same time.
From variations of salinity and oxygen concentration with the tide, it appears that the watermass is almost completely renewed at each high tide.

The most common zooplankton group are the nauplii. Oithona brevicornis in the most abundant copepod species.
The density and diversity of the zooplankton are also influenced by the tidal system. Presumably several zooplankton groups perform vertical migrations to the bottom to avoid being washed out to the ocean.
The highest zooplankton densities are measured at low tide, especially at night. With high tide a diluting effect seems to occur, in addition to a current driven movement of zooplankton groups.

The respiration of plankton per unit dry weight did not show any definite day/night rhythm.
The second part of this work is a study based on the morphological structure of the feeding appendages of three calanoid species. This gives information on the habits of these species. According to the results, Tortanus capensis can be defined as a carnivore species. Acartia natalensis and Pseudodiaptomus stuhlmani on the other hand show a more omnivore character.

MANGROVE-ROOT EPIBIONTS: PATTERNS OF DISTRIBUTION AND ABUNDANCE, AND EFFECTS ON MANGROVE ROOT GROWTH IN BELIZEAN MANGALS

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Mangrove ecosystems are considered to be primarily decomposer-based ecosystems. The importance of direct and indirect plant-animal interactions in these ecosystems only recently has begun to be addressed. The aerial prop roots of the neotropical red mangrove, Rhizophora mangle L., begin growing well above highest high water and often extend well below lowest low water (LLW) before rooting in benthic substratum. In Belize, Central America, prop roots that extend below LLW are colonized and fouled by diverse assemblages of animals and plants, including macroalgae, hydrozoans, bryozoans, ascidians, sponges, anemones, hard corals and isopod crustaceans. We studied the distribution and abundance of these epibionts on mangroves growing in estuaries on the southern coast of Belize, and on mangrove cays between the mainland and the Belizean barrier reef. We also experimentally examined some effects of these epibionts on mangrove root and whole plant growth.

Overall species richness of mangrove-root epibionts increases with increasing distance from the mainland and decreasing distance from the barrier reef. In Placencia Lagoon, a mainland estuary, we found only five epibiont species living on mangrove prop roots. In contrast, at Twin Cays, 25 km east of the mainland, we found 17 species of algae, 10 sponge species, 8 cnidarians, and 12 ascidians on prop roots. Mangroves at Lark Cay, only 7 km off-shore, had an intermediate level of epibiont species richness. There is no vertical zonation of species on mangrove roots, but overall species composition on roots varied between January 1988 and January 1990. This variation in species composition is

correlated with seasonal salinity changes in Placencia Lagoon and around off-shore cays. Ascidians, sponges, and anemones transplanted from Lark Cay into Placencial Lagoon failed to survive, but reciprocal transplants from Placencia Lagoon were able to survive off-shore. The benthic gastropod predator Melongena melongena, present only in mainland estuaries, also had a negative effect on root-epibiont species richness in these estuaries. Wood-boring isopod crustaceans are also prominent members of the root-fouling community. In the mainland estuaries, Sphaeroma terebrans (Sphaeromatidae) is the most common isopod, while limnoriid isopods are more common on the cays. These isopods damage root apices and reduce root relative growth rate (RGR_{root}) by up to 60%. On off-shore cays, negative effects of these isopods are ameliorated by sponges and ascidians. In the mainland estuaries, where epibionts are less common, isopod damage to mangrove roots is much more severe. In addition to inhibiting isopod colonization, sponges and ascidians increase RGR_{root} by upto 3-fold relative to roots lacking these epibionts and protected from isopods. The mechanism for this facilitation of root growth is unknown, although preliminary evidence indicates that sponges may be nutrient sources for mangrove roots. Hydrozoans and coralline algae reduced RGR_{root} by 50% relative to unfouled controls.

Mangroves, root-fouling epibionts, root herbivores, and benthic predators are involved in a complex web of interactions that are major determinants of mangrove growth and production. We have used a combination of observational, correlative, and experimental studies to develop an understanding of the importance of these interactions in Belizean mangrove swamps. Similar studies in mangrove swamps throughout the world would help to clarify the importance of plant-animal interactions in these widespread tropical ecosystems.

SIZE OF THE MANGROVE OYSTER (CRASSOSTREA CUCULLATA, OSTREIDAE), IN A MANGROVE CREEK (GAZI, KENYA) IN RELATION TO ENVIRONMENTAL PARAMETERS.

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In a study of the influence of environmental factors on the size of Crassostrea cucullata, the length of 956 oysters, growing along two transects in the mangrove creek in Gazi were measured. Length is defined as the distance from the centre of the hinge to the farthest point on the opposite end. Measurements were made with calipers, to the nearest 0.1 mm. Both transects were located near the entrance of the creek, on opposite sides of the main channel. For each of the measurements, a number of parameters were recorded : species of the mangrove tree and diameter of the branch serving as a substrate, approximate density of the oyster growth, height above the bottom, height above datum, and orientation with respect to the main current.

A regression analysis was performed to try to correlate length with each of these parameters separately. The species of mangrove tree, diameter of the branch substrate and the orientation appeared not to be of importance. For the density, the length was not influenced up to a cover of 70%. For densities higher than 70%, there was a fairly strong negative correlation (r^2 =0.674).

Length seemed not to be correlated with height above bottom for heights higher than 20 cm. The oyster length at lower levels is smaller than the lengths at higher levels.

The correlation with height above datum was negative but very low (r^2=0.060). However, if all measurements of oyster closer than 20 cm to the bottom, and all from a density of more than 70% are deleted from the data set, the correlation increased dramatically, the slope still being negative (r^2 =0.850, n=544).

So height above datum, and thus percentage of time immersed, seems to be the primary factor determining the length of the oyster. This relationship is obscured by the influence of crowding, and proximity to the bottom.

VARIATIONS OF FORM OF Crassostrea cucullata AS RELATED TO ENVIRONMENTAL PARAMETERS.

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Fourier analysis was used to describe the circumference of oysters of the species Crassostrea cucullata growing in the mangroves of Gazi Creek. The result of the Fourier analysis is a set of coefficients, that can describe the form with any degree of precision, depending on the number of coefficients calculated. These coefficients were compared for the different specimens, using cluster analysis. The different groups of oysters resulting from the cluster analysis were then compared with environmental parameters.

The dataset was collected by taking photographs of 85 oysters, all growing in a limited area of 10 x 10 meter. Only oysters were taken that did not touch any other oyster, so that alteration of form caused by competition for space is not influencing the results.

The environmental parameters considered were (1) the species of mangrove tree on which the oyster was growing (Avicennia marina, Rhizophora mucronata, Brughiera gymnorrhiza, and Sonneratia alba), (2) orientation with respect to tidal currents (parallel or perpendicular), (3) diameter of the mangrove branch serving as substrate (diameter less than 30 mm or more than 100 mm), and (4) height above datum (continuous measurement).

The classification of the 85 oysters by cluster analysis is highly correlated with both height above datum, and diameter of the substrate. The correspondence of the clusters with substrate diameter is virtually perfect (only one misclassification out of 85). For the clusters based on the height measures, 9 oysters, for intermediate levels for this parameter (between 3.05 and 3.13 m above datum), were distributed over the two groups, but all the others were correctly classified.

The correspondence between the groups obtained by cluster analysis and the other environmental parameters was less outspoken. Mangrove species did not seem to have an influence whatsoever on the form (although there is a clear influence on the density). For the orientation with respect to tidal current, there were eleven misclassifications.

ECOLOGICAL NOTES ON Mida Creek (Kenya) DECAPOD CRUSTACEANS.

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Zonation of decapods reflects the trophic level they occupy in the mangrove food-web: at higher intertidal levels - above high water spring - the only decapod species encountered are the leaf--eaters Cardisoma carnifex (Brachyura, Gecarcinidae) and Sesarma meinerti (Brachyura, Sesarmidae), both powerful burrowers. At intermediate levels - from high water spring to low water neap, including thus all the lower mangrove belt - species diversity is the highest, most decapods being detritivorous and/or predators. Among brachyurans, the detritivorous, Oocypode ceratophthalmus, Dotilla fenestrata and two species of Uca (Ocypodidae) are very common. Predators are represented by several species: 2 species of Metopograpsus (Grapsidae), Sesarma elongatum (Sesarmidae), living mostly on trees, Thalamita crenata Scylla serrata (Portunidae) and, living in burrows, Epixanthus dentatus and Ozius guttatus (Xanthoidea), hidden among mangrove roots. Anomurans are very common among the lower mangrove belt: they are represented by two species of Paguridae (Clibanarius longitarsis and C. laevimanus), detritivorous, and by an unidentified species of Porcellanidae, filter-feeder. Natantia are finally represented by some species of mud burrowers Alpheidae and by an extraordinary air-breathing shrimp, Merguia oligodon (Hippolytidae), living among mangrove roots.

Very little relationship seems to exist between the above intertidal species and the lower intertidal or subtidal ones. In the area between low water neap and low water spring levels (a mud platform, 100-200 m wide, with mangroves) other decapods are actually present (Portunus pelagicus - Portunidae ; Eriphia smithii - Xanthidae, Pilumnus vespertilio - Pilumnidae, etc.) but they never venture near the mangrove belt nor the mangrove fauna seems ever to enter such long seawards migrations.

Upper species activity is only affected by day-night cycle while more intertidal species are mostly affected by tidal cycle. During low water, Metopograpsus and S. elongatum are active predators on trees and the two Xanthoidea on mud, while during high water, ground predation is monopolized by Portunidae.

The three systems seem then quit independent from each other. Most of the species are isospatial, preferring to hide during high water (if air-breathing) or at low water (if water-breathing) instead of migrating up and down as isophasic species do. This strategy obviously reduce the chances that species from different levels may interact with each other.

Mangrove leaves are the direct dietary inputs at the first level, while leaves, wood and barks detritus (together with associated saprobionts and algae) support the food web at the second level (predators feeding mostly on local detritivorous as Anomura, Gastropoda and small Ocypodidae) and local detritous accumulation, benthic and perhaps pelagic fauna, is probably responsible for the dietary input of the lowest level fauna.

Many common species of decapods (Sesarma guttatum, S. smithi, S. eulimene, S. ortmanni) were not found in the area under study. Better knowledge on the decapods ecology and mangrove systems are needed in order to understand the adaptive value of the observed zonation patterns and the real role of decapods in the energy flow of Kenyan mangroves.

DISTRIBUTION & ABUNDANCE OF THE MACROZOOBENTHOS IN GAZI MANGROVE SWAMP, KENYA.

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Studies were made on the macrozoobenthos inhabiting Gazi mangrove swamp on the south coast of Kenya. Stratified random sampling using replicate quadrats was employed and all animals to a depth of 10cm were counted.

A clear pattern of zonation was established for the fauna within the mangrove zones (landward sand flat, Lumnitzera, Avicennia, Ceriops, Rhizophora, mud bank).

Discriminant analysis shows that particle size, organic content and water content of the sediment are the most important factors determining the species composition and population structure of the zoobenthos.

The observed species distribution and abundance in the Gazi mangrove swamp is similar to those reported for other areas of the Western Indian Ocean.

grain size

1.9 (mm ?)

1.4

$\phi = -\log_2$ mm ?

pH
‰
org cont
part. size
water cont.
sed:

Fe
Mn
Zn

80 m

4-5

CKAR

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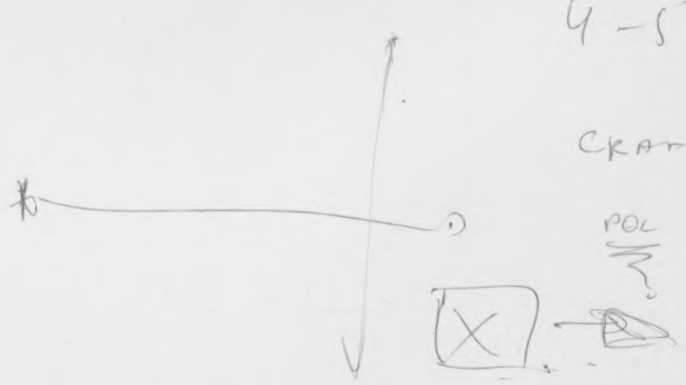

SOME OF THE FACTORS AFFECTING THE DISTRIBUTION AND ABUNDANCE OF THE MANGROVE CRAB, Uca lactea (MILNE EDWARDS) IN THE KUNDUCHI MANGROVE CREEKS, DAR ES SALAAM, TANZANIA.

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The density of Uca lactea in the Kunduchi mangrove forest was determined and correlated with percentage pore water, percentage organic content and median sand grain size of the sediment. The number of crabs ranged from 0-33 crabs/m^2 in low density areas, 44-89 crabs/m^2 in medium density and 100 - 244 crabs/m^2 in high density areas. The density was found to correlate strongly with the percentage pore water in areas sampled. The regression lines of density as a function of pore water suggested an existence of a critical pore water content between 9.7% and 11.4%.

Similarly, the density of crabs was observed to correlate with organic matter content of the sediments which ranged from 0.3% to 6.4%. However, the correlation was weak in some areas. The density of crabs displayed strong negative correlation with sand grain size in some areas only. This relationship was not observed in areas where the organic matter was not correlated with sand grain size.

Possible explanation for the observed differences within and between areas are discussed. There seem to exist a specific interplay between percentage pore water, sand grain size, percentage organic matter and probably other factors to determine the density of Uca lactea in the Kunduchi mangrove forest.

RELATIVE GROWTH AND DIET COMPOSITION IN THE MUD CRAB SCYLLA SERRATA

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Relative growth of 3 meristic characters, i.e. carapace width, abdomen length and width and claw length and width was investigated in a sample of Scylla serrata inhabiting the Shimoni mangrove swamp in Kenya. The diet composition of S. serrata was also determined and compared with that of another portunid crab Thalamita crenata which occurs in this mangrove swamp.

Female S. serrata exhibited a positive allometric growth of carapace width, which facilitates an increase in internal carapace volume, to accommodate the maturing ovaries which spread laterally. Male carapace width had a constant (isometric) growth rate because testicular development does not involve lateral propagation.
The male abdomen maintained an isometric growth relationship because it mainly serves as a protective cover for the gonopods. In females it is used for brooding eggs hence a positive growth rate increase in its length and width maximizes fecundity.
The chelipeds are used for feeding. This involves tearing at byssal threads of attached Pelecypoda and crushing their shells. A high positive growth rate increase serves to produce a powerful structure which can generate the forces required for crushing these shells.

The diet of S. serrata consists of Crustacea, mainly Ocypodid and grapsid crabs, Pelecypoda, Phaeophyta and seagrasses. Although T. crenata, utilizes the above foods, competition is minimized because S. serrata is a nocturnal crab while T. serrata feeds more actively during the day.

BIODETERIORATION OF MANGROVES BY WOOD BORERS AND THEIR CONTROL

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Mangroves are endangered ecosystems on account of their destruction by human activities. Further, massive infestation by bacteria, fungi and wood-boring animals cause extensive damage to the mangroves all along the coasts of India. Hence, the present investigation was made to study the intensity of biodeterioration by wood-borers from Pichavaram mangrove forests, South-east coast of India. Sphaeroma terebrans Bate. (Crustacean, Isopod), is the most predominant wood-borer in the mangrove woods. Studies were also made to control the wood-borer using 21 marine plant extracts. This paper emphasises the important area of marine bioactive compounds as wood preservatives.

CORAL REEF ECOSYSTEMS

PHASE SHIFTS IN CORAL REEF COMMUNITIES AND THEIR ECOLOGICAL SIGNIFICANCE

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Many coral reefs around the world have degraded to a degree that their present intrinsic values and utility are greatly reduced: mass coral mortality followed by algal invasions, local depletions and extinctions of reefal fisheries, deficit of reef accretion compared to physical and biological erosion. Though we can identify proximal causes (outbreaks of coral predators and eroders; over-fishing; habitat destruction), we do not have a good understanding of how population, community and ecosystem structure and function differ in degraded from un-degraded reefs. The deficiencies in our understanding limit our ability to interpret the long-term significance of reef degradation, and therefore to develop scientifically based plans for conservation and management of reefs.

A particular course of action, or lack of action, based on uncritical acceptance of either of two widely held but opposing views of temporal variability can lead to further deterioration of specific reefs. Neither of these views - that reefs are either inherently stable and fragile, or inherently unstable and resilient - is universally true. This presentation reviews various studies to derive a unifying model which describes temporal changes in sessile benthic populations and communities on coral reefs. The model places degradation in the context of a reef's full range of possible structure and function. Reefs can be knocked precipitously or move slowly from one phase (coral-dominated) to another (coral-depleted and/or algal dominated). Transitions in the other direction ('recovery') involve changes (e.g. succession) in populations and communities (of all reef-associated biota, not just sessile benthos), and in reef function (e.g. community metabolism, trophodynamics) which are of great intrinsic interest but only poorly apprehended.

A TAXONOMIC AND ECOLOGICAL STUDY OF SCLERACTINIAN CORALS ON THE KENYAN REEF FLATS

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The intertidal reef flats along the Kenyan coast are exploited for fishing, shell collecting and recreational purposes such as snorkelling. The study areas Vipingo, Kanamai, Nyali and Shelly Beach are part of the fringing reef off the Kenyan coast and all have been subjected to exploitation by local fishermen using traps and spears for fish, octopus, lobsters etc. The Nyali study area has recently become a protected area within the Bamburi National Park.

Corals are a prominent feature of the intertidal flats and this study involved surveys on the presence of coral species and their taxonomy at each site by use of snorkelling and reef walking during the low spring and neap tides. The coral genera common to all the four study sites are Pavona, Favia, Galaxea, Pocillopora Astreopora, Seriatopora and Porites. Kanamai appears to be the least diverse of the 4 sites. A total of twenty-three genera have been identified and these could be indicator species that are tolerant to environmental interference.

THE INCIDENCE OF HURRICANES OF THE NORTH COAST OF JAMAICA SINCE 1870: ARE THE CLASSIC REEF DESCRIPTIONS ATYPICAL?

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The study of coral reefs in Jamaica was established by T.F. Goreau, who worked at the University of the West Indies from 1951 to 1970. His students and colleagues continued to use the Discovery Bay Marine Laboratory, which he founded, and a considerable body of literature emerged in the 1960's and 70's. Several reef zones more dominated by luxuriant stands of Acropora spp., as documented in classic descriptions by Goreau and his colleagues (1959, 1973). For more than 30 years, the reefs suffered no serious hurricane impact, and these corals thrived. On the south coast, Goreau had described the effects of a 1951 hurricane, and others passed close by. Hurricanes were believed to be "rare" on the north coast, and the impact of Hurricane Allen in 1980 was greeted as an unusual and catastrophic event.

Published records of storm tracks indicate that, in the last 120 years, at least 30 hurricanes have passed within 200 nautical miles of Discovery Bay. In the absence of information on their intensity, an approximate measure of their impact is the reciprocal of their closest distance. Recent experience suggests that piccage within about 40 miles, whether to the north or the south, generates waves capable of destroying Acropora palata stands. 13 hurricanes have passed that close to Discovery Bay in the last 120 years, with a median interval of 7 years. Large colonies of A. palata (over 1m high) would take about 12 years to develop. The total period in which the reef have been free of major disturbance for more than 12 years is only 33 years, 28% of the total period. The longest such interval since 1874 is one of 36 years, from 1944 to 1980. The luxuriant Acropora stands of the classic descriptions may therefore be atypical; one extreme of a variable condition.

IMPORTANCE OF THE LAC-LAGOON ON BONAIRE (NETHERLANDS ANTILLES) FOR REEF FISHES

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During May - November 1981 for 16 reef fish species length, distribution and abundance were studied. Abundance was determined using a visual census technique.

Sic 'biotopes' were studied, viz. seagrass beds (Thalassia testudinum) and mangroves in the lagoon and four depth zones on the reef.

From mutual comparison it appeared that the seagrass beds form the most important biotope for the juvenile stages of four fish species, viz. Haemulon flavolineatum, H. sciurus, Ocyurus chrysurus, Sparisoma viride and Acanthurus chirurgus, while mangroves are important for four other species, viz. Lutjanus apodus, L. griseus, Sphyraena barracuda and Chaetodon capistratus. For five species the lagoon seemed to be less important, viz. Haemulon chrysargyreum, Lutjanus mahogoni, Abudefduf saxatilis, Acanthurus behianus and A. coeruleus; their juveniles mainly use the shallow reef. Of two species (Haemulon carbonarium, Anisotremus surinamensis), of which adults were only found on the reef, too little juveniles were found to draw conclusions. For some species periodicity and/or growth could be derived from the obtained data.

LAND-BASED POLLUTION AND ITS IMPACT ON CORAL REEFS AND RELATED ECOSYSTEMS: THE CARIBBEAN EXPERIENCE.

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Over the last 15 years, the Caribbean has experienced major changes both culturally and economically. Most of the Caribbean island nations, as well as Belize, are turning to tourism as the mainstay of their economies. Tourism depends on coastal zones which are environmentally healthy. However, these changes are resulting in degradation of coral reefs and their related ecosystems, mangroves and seagrasses. The coral reefs throughout the Caribbean are rapidly dying, being smothered in algae and slowly collapsing. Although there are a number of complex interrelated causes for this phenomenon, land-based pollution is believed to be the major cause. This is primarily from nutrient enrichment of nearshore marine waters associated with improperly or untreated domestic sewage originating from major urban areas and from tourism developments. The world's tropical waters are nutrient poor and ecologically thrown out of balance by this enrichment. Second in importance in causing coastal degradation is believed to be pollutants associated with agricultural runoff including sediment, pesticides and fertilizers. The solutions are obvious. Some, such as appropriate sewage treatment and disposal, will be capital intensive. Others will require changing traditional practices (e.g. small farmers) and will be slow in coming. Although, donors and decision makers are beginning to become sensitized to these issues, no one to date has put forth the level of effort of finances necessary to have a positive impact in helping to conserve the Caribbean's coastal zone. If immediate and large scale efforts are not put forward, not only does the world risk to see the collapse of an entire ecosystem, the Western Atlantic's coral reefs, but the collapse of the tourist industry on which most of the Caribbean is counting on for its economic future.

African coastal countries and Indian Ocean nations who wish to develop long term sustainable coastal tourism, have many lessons to be learned from the shortsightedness of the Caribbean in this area.

ABUNDANCE AND SPECIES RICHNESS OF CORAL REEF FISH ON THE KENYAN COAST: THE EFFECTS OF PROTECTIVE MANAGEMENT AND FISHING

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Underwater censuses were used to measure species richness and abundance of coral reef fish at nineteen study sites on the Kenyan coast. While species richness was highest in marine parks where no fishing or collecting is allowed, the same was not true for fish abundance, or for biomass of commercially important fish. Some of the highest densities and weights of fish were recorded from the marine reserves where traditional fishing methods are allowed. Areas with higher fishing intensities had smaller standing crops of fish, but not comparably smaller abundances. This suggests that average fish size is lowered by more intense fishing. Two factors, siltation from rivers and dynamite "fishing," have a major impact on the fish communities. Reefs badly damaged from dynamiting including Mako Kokwe in the marine park, are characterized by low species richness and a low biomass of commercially important species. At Malindi, densities and biomass of fish were of a similar magnitude to dynamited reefs, despite the prohibition of all fishing and collecting for the last 20 years. The reef has been subjected to a heavy influx of sediment from the Sabaki river since the early seventies.

Thus, the effects of protection and fishing on reef fish assemblages were confounded by other major impacts on Kenya's reefs, namely siltation and dynamiting.

REGIONAL COOPERATION IN SCIENTIFIC INFORMATION EXCHANGE IN WEST INDIAN OCEAN REGION

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The Intergovernmental Oceanographic Commission (IOC) of Unesco in February 1989 initiated a project called RECOSCIX-WIO or Regional Cooperation in Scientific Information Exchange in the Western Indian Ocean Region. The project's main objectives are (a) to provide marine scientists with relevant and up-to-date scientistic publications; (b) to improve communication between marine scientists within this region; (c) to promote contacts between marine scientists from within and outside this region; and (d) to improve the link between marine scientists in this region and other institutions or organizations, including the international organizations.

Fourteen marine science institutions in eight countries of the region and eight marine science libraries outside the region are now participating in the project. A regional dispatch centre is hosted by the Kenya marine and Fisheries Research Institute, located in Mombasa. This dispatch centre acts as a traffic controller for the information coming to and going of the region in the framework of the project.

The project provides the following services:

- Query handling: request for information on specific topics can be sent to the RDC where searches are made in local (ASFA CD-ROM) and remote (on-line DIALOG) data-bases. Abstracts are sent to the requester on diskette or paper.
- Document delivery: request for hard copies of scientific publications can be obtained through the network of libraries in and outside the region.
- Special publications: for special occasions like symposia, conferences, courses, etc. special bibliographies can be prepared.
- Special products: a directory of marine scientists has been prepared. This directory is available on paper or in computer searchable format. The directory contains practical information (address, phone, etc.) and information on the scientist's scientific interests (subjects).

RECOSCIX-WIO also publishes a newsletter 'WINDOW'. The main objectives of this publication are (a) to publicize the project in and outside the region; (b) to publicize marine science institutions in- and outside the region; (c) to publicize the activities of other organizations active in this region; and (d) to provide any information which may assist marine scientists in this region with their work (training, conferences, funding possibilities,..).
'WINDOW' is a quarterly publication and is printed in 500 copies of which 140 are mailed to individual marine scientists within the region.

NUTRIENT CYCLING , CHEMICAL AND PHYSICAL PROCESSES

HYDRODYNAMIC OF TROPICAL COASTAL MARINE SYSTEMS: MANGROVE SWAMPS AND CORAL REEFS

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Fringing mangrove swamps play a key role in controlling the tidal hydrodymanics, flushing rates and sedimentation patterns of tropical estuaries. These swamps generate an asymmetry of tidal currents in both the tidal channels and the swamps. The flushing rates of these estuaries is determined by the lateral trapping effect in fringing mangrove swamps. Secondary currents aggregate floating material such as mangrove litter. In the dry season in the presence of a vast mangrove swamp, evapotranspiration generates an inverse estuarine circulation if there is negligible freshwater runoff, or a salinity maximum zone if there is measurable freshwater runoff. In the latter case, estuarine waters can be totally isolated for several months from oceanic waters. In the former case, the baroclinic circulation traps high salinity mangrove water and its detritus near the bottom where anoxic conditions can result. Groundwater flow plays an important role in the chemical, nutrient and salinity budget of mangrove creeks and this process is enhanced by the presence of numerous crab burrows.

The physical and chemical characteristics of water masses in coral reefs reflect not only those of the surrounding offshore waters, but also reef-driven influences. Reefs modify the water circulation not only in their immediate surroundings but also that in offshore waters many diameters away from the reef. Important effects that will be described include upstream blocking effects and downstream eddies and that this circulation is strongly three-dimensional and controls the trapping and aggregation of floating particles such as coral eggs. The circulation introduced by breaking waves on the reef crest remain poorly known. When this wave-induced circulation is small, reliable numerical models are now available to estimate flushing properties of coral reef lagoons. Flow through the reef substrate may also be important in the nutrient budget of coral reefs. Upwelling has been identified as a major nutrient source in many reef areas, and mechanisms include the spur-and-grove pumping, the endo-upwelling in deep oceanic atolls, wind-driven shelf-scale upwelling, topographically enhanced internal tides at the shelf break, the tidal jet effect, and boundary mixing. Our ability to reliably model the fate of buoyant particles (coral eggs, oil...) near coral reefs is still poor because of the strong small coals three-dimensional water circulation around reefs.

A RESIDUAL CIRCULATION MODEL OF GAZI CREEK, SOUTH COAST, KENYA

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A model, 2-dimension in the horizontal plane but averaged over the vertical dimension has been developed for the residual circulation in the Gazi creek.

Simulations were done (with the stream function equations) assuming (1) an initial stream function of 5000 $m^{3}s^{-1}$ along the creek boundaries, and (2) a rigid bottom boundary so that bottom velocity is zero. The simulations have been done until equilibrium was achieved with various initial and boundary value conditions using a successive over-relaxation (SOR) finite difference iterative scheme. The optimal value of the over-relaxation coefficient was found as 0.4.

Circulation patterns obtained match observations fairly well. Small transport gradients, corroborating the mangrove presence, were obtained in the creek interior. The intensity of the stream function increases towards the open sea due to the steeper depth gradients yielding as one would expect, higher transport gradients. The treatment of the creek with Chale Island gives the more realistic results, compared to the case without the island.

PHYSICAL PROCESSES IN THE RUFIJI DELTA AND THEIR POSSIBLE IMPLICATIONS ON THE MANGROVE ECOSYSTEM

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The physical processes such as coastal currents, estuarine circulation and monsoon winds prevailing in the Rufiji Delta are discussed. The relationship between these processes and the occurrence of long-term trapping of the river discharge and the outwelled waters from the mangrove swamps in the nearshore has been observed. The trapped water in the nearshore zone significantly reduces the mixing between the estuarine and offshore waters, leading to the two waters having distinctive properties. The existence of the zone is supported by evidence from aerial photographs and measurements of salinity and suspended sediments concentration.

The trapping phenomenon is discussed in the light of its possible implications on the ecology of the mangrove ecosystem. This may explain the enhanced growth of the mangrove in the delta compared to other areas. This trapping effect may be providing more time for: nutrient retention in the mangrove zone, incorporation of the decomposed leaf litter and fine sediments in the substrate, and settling of fruits and seedlings in the swamps, (thereby enhancing the regeneration of the mangroves). However, with increase of agricultural projects in the Rufiji basin, it is suggested that the fishery industry in the delta may be getting adversely affected as a result of accumulation of land-based pollutants due to trapping effect.

SEAGRASS MEADOWS AS TRAPS OF SESTON AND DISSOLVED NUTRIENTS

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Seagrass meadows have a high nutrient demand, connected with their high annual production. The nutrients involved, however, are not all retained within the seagrass beds. A series of processes lead to nutrient losses from the seagrass bed, such as export of leaf material with currents, leaching losses from living and senescing plants and nutrient transfer by mobile foraging animals. Obviously, the persistence in time of most seagrass meadows points to an existing balance between nutrient losses and gains. Three processes may contribute to the replenishment of nutrients: first, seagrasses are capable of capturing nutrients from the ambient water; second, the seagrass canopy tends to traps seston particles from the water column; third, nitrogen-fixation specifically results in enrichment of seagrass meadow with nitrogen nutrients. A survey of the existing literature shows that nitrogen-fixation is a feature of nearly all seagrass beds investigated; potentially more important in terms of nutrient inputs, however, are sedimentation of seston particles and nutrient uptake by the leaves. Together these processes may effect an annual nitrogen input to the seagrass meadow of up to several tens of grams per square metre.

Along the Kenyan coast and elsewhere extensive seagrass vegetations can be found as a belt between the mangroves and the ocean. This position, and the processes associated with the seagrass canopy mentioned above, i.e, uptake of dissolved nutrients from the water column by the leaves and the trapping of seston particles, may imply that seagrass vegetations reduce the extent of the tidal fluxes of seston and nutrients between mangrove and ocean.

SPATIAL AND TEMPORAL VARIATIONS IN DISSOLVED INORGANIC NUTRIENTS AND PHYTOPLANKTON PRODUCTION IN THE MUTHUPET MANGORVE LAGOON, TAMIIL NADU, INDIA

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A detailed study was carried out on the hydrobiocoenology of mangrove ecosystem of Muthupet. The present paper deals with the hydrological regimes and the productivity of the area. Monthly variations in surface water temperature, salinity, dissolved oxygen, pH and extinction co-efficient along with dissolved inoorganic nutriients such as PO -p, NO_4-P, NO_3-N, and SiO_4 were studied, both during the high tide and the low tide rigimes, at three stations, from January 1985 to December 1985. Among the hydroological parameters, wide variations were recorded with respect to salinity, the highest and lowest value being, 42.4‰ and 0.3‰ respectively. The temperature, dissolved oxygen and pH varied from 24.3 to 32.3°C, 2.16 to 5.86 ml/l and 6.6 to 8.5 respectively. Extinction co-efficient value were high during the monsoon period (range: 3.68 to 14.29) and low during the summer (1.46 to 4.48) and the pre monsoon seasons (1.83 to 6.71). the NO_3-N, NO_2-N and SiO_4 content fluctuated from 0.280 to 45.53 μg at/1, 0.014 to 1.432 μg at/1 and 8.42 to 236.39 μg at/l respectively. All the above nutrients showed high values during the monsoon and early post monsoon months and their concentration was loow during the summer and the premonsoon periods. On the other hand PO_4-P concentration varied from 0.423 to 1.682 μg at/l. During the monsoon months PO_4-P content was moderate (range 0.192 to 0.878 μg al/l). Nitrate: Phosphate ratiowas high during the monsoon months and low during the summer and the premonsoon periods. During the study period gross and net primary production range from 15.9 to 204.2 mgC/m^3/hr and 7.8 to 115.5 mgC/m^3 /hr respectively. The role of salinity, temperature and extinction co-efficient and the availability of nutrients on primary production has been discussed in detail.

SOME MICROBIAL, PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE MANGROVE ECOSYSTEM IN NIGERIA

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Soil profiles were sunk to a depth of 0-235cm (A) and 158cm (B) in two locations in the mangrove swamp area of the Niger Delta zone of Nigeria. Soil samples were taken from different horizons down the profile.

The population of fungi in profile (A) fluctuated within the horizons. The highest population of 100 x 10^4/100g soil was in the 38-57cm layer. The population thereafter decreased down the profile. The variation in the bacteria population was slight. The population range was 3.3 x 10^6/g soil to 12.0 x 10^6/g soil.

For profile (B), the highest population of 57.3 x 104/g soil fungi was in the 75-100cm layer. The lowest population of 18.3 x 10^4/g soil was in the 125-158cm layer. Bacterial population fluctuated slightly. The textural class of profile (A) varied down the profile. Down to 57cm, the soil texture was sandy clay loam, then sandy loam and clay loam in the last layer. The textural class in profile B varied from sandy loam to clay loam in the last layer.

The soil pH of both profiles was slightly acidic when wet and showed greater acidity when dry. Available P decreased down the profile in (A) but increased down the profile in (B). The % total N and % Organic Matter increased down to 38-57cm and then decreased. There were fluctuations in the quantities of K, Na, Ca and Mg in the soil horizons for the two soil profiles. The soil characteristics are discussed in relation to the nutrient cycling capacity of the mangrove ecosystem.

MINERAL DISTRIBUTION IN THE DELTAIC SOIL OF MANGROVE FOREST, CAUVERY BASIN, TAMIL NADU, INDIA

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Mangrove forests are abundant on both the East and the West coasts of the Indian peninsula. A detailed study on the hydrobiolcoenology of the mangrove ecosystem of Muthupet (Cauvery river basin) Tamil Nadu, India, was undertaken. The present paper outlines the results of investigation on the distribution of mangrove plants in the Muthupet mangrove in relation to the chemical characteristics of the soil with reference to a few important trace metals. An attempt has also been made to measure some of the ecological parameters used in species zonation. The range of electrical conductivity of the estuuarine soil ranged from 1.00 to 6.00 (mhos) and the pH of soil ranged from 7.8 to 8.4. The concentration of nitrogen and phosphorus in the forest and in the mud flats have also been analysed. A distinct zonation pattern, in the mangrove community, has been linked with the variation in edaphic factors, which are usually associated with the degree of tidal influence.

DEGRADATION OF MANGROVE LEAF LITTER UNDER AEROBIC CONDITIONS

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Degradation of Avicennia marina (Forks) Vierh. The leaf litter was studied in the laboratory for three months. The leaves were incubated in filtered estuarine water in a series of erlenmeyer flask for various number of days and the amounts of N. P. K. and Na remaining in the leaves determined.

It was found that the rates of degradation of the leaves were very rapid in the first 24 h (1g%) but slowed down thereafter reaching 30% after six weeks. Most of the degraded material went into solution as only about 5% of the original material existed as suspended solids after three months incubation. Nitrogen loss was also rapid during the first day of incubation, after which the rates declined slowly to reach 28% in 42 days. After that there were gains in the nitrogen contents of leaves of up to 30% in three months. Nitrification was an important process for the gains. Rates of phosphorus loss were fast reaching about 60% in three months. Microbial degradation of the leaf litter was responsible for the high losses. Potassium was leached out of the plant material very rapidly. About 90% of the potassium was leached out within one day. However, the rate of sodium loss was about 40% throughout the incubation period.

The study shows the importance of mangrove leaf litter to nutrient input into the aquatic system.

VARIATIONS IN THE CONCENTRATIONS OF SOME NUTRIENTS AND OTHER ELEMENTS IN MANGANESE DIOXIDE AND CALCIUM CARBONATE AMELIORATED ACID SULPHATE SOIL-WATER OXYGENATED CLOSED SYSTEM.

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The extent of acid sulfate soils within the humid tropical acid wetland or mangrove ecosystems in Nigeria and Thailand is reviewed. Acid wetlands have identified soil acidity related problems which are major constraints to rice production. utilization of acid sulphate soils require in addition to drainage, water table management and use of economic chemical ameliorants. The us of small quantity of MnO_2 and $CaCO_3$ as ameliorants was tested in laboratory closed system to determine effects on concentrations of extractable Al, Fe, Mn, Ca, Mg, P, Cu, Zn, Ni and Pb of the soil water suspensions. Three extrants: water, ammonium acetate and hydroxyamine hydroloride solutions were used to extract for water soluble, exchangeable elements, and reducible amorphous iron forms in the soil samples. Nutrient and other elements contents in the extracts were determined using Inductively Coupled Argon Plasma (ICAP) Spectrometer. Data of content of various elements in soil samples from Degema, Nembe, Buguma in Nigeria and Chaochoengsaa in Thailand were obtained. Data obtained indicate that there is not much variation on the solubility of elements in soils treated with ameliorants. Results therefore support the use of MnO_2 and $CaCO_3$ as economic ameliorant for acid sulphate soil management for wetland rice production.

METHANE PRODUCTION IN THE MANGROVE SEDIMENTS OF KODIAKKARAI (S.EAST COAST OF INDIA)

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Most Probable Number (MPNs) of methanogens in the mangrove sediments of Kodiakkarai (10° 18 'N; 79° 52'E) Southeast coast of India, where the Avicennia sp. is the predominant vegetation were determined. The study was carried out for a period of one year from July 1987 to June 1988 (monthly collection). Trimethylamine was used as the methanogenic substrates. The average MPN of the methanogens was $5.9x10^4$ MPN/gm, with maximal bacterial number of $1.1x10^5$ MPN/gm during the post-monsoon, summer and early pre-monsoon seasons. The bacterial population was found to decrease during the monsoonal months (October-December) to reach the minimal value of $3.6x10^3$ MPN/gm during December 1987. Salinity, temperature, redox potential (Eh) and hydrogen-ion-concentration were known to exert significant influence on the methanogens.

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OBSERVATIONS AND ANALYSIS OF A STRATIFICATION-DESTRATIFICATION EVENT IN A TROPICAL ESTUARY

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A data set comprising 31 continuos tidal cycles was collected in the Sungai Merbok Estuary, Malaysia, in June 1987 as part of an ecological study of nutrient fluxes from a tropical mangrove estuary. Currents, salinity and salinity stratification at a deep-channel (15m) station near the mouth of the Merbok Estuary showed a pronounced spring-neap variability. The slow currents and weak vertical mixing at neap tides favoured the formation of a stratified water column and generated a neap-spring cycle of water column stabilization and destabilization. A strong stratification event occurred during the period of observations. This was partly driven by a modest freshwater spate which coincided with neap tides. An eddy viscosity-diffusivity model of the stratification, which assumed a constant, longitudinal salinity gradient, demonstrated a pronounced stratification - destratification cycle due to neap-spring variations in vertical mixing. Larger and more realistic stratification was modelled when the estimated, time- varying longitudinal salinity gradient was incorporated. This
gradient maximized in response to the peak in freshwater run-off. The measured and modelled density driven circulations showed qualitative similarities and were of order 10cm per second at neap tides. The circulation was weaker during spring tides.
The tidally-filtered salt transport due to vertical shear was directed up-estuary and was an order of magnitude smaller during spring tides. The results are discussed in terms of their relevance to mangrove-system oceanography.

SOME HYDROGRAPHIC CHARACTERISTICS IN TUDOR CREEK SYSTEM

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Hydrographic observations were carried out in lower and upper reaches of Tudor inlet in January through March and June, 1987. The properties investigated were mainly tidal currents, salinity and temperature. The distribution of these properties is presented and various factors associated with the distribution discussed.

Drift measurements confirmed that tidal currents dominated in the main channel. During each tidal [phase the flow in the main channel was in one general direction, with velocity ranging from 10 cm/sec. to 80 cm/sec. Maximum velocity of 40 cm/sec. occurred at the bottom one hour following the flood. Two directional flow was only observed half an hour before low water. Along the side of the channel flow was complicated by current loops arising from long shore rip currents formed especially in the neighborhood channel bends. The loops of eddies contained water of slightly different conditions than in main channel and suggested traped of which entrainment in the main flow during various tidal phases may be the to the parchness in the inlet.

Temperature remained more or less uniform, but salinity varied from 27-30.5‰ indicating a longitudinal salinity gradient. The influence of fresh water from rivers appeared to be small in the shallow and wide upper reaches of the inlet.

A boundary observed in mid-part of the channel was associated with a change in degree of mixing in the water column due to sudden shoaling of the bottom topography.

FISHERY BIOLOGY AND MARICULTURE

Thalassia testudinum (+) (−) Rhizophora mangrove.

MANGROVES AS A HABITAT FOR FISH AND PRAWNS

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Mangrove waterways (inlets) and mudflats in Selangor, Malaysia are the habitat for 113 species of fish and 11 species of prawns. The vast majority of those sampled in inlets were juveniles. Samples from an enclosure trap erected on a mudflat during receding high tides captured 36 species of fish and 11 species of prawns. It is apparent that large populations of shallow water fish invade the mangrove shore during high tide to feed on benthic food resources therein.

* feeding grounds for juveniles and some adults.
* nursing grounds for juv. prawns.

MANGROVES/SEAGRASSES INTERACTIONS AS CRITICAL HABITATS FOR ESTUARINE NEKTON ASSEMBLAGES AND LIFE-CYCLES, MEXICO

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More than 80 fish species use these habitats with a community seasonal biomass range from 0.6 to 5.2 g wet wt m-. Seventeen species are dominants, of which the following are permanent residents: Sphoeroides testudineus. Archosargus rhomboidalis, A. probatocephalus, Arius felis, A. melanopus. Eucinostomus gula, Bairdiella chrysoura. Orthopristis chrysoptera, Acanthostracion quadricornis.

24-hours sampling indicated diel use of the area by: Opsanus beta, Chilomycterus schoepfi, Lutjanus griseus, Anchoa mitchilli, Cynoscion nebulosus and Diapterus rhombeus.

Seasonal biomass and diversity were correlated with population structure, feeding habitats, season of the year (dry, wet, "nortes"), and patterns of primary productivity (phytoplankton, seagrass, mangrove). This analysis allows the definition of 3 patterns of life-cycles in a clear "nektonic seasonal programming".

EVIDENCE FOR DEFINITE SPAWNING SEASONS IN A TROPICAL FISH: THE SPAWNING CYCLE OF THE RABBIT FISH SIGANUS SUTOR OF KENYA

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The maturation cycle of both male and female rabbit fish Siganus sutor (Valenciennes, 1935) is described. Based on (a) the temporal variations in the condition factor and the relative weight of the gonads, (b) the progression of peaks of maturity stages with seasonal occurrence of spent fish in the samples, and (c) the seasonal appearance of juveniles in the creeks, the existence of two definite spawning seasons is established. One is in January/February, and the other in May/June. This is an interesting result for a tropical marine fish.

FOOD OF A NOTED CORAL FISH, EPINEPHELUS CHLOROSTIGMA (PISCES: SERRANDIDAE), FROM SOME COASTAL AREAS OF THE ETHIOPIAN RED SEA

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A study of the food of 392 specimens of Epinephelus chlorostigma was made from some coastal areas of the Ethiopian Red Sea. Their total length ranged from 20 to 52 cm. Qualitative and quantitative analysis of the food was made. Accordingly, small fishes form the main food of the species while crustaceans and gastropods were also important. E. chlorostigma was found to be feeding in all months of the study period but high percentages of empty stomachs were recorded during the winter months. Wind was found as a main factor to hinder acquisition of food. Fish prey became important in the diet with increase in size of the predator. The lower size groups show a pronounced preference for crustaceans and gastropods.

THE FEEDING ECOLOGY OF THE JUVENILES OF SIX FISH SPECIES FROM THE GAZI MANGROVE CREEK, KENYA.

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The feeding ecology of juveniles of six fish species occurring in the Gazi creek was studied. The fish species studied were landed by beach seining the shore waters of the creek at low spring tides. The white-spotted spinefoot Siganus sutor (Valercienves, 1835) was found to be predominantly herbivorous, while two terapons Terapon jarbua (Forssk., 1775), and T. theraps Whitley, 1943 were predominantly carnivorous. T. jarubua was more selective in diet (food items), while T. theraps was a general feeder. Both species fed commonly on shrimps and other crustaceans though T. theraps was found to graze on sea weeds too.

Gerres oyena (Forssk., 1775), a silver biddy, was found to feed mostly on copepods while Lutjanus fulviflammus (Forssk., 1775), a blackspot snapper, fed mostly on shrimps but with a more diverse diet than the silver biddy. The presence of the juveniles of the giant trevally, Caranx ignobilis (Forssk., 1775), in the creek was also noted; these were found to have a predominantly carnivorous habit with shrimps forming a greater part of their diet.

Except for G. oyena, all the studied species were found to actively feed during the low tide as they had prevalence of full stomachs. G. oyena had partial to empty stomachs dominating. S. sutor whose diet was expressly herbivorous showed slower digestion of the stomach contents than the rest who were carnivorous.

ECOLOGY AND FISHERIES OF PENAEID SHRIMPS IN MANGROVES AREAS (MADAGASCAR)

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The mangrove swamps and associated estuaries are used by a large number of fishes and shrimps as shelter, feeding and nursery grounds. It is known that in their life history, the penaeid shrimps reach the estuaries and mangrove areas at the post-larval gstae. Then, the juveniles become subadult, go back to deeper waters, attain sexual maturity and join the breeding adult population offshore.

A case study of the distribution and the ecology of the young penaeid shrimp in the mangrove areas have been carried out at CNRO. It consists to determine the distribution, the migration and the availability of young penaeid shrimps in mangroves areas. The areas studied was Ambaro Bay (on the north western coast of the island) where the annual catch of penaeid shrimp fishery comes to more than 1.300t. The main species exploited in the zones is Penaeus indicus. Three estuaries were selected for this study.

The distribution of the young shrimp are related with the salinity but any correlation has been found with the dissolved oxygen.

Spawing and egg production occur from October to February and an other one in April to May. The annual recruitment of post larval penaeid to nursery areas comes after the spawing period and peaks at two seasons: in October and in January to March. The juvenile emigration from the mangrove zones is also during two seasons: one period of July to September and a more little one in February to April. The tide current undoubtedly has a great influence in the distribution and the migration of these young animals. In all the three rivers, juvenile shrimps are widely abundant in wet season (October to April). The young shrimp population consists of two generations per year and the growing period is about 4 to 6 months in these mangrove zones studied.

There are two types of exploitation operating in shrimp fisheries in these areas:

- a traditional and artisanal fishery with intertidal trap which catch juvenile penaeids;
- an industrial fishery using mechanized bottom trawling.

Of course, this exploitation is running the risk of been excessive and has some impacts on the recruitment to the adult population offshore. A national management is recommended to maintain the ecological future of the mangroves and to prevent the decreasing penaeid stock there. The shrimp farming has to be developed in Madagascar as many mangrove areas show good prospects for this exploitation.

THE EFFECT OF OOCYTIC ATRESIA ON FECUNDITY ESTIMATES OF SIGANUS SUTOR OF KENYAN MARINE INSHORE WATERS.

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In the strongly group-synchronised oocyte development of Siganus sutor (Valenciennes, 1835) the group of oocytes to be released in the immediately following spawning, is identified. The smallest size of oocyte belonging to this group was identified by the presence of cytoplasmic vacuoles in oocytes examined in histological sections. These vacuolated oocytes corresponded to oocytes of 150um diameter obtained by treatment with Gilson's fixative. The mean number of such oocytes in stage 4 (late developing) ovaries was found to be 585,000. The proportion of these oocytes removed by atresia before spawning was determined on histological sections to be 5%. The corrected estimate of mean fecundity was thus 556,000 oocytes per spawning.

MARICULTURE DEVELOPMENT IN KENYA: ALTERNATIVE TO SHRIMP POUND SATING IN MANGROVE ECOSYSTEMS

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Mariculture practice is relatively new in Kenya and as such there exists little coastal aquaculture in the country yet. The urgent need to develop this sector is discussed taking into account the status, identification and utilization of the suitable coastal sites for shrimp farming. Due to several physical attributes, the mangrove areas are generally the most suitable sites and hence they are the target sites for shrimp pond construction. At the Kenya coast, solar salt production ponds also compete for these mangrove areas and indeed in each of the 8 existing solar salt farms (Salinas), 50% of the ponds are located in mangrove zones and tidal flats. With the increasing awareness of the unique ecological role played by the mangrove ecosystem, there is need to stop any further conversion of mangrove swamps into ponds. A much more efficient use of the already cleared mangrove areas is assessed against the background of diversification of salt farming i.e. integrating solar salt production with shrimp farming and brine shrimp Artemia culture. To develop shrimp farming without further destruction of mangroves, a shift from tide-fed to pump-fed systems is recommended to divert coastal aquaculture development out of the mangroves to higher grounds.

THE MANGROVE AND MARICULTURE INDUSTRY OF ECUADOR

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In the outer intertidal zone of much of the Ecuadorian coastline there is a narrow band of mangroves. This is located next to a non-vegetated area of salt flats situated in the more inland intertidal zone. By 1967, the total area of this mangrove forest was 209,695 Ha, but by 1984 it has been reduced to 182,107 Ha, equivalent to a loss of 10.6%.

Eight species of mangroves are distributed along the litoral provinces of the country: Esmeraldas, Manabi, El Oro and Guayas, but it is the latter which has the largest area of woodland amounting to approximately 121,464 Ha.

In the neighborhood of this plant community the mariculture industry of Ecuador has florished. More than 94,000 Ha of land have been allowed for the construction of ponds, but as yet only 60,000 Ha have been utilized. Of the ponds built, only around the 70% are in production. There are more shrimp in salt flats in Guayas than in any other province. Around 52,911 Ha of ponds are located here, mainly near the borders of the Gulf of Guayaquil estuary.

The nutrient richness of the shrimp pond effluents has produced some eutrophication effects in the water of the estero Salado, a branch of the inner estuary of the Gulf.

FISHERIES AND AQUACULTURE MANAGEMENT IN MANGROVE AREAS OF NORTH EASTERN BRAZIL

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A brief review is given as for the manifold utilization forms and concepts in mangrove habitats, considering commercial and non-commercial species for fishing, aquaculture and specific fishing techniques. A comparison is provided between the Southeast-Asian and the Brazilian mangrove areas with respect to the different socio-cultural and socio-economic implications of fishing societies depending on mangrove resources. Moreover, the different concepts of the ecological and economic perception of mangrove resources are discussed with regard to the regional fisheries development issues.

In the Brazilian State of Sergipe a 5 ha model fishfarm, initiated as German Technical Cooperation project, has been constructed within a dense Rhizophora basin forest. Ponds and gates are designed in order warrant water exchange with tidal water necessary for the survival of mangrove stands which remain within the ponds. Four production cycles of 2 indigenous mullet species (Mugil liza, M. urema) are tested, each at an operational enhancement such as varying stocking density, reduced water exchange, fertilization and supplementary feeding. A 4 years scientific program investigates the hydrologigal and sedimentological changes at the site and monitors the particulars of the mangrove's stands within the ponds. Parameters studied are morphological changes, growth rates, litter fall and variations in the population dynamics of selected biota.

The paper gives a general overview about fisheries and aquaculture ventures and impacts on mangroves in Northeastern Brazil. The results of the model fishfarm in the State of Sergipe are presented under the aspect of implementing ecologically and economically viable management concepts for aquaculture in mangrove areas. At the same time, modification aspects of state legislation are discussed with reference to land utilization in mangrove areas and with reference to regional fisheries development strategies.

FEASIBILITY FOR MARICULTURE IN MANGROVE SYSTEMS: CASE STUDY OF AN OYSTER CULTURE IN GAZI BAY.

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A project of culturing the edible oyster Crossostrea cucullata in Gazi bay was identified by the Kenya Belgium Project during a precedent phase. The species C. cucullata and the site (Gazi bay) were fixed factors.

Our work consisted in verifying and optimizing the technical and economical feasibility of the project. In order to meet these purposes we integrated the ecological, social and economical context in our study. At first we carried out a market survey to identity the demand. The only interesting potential market is provided by the Kenyan tourist industry. This specific demand determines the third factor: the commercial form of the oyster (alive with a good shape and size). We analysed also the ecosystem of the mangrove with a special regard to biological, physical, chemical and human activity factors which can constitute some limitation for oyster culture.

We used a decision matrix to adapt the cultural methods to the main constraints (intertidal species, muddy substrate and commercially adapted product) imposed by the fixed factors.

According to the experiments of the K.B.P., we selected as culture system the racks with suspended roman tiles as collectors and the "polochons" for the fattening.

Once the main constraints were satisfied we tried to optimize the other factors according to the rentability equations.

Yield increases can be obtained by the use of "polochons", the control of the fouling organisms and predators, the choice of optimal tidal level and growing area. Production costs can be reduced and highest sale prices can be obtained with a good marketing policy. With the best cultural method we performed a financial analysis for several models of farm (small scale farm with 22 racks, medium farm with 110 racks and a pilot project of production and commercialization with 700 racks).

For each model we calculated the fixed and variable costs, the break-even point, the sensibility to the production, the pay-back period and the internal rate of return.

Environment was also taken into account with the study of ecological impact and of sanitary conditions.

BIOMASS PRODUCTION AND CARRAGEENAN YIELDS OF FOUR STRAINS OF CARRAGEENOPHYTES PRESENTLY FARMED ON DANAJON REEF, NORTHERN BOHOL, PHILIPPINES

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Farming of carrageenophytes on reefs and one of the most productive alternative livelihood industries among the coastal inhabitants in the country today, is experiencing decreasing productivity and cropping management problems. Comparative studies on the biomass and carrageenan productions of two strains of Eucheuma denticulatum and two strains of Kappaphycus alvarezii were done to assess the seasonality in their production capacities.

The high and considerably similar refined carrageenan yields (49-51% of dry wt.) of the four strains in the first cropping season (June-October) coincided with their high biomass production with plants averaging from 1.1 to 1.8 kg each at harvest. The poor refined carrageenan yields (21-33%) recorded in the second croping (October-February) coincided with their season of low biomass (average weight: 0.34 to 1.0 kg). The four strains, however, recorded contrasting performance in the third cropping season (February-July) with two E. denticulatum strains recording high refined carrageenan yields (43 and 42.5%) together with high biomass (average weight: 1.5 and 1.6 kg) in contrast to the low refined carrageenan yields (30 and 39%) and low biomass (average weight: 0.21 and 0.28 kg) of the two K. alvarezii strains. Records for semi-refined carrageenan yields (SRC) in the second and third cropping seasons were quite consistent and similar for the four strains 42-55%) except in the second cropping where the two K. alvarezii strains recorded low SRC.

The application of these information to the croping management of the four strains to improve their cropping management of the four strains to improve their cropping performance is discussed.

NUTRITIONAL STUDIES OF ULVA FASCIATA DEL. AND SARGASSUM BINDERI SOND. FROM MACKENIZE POINT, MOMBASA, KENYA.

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The wild Ulva fasciata and Sargassum binderi analysed for their nutritional value showed to chemically constitute: high carbohydrate content (50% - 81.6%), protein content (4.0 - 7.5%), low oil content (0.2 - 0.25%), fibre content (6.5 - 11.3%), vitamins and ash content (5% -22.5%) rich in mineral matter. Distinct seasonal variations with Northeast monsoon minima and Southeast monsoon maxima were evident for carbohydrate and fibre contents. In contrast, ash content showed a seasonal variation with Northeast monsoon maxima and Southeast monsoon minima. Only limited variation in protein and oil content were recorded. Correlations between chemical composition and various hydrographic and nutrient parameters indicated that ash content was negatively correlated with all other tissue components but positively correlated with temperature and salinity. All other chemical components were negatively correlated with temperature and salinity. Proteins were however, positively correlated with dissolved inorganic nitrogen.

STRAIN SELECTION IN CARIBBEAN GRACILARIAS: RESPONSE OF SOME STRAINS TO TEMPERATURE, LIGHT AND DEHYDRATION

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The interaction of light and temperature on the growth of five species of Gracilaria, viz. G. cervicornis, G. debilis (Polycavernosa debilis), G. domingensis, G. mammilaris and G. verrucosa were studied using a gradient table under different temperature (11-30 C) and light intensity (40 - 280 uE. m2. s^{1} combinations. G. verrucosa was tolerant to various combinations while G. domingensis, G. carvicornis and G. mammilaris had a narrow tolerance range between 22 and 26°C and 100 - 150 μ E.m2. S^{-1}. Gracilaria debilis grew reasonably at all light intensities at 22°C. The compensation point for all the species was about 30 μ E. Sporelings of G. debilis, G. mammilaris and G. verrucosa were tested for their tolerance to dehydration. Sporelings of G. dabilis tolerated 30 min. of dehydration. These sporelings grew slightly slower than controls but had higher agar content. It appears that there is a relation between the high agar content and tolerance to stress at earlier stages of growth, which has implications for breeding work.

POLLUTION OF COASTAL ECOSYSTEMS

EFFECTS OF VARIOUS DISPERSANTS ON TROPICAL ORGANISMS: CORALS, MANGROVES, SEAGRASS, TROPICAL COMMERCIAL FISH IN JAMAICA

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For the first time anywhere in the world's tropics (in Jamaica, under the direction of the Office of Disaster Preparedness) a series of dispersant products were screened to determine toxicity on the most important tropical matrix organisms. The laboratory test procedures used were standardized tropical toxicity test methods from U.S. and U.N. sources. 100,00 ml seawater with specimens collected and transported under optimal conditions were taken to out-of-door facilities, controls and oil only were run.

The coral selected were reef crest, Acropora palmata, back-reef and estuarine, Porietes porietes, and reef-building, Monstastrea annularis. The mangroves were black (Avicinnia niger), red (Rhizophora mangle) and white (Laguncularia). The seagrasses were turtle grass (Thalassia testudinum), shoal grass (Halodule wrightii) and manatee grass (Syringodium filiforme). The fish were important to Jamaican nearshore fisheries, doctor fish (Acanthurus), grunts (Haemulon), squirrel fish (Holocentrus rufus) and sea bream (Archosagus rhonbodales). Concentration levels of dispersant were 12.5 ppm to 125 ppm only mangroves were tested at higher concentrations). The sensitivity index, which occurred, showed that fish and corals were more sensitive than seagrass which was more sensitive than mangroves. Ranking of dispersed oil products was generally similar between biological groups in terms of toxicity. High, medium and low toxicity dispersant products were found in the 13 tested dispersant products on all groups (8 additional products on mangroves). Field tests consisted of toxicity testing on in situ intertidal mangroves with seagrass and coral seaward of the mangroves. Three of the least toxic dispersants, Cold Clean, Finasol OSR-7 and Corexit 9550 (the least toxic products), were field tested for the first time.

For those oil spills when mechanical means are not adequate and non-treatment would result in substantial environmental damage, a set of tropical policies for "within 3 mile" dispersant use were developed. The dispersant use policy, when mechanical means fail or are inadequate, was formulated by the Jamaican Oil Spill Committee and will be presented in brief.

INFLUENCE OF THERMAL EFFLUENTS ON THE PHYTOPLANKTON ECOLOGY OF MANGROVE ESTUARIES OF TUTICORIN, SOUTHEAST COAST OF INDIA

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The ecology of phytoplankton of two mangrove estuaries viz. thermal estuary and Pullavali of Tuticorin, southeast coast of India was studied for a period of six months (Sept. 1988-Feb. 1989) through fortnightly collections. While the thermal estuary bordered by Avicennia alba was under the continuous discharge of the nearby Thermal Power plant, the Pullavali estuary bordered by A. marina was free from such thermal pollution. The temperature and salinity ranges of these two estuaries were from 31,3 to 35.6°C and 28.5 to 30.8°C and 25.4 to 34.2% and 1.5 to 34.5% respectively. The species diversity of these estuaries determined by the formula,

$$D = \frac{S-1}{\log e N}$$

where, S, the total number of species and N, total number of individuals in a given sample, was interesting. The thermal estuary had poor species diversity values (1.5 to 2.2) and biomass which was contributed mainly by the centric microphytoplankton (plankton collected by a 41 um mesh sized net) such as Cyclotella meneghiniana, Coscinodiscus jonesianus and Planktoniella sol. The Pullavali estuary on the otherhand, showed invariably good species diversity (2.7 to 3.8) and biomass for which the pennate nanophytoplankton species such as Asteronella japonica, Pleurosigma elongatum, Gyrosigma balticum, Nitzchia closterium, N. longissima, N. seriata and Thalassiothrix nitzschioides contributed much. The density of phytoplankton varied from 1.52×10^3 to 1.38×10^4 cells/l in the thermal estuary and from 1.82×10^5 to 1.67×10^7 cells/l in the Pullavali estuary and the maxima were associated with the lowering of temperature or salinity. The ratios of microplankton to nanoplankton were in the order of 74: 26 (Thermal estuary) and 32:68 (Pullavali estuary). Based on the temperature and salinity tolerance, the autochthonous eurythermal and euryhaline diatom species and the allochthonous stenothermal stenohaline and freshwater diatom species have been identified and grouped for these estuaries. The simultaneous physico-chemical parameters as such temperature, salinity, pH and dissolved oxygen studied showed that the tidal exchange and salinity fluctuations appeared to be master factors in controlling the distribution and abundance of phytoplankton in the Pullavali estuary. The findings of the present investigation have been compared and discussed with that of other south Indian mangal estuaries.

CONCENTRATION OF HEAVY METALS IN ANADARA ANTIQUATA (PELECYPODA) FROM OCEAN ROAD BEACH, TANZANIA

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Anadara antiquata (Pelecypoda)) is a common mollusc used as food and normally collected by women. Over 40 samples were taken from Ocean Road Beach and analysed for iron, coppper, zinc, cadmiun and lead using AAS. Preliminary results have shown that the bivalves have elevated levels of iron 600 - 1600 u g^{-1}, low levels of copper 0-2 u g^{-1}, elevated levels of zinc 80-100 u g^{-1}, very low levels of cadmiun and lead.

The screening was done so as to use the bivalve as an indicator of heavy metal pollution for Tanzania but also to warn potential eaters as to the danger of heavy metal poisoning. From the results there is no real danger of pollution except for zinc. However depending on the method of cooking the zinc levels do not pose a real threat to eaters.

PRELIMINARY OBSERVATIONS ON EFFECTS OF OIL SPILLS ON THE MANGROVE ECOSYSTEM IN MOMBASA CREEKS

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On 13th July 1988, a storage tank holding 5000 tons of heavy fuel oil was accidentally punctured and about 4000 tons of oil flowed into the sheltered Makupa creek adjoining the Kilindini harbour creek of Mombasa. On 3rd February 1990, a barge holding 420 tons of fuel oil sank in the Kilindini harbour releasing an undetermined amount of oil into the Kilindini/Port Reitz and Makupa creeks. The spilled oil polluted the mangrove ecosystem resulting in defoliation and withering of about 12 ha of mangrove trees, caused a massive kill of mud crabs, and exerted acute stress on meofauna. In this presentation, the immediate and chronic impact of the oil spills and the chances of recovery of the mangrove ecosystem is discussed.

EXPLOITATION, CONSERVATION AND MANAGEMENT ASPECTS

PROTECTION AND MANAGEMENT OF MARINE AND COASTAL AREAS WITHIN THE FRAMEWORK OF UNEP'S REGIONAL SEAS PROGRAMME

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The Regional Seas Programme at present includes ten regions and involves over 130 coastal States and Territories. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassinng a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities. Many of the world's significant mangrove areas are included within the regional seas.

All action plans are structured in a similar way. An action plan usually includes the following components: Environmental assessment, environmental management, environmental legislation, institutional and financial arrangements.

Environmental assessment is thus one of the basic components of the regional seas action plans. It concerns assessing and evaluating the causes of environmental problems as well as their magnitude and impact on the region. Emphasis is given to such activities as: baseline studies; research and monitoring of the sources, levels and effects of marine pollutants; ecosystem studies; studies of coastal and marine activities and social and economic factors that may influence, or may be influenced by environmental degradation; and the survey of national environmental legislation.

Environmental assessment is undertaken to assist national policy makers to improve the management of their natural resources in a more effective and sustainable manner and to provide information on the effectiveness of legal/administrative measures taken to improve the quality of the environment.

It is essential to bear in mind that all components of a regional programme are interdependent. Assessment activities identify the problems that need priority attention in the region. Legal agreements are negotiated to strengthen co-operation among States in managing the identified problems. They also provide an important tool for national policy-makers to implement national control activities. Management activities, aimed at controlling existing environmental problems and preventing the development of new ones, are one of the means by which States fulfill their treaty obligations. Co-ordinated assessment activities then continue to assist Governments by providing scientific information by which to judge whether the legal agreements and management policies are effective.

STATUS AND EXPLOITATION OF THE MANGROVE AND ASSOCIATED FISHERY RESOURCES IN ZANZIBAR

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The status of the mangrove resources in terms of distribution and growth forms on the two Islands of Zanzibar (Unguja and Pemba) were investigated. Pemba Island, in addition to having a larger area under mangrove vegetation (approximately 12,000 ha) than Unguja Island (approximately 6,000 ha) was found to have the largest number of species (9) compared to Unguja (8). The purposes for which each mangrove species is used locally together with exploitation levels, were also examined. Cropping intensities in Pemba Island varied between 80-5000 cut plants per hectare while on Unguja, it varied between 500-20,000 cut plants per hectare.

Pemba's mangrove forests were seen to be relatively less heavily exploited compared to those on Unguja Island, where clearfelling was also found to be quite common. Charcoal, lime and salt production appeared to be among the major activities involving the utilization of mangrove wood. The fishery resources associated with the mangrove vegetation were also examined. These ranged from shell-fishes to finned fishes. Most locally commercial fish species were found to be strongly linked with the mangrove vegetation at one stage or another during their life cycles. The mollusc Pyrazus sp (a very cherished food as well as bait item on both the Islands) were never found anywhere else except in the mangrove stands. Fish species of the genus Lethrinus and Chanos chanos were often found in the tide pools within mangrove vegetation.

EXPLOITATION OF MANGROVE AND CORAL REEF ECOSYSTEMS OF THE WEST AND SOUTH COASTS IN SRI LANKA

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Mangroves are tropical tree species and genera existing in brackish and saline water of tropical coasts. Similarly, corals are also widely distributed in the shallow warm (over 20°C) seas. The ecosystems of mangroves and coral reefs produce food and provide shelter as well as breeding and nursery grounds for microscopic and mesoscoopic fauna. They help to preserve the balance of nature and have played an important role in supplying food and raw materials to inhabitants of coastal areas. The human impact on both these ecosystems arises directly as a result of environmental damages caused by man's desultory usage and over-exploitation.

There are about twenty six species of identified true and semi-mangroves which fall into seventeen families in the west and south coasts of Sri Lanka. They supply food and beverages, timber for construction of houses and fishing boats, house-hold items, agricultural manure, animal feed and medicine. Mangroves have been destroyed due to the unplanned exploitation for human settlements, industrial activities, agriculture, tourism and recreation. A considerable amount of mangrove species have also been damaged by discharge of toxic substances and polluted water into lagoons, lakes, estuaries and tidal creeks. This destruction has directly and indirectly resulted in the depletion of wild-life and influenced the livelihood of the people.

The coral reefs in Sri Lanka are predominately of the fringing and barrier-like types. They occur in many places around the island as dead and living coral reefs and in the coastal lowlands as buried and emerged coral reef patches. Although fringing reefs abounded in the continental waters only a few contain true coral reefs of different forms. These submerged and living corals in the continental shelf and buried corals in the interior are now being destroyed for the illicit production of lime. Tourism, fishing and navigation are also responsible for the destruction of these resources.

This continued destruction in both habitats have created a number of environmental problems viz: (a) The destruction of mangroves and coral reefs which have a negative impact on the growth of species, organisms and other marine flora and fauna; (b) The destruction of habitats that can increase the speed of swell and high waves and bring about coast erosion; (c) Disposal of industrial pollution and waste as well as well as siltation that degrade the habitats;
(d) Pollution of stagnant water-holes and ditches where buried corals are mined that provide breeding grounds for various types of mosquitoes; (e) The increase in the salinity of water and soil in the cultivated lands that cause the degradation of mangrove swamps and marshes; (f) Pollution of air from lime kilns.

Therefore an increased public awareness of the physical, biological, socio-economic and cultural consequences of unplanned exploitation of mangroves and coral reef ecosystems is of utmost importance for their sustainable use, conservation and management.

SITUATION, CONSERVATION AND MANAGEMENT OF MANGROVE ECOSYSTEMS IN SOMALIA

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The Somali Democratic Republic has the longest coastline in tropical Africa, with about 2,000 km along the Indian Ocean and approximately 1,300 km facing the Gulf of Aden. The coastline extends between 12°N and 2°S and the coastal ecosystems vary widely.

While along the Gulf of Aden only small pockets of mangrove ecosystems still exist, south of Kisimayo towards the border of the Republic of Kenya an extensive area is covered by mangrove stands along the Indian Ocean and the creeks.

The paper describe the characteristics and ecological needs of seven important species found in Somalia characterizing those mangrove stands and presents also their utilization possibilities in terms of tannin, timber and as woodfuel/charcoal. The state of utilization of the mangroves themselves, but also of their ecosystem is assessed for historical and present times.

The importance of this ecosystems in terms of biodiversity and for the survival of species already endangered are highlighted.

The factors that deteriorate the Somali mangrove ecosystems are various and range from indiscriminate removal of stands through unwise over utilization of the different parts of the ecosystem to the danger deriving from pollution for the whole system. The different negative impacts and their present state are discussed and possibilities to improve the situation are proposed in the paper.

After describing the present legislation concerning the conservation of mangrove ecosystems in Somalia the author discussed the actual protection needs on the light of the Somali National Conservation strategy and presents a concept for the future conservation and management plan of this important but vulnerable biotic community.

HUMAN USES AND MANAGEMENT IMPLICATIONS OF THE MANGROVE ECOSYSTEM OF INDIA

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India has about 7,000 sq.km. of its area under mangroves. These consist of deltaic mangroves along the eastern coast, estuarine mangroves along the western coast and insular mangroves on the Andaman and Nicobar Islands. The whole ecological complex of the mangrove is often referred to as "Mangal". The mangroves are being increasingly recognized as a precious resource of numerous plant and animal products. These have played a vital role in the economies of tropical peoples and mangrove dwellers for thousands of years, providing a wide range of timber products and other materials on a sustainable basis. The principal economic plant species belong to the genera Rhizophora, Avicennia, Bruguiera, Kandelia, Ceriops, Excoecaria, Sonneratia, Nypa, Lumnitzera, Aegiceras, Heritiera, Aegialitis, etc. The mangrove ecosystems in India are traditionally utilized for various purposes such as fisheries, salt pans, firewood, charcoal, timber, boat-building, fodder, manure, medicine, wax, honey, shells, edible animals species, etc. The mangrove swamps are spawning and nursery areas for fish, crustaceans and molluscs, and have been recognized as most suitable sites for fish farming and aquaculture. As much as 80 per cent of the Indian fishery catch from the lower delta region comes from Gangetic Sunderbans - one of the largest mangrove forests of India. Some of the most common fish of mangroves are species of Liza, Mugil, Lates, Polynemus, Sciaena, Setipinna, Pangasius, Hilsa, Ilisha, and Etroplus. The major fishery in the mangroves of Goa consists of species belonging to Meretrix, Crassostrea (mollusc), Penaeus, (prawn), Scylla (crab), Mugil (fish) and Lates (fish). The yield of mangrove wood of the Andamans is estimated at 160 tons/acre (or 8000 cft/acre). The barks of Rhizophora, Bruguiera and Ceriops spp. are used as source of tannin (35 per cent). The disappearance of certain species like Nypa fruticans, Heritiera fomes, Xylocarpus moluccensis etc. in the Indian Sunderbans is due to ecological and anthropic causes. The mangroves in the Sunderbans are the last remaining habitat of the Bengal tiger in Bangladesh. The mangroves represent one of the most neglected living resources which have been over-exploited for use as firewood, charchoal, thatched roofs, etc.

Due to demographic pressure, industrial pollutants and effluents, oil spill, reclamation of land, coastal plantations, salt industries, cement factories, etc. the mangrove forests are facing extinction. With the destruction of mangroves, the deltas are shifting and posing great problem in shipping. The number of migratory birds has suddenly decreased in and around Chilka lake in Orissa. The coastal areas of Gujarat, particularly Saurashtra and Kutch face a serious problem of salinity ingress due to excessive withdrawal of ground water, sea water ingress in lower aquifers, tidal water ingress in upper aquifers and salt-laden winds blowing from the sea. Keeping in view the economic potential of mangroves and ill-effects of its destruction, the national mangrove committee had identified 15 areas in the country for effective management and conservation of mangroves. As developing countries expand and diversify their economic development, increasing pressure is being put on the exploitation of coastal mangroves. An integrated mangrove resource development program has been undertaken as a major component of ecosystem development.

THE MANAGEMENT OF INSULAR CARIBBEAN MANGROVES IN RELATION TO SITE LOCATION AND COMMUNITY TYPE

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Mangrove ecosystems occupy different locations on Caribbean island coasts, ranging from open bays (fringe mangrove) to totally enclosed salt ponds and salinas. On geomorphically active coastlines, such as south Jamaica, systems are at varying degrees of maturity and productivity. Furthermore, because of system variability, the interactions between mangroves and associated marine systems, such as coral reefs and seagrass beds, are developed to different degrees.

Community structure and productivity of a range of mangals on different islands of the Greater and Lesser Antilles are discussed; forcing functions and levels of interactions with the marine environment are identified.

Mangroves are threatened and impacted by development activity, because of their coastal location and the importance of coastal economies in the Caribbean. The rational choice of management options must be based on the range of goods and services provided by the different systems; and a good understanding of their ecology is essential when choosing sites for protection, waste disposal, landfill, marina development and fisheries enhancement. Examples are given from current studies in Jamaica, St. Lucia, the British Virgin Islands and Trinidad, of a flexible management response to mangrove ecosystem diversity.

MANAGEMENT OF MARINE NATIONAL PARKS AND RESERVES IN KENYA

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It is in the best interest of Kenya to achieve a sustainable yield of its natural marine resources. Sustainable exploitation implies the wise use (development) and careful management (conservation) of individual species and communities together with the habitats and ecosystems on which they depend.

Coral reefs, tide pools, bays, scenic coastlines and beaches, offshore island and other marine environments are important natural areas that in many countries are threatened by many detrimental uses and abuses. These detrimental effects include: pollution from sewage, oil, pesticides, silting, dredging and filling, and coastal development. Collecting of corals, shells, tropical fishes and other forms of marine life by collectors (amateur as well as professional) for personal uses and by commercial interests for the tourist trade and for export have damaged selected coral reefs in Kenya.

Tourism in Kenya is the leading foreign exchange earner. It is in realization of the potential of coral reefs as tourist attractions that those in the tourist industry have facilitated the establishment of marine national parks and reserves.

The marine protected areas in Kenya are: Malindi and Watamu Marine National Parks and Reserves, Kisite/Mpunguti Marine National Park and Reserve, Kiunga Marine National Reserve and Mombasa Marine National Park and Reserve. Ras Tenewi Coastal Zone National Park and Chale Island Marine National Park have been proposed.

These marine protected areas are managed by the Kenya Wildlife Services, a state corporation. They are governed by an act of Parliament: The Wildlife (Conservation and Management) Act, Chapter 376, Laws of Kenya.

THE EXPLOIITATION OF SOMALI COAST ECOSYSTEM PRODUCTS AND AREA CONSERVATION MANAGEMENT ASPECTS

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Somalia lies on the eastern coast of the African Continent. Its coastline forms the Horn of Africa and is thus divided into a northern component (Gulf of Aden) and a southern component about 2,000 km long making it one of the longest national coastal areas on the continent. The country straddles the equator, but its major portion lies north to about 12N. It is typically dry and is covered in semi-desert grassland and shrubland, bushland thickets dominated by Acacia and Comiphora. The coastal areas of Somalia contain habitats for three endangered marine species excluding the great whales that inhabit the Indian Ocean. These are, the Green Turtle (Chelonia myda,) the Hawksbill Turtle (Erotmochelys imbricata) and the Dugong dugon.

Coastal areas types

In general the land area contiguous to the shoreline of the Somali coast consists of:

(i) Flat sand and gravel covered, coastal plains of varied width and usually occurring at the mouth of wadi system;
(ii) Mountains with pecipitous cliffs that form a rocky shoreline; and
(iii) Coastal dunes that are active, i.e. have no vegetation cover, or are covered with thorn-bush scrub and acacia woodland.

At the shoreline of the dune and coastal plain system there is generally a sandy beach. In the north from the Somali-Djibouti border to Ras Asir and from Ras Asir south to around Eil the beach sand is derived from wind and water eroded rock. From south of Eil to the Kenya border the beach sand is partially or fully derived from eroded pleistocene or contemporary coral reefs.

Exploitation of marine species

At present the most important exploitation of marine species from a coastal conservation point of view involves marine turtle, dugongs, coral reefs and mangroves.

Action strategy for marine conservation in Somalia

The designation, establishment and management of marine and coastal protected areas and conservation of marine species in Somalia is a complete new area of endeavour for the government. As a first step Somalia has signed the convention for protection, management and development of the marine and coastal environment of Eastern Africa Region in 1985 together with the protocol concerning protected Areas and Wild Fauna and Flora in the Eastern African Region.

THE RESTORATION OF MANGROVE AND SEAGRASS FOR INCREASED FISH NURSERY PRODUCTION

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The sciences of coastal restoration are relatively recent (25 years), but have advanced rapidly due to use of upland techniques.

The egg cases and early stages of hundreds of nearshore tropical fish have some part of their life cycle very close to shore in mangroves and seagrasses. This has been shown by extensive studies in the Caribbean and Gulf of Mexico. When mangroves and seagrasses are removed, the egg cases and juveniles become far less. When the restoration occurs, frequently the numbers of animal juveniles cannot be statistically separated from the unimpacted areas.

The types of impact which can be accomplished are dredge and fill, thermal effluents, constructive impacts, mining spills, certain areas of sewage impact, oil spills (mangroves), beach fill, mariculture areas. The areas of difficulty to restore are erosive areas, high turbidity (for seagrass).

Techniques and results from the Caribbean, Asia and the Middle East will be discussed.

REGENERATION STRATEGY OF MANGROVES ALONG THE KENYA COAST: A FIRST APPROACH

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Mangrove forests occupy large areas along the Kenya coast where they contribute both directly and indirectly to the local economy. Directly by providing poles for construction, fuel wood and charcoal, and indirectly by providing food and protection for offshore communities, by stabilizing the shoreline and filtering run-off water from upcountry.

Despite this entanglement and interrelation with the local economy, still little is known about the structure and functioning of the mangrove ecosystem. In June 1990 a research project sponsored by DANIDA and AWF was carried our by botany students of Nairobi University to investigate the regeneration strategy of the mangroves at Gazi Bay and Mida Creek.

Statistical analysis of more than 400 quadrats (5 x 5m) sampled along 35 line transects in 4 mangrove forests showed that mangrove seedlings follow the same distribution pattern in the intertidal zone as their parent trees. In other words, mangrove seedlings mainly develop within a well-defined zone specific for the species. The "optimal distribution zones" for the various mangrove trees and their seedlings are defined in terms of "altitude above datum level".

When using the categories (i) "fixed" (the seedling uses a pneumatophore, a rock or any other fixed object in the substratum for anchorage and protection) and "not fixed" and (ii) "covered" (the seedling is covered by the parent tree) and "not-covered" it was seen that:

- mangrove seedlings in an "undisturbed mangrove forest" are predominantly "fixed" and "covered". Only Avicennia marina seedlings (principally growing at the landward side of the forest) tend to be "not fixed"
- mangrove seedlings in an "overexploited or cleared mangrove forest" predominantly are "fixed" and "not-covered", indicating that the seedlings have been transported by the water.

It was also observed that Avicennia marina, Rhizophora mucronata and Sonneratia alba were able to coppice (regeneration of the crown from stumps left after felling). Up to 30% of the felled Sonneratia alba trees showed coppicing capacities. Especially the Sonneratia trees situated in their "optimal distribution area " (near the seaward side of the forest) were able to coppice, whilst trees beyond this "optimal distribution area" seem to loose their coppicing ability.

When considering mangrove re-afforestation projects along the Kenya coast, it is learnt from the present study that seedlings should be planted under "fixed" cpnditions on their optimal distribution area. The use of the regeneration form stumps or stems still needs further investigation.

IMPACT OF THE PAST MANAGEMENT PRACTICES ON THE PRESENT STATUS OF THE MUTHUPET MANGROVE ECOSYSTEM, TAMILNADU, INDIA

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Muthupet mangrove ecosystem (10° 25'N and 19° 30'E) is located at the southern end of the Cauvary delta on the east coast of India. The swamp is characterized by the presence of only 4 species of exclusive mangroves namely Avicennia marina, Excoecaria agallacha, Aegiceros corniculatum and Acanthus ilicifolius.

Community structure analysis carried out at four randomly selected quadrats showed that the relative density, relative dominance, relative frequency and importance value of A. marina was relatively higher than the other three species. Hence, Muthupet mangrove ecosystem is characterized by the mono-specific dominance of A. marine. Earlier palynological studies indicate that species like Rhizophora was present in this swamp some 200 years ago. It is believed that the past management practices together with the present poor scientific policy of the decision makers and harsh environmental conditions may be considered as a few factors responsible for the disappearance of Rhizophora from this mangrove swamp.

EXPERIENCE WITH RHIZOPHORA RACEMOSA PLANTED 1987 - 1989 FROM PROPAGULES ON A MANGROVE REHABILITATION SITE AT LOWER ALLEN TOWN IN SIERRA LEONE

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Mangroves occupy about 47% of the Sierra Leone coastline covering an area of 171,600 hectares. In 1986 the Government of Sierra Leone assisted by the UNDP/FAO began an assessment of these resources as part of its plans to improve the rapidly deteriorating fuelwood situation in Freetown and the surrounding rural districts in the Western Area of the country. Indicative volume data obtained from limited field studies show that there are many locations in the Kambia, Moyamba and Bonthe Districts with mature stands that could have an immediate impact on relieving fuelwood shortage if properly managed. At the same time there are large degraded tracts in the Sierra leone River Basin of prime protective and socio-economic importance in need of urgent rehabilitation.

The strategy of rehabilitating the derelict mangrove site at Lower Allen Town started in 1987 with the preparation of a management plan (456 ha) and the planting of Rhizophora racemosa in pure stands because of its good form, excellent growth and the availability of large supplies of propagules. A small trial consisting of 5 of the other species found in Sierra Leone was established in the same vicinity.

The paper provides information on the characteristics of the area and the species and describes the techniques used to establish approx. 90 ha. A table showing the rate of growth over a 3-year period is included together with a comparison of the performance to date of the 5 other species.

The results are discussed and confirm the potential of Rhizophora racemosa for an expanded replanting programme in the Sierra Leone River Basin. The experience may of be relevance to other countries where replanting is considered necessary to recover similar degraded mangrove ecosystems.

BIOTECHNOLOGY IN MANGROVE AFFORESTATION

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Mangroves are remarkable tropical plants of great economic and ecological significance. The fast depletion of the mangroves has already caused soil erosion in coastlines and significant fall in fishery production. Hence, a large scale plantation of the mangroves in degraded shorelines is an immediate need to protect coastal economy. But conventional method of mangrove propagation is difficult due to high pollen sterility and poor vegetative propagation. Hence, tissue and cell culture techniques have been attempted for the first time in the present investigation.

The aspects such as selection of explant, establishment of sterile culture, development of culture media, environmental conditions and propagation techniques have been studied in 9 mangroves viz., Rhizophora apiculata, R. mucronata, R. lamarckii, Avicennia marina, A. officinalis, Excoecaria agallocha, Lumnitzera racemosa, Bruguiera cylindrica and Susuvium portulacastrum, using 5 culture media of 55 hormonal combinations. The results of the techniques are discussed for their possible utilization in afforestation of mangroves.

POSTERS

MEIOFAUNA FROM SEAGRASSBEDS NEAR MANGROVES IN KENYAN COASTAL BIOTOPES

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The epiphytic meiofauna of Thalassodendron ciliatum has been studied at two different sites along the Kenyan coast: Gazi Bay and Nyali Beach. Eighteen taxa have been found from which nematodes and copepods were the most dominant groups. It is however remarkable that the diversity and numbers of animals is significantly higher in Gazi (1,300 - 6,800 ind. per g dw seagrass) than in Nyali (300 - 600 ind. per g dw seagrass). This is related to the abiotic features of both sites (current patterns, length of seagrasses .....). The nematodes are identified to genus level 88 genera were found with Anticoma, Euchromadora, Prochromadorella, Spilophorella, Viscosia as the dominant ones. The dominant family is the Chromadoridae.

Multivariate analysis of the data showed striking differences between the two sites. The characteristics of the epiphytic nematodes are discussed.

This study is part of an ecological approach of the Dynamics and Assessment of Kenyan Mangrove ecosystems.

GILL MORPHOMETRY AND DESICCATIONS TOLERANCE IN SUPRATIDAL AND INTERTIDAL FIDDLER CRABS

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Gill morphometry and desiccation tolerance of the fiddler crabs Uca lactea, Uca inversa and Uca urvillei which inhabit intertidal and supratidal areas in Gazi mangrove creek were studied. Differences in gill morphometrics among the three species were consistent with terrestrial living. Uca lactea were found to posses the lowest total gill area 2070.8 mm^2 followed by Uca inversa 2774.8 mm^2 and Uca urvillei 3660.5 mm^2.

Expressed as a ratio to their wet weight, the above values change consistently to 2516 $mm^2\ g^{-1}$: 2455.6 $mm^2\ g^{-1}$, 140.25 $mm^2\ g^{-1}$ in Uca lactea, U. inversa and U.urvillei respectively (n = 10). In these ratios Uca urvillei has the smallest mass specific gill area due to the fact that they posses a larger and heavier cheliped.

The lowest number of gill lamellae per millimeter gill was found in Uca lactea with 4-6 lamellae per millimeter. In Uca inversa the numbers range from 6-8 and in Uca urvillei 6-12 lamellae per millimeter gill (n = 10). This comparison indicates a better adaptation to aerial respirations in Uca lactea.

Surface temperatures in the open mangrove habitat can reach 34°C. The three species of fiddler crabs, each inhabiting a distinct zone within the mangrove, were studied to determine whether they differed in their physiological responses to temperature. In relation to their zonations on the shores, the species showed a decrease in their ability to tolerate water loss with decreasing tidal position, i.e. Uca urvillei tolerate only 25.6 $\pm$ 2.25% water loss compared to 30.6 $\pm$ 3.6% in Uca inversa and 47 $\pm$ 9.9% in Uca lactea (n = 10).

Laboratory experiments show that crabs lose 2% body water per hour at 40°C, but Uca lactea generally survived desiccation longer and also tolerated a greater percentage water loss.

DIURNAL VARIATION IN THE PHSICO-CHEMICAL PROPERTIES AND PRIMARY PRODUCTION IN THE INTERCONNECTED MARINE, MANGROVE AND FRESH WATER BIOTOPES OF KAKINADA COAST, ANDHRA PRADESH, INDIA.

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Diurnal variation in hydrological parameters and dissolved inorganic nutrients such as PO_4-P, NO_3-N, NO_2-N and NH_4-N were studied in three interconnected biotopes including fresh water, marine and mangrove brackish water of the Kakinada Coastal Zone, Andhra Pradesh. Samples were collected at an interval of 3 hours, For a period of 24 hours. In the marine environment salinity varied from 26‰ to 32‰ whereas in the mangrove waters it fluctuated from 12‰ to 20‰ and in both these biotopes salinity showed bimodel type of oscillation. Dissolved oxygen content was high in the mangrove waters during day time which decreased rapidly during the night. The concentrations of PO_4-P, NO_3-N and NO_2N were high in the fresh water canal, the maximum and minimum value being 1.110 and 0.730 μg at/l, 26.40 and 13.88 μg at/l and 0.520 and 0.252 μg at/l respectively. In the marine environment PO_4-P concentration varied from 0.345 to 1.195 μg at/l, $NO_{3\text{-N from } 1.03}$ to 6.62 μg at/l and NO^{2}-N from 0.086 to 0.506 μg at/l. The highest and lowest concentration of PO_4-P NO_3-N, NO_2-N recorded in the mangrove waters were, 0.790 and 3.25 μg at/l, 7.10 and 1.60 μg at/l and 0.060 and 0.278 μg at/l respectively which may indicate that the concentrations of these nutrients were lesser in the mangrove biotope than in the marine and freshwater environment. The concentration of ammonia was relatively very high in the mangrove water. Gross and net primary production in the mangrove water was 262.3 mgC/m^3/hr and 136.5 mgC/m^3/hr respectively which was to 4 times higher than there was no 'export' of dissolved nutrients from the mangrove environment to the adjacent marine waters.

THE LOCAL RESOURCE UTILISATION OF NYPA FRUTICANS WURMB IN MALAYSIA

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Coastal resources, both renewable and non-renewable, are varied in Malaysia, ranging from coral reefs, shallow waters to swamp forests. Mangroves and nipa swamps form only a small proportion of the total forest products. With the exception of Sarawak state, there is little available information on trade in nipa (Nypa fruticans Wurmb) products in the market. Subsistence utilization of the palm among folks populating the coastal zone and tidal rivers is traditional. The primary materials harvested or extracted are the leaves and the free flowing sap from wounded inflorescence/infrutescence stalks. The leaves make good quality thatch, light construction materials for walls and materials for weaved handicrafts. Sugar is obtained from the freshly gathered plant sap. Slightly fermented sap provides wine whilst if elaborate fermentation procedures are followed alcohol is produced and even vinegar. The techniques for procuring nipa end-products are mainly traditional learnt not by formal instruction but rather through apprenticeship or from the home environment. Field data on nipa resource utilization plus norm market prices for the products have been relied on to translate the potentials of the swamps into economic value.

SEASONAL VARIATION IN THE CHEMICAL CONSTITUENTS OF BENTHIC MACROALGAE FROM THE SOUTH COAST OF JAMAICA

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Dominant benthic macroalgae from six different sites on the south coast of Jamaica (small point, Hellshire Bay, Half Moon Bay. Two sisters Bay, Wreck Bay - all from the Hellshire area and Bowden Bay) were assessed for monthly variation in chemical composition for one year. Analyses were made for soluble carbohydrates, proteins, lipids, potassium and sodium on Bryopsis pennata, Caulerpa sertulariodes, Penicillus capitatus, Halimede sp., Dictyota dentata - all from Helshire area, Sargassum vulgare, Hypnea musciformis and Gelidiella acerosa from Bowden.

There was marked variation in all the parameters but it was dependent on both the sites of collection and the species. Same species gave different values depending on the site of collection as in the case of Caulerpa sertularioides. Bryopsis pennata recorded the highest protein and lipid contents, both about 16% while the lowest protein (1.4%) and lipid (0.8X) were observed in Helimeda sp. and Hypnea respectively. Highest carbohydrates of about 10% were recorded in G. acerosa and H. musciformis. Sargassum vulgare and G. acerosa had a slightly different variation trend in that protein carbohydrates ratios were nearly uniform suggesting that the growth rates were uniform. These and other results and possible explanations for the observed seasonal variations will be discussed.

THE EFFECTS OF RIVER DISCHARGES ON A CORAL REEF ECOSYSTEM NEAR MALINDI, KENYA

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In October 1982 - May 1983 a study was carried out on the reef system south of Malindi, Kenya, by ten biology MSc. students and four human geography students of the University of Nijmegen. The study area covered roughly 30 km of coastline south of Malindi township and consisted of the Watamu Marine National Reserve, and the Malindi and Watamu Marine National Parks. Aim of the study was to assess the relative contribution of several possible factors of disturbance, to the noticeable reef decline. The investigations were focussed on the Sabaki river and its drainage basin.

The Sabaki (Athi or Galana) drainage basin has undergone drastic changes in both land-use practice and intensity over the past decades. This has resulted in changes in hydrology, with more pronounced flooding, and accelerated erosion, with a silt load that has leapt from about 58,000 tons/annum in the 50's' to 7.5 x 10^{6} tons/annum in the 70's. Most sediment originates from the Machakos hills and the Tsavo river subcatchment, which both harbour soils with a high erosion hazard.

Coastal water salinities and temperatures measured in '82 - '83 indicate that fluctuations of these factors did not result in a stressing of the reef environment, unless, perhaps, Sabaki floods are unusually strong. Adverse effects are primarily to be felt through smothering by sediments, and light reduction by suspended sediments. In the north, where sediment influx is highest, reef smothering in some localities has resulted in a replacement of coral growth by seagrass (mainly Thalassodendron ciliatum). In other areas, where the sediment influx is apparently very high, seagrass also succumbs and gives way to almost bare substratum. Secchi disk visibility ranged from about 10-16 m (max. 24 m) before Sabaki waters entered the coastal zone (Nov.-Dec.), to 4-10 m (min. less than 1m) after influx. Calculations combining visibility, coral distribution + light requirements, and water depth data, indicate that prolonged stress due to reduced illumination occurs in the northern parts of the reef system (near Malindi), and in deeper reef sections near Watamu.

ANTIBIOTIC ACTIVITY OF MANGROVES

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In vitro antibacterial and antifungal activities of 19 mangroves were evaluated against 15 bacterial and 7 fungal pathogens. The susceptibility was assessed following the agar disc diffusion method. Crude ethanolic extracts were used for this sensitivity test. The present study revealed that all the mangroves exhibited antibacterial activity against one or more bacterial strains. Among the mangroves, root of Acanthus ilicifolius, seed of Bruguiera cyclindrica, leaf and bark of Excoecaria agallocha, leaf of Rhizophora lamarkii, Salicornia brachiata, Sueda maritima and Sueda monica showed considerable activity against gram positive and gram negative bacteria. Among the 3 species of Rhizophora the activity of R. lamarkii was found to be prominent than R. apiculata and R. mucronata. The gram positive bacteria Staphylococcus aureus was found to be the most susceptible pathogen, but surprisingly, the Proteus mirabilia and Vibrio cholerae among gram negative organisms also showed high sensitivity to the plant extracts.

The screening for In vitro antifungal activity showed that about 27% of the mangroves showed remarkable antifungal activity. Extracts of the leaves and roots of the mangrove Acanthus ilicifolius showed remarkable antifungal activity. The bark of Avicennia officinalis, the leaves and seeds of Bruguiera cylindrica, leaves of Excoecaria agallocha and Sueda monica also exhibited antifungal activity. The extracts of mangroves inhibited Helminthosporium orizae to a greater extent, followed by Trichoderma viridae and Trichophyton mentagrophytes. None of the plants were active against Aspergillus flavus. The seasonal variation in the activity of mangrove was not prominent but E. agallocha and R. lamarkii was showing a little enhanced activity during summer and premonsoon than in other seasons. Many mangroves hitherto not investigated have been studied and reported in the present study. Yet there are many more mangroves not studied systematically from these coasts and the chemical investigation may also yield many interesting compounds.

EAST AFRICAN WILDLIFE SOCIETY

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The Society was originally founded as the Kenya Wild Life Society in 1956 with its counterpart, the Wild Life Society of Tanganyika.

The purpose of the Society was to give public backing to the then Trustees of the Kenya National Parks, the Game Department, and the wild animals under their protection. The Society also aimed to provide a forum for discussing conservation issued while monitoring the performance of Government in wildlife conservation. If certain species were to avoid extinction in East Africa, then some sort of controlled use of wildlife was mandatory. In 1961, the Wild Life Societies of Kenya and Tanzania were amalgamated and joined by wildlife enthusiasts in Uganda to form the East African Wild Life Society.

Initially, efforts were concentrated on the larger game species such as the elephant, leopard, lion, cheetah and rhino which were the targets of big game hunters. At this point, little attention was paid to the smaller species such as corals, antelope, birds, and butterflies. Nevertheless, over the years, the Society came to the realization that success could not be achieved through wildlife conservation alone. In order to preserve wildlife's habitats would have too be preserved as well. Hence, the current objective of the Society is "to safeguard wildlife and its habitat in all its forms, as a national and international resource."

Over the last three decades the Society has channelled a great deal of its funds to sponsor projects at the Coast in order to recommend the best conservation strategy. Various findings would be explained during the conference.

Despite the current levels of public awareness various problems such as excessive shell collection, overfishing and siltation due to poor agricultural practices, dynamiting and deforestation have continued. More support is required from various sectors so as to adequately conserve the marine resources.

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International Symposium on

THE ECOLOGY OF MANGROVE AND RELATED ECOSYSTEMS

24 - 30 September, 1990

Mombasa, KENYA

Organised by

the Department of Zoology, University of Nairobi

In collaboration with Kenya Marine and Fisheries Research Institute
and RECOSCIX - WIO Regional Dispatch Centre

With sponsorship of:
African Biosciences Network
US - National Research Council
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The Netherlands Ministry of Agriculture, Nature Management and Fisheries
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- **Dr. E. Martens** (Secretary)
  Department of Zoology, University of Nairobi
- **Prof. S. Dadzie**
  Department of Zoology, University of Nairobi
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  Kenya Marine & Fisheries Research Institute
- **Mr. P. Pissierssens**
  RECOSCIX-WIO Regional Dispatch Centre, KMFRI

PRINCIPAL SYMPOSIUM TOPICS

- **Status, primary productivity and taxonomy of mangroves, seagrasses and algae**
- **Consumers in mangrove ecosystems**
- **Coral reef ecosystems**
- **Fishery biology and mariculture**
- **Exploitation, conservation and management aspects**
- **Nutrient cycling, chemical and physical processes**
- **Pollution of coastal ecosystems**

The Proceedings will be published as a single issue of the International Journal Hydrobiologia
(Kluwer Academic Publishers) with the sponsorship of The Commission of the European Communities.

DECLARATION ON MANAGEMENT STRATEGIES

The **Mangrove, Seagrass and Coral Reef Ecosystems** are of paramount ecological and economical importance but have already undergone great degradation which is advancing at an alarming rate. If present trends continue, the natural resource basis of the economy and ecology of tropical coastal regions will soon be ruined. This was the unanimous conclusion of the 110 scientists from 23 countries who gathered in Mombasa, Kenya, for a Symposium on the ecology of these ecosystems.

Mangrove forest systems yield large amounts of fish, crabs, prawns and oysters. They are also valuable sources of fuelwood, timber, tannin and other natural products. Their non-marketable value is of equal importance: stabilization of the coastline, an indispensable nursery ground for numerous marine species with commercial value, a natural filter maintaining the clarity of nearshore water, a home for resident and migratory birds and other wildlife. Many of the true mangrove flora and fauna are now endangered by the clearing of the mangroves. It has been shown that in many countries between 25 to 100% of the mangrove forest has been destroyed already in the last twenty years.

Seagrass beds are highly productive ecosystems which provide substantial support to human coastal populations through seafood production, provision of nursery grounds for marine fauna, and their potential for rehabilitating degraded coastal areas.

The coral reef has also a considerable economic value. In most tropical countries it provides the backbone of the inshore fisheries. Moreover, tourism related to coral reefs has become a major money earner in many tropical countries. But when the reefs die and fish become scarce, the tourists lose interest.

These habitats are often interlinked in manifold ways. They are very vulnerable to careless human exploitation which looks only to short-term gains. These systems are an invaluable national heritage which will be destroyed for ever unless we act now, in order to pass them on to our children.

This international scientific assembly concluded that much can be done to stop the degradation of these damaged ecosystems and to rehabilitate them. But new techniques must be found to use them on a sustainable basis for long term economic return and for the wellbeing of coastal human settlements and a healthy environment.

The scientists gathered in the symposium therefore **recommend the following strategies** to achieve the above goals.

- Establishment of **national Coastal Management Plans** including the following components:
  - Survey of both natural and human resources and their present uses.
  - Identification of the problems affecting these ecosytems.
  - Adjustment of the legal frameworks with regard to the uses of these ecosystems and enforcement of existing management regulations.
  - Provision of technical assistance and training (agriculture, forestry, fisheries, land use) for the introduction of economically *and* ecologically viable activities in these ecosystems.
  - Rehabilitation of damaged areas.
  - Creation of natural reserves both for tourism and for the recuperation of natural plant and animal populations.
  - Education and creation of public awareness on the value and problems of these ecosystems.
- In formulating and implementing this Plan *all* concerned parties should be involved, i.e., the inhabitants and the outside users of these ecosystems, the policy makers, the scientists and technical experts, and also the national and international funding agencies.
- To achieve the above, use should be made of the existing institutions and networks. The scientists gathered in this Symposium intend to carry on and develop further the working relationship already established between them. They also urge the establishment or strenghtening of regional and international associations of scientists to provide the scientific basis to existing national and regional Management Plans.

This gathering of scientists further urges the ratification of regional and international Conventions which deal with the protection, management and development of the mangrove and related ecosystems.

The Secretariat of the Organizing Committee of this Symposium and the scientists indicated with an asterisk in the list of the participants will be pleased to provide more information on the above statement.

STATEMENT OF PRIORITIES FOR SCIENTIFIC RESEARCH

The **Symposium** highlighted both recent advances in coastal zone ecosystem studies and areas of future research that should be considered priorities to resolve outstanding problems, especially those related to the management of **mangrove and related ecosystems**.

APPLIED RESEARCH

The philosophy underlying applied research is that it should be directed towards management of the forest product or the aquatic product on a sustainable basis taking into account the integrated nature of the ecosystem. Emphasis should be placed on minimizing perturbations to the system, i.e., keeping inputs to a minimum in order to maintain ecological integrity. It is recognized that the main impact on the mangroves is due to increased human population pressure and that the scale of management will vary according to the socio-economic situation existing in any particular region.

Investigations into the following broad areas are needed:

- The methods for efficient land use in the adjacent watershed of the mangal, seagrass beds and coral reefs. Deleterious effects may include increased siltation, reduced tidal recharge and agricultural pollution.
- The effect of management of mangroves on off-shore fisheries. Management practices may have consequent effects on fish, prawn and other aquatic resources for which the mangal acts as a nursery.
- The impact of industrialization on the mangal and related ecosystems. Industrial processes are taken here to include the creation of salt ponds, dredging, marinas and mining, etc.
- The effect of domestic and industrial effluents and how to minimize and control the impact of these effluents.
- The effect of aquatic farming techniques (fish, shrimp and oyster ponds and cultivation of seaweed) which may result in effluents, sedimentation and/or siltation. Comparative studies of destructive/non-destructive farming techniques should be carried out with the view to minimizing any negative effects.
- The effect of human activities on physical, chemical and biological soil processes.
- Research on management practices appropriate to different mangrove forest types. Promotion of a biotechnological approach in research on mangrove silviculture.
- Socio-economics of coastal human settlements dependent on mangroves.
- Investigation of natural products of mangals.
- The impact of global climate change.
- *Active* rehabilitation of seagrass beds and coral reefs.

BASIC RESEARCH

In order to study management practices and their impact, ongoing basic research into key areas is required.

- Interlinkages between mangrove, coral and seagrass ecosystems. The possible interlinkages indicated during this Symposium should be further investigated.

- Hydrological processes: further information is needed about nearshore hydrological processes operating at the small and meso-scale and elaboration of predictive models.

- Geochemical processes: nutrient cycling and energy flow.

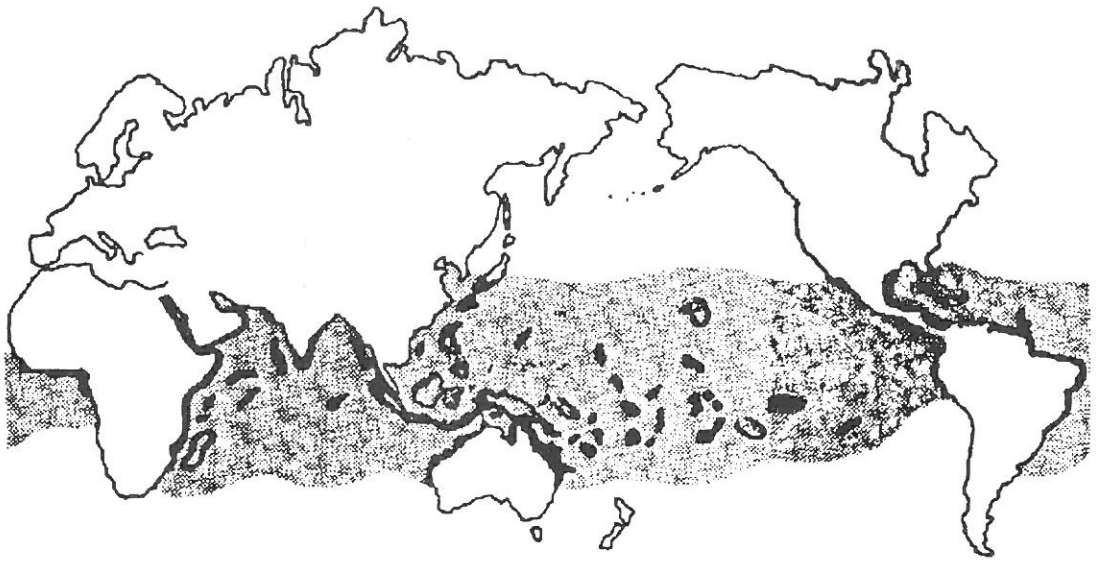
- Biological processes including: microorganisms, phyto- and zooplankton and benthos, reproductive biology and life history of animals and plants, recruitment and trophic relationships of animals, plant-animal interactions.

- Physical, chemical and biological soil processes.

- Use of bioindicators.

FUTURE CONTACTS

It was decided that a future meeting take place in 1992/93 in Mexico. The EPOMEX Program of the Autonomous University of Campeche, Mexico, has offered to host such a meeting which may take the form of a workshop. An appropriate theme should be decided upon and preparations initiated by the host Institution.



LIST OF PARTICIPANTS

The participants whose names are marked with an asterisk (*) are willing to give more information about the Declarations adopted by the Symposium.

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