PROCEEDINGS OF THE SYMPOSIUM ON COASTAL AQUACULTURE

Held at Cochin

From January 12 to 18, 1980

PART 4: CULTURE OF OTHER ORGANISMS, ENVIRONMENTAL STUDIES, TRAINING, EXTENSION AND LEGAL ASPECTS

(Issued in December 1986)

MARINE BIOLOGICAL ASSOCIATION OF INDIA

POST BOX NO. 1023, COCHIN-682 031, INDIA

Price : Rs. 400.00

SYMPOSIUM SERIES 6

Abbreviation

Proc. Symp. Coastal Aquaculture, Pt. 4.

PRINTED IN INDIA BY A. D. THOMAS STEPHEN AT THE DIOCESAN PRESS, MADRAS 7 AND PUBLISHED BY E. G. SILAS ON BEHALF OF THE MARINE BIOLOGICAL ASSOCIATION OF INDIA, COCHIN-682 031

Proc. Symp. Coastal Aquaculture, 1986, 4 : 1084-1087

PRODUCTIVITY OF DIFFERENT MANGROVE ECOSYSTEMS

M. S. RAJAGOPALAN, C. P. GOPINATHAN, V. K. BALACHANDRAN AND A. KANAGAM

Central Marine Fisheries Research Institute, Cochin-682 031

ABSTRACT

This paper embodies the results of field studies conducted on productivity in three different mangrove areas, *viz.*, Cochin Backwater, Killai Backwater and Andaman Nicobar Islands. The rate of production varied in these areas, but generally indicated a good production rate. The energy inputs from various sources into the ecosystem and the process of conversion are discussed in the light of an overall energy budget available. The productivity of adjacent marine environments is also discussed in the light of their suitability for development of mariculture practices.

INTRODUCTION

THERE is increasing awareness in our country and elsewhere on coastal aquaculture as a measure for increasing production of finfishes and shellfishes. As an essential prerequisite, it has become necessary to survey suitable areas for mariculture in estuarine and lowlying areas and assess the productivity of such areas, so that the investigations will provide a clue to the stocking capacity in the areas chosen for culture practices. This would also enable an assessment of the fluctuations in potential yield of finfish and shellfish stock per unit area.

It is now well known that mangrove areas which are found in estuarine and coastal regions are potential source of organic detritus that enrich the estuarine and inshore regions, in the vicinity of which aquaculture and seafarming are undertaken. Heald and Odum (1970) has drawn attention to the magnitude of organic productivity in the Florida mangrove creeks. The mangrove areas generally provide detritus-rich food for a number of estuarine organisms such as mullets, *Chanos*, *Etroplus*, prawns, oysters and mussels, in addition to providing shelter for the juvenile stages of these groups.

In India, mangrove formations are rich in Sunderbans, Godavary Delta, Andaman-Nicobar Islands and Kauvery-Delta of Tamil Nadu. As a part of the ecological investigations on mangrove areas carried out by Central Marine Fisheries Research Institute, primary productivity in the mangrove areas were estimated in Cochin Backwater (Kerala), Killai Backwater (Tamil Nadu) and Andaman Nicobar Islands, and the present paper embodies the results of these studies.

The authors are grateful to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, Cochin for the guidance and encouragement given to this research programme. They are also very thankful to Dr. P. V. Ramachandran Nair and Dr. K. J. Mathew for their suggestions.

MATERIAL AND METHODS

Light and dark bottle oxygen technique has been used for estimating the productivity with occasional cross checks by ^{14}C technique

(Steemann Nielsen, 1952). In the ^{14}C technique, 5 μg of $NaH^{14}CO_3$, 1 ml was added to samples taken in 60 ml reagent bottles. The samples were incubated in natural light for 2 hours. Activity of the filter was determined on a Geiger Counting System having an efficiency of 3.2%. The use of ^{14}C was highly restricted in the experiments because of the high variability in salinity and temperature in these ecosystems which in turn governs the total CO_2 concentration of the water. The sampling has been done only at the surface waters and the incubation has been carried out under identical conditions of temperature and light. In view of the limited depth of the mangrove waters, it was not felt necessary to conduct sampling throughout the water column. As the light penetration takes place upto the bottom, there is not much limitation regarding the available energy for photosynthetic activity. So the availability of nutrients as well as the process of regeneration are considered the major criteria governing the productivity. The oxygen technique of production per unit volume has been computed assuming PQ as 1.25.

Areas investigated

The estuarine system of Cochin has a total coverage of about 300 sq km. The mangrove formations are restricted and of a patchy nature in some islands in the backwater system and in some reclaimed areas near the Cochin Bar-mouth. The stations studied during the present investigation are situated on the southern part of Cochin near Perumbalam. The mangrove vegetation showed typical forms such as *Avicennia officinalis, Rhizophora mucronata, Bruguiera cylindrica, Excoeccaria agallocha, Aegiceras corniculatum, Acanthus ilicifolius* and *Clerodendron inerme*.

At Killai area, in the Coleroon and Vellar estuaries near Porto Novo (Tamil Nadu), dense formations of mangrove vegetation are found in an area spreading to about 1000 ha. The mangrove vegetation is comparatively rich with the formations of *Rhizophora mucronta, R. apiculata* in the inter-tidal zones and other species such as *Avicennia marina, A. officinalis, Bruguiera cylindrica, Ceriops decandra* and *Excoeccaria agallocha* in the immediate background. Species such as *Aegiceras corniculatum* and *Lumnitzera racemosa* are usually found growing between the prop roots of *Rhizophora*. The vegetation shows distinct zonation and spatial distribution, as a result of mixing of freshwater and brackish-water. It is estimated that the litter production is about 3 tonnes/ha/year in this mangrove area (Sundararaj, 1978). This gives an indication of protein rich detritus matter available for fishes and prawns which are abundant in the area.

The Andaman Nicobar Islands consist of several islands extending to about 800 km between lat. 6°40′ and 13°41′N. These islands offer a vast coast line where mangrove vegetation thrives under typical tropical conditions. Because of the thin population of browsing cattle and less human interference, the mangroves of these islands are well preserved by nature as compared to regions like Gujarat where man has continuously exploited them for fodder and firewood. The mangrove area of the islands is estimated to be about 1,15,200 ha and within this ecosystem live a host of animals such as crabs, molluscs, and juveniles of prawns and fishes.

As regards the mangrove vegetation in the Islands, *Rhizophora mucronata* and *R. apiculata* exhibit dense formation along the border of bays and creeks. The tree forms grow to heights of 10-15 m. Behind the inter-tidal zone *Bruguiera parviflora* and *B. gymnorrhiza* are common. In certain pockets, *Sonneratia caseolaris, S. alba, Avicennia marina, Aegiceras corniculatum* and *Nypa fruticans* occur in good numbers.

Table 1 gives the values of primary production in different mangrove areas investigated.

Within the productivity range mentioned above for Cochin estuarine system, the primary peak is observed usually in the month of June and a secondary peak in the post monsoon months September to November.

TABLE 1. *Productivity of different mangrove areas*

Mangrove areas	Range in the rate of production (mgC/m³/day)	Seasons of observation
Cochin Estuarine system	725-3200	all seasons
Killai Backwater	125-760	Summer months
Andaman-Nicobar Islands	510-3600	Summer months

Sundararaj and Krishnamurthy (1973) observed a very high production rate of 836.89 mgC/m³/hr at the mangrove station in Killai backwaters in the summer of 1972. It was nearly 4 fold when compared to the rate observed in the adjacent estuarine waters.

In Andaman and Nicobar islands, the productivity rate of 510 mgC/m³/day was observed in Kimoi's backwater in Car Nicobar and the high production rate of 3600 mgC/m³/day was observed at Corbyn's cove.

Thus the rates of production in the observed mangrove areas were moderate to high.

DISCUSSION

In a survey undertaken on the productivity of the prawn culture fields around Cochin, *Gopinathan et al.* (1982) have estimated the production in the seasonal and perennial prawn culture fields as ranging from 650 to 3,800 mg C/m³/day. Nair *et al.* (1975) have estimated the total production in the entire estuarine area of Cochin as 100,000 tonnes of Carbon/annum.

For the estuarine system of Cochin, Qasim (1970) has estimated the gross production as ranging from 270-295 gC/m³/year and an average production equal to 280 gC/m³. The average net production for 24 hrs has been computed as 124 gC/m³/year and out of this only 25% is consumed by zooplankton herbivores and the rest is available as surplus food in the form of organic detritus. This will amount to 1000 kg/ha/annum.

Further, during the course of their investigation in the mangrove areas in the Cochin system, the authors estimated that the average quantity of detritus resulting from mangrove litter fall as 1500 kg/ha/annum. Thus the total quantity of basic food available for an omnivorous feeder such as prawn is estimated at 2500 kg/ha/annum in mangrove and mangrove adjacent waters.

Qasim and Easterson (1974) have determined the nutritive value of the estuarine detritus and the energy conversion of a penaeid prawn, *Metapenaeus monoceros* based on laboratory experiments. They found a gross growth efficiency of 10.5 to 35.2% and the assimilation efficiency in the order of 93%.

Taking an average conversion efficiency of 20% for prawns, the detritus production of 2500 kg/ha/annum will sustain a production of 500 kg of prawns ha in the mangrove adjacent prawn fields in the Cochin estuarine system and this figure will go upto 800 kg/ha if we take the conversion efficiency as 30%.

In prawn culture demonstrations carried out in farmers' field by the Central Marine Fisheries Research Institute in Narakkal and other areas near Cochin, it has been observed that prawn seeds stocked at the rate of 40 to 50 thousand/ha has given yields ranging from 123 to 595 kg after a period of about 3 months. The size of seeds varied from 15 to 50 mm at the time of stocking (Anon, 1978). Based on this data and the productivity and conversion efficiency as worked out above it is possible to indicate the optimum stocking densities for a commercially very important cultivable species such as *Penaeus indicus*.

Production rate of basic detrital food	.. 2500 kg/ha/annum
Expected production of prawn (*P. indicus*) at 20% conversion efficiency	.. 500 kg/ha
No. of harvestable prawn at av. wt. of 12 g each	.. 41,667
∴ stocking density of prawn seeds/ha at a survival rate of 80%	.. 52,084
Say	.. 52,000

In conclusion it may be stated that mangroves in coastal areas and estuaries greatly enrich the productivity of surrounding water bodies. Mangrove creeks and waterways serve as nursery grounds and shelter for a variety of fishes, prawns and molluscs which are commercially important. The productivity of this ecosystem is of particular significance to coastal aquaculture for which national priority is being assigned.

REFERENCES

ANON. 1978. Intensive culture of marine prawns. *Mar. Fish. Infor. Serv. T & E Ser.*, 3 : 9-13.

GOPINATHAN, C. P., P. V. R. NAIR, V. KUNJUKRISHNA PILLAI, P. PARAMESWARAN PILLAI, M. VIJAYAKUMARAN AND V. K. BALACHANDRAN 1982. Environmental characteristics of the seasonal and perennial prawn culture fields in the estuarine system of Cochin. *Proc. Symp. Coastal Aquaculture, MBAI*, 1 : 369-382.

HEALD, E. J. AND W. E. ODUM 1970. The contribution of mangrove swamps to Florida fisheries. *Proc. Gulf and Carib. Fish. Inst.*, 22 : 130-135.

NAIR, P. V. R., K. J. JOSEPH, V. K. BALACHANDRAN AND V. K. PILLAI 1975. A study on the primary production in the Vembanad Lake. *Bull. Dept. Mar. Sci. Univ. Cochin*, 7(1) : 161-170.

QASIM, S. Z. 1970. Some problems related to the food chain in a tropical estuary. In : J. H. Steele (Ed.) *Marine Food Chains*. Oliver & Boyd, Edinburgh. pp. 45-51.

——— AND D. C. V. EASTERSON 1974. Energy conversion in the shrimp *Metapenaeus monoceros* fed on detritus. *Indian J. mar. Sci.*, 3 : 131-134.

STEEMAN NIELSEN 1952. The use of radio-active Carbon (14C) for measuring organic production in the sea. *Extract. J. du Conseil Internat. Pour. L'explor. de la mer.*, 18 (2) : 117-140.

SUNDARARAJ, V. AND K. KRISHNAMURTHY 1973. Photosynthetic pigments and primary production. *Curr. Sci.*, 42 : 185-189.

———, 1978. Suitability of a mangrove biotope for brackishwater aquaculture. *Seafood Exp. J.*, 10 (12) : 23-27.