Textbook of
Oyster Biology and Culture in India

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and
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Oyster Biology and Culture in India

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Preface

OYSTERS, an important group among the bivalve molluscs are highly esteemed as seafood in many temperate countries where consumption of raw oysters is popular. Oyster is probably the most studied invertebrate and marine aquaculture may have begun with oysters. Oyster farming has a long history and it has been reported that the Chinese practiced oyster culture before the Christian era while in Europe the Romans farmed oysters since the beginning of the first century B.C. by adopting the simple method of relaying the oyster seed in suitable grow out areas. In late 1920s the Japanese developed the 'hanging culture' and by 1950s made rapid strides by adopting the raft and long line oyster culture in depths upto 30 m. The latter half of the 20th century ushered in the spread of oyster culture to several parts of the world and there is growing interest in tropical countries, which have the advantage of cheap labour and producing market size oysters in a short period of 6-10 months against about 2 years or more in temperate countries, depending upon the method of culture and the species. The noted oyster biologist Dr.Gary Newkirk stated that oysters are cultured in all the continents except in the Antarctica. As per the FAO statistics, the world aquaculture production of molluscs in 2003 was 1,22,84,758 mt and among them the oysters accounted for 44,96,609 tonnes (36%). These figures highlight the importance of oysters in the global perspective. China emerged as a world leader in oyster production with about three-fourth production as its share.

In India, the first attempt to farm the oysters on scientific lines was made in 1910 by the British Biologist Dr. James Hornell. Realizing the importance of oyster culture, the Central Marine Fisheries Research Institute initiated a Research Project on oyster culture at its Tuticorin Research Centre in late 1970s by collecting natural spat. A devoted band of scientists under the able leadership of Shri K. Nagappan Nayar, followed by others, have successfully developed the technology of seed collection from nature, farming systems using racks for holding trays and oyster rens and also large scale hatchery production of seed. During 1993-95 several programmes were taken up by the CMFRI to assess the suitability of various sites in several states for oyster culture by using both hatchery and natural spat. These studies showed that several places in the four southern states are suitable for oyster culture, and the most important being the Ashtamudi lake in Kerala which emerged as a highly suitable site both for spat collection and grow-out culture. In the mean time, significant contributions on various aspects of oyster culture have come from

the College of Fisheries, Mangalore. After nearly two decades of research and development by the CMFRI, the first commercial oyster farm came up in 1996 at Dalavapuram in the Ashtamudi lake. Since then, with active support, in imparting training, technology transfer and continuous interaction in the field with the oyster farmers by the CMFRI scientists, coupled with the involvement and participation of financial institutions, developmental agencies and others, oyster culture is fast picking up in Kerala, with the current production being 750-800 t. The average annual production of oysters by the harvest of wild stocks is 18,800 tonnes / year. A major constraint at this time is marketing, since in India oyster consumption is traditionally limited to a few coastal communities and oysters are practically unknown in the vast interior of the country except for a few metropolitan cities. The technology for the preparation of several products with oysters is readily available in the country. The availability of indigenously developed and time tested packages of oyster culture technology, a strong research base to optimise production, increased awareness among the prospective farmers about the economic benefits of oyster culture and the readiness of developmental and financial institutions to provide credit, augurs well for the rapid development of oyster culture in the country.

Dr. K.A. Narsimham, senior author rendered over 37 years of service in the CMFRI and has over 70 scientific papers to his credit. During his long association with this Institute, he made significant contributions on most groups of molluscs of commercial importance in India. He functioned as the Head of Molluscan Fisheries Division for over four years. He played a major role, in association with his colleagues, in identifying various sites suitable for oyster culture in India and in the transfer of oyster culture technology to the farmers. As Principal Investigator of the bivalve hatchery project, in collaboration with his colleagues, he achieved a major breakthrough in the large-scale hatchery seed production of various clam species. He is a recipient of Ind. Aqua 1993 award, in recognition of his outstanding contributions in developing complete package of technology for clam culture.

Dr. (Mrs.) V. Kripa, Senior Scientist and co-author of the book is working in the CMFRI for the last 20 years. She has worked on the clam, oyster, mussel and cephalopod resources of the south-west coast of India. She took the Ph.D. degree from Cochin University of Science and Technology for her thesis on the rock oyster *Saccostrea cucullata*. She also received National award in 2001 for her article in Hindi on "Molluscan Mariculture" under the non-Hindi speaking category. She is playing a significant role in the technology transfer of oyster culture with particular emphasis on women empowerment in this area.

This book, Oyster Biology and Culture in India contains 12 Chapters and after a general introduction to oysters in Chapter 1, oyster resources, their

distribution and ecology are dealt in Chapter 2. Biology, unwanted species, fisheries, seed production, technology of farming, economics of oyster culture and technology transfer are dealt in Chapters 3 to 9 respectively. Chapter 10 gives information on oyster culture practices in major oyster producing countries in the world and Chapter 11 on recent developments in oyster culture in the global perspective. In the concluding Chapter 12, the authors, after a critical examination of the current status of oyster resources and culture in India, underscore the strategies for developing oyster culture in the country. This book, although mainly targeted to meet the requirements of university teachers, researchers and students is also expected to cater to the needs of personnel from fisheries / rural development agencies, financial institutions, NGOs and entrepreneurs. I am confident that this book will stimulate further research and development initiatives in oyster culture in India.

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Dr KA Narasimham
December, 2006 Dr (Ms) V Kripa

Contents

CHAPTER 1

Introduction

OYSTERS are bivalve molluscs occurring worldwide in temperate, subtropical and tropical seas. Generally they inhabit the coastal waters. Certain species of oysters also occur in lagoons, estuaries and backwaters. They are endowed with a pelagic larval life which ensures wider distribution. The larvae settle on hard substrates such as rocks, molluscan shells or on firm bottom areas, undergo metamorphosis and lead sedentary life. Oysters are filter feeders, feed low in the food chain and play a crucial role in the coastal ecosystem. The soft body parts of the oyster are enclosed within two shells which protect the animal from external disturbances. Oyster meat is nutritious and rich in protein and minerals.

From time immemorial, the oysters are traditionally eaten in many parts of the world and are currently among the high priced seafoods in many temperate countries where consumption of raw oysters is very popular. They are exploited from the natural beds and are also farmed on a large scale in many countries. In view of their economic importance oysters are the objects of intensive studies by a large number of workers. Angell (1986) stated that "The oyster is probably the most studied invertebrate organism and much is known about its biology". During 2003, the world production of oysters by the harvest of natural populations was estimated at 1,99,517 mt and through aquaculture at 44,96,609 mt. Among the oysters, *Crassostrea* (Sacco) is by far the most important genus. The Eastern oyster, also called American oyster, *C.virginica* (Gmelin) formed a significant portion (83.5%) of the production by the harvest of wild stocks while the Pacific oyster, *C.gigas* (Thunberg) is the most dominant among the farmed oysters accounting for 97.3% of world oyster production in 2003 (FAO, 2003a; 2003b).

The oyster fisheries in many parts of the world have declined due to habitat destruction, pollution, diseases and overfishing. Historically, the growth and decline of the Eastern oyster, *C.virginica* fishery in the Chesapeake Bay, USA is perhaps the best documented. The oyster catch peaked in Maryland at 6,15,000 t in 1884 and declined to 12,000 t in 1992. The decline was attributed to 'reduced water quality', diseases and fishing (see Rothschild *et al.,* 1994). Habitat destruction by using dredges for harvest and overfishing were considered as prime factors by Rothschild *et al.* (1994). For the recovery of the fishery these authors suggested a 4 - point strategy namely: (1) fishery management (2) replenishment (3) habitat replacement and (4) broodstock sanctuaries.

Oyster farming has a long history as reported by Guo *et al.* (1999), and the Chinese cultured oysters since more than 2000 years ago. Bardach *et al.* (1972), stated that "Marine aquaculture may well have begun with oysters, which were cultivated in Europe during Roman times". In Japan, oyster culture began in 1670 in the Hiroshima Bay (Imai, 1977). Newkirk (1991) stated that oysters are cultured on every continent except Antarctica. Oyster culture began by collecting oyster seed on stones and similar hard materials (cultch) and relaying the cultch on firm grounds. There was little management practice involved and the production was low. This was followed by the stick, stake and rack culture methods which were independent of the nature of substratum and gave higher production when compared to the on-bottom culture. By 1950s with most of the shallow coastal grounds used for oyster farming, the Japanese initiated raft and longline culture extending up to 30 m depth. When compared to rafts, longlines were found better suited to withstand the rough sea conditions in coastal waters. Extension of the farming grounds into deeper waters resulted in substantial increase in the production of oysters in Japan. Hatchery technology for oyster seed production was developed in 1950s.

China has emerged as the world leader in oyster farming accounting for 84% of production in 2003 followed by Japan (5.8%), Korean Republic (5.3%), France (2.6%) and the USA (2.4%). Several technological advances have been made in oyster culture in recent years, particularly in temperate countries. Following the success of oyster culture in these nations, and in the context of increasing demand of the commodity, the tropical countries also evinced keen interest to develop oyster culture where it is practiced as a small-scale activity. The tropical countries have the advantage of faster growth rate requiring only 6-8 months of culture against 2-4 years in many temperate countries. Besides, low production cost due to cheap labour is also a favourable factor. The major problems faced by the oyster culture industry include pollution, diseases and continuous high stocking density culture in the same site, exceeding the carrying capacity of the water body. Low domestic market demand is a constraint in some countries.

In India, the first attempt to bring together the available information on oyster resources was made by Alagarswami and Narasimham (1973) followed by Rao (1974). The Central Marine Fisheries Research Institute brought out a comprehensive account on oyster resources, biology and culture in a Bulletin entitled 'Oyster Culture: Status and Prospects' (CMFRI, 1987). Rao *et al.* (1992) described the technology of seed production and farming of *Crassostrea madrasensis* and James and Narasimham (1993) gave an account on oyster culture in a Handbook on farming of molluscs in India. Narasimhan *et al.* (1993) gave an overview of the molluscan resources of the country which included oysters. Joseph (1998) dealt on oyster culture in the tropics, which included India. Recently Appukuttan *et al.* (2000) gave an update account of

oyster culture along with the mariculture of other bivalves in the country while Muthiah *et al.* (2000) gave information on oyster culture. Kripa *et al.* (2004) described the development of oyster farming as a rural development program in Kerala especially as a group farming activity.

Among the Indian oysters, *Crassostrea madrasensis* is the most dominant, occurring in the estuaries, bays and backwaters along the east coast and south-west coasts (*Fig.1.*). Oysters are harvested at low tides in shallow waters by dislodging them with a chisel and hammer. Oyster fishing is a small-scale activity in the country. Many preparations are made with cooked oyster meat and it is also processed into several products. The oyster shell finds application in lime-based industries. The average annual production of oysters by fishing for the period 1995-1999 from the country was estimated at 18,800 tonnes (CMFRI, 2001). This reflects substantial increase in production when compared to mere 1000 tonnes/year reported for 1980s by Alagarswami and Meiyappan (1989).

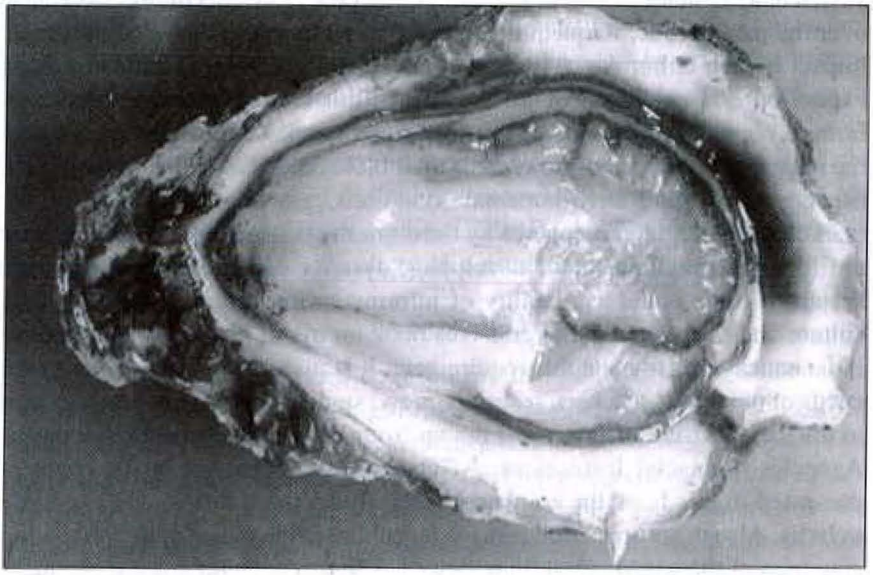

Fig. 1. The oyster *Crassostrea madrasensis* with one valve removed to show the meat in shell
Courtesy: CMFRI, Cochin, Kerala

During 1970s work on oyster culture was taken up at the Tuticorin Research Centre of CMFRI, Tuticorin. Methods of natural spat collection, grow out culture by using trays and rens held on or suspended from racks were developed. With the setting up of the Shellfish hatchery in 1980 at Tuticorin, oyster spat were successfully produced in 1982 (Nayar *et al.,* 1984). This hatchery at Tuticorin played a significant role in providing oyster seed to undertake location testing studies to find out their suitability for culture, at

several places along the Indian coast. The very first attempt in 1993 to test the suitability of the Ashtamudi Lake in Kerala for oyster culture proved successful. In 1994, the CMFRI has set up a rack and ren oyster culture demonstration farm in the Ashtamudi Lake. This water body proved to be a very good site for oyster seed collection. The first commercial oyster farm was set up in 1996 by an enterprising farmer in the Ashtamudi Lake, close to the demonstration farm of CMFRI, followed by several villagers venturing into oyster culture in the estuaries of Kerala. Beginning in 1980s at Tuticorin and since 1995 at Ashtamudi, the CMFRI is conducting training programmes covering all aspects of oyster culture to farmers and others, lending technology support and is linking the farmers with developmental agencies for finance and marketing. The rack and ren method of farming is adopted by the farmers. The annual production of farmed oysters (*C.madrasensis*) in India is estimated to be between 750-800 tonnes.

In India, coastal aquaculture is at present mainly centered around shrimps, largely due to their high price, demand in the export trade and the technological advancements made in breeding, seed production and field culture. However, over the past decade, frequent disease outbreaks and negative environmental impact of their culture in coastal areas have greatly hampered the accelerated expansion and extension of this sector. In this context, entrepreneurs and farmers are attempting to diversify the farmed species, and oysters are among the most preferred species, in view of their biological characteristics, adaptive capacity to varying environmental conditions, growing demand in export market and enlarging acceptance by the domestic consumers. In this scenario, the foremost requirement of developing oyster culture on a scientific and sustained basis is the availability of information on different aspects of its culture and the related paradigm. This book on oyster biology and culture in India endeavours to meet this requirement. It is mainly written to cater to the needs of university teachers, researchers and students in India. It is also useful to a wide spectrum of personnel drawn from Fisheries / Rural Development Agencies, Financial Institutions, NGOs and entrepreneurs. In the chapters presented in this book the emphasis is chiefly on the status of oyster culture in India. Also the progress made in oyster culture in the major oyster producing countries of the world is briefly reviewed. The recent technological advances made in other countries in the hatchery production of seed and grow out culture have been dealt with. In the light of the developments in oyster culture in other countries, the gaps in knowledge, future research needs, constraints faced by farmers and the steps to be taken for the development of oyster resources and culture on a sustainable basis in the Indian context are highlighted.

The production of figures in tonnes by weight given in this book are in metric tonnes.

QUESTION

1. Write briefly on the development of oyster culture in India