Ela Foundation

Ela Journal of Forestry and Wildlife

ISSN 2319-4361
(Indexed in Google Scholar)

Volume 6 | Issue 1
January - March 2017

A quarterly scientific refereed e-Journal of Ela Foundation and Forest Department, Maharashtra for Nature Conservation through Education and Research

Special Issue
Part 1

Marine Biodiversity

- Mangroves
- Fishes, Crabs
- Otters, Dolphins, Whales
- Conservation
- Policy

GOI-UNDP-GEF PROJECT SINDHUDURG

Mangrove Cell: Conserving the Coast and Beyond

N. Vasudevan*

The ocean constitutes over 90% of the habitable space on the planet. Not surprisingly, the seas around us harbor far greater biodiversity than ever existed on terra firma. Within this astoundingly rich environment, many marine species are struggling for survival and many more are facing varying degrees of threats to their existence. As the natural guardians of mangrove forests and as authorities empowered under the Wildlife Protection Act, the mandate of the foresters spill beyond the terrestrial regions, and have an equal responsibility to conserve the coastal and marine life forms.

Forest Department of Maharashtra ventured into the realm of conservation of coastal and marine biodiversity in 2012 by creating a dedicated unit called the "Mangrove Cell". As the country's first such state-wide unit, its creation has led to the unprecedented extension of the activities of Maharashtra Forest Department to the coastal areas. In a very short period, the Cell, despite serious staff shortage and resource crunch, has been instrumental in launching many path-breaking initiatives, and in bringing coastal and marine biodiversity issues to the forefront of our conservation agenda.

The launching of the UNDP-GEF Project on "Mainstreaming of Coastal and Marine Biodiversity in Sindhudurg District" in the latter half of 2012 gave Mangrove Cell the opportunity to initiate a number of innovative programmes for conservation of our coastal and marine biodiversity. These efforts were further strengthened on launching of the bilateral project towards improving conservation of marine biodiversity called "Sustainable Management of Coastal and Marine Protected Areas" (SM-CMPA) with the help of the German agency called GIZ, based on the 'International Climate Initiative' Agreement between Government of India and the Federal Republic of Germany. Under these two projects, the Mangrove Cell has not only undertaken research, conservation and capacity building measures, but has also sought to promote the organic link between conservation and livelihood. Important studies, particularly with respect to baseline surveys of key coastal and marine species, and pilot demonstrations of livelihood and tourism activities, have been implemented under the projects, which have not only been accepted by the communities but also lauded at the district, state and national level. A majority of these programmes are now being proposed for upscaling across the coastal India.

I'd like to acknowledge that our efforts would not have been as successful without the strong support that we have received from the various Government Departments, institutes and NGOs. This has helped Mangrove Cell in successfully demonstrating an inter-departmental approach towards marine and coastal biodiversity conservation, by partnering with a range of government departments such as Fisheries, Agriculture, Tourism, Revenue, Police, Urban Development, Revenue, Skill Development etc. The Cell has also forged strong partnerships with many leading national institutions and agencies, facilitating the introduction of new and improved technologies and best practices to the Maharashtra shores. National Institute of Oceanography (NIO), Central Marine Fisheries Research Institute (CMFRI), Central Institute of Fisheries Technology (CIFT), Central Institute of Brackish Water Aquaculture (CIBA), Marine Products Export Development Authority (MPEDA), Wildlife Institute of India, Salim Ali Centre for Ornithology, Bombay Natural History Society and Ela Foundation are just a few names in that long and illustrious list of partners with whom the Cell has implemented several exemplary programmes.

It is my pleasure to have been given the opportunity to showcase some of the significant interventions implemented under the leadership of the Mangrove Cell in this special issue dedicated to 'Marine Ecology'. I hope this issue facilitates increased awareness on the efforts being taken by the Maharashtra Forest Department towards coastal and marine biodiversity protection, and more importantly, I look forward to your continued support and encouragement towards our activities.

* IFS, APCCF,
Mangrove Cell, Maharashtra State

Anthropocene: A Challenge in Mangrove Conservation

Prof. Dr. Satish Pande*

Mangroves have survived through turbulent times of increasing anthropogenic pressures. The present era following the Holocene, characterized by human domination of Earth, may be termed as Anthropocene (as suggested by Paul Crutzen). Since the importance of mangrove ecosystem was communicated by Golley, Odum and Wilson in 1962 (Ecology), we have better understanding about mangrove geomorphology, zonation, enhydrology and ecophysiology. Instead of general approaches, a wider scale conservation program of mangrove landscapes with multiple integrated small scale community level and even tree level approaches is now being implemented.

In the Anthropocene, mangroves are facing intense pressures due to incessant human activities. Frequent release of greenhouse emissions leading to global warming and sea level rise, changes in marine hydrology due to industrial, sewage and agricultural runoffs, and cutting of mangroves for development activities are the hall mark of Anthropoce. The buffering of the devastating effect of tsunami by mangrove forests in SE Asia promoted several governments to conserve and increase their mangrove cover. However, the response of mangroves to varying energy levels of waves has to be understood before shortlisting areas for mangrove plantation.

Mangroves cover over 10 million ha globally over 120 countries. The rate of global decrease in mangroves is higher than that of other forests (FAO 2007). About 21 % mangroves exist in protected areas of IUCN Categories I-VI (including areas where sustainable use is permitted) and this percentage is higher than all other forests worldwide. Mangroves come under three important global agreements, the Ramsar Convention, the UNESCO Man and Biosphere Program and the World Heritage Convention. Several regional and National regulations and laws also govern mangrove conservation and utilization. In India, the Mangrove Cell was established by the Forest Department for the conservation and sustainable use of mangroves. Involvement of local communities and stakeholders and their participation in scientific mangrove resource management through sustainable use, policy drafting and monitoring appear promising. It is suggested that ecosytem valuation, banking facility, carbon points and other financial instruments should be implemented for winning community support. (Lugo, Medina and McGinley, 2014. Mangrove Conservation in the Antropocene. Vol 20:11-38).

Atmospheric warming and sea level fluctuations will lead to a conflict between halophytic and non-halophytic species along the coasts. The introduction of exotic species, novel mangrove-soil interactions due to pollution can change mangrove distribution in the future. Flexibility, regional response evaluation and adaptive methods in research and management of mangroves will assist their survival in the Anthropoce.

*MD, DNB, PhD, F.M.A.Sci., FLS
Chief Editor

Interdepartmental Efforts for Conservation

Jeet Singh*

It is a matter of immense pleasure that '*Ela journal of Forestry and Wildlife*' has come up with a special issue on marine life and mangrove conservation. India is one of the countries that can boast to have a long coastal life-belt which is not only fascinating but equally challenging at the same time. This sector can reward all its stakeholders on a sustainable basis in perpetuity if managed scientifically and conserved effectively.

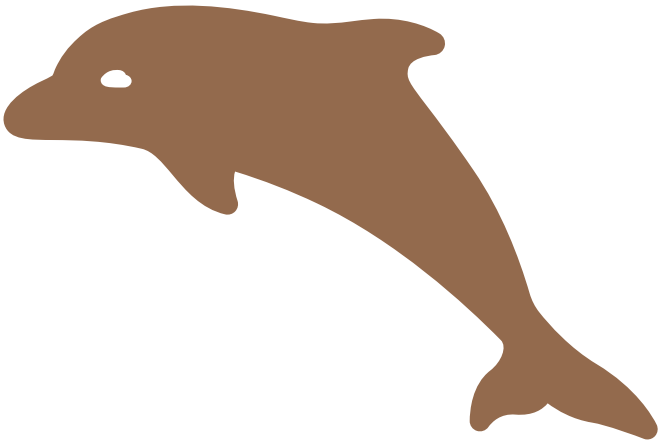
In recent past, Maharashtra Forest Department has set up a dedicated cell for the conservation of mangroves and their sustainable use for creating livelihood options for the dependent stakeholders living in the vicinity. The cell has successfully launched such initiatives and has also been effective in creating awareness about the potentials of this unique sector.

This special issue has covered many important aspects pertaining to this sector including marvellous underwater marine life, marine fauna from the elusive otters to gigantic whales and their conservation, fisheries and mangrove forests. Various technical papers included in it will certainly evoke a wide response from all others who are also keenly interested in the mangrove ecosystem and marine life.

But no ecosystem can survive the onslaught of development unless local communities are involved in its conservation on a long term basis. The regional communities and stakeholders should to be involved and sustainably rewarded on a perennial basis for maintaining the robust health of any ecosystem, and mangroves are not an exception. All government departments and other stakeholders must motivate them for conservation of these resources and against unscientific treatment in their management. Ultimately, they are the first anthropogenic users and foremost beneficiaries from the coastal ecosystem.

The other important issue is that this sector needs inter-departmental approach for handling the various difficulties. Revenue, fishery, agriculture, irrigation, oceanography, forest and all other relevant departments should have joint projects to deliver better results. One department can look after one technical issue but it does not solve the problem in totality. Perhaps this will happen only if such Special Issues involving all departments publish their findings under one umbrella I am sure that several more such ventures will follow in the forthcoming issues of the '*Ela journal of Forestry and Wildlife*'.

*IFS
APCCF (RET)



Oyster farming by women self help groups At Wadatar, Sindhudurg district in Maharashtra State

Asokan P.K[1], Mohamed.K.S[1], Vipinkumar V.P[1] Kripa.V[1], Sasikumar.G[1], Vidya, R[1] Kaladharan.P[1], Alloycious,P.S[1], Jestin Joy.K.M[1], Digamber,P.B[2], Surendranathan,V.G[2], Rohit.S[2], Suhail.J[2], Daya.P[2], Durga.T[2] and Ghosh,S[2].

[1]*Central Marine Fisheries Research Institute, PB No: 1603, Ernakulam North P.O, Kochi- 682018.*
[2]*Sindhudurg Project, Office of the Range Forest Officer, 48-1, Dhananjay Niwas. Medha Malvan-416606, Sindhudurg District, Maharashtra-416606.*

Citation: Asokan P.K., Mohamed.K.S., Vipinkumar V.P. Kripa.V., Sasikumar. G., V. R. Kaladharan, Alloycious, P. S., Jestin Joy. K. M., Digamber, P. B., Surendranathan,V. G., Rohit.S., Suhail.J., Daya. P., Durga.T. and Ghosh, S. (2017). Oyster farming by women self help groups At Wadatar, Sindhudurg district In Maharashtra State.
Ela Journal of Forestry and Wildlife 6(1): 295-300

Date of Publication:
31-3-2017

ISSN 2319-4361

Referee: N. Vasudevan

Abstract:

Practical dissemination of bivalve farming technologies in the potential maritime locations of Sindhudurg district was undertaken by ICAR-CMFRI. Initially a demo-oyster farm was setup in Wadatar, in Sindhudurg District under the UNDP-GEF funded project "Demonstration of bivalve farming at Sindhudurg District in the State of Maharashtra". The training and demonstration for oyster farming was given to the Self Help Groups-SHG, *"Prasidhi"* consisting of 10 members. Five hundred strings containing 7,000 numbers of oysters were harvested. Each string consists of 10-15 live oysters. Live oysters were sold at the rate of Rs. 150-200 per dozen. A total profit of Rs.45,000 was realized. This successful case study can be used as a case manual for group action for bivalve farming technology.

Construction of a rack at Wadatar

Training on oyster farming at a culture site in Sindhudurg

Introduction:

Subsistence fishery of bivalves is an age old practise in many coastal areas of the country. The culture of edible oysters was pioneered by James Hornell in Pulicat lake (Hornell,J. 1910 a,b). After a gap of seven decades, farming of edible oysters was taken up at Tuticorin Research Centre of CMFRI-Central Marine Fisheries Research Institute (Nayar and Mahadevan,1983). Initially, rack and tray method for rearing was followed with lime coated semi-cylindrical terra cotta roof tiles used as cultch material for spat settlement. Later, rack and string method was used wherein the oyster shells were the cultch material, which reduced the cost of material and labour. Rope culture of mussel in rafts was first tried in the open sea at Vizhinjam and Calicut centres of CMFRI in the 1970s (Appukuttan *et al*.,2000). Later, success in rope culture system by rack culture in the backwaters helped in popularising mussel farming in Kerala and later in Karnataka where the wild seeds of mussels are available However, this operation is restricted to the non-monsoon period. The production of farmed mussel in our country is near 8,000 tonnes. The production is mainly from Padanna, Kannur and Calicut in North Kerala and in Dakshin Kannada district of Karnataka (Mohammed *et al*.,1998; Sasikumaar *et al*.,2000). Oyster farming is mainly practised in Quilon, Allepey and Ernakulam districts of Kerala. This successful model of popularising bivalve farming has been adopted in Sindhudurg.

Maritime states along both the coasts of India have an extensive network of estuaries. These estuaries are subjected to wide variations in hydrographic condition due to the southwest monsoon during June to September and a less intense northeast monsoon from October to November. It is the non-monsoon period that is conducive for mussel farming.

Oyster farming has been proved as one of the profitable ventures in marine fisheries sector of the coastal belts of Maharashtra, successfully undertaken by mobilizing the women's self help groups. The CMFRI has successfully demonstrated oyster farming in the estuarine areas of the Sindhudurg district in Maharashtra, which has resulted in a positive socio-economic impact on the coastal fishing community especially among women. Edible oysters are one of the most widely cultivated bivalve mollusc all over the world. Being filter feeders, the oyster converts primary production in the water into nutritious sea food. Farming of these filter feeding bivalves has the advantage of being an eco-friendly aquaculture practice as there is no addition of feed to the system and hence feed cost and effort is also saved. As compared to other aquaculture technologies, oyster farming does not need very sophisticated practices and hence the outlay in capital is also less. The culture period is short as green mussels are one of the fastest growing bivalves which take five to six months and oysters takes about eight months to reach their market size. The materials required for culture are minimal and

Training on construction of rens by the 'Prasidhi SHG'

Training on construction of rens by the 'Prerana SHG'

sourced locally. The local market is good especially in Kerala, Karnataka, Goa and Maharashtra.

In consultation with the Sindhudurg district administration, a master plan was created to transfer the technology to potential beneficiaries. The entire farming operation, *viz.*, starting from seed collection to marketing, was done by the women themselves. In succeeding years the farming activities were intensified by the involvement of more groups. Now, oyster farming is a part-time vocation of the coastal fisherfolk in the Sindhudurg coastal belts.

Bivalve farming is constrained due to the lack of adequate seeds, quality of seeds and issues of environmental over-capacity in the main farming area. As the present study dealt with the documentation of a descriptive case study from the gender perspective in oyster farming SHGs, focusing on the gender equity and equality, there is ample scope to explore the gender empowerment paradigm along with emphasis on the three pillars such as economic empowerment, well- being and decision making. Being an important stakeholder of fisheries sector, women shoulder various roles.

Despite the economic and socio cultural significance of fishing in Maharashtra State, the women fisher folk at large are excluded from the mainstream of the society in the economically disadvantaged category without accruing the benefits from the fishing industry (Kurien, 1994). Traditionally, fisher women are important stakeholders in fish processing and marketing. With an increase in the awareness level among women on the economic activities and dissemination of aquaculture techniques, rural women from other castes have joined the fishery sector. Women constitute about half of the total population and comprise one-third of the labour force. Although, it is largely accepted that the role of women in fisheries sector is limited to processing and marketing, then, their role in activity like aquaculture cannot be ignored. On the other hand, their participation in this sector should be strengthened for better production.

Like any other sector of agriculture, women participation in aquaculture remains largely unnoticed. Women are rarely considered a target group for the adoption of new technology. Because women constitute half of the total population, negligence in brining to them to the forefront of action gives a negative signal to the total development process. It is estimated that women carry out almost 70% of agricultural workload, but in aquaculture, their role has not been properly identified. Women's role in fisheries is very significant and there is gender bias with respect to their work. This discrimination may be noted from the country's scenario through the economic upliftment of fisherwomen through appropriate policies, programs and projects. Women are the important stakeholders of our development process. The extension system hardly targets women folk for technological empowerment. Though the participation of women in fishery sector is age old, they

are still engaged in traditional methods of processing and marketing. Their participation in the culture sector is not properly defined as yet. Aquaculture is a developing sector and women participation in this sector needs meticulous planning for technological empowerment while addressing social and economic barriers. On-farm trials conducted by DRWA, CIFA, CIBA and CMFRI have revealed the strong motivation and capability of women for taking up aquaculture (freshwater, brackish water and marine). Empowering women in different aquaculture practices (freshwater and brackish water) can provide a suitable option for sustained economic and nutritional security of the family and thereby an in-depth observation on these dimensions made through the present study has ample scope to explore the paradigm of gender balance and women empowerment based on the views of 'Women in Development' (WID) and 'Gender and Development' (GAD).

Judicious utilization of common property resources for sustainable development without endangering the environment is possible through community participation. The development and empowerment of weaker sections and gender mainstreaming in the Indian fisheries sector in a broader visualization will be materialized to a great extent with the help of poverty eradication programs through transparent media, particularly the SHG's which can play a vital role for the development of fisheries sector. The requisite of the participation of fishing community, especially women, in the planning and implementation of various coastal sector development program is therefore of utmost importance.

Materials and Methods:

The data gathering protocols on gender mainstreaming were standardized. Major variables and dimensions to be quantified during data collection were shortlisted with expert consultation. Local enumerators were trained for data collection in the potential pockets where the mariculture technologies were being disseminated. Similarly the secondary data collection also contributed a vital role. Surveys were conducted at Malwan, Sindhudurg on the 1st March 2015.

Data was collected on socio-economic and behavioural aspects from fisher folk respondents among the different types of identified stakeholders under primary, secondary and tertiary sectors in the study locations of the mariculture technology. The information was essentially gathered through secondary data collection and triangulation was done in consultation with major sources of information such as the fishermen co-operative societies and SHG's of fisher folk using the survey staff of the Fishery Resource Assessment Division of ICAR-CMFRI and marine fisheries census reports of ICAR-CMFRI. Data was also gathered on demographic characteristics and elucidated specific case studies of women in mariculture sector. A review of the existing livelihood methods of women fisherfolk, mobilized as SHG's in the selected mariculture locations was also undertaken in the present study. The dependent variables like Group Dynamics Effectiveness of SHGs were measured by developing appropriate indices like the GDEI and other arbitrary scales for the assessment of gender perspectives like participation profile, constraint analysis, were standardized. The assessment of Group Dynamics Effectiveness of SHG's was done with a standardized protocol developed with twelve identified sub-dimensions, namely, Participation, Influence and Styles of Influence, Decision Making Procedures, Task Functions, Maintenance Functions, Group Atmosphere, Membership, Feelings, Norms, Empathy, Interpersonal Trust and Achievements of SHG.

The practical awareness and capacity building programs, including the training on oyster farming, were conducted at Wadatar for the benefit of the selected SHG. Technical training was given by the ICAR-CMFRI officials. The SHG's engaged in Oyster farming are Aprekar Swayam Mahila Bachatgat, Chavdekar Swayam Sahayatha Bachatgat, Prasidhi Bachatgat and Jay Bhagrang Swayam Sahayatha.

Under the UNDP-GEF project, training of the SHG's in Wadatar area for bivalve farming was conducted on the 16th October, 2015 for which two racks were assembled. On 9th of December, 2015 training in bivalve farming was given at Taramumbari and on 10th December training was organized at Vengurla and on 11th December the venue was at Devbaug near Malvan. In all the training centers, the fishermen were given hands-on training in making the oyster ren as cultch material and rack making were demonstrated.

By October 2015, the participants were given training on various aspects of oyster and mussel farming followed by practical training on rack and ren construction. A manual on bivalve farming in Marathi was published as the project output and distributed to all the participants. Four SHG's have been identified across the proposed sites by scholars and the staff at Sindhudurg.

Results:

Localities identified for bivalve farming through various visits were Devbhag, Taramumbri, Wadatar and Vengurla in the Sindhudurg district. Detailed discussions

with the bivalve fisher folk of the four identified areas of Sindhudurg were held. SHGs were mobilized in 2014 and CMFRI set up a demo oyster farm in Wadatar, in Sindhudurg District under the UNDP/GEF funded project "Demonstration of bivalve farming at Sindhudurg District in the state of Maharashtra". Training was imparted along with demonstration of oyster farming to the SHG, *"Prasidhi",* which consisted of 10 members. About five hundred strings containing 7,000 oysters were harvested. Each string consists of 10-15 live oysters. The recorded meat content was high at 11-12%. Live oysters were sold at the rate of Rs. 150-200 per dozen. The overall cost of production was estimated as Rs. 18,000-20,000. About 50% of the total production were sold as live oyster and a total revenue of Rs. 50,000 was obtained from live oyster sale alone, apart from the revenue earned by the of selling the meat of small oysters, which contributed around Rs.15,000. Therefore, the total revenue is calculated as Rs 65,000 with a profit of Rs.45,000. This success case can be used as a case manual for group action on a sustainable basis for bivalve farming technology.

The results of the yield and GDEI scores obtained for each SHG are presented in the Table below. The highest score on GDEI and C:B Ratio was obtained by Prasidhi SHG, which indicates a significantly positive correlation between BC Ratio and GDEI as achievements in terms of the yield is the most important dimension of GDEI.

Sl.No	Self Help Groups	C:B Ratio	Group Dynamics Effectiveness Index (GDEI)
1	Aprekar Swayam Mahila Bachatgat Devgad, Sindhudurg	1:3	0.85
2	Chavdekar Swayam Sahayatha Bachatgat, Devgad, Sindhudurg	1:2.9	0.84
3	Prasidhi Bachatgat Devgad , Sindhudurg	1:3.5	0.89
4	Prerana Swayam Sahayatha, Devgad , Sindhudurg	1:3	0.85
5	Jay Bhagrang Swayam Sahayatha Devgad, Sindhudurg	1:2.8	0.84

(C:B – Cost:Benefit; B:C-Benefit:Cost)

Discussion:

For a group to be developed as a SHG, it has to pass through various phases such as Formation phase, Stabilization phase and Self Helping phase. A SHG consists of members that are linked by a common bond, like caste, sub-caste, community, place of origin, activity etc. In an intensive study of Group Dynamics, Pfeiffer and Jones (1972) identified the factors of group dynamics and how the group is organized, the manner in which the group is led, the amount of training with regards to membership and leadership skills, the tasks given to the groups, its prior history of success or failure, etc. In a detailed study on group dynamics, Hersey and Blanchard (1995) gave emphasis on helping and hindering roles played by individuals such as establishment, dedication, dependence, attendance and avoidance along with aggressive, persuasive and manipulative behavior.

The SHG's promote a cooperative and participative culture among the members, which ensures the empowerment culture of the Self Helping phase. The loan sanctioning, utilization, accounts maintenance and timely repayment of loans, etc. are systematically accomplished with proper maintenance of the records by the group members. This ascertains the fulfillment of norms and standards of the SHG leading to economic empowerment of the members. The major expenditure required for bivalve farming is for labour and materials such as bamboo, nylon rope, coir, cloth, seed, etc. The labour costs essentially include construction, seeding, harvesting, etc. The BC Ratio of SHG's was found to be substantially good which proves the profitability of mussel farming in the first crop itself, whereas, in the subsequent years, material costs such as those of bamboo, rope, cloth and labour cost in construction, etc. are negligible, which ensures reasonable profit and adoption of mussel farming enterprise bringing about economic empowerment of rural women through organized Self Help Groups.

This successful case study in Sindhudurg essentially focused on the major objective of assessing the group dynamics of the SHG's of women fisher folk and identifying the important dimensions contributing to their effectiveness and assessing the influence of personal and socio-psychological characteristics on group dynamics. The project stressed on the popularization of and evaluation of molluscan culture technologies in the coastal

belts of potential maritime locations in Sindhudurg coast in consultation with NGO's and the State Government Departments mobilized SHG's. Whether The SHGs', are a temporary phenomenon, or would they continue on a sustainable basis, needs to be analyzed and probed. (Fernandez, 1995). The constraints have to be addressed, and empowerment should be brought about by adopting suitable economically viable micro enterprises in the fisheries and allied sectors by strengthening of these SHG's (Vipinkumar *et al*, 2013).

Bivalves being filter feeders need to be depurated before marketing as they may accumulate contaminants in higher levels than the ambient waters. The main function of depuration is the elimination of the microbial contaminants. By providing the ideal physiological conditions to the filter feeders to perform filtration activity with continuous flow of water ensures elimination of the depurated matter. A common depuration plant for the bivalve growers would help in getting value addition to the product. Organized fishermen's cooperatives can play a vital role in various stages of seeding, harvesting, sorting, grading, packing and marketing with an intention of export potential. As mussel seed availability is a major constraint, a bivalve hatchery unit in the coastal area would be a great boon in furthering bivalve farming in the region.

Acknowledgment:

Authors are grateful to Dr. A. Gopalakrishnan, Director, ICAR-CMFRI, Kochi and Shri. N. Vasudevan, I.F.S., CCF, Mangrove cell, Mumbai and CEO, Sindhudurg Project for their keen interest and encouragement for the project.

References:

Appukuttan K.K., Mohamed K.S., Kripa V., Asokan P.K., Anil M.K., Sasikumar G., Velayudhan T.S., Laxmilatha P, Koya K.P.S., Radhakrishnan P, Joseph M., Alloycious P.S., Surendranathan V.G, Sivadasan M.P., Nagaraja D., Sharma J., Naik M.S., Survey of green mussel seed resources of Kerala and Karnataka. Mar Fish Inform Serv T&E Ser, 2000, 168:12–19.

Fernandez, A.P. Self Help Groups- the Concept. Mysore Rehabilitation Development Agency. 1995, 1-5

Hersey, P. and Blanchard, K.H. Management of organizational Behaviour (6th ed.) Prentice Hall, New Delhi. 1995, 345 -365.

Hornell, J. 1910a. Report on the suitability of Pulicat Lake for Oyster-Culture. *Madras Fish. Bull*. 4:1-23.

Hornell, J.1910b. Note on an attempt to ascertain the principle determining factor in oyster spawning in Madras backwaters. *Madras Fish Bull*., 4: 25-32.

Mohamed, K S, Muthiah C, Nagaraja D, Sampathkumar G Initiation of marine mussel culture activities in Dakshina Kannada District, Karnataka. *Mar Fish Inform Serv T&E Ser* 1998, 155:10–15.

Nayar,K.N and S.Mahadevan.1983. Oyster culture at Tuticorin. Proc.Symp.Coastal Aquaculture. Part 2: 427-435.

Pfeiffer, J.W. and Jones, E.J. Annual Handbook for Group Facilitators. Vol.3. Pfeiffer & Company, San Die go, California. 1972, 19-24

Sasikumar G, Muthiah C, Nagaraja D, Sridhara B, Bhat GS Mussel culture in Mulky estuary, Dakshina Kannada District, Karnataka during 1997–99. *Mar Fish Inform Serv T&E Ser.*,2000, 164:14–18

Vipinkumar. V.P, Shyam. S.Salim, Narayanakumar. R, Sathiadhas. R, Madan.S, Ramachandran.C, Swathilekshmi.P.S, Johnson.B and Aswathy.N. Coastal Rural Indebtedness and Impact of Microfinance in Marine Fisheries Sector, Central Marine Fisheries Research Institute, e book No:2, Kochi. 2013,165.

Square Mesh Codends for Selective Trawling: A Case Study along Sindhudurg District, Maharashtra

V.R. Madhu[1]*, Paresh S. Khanolkar[1], Leela Edwin[1], Merwyn Fernandes[2], S. Ghosh[3] and Vasudevan, N.[3]

[1]ICAR-Central Institute of Fisheries Technology, Matsyapuri, Willindon Island, Cochin – 682 029
[2]TRAFFIC, India, 172-B Lodi Estate, New Delhi – 110 003
[3] Mangrove Cell, II[nd] Floor, A Wing, S. R. A. Bldg., Bandra(East), Mumbai-400 051
(*Corresponding author- email: Madhu.VR@icar.gov.in)

Citation: Madhu V.R., Khanolkar Paresh S., Edwin Leela, Fernandes Merwyn, Ghosh S. and Vasudevan N. (2017). Square Mesh Codends for Selective Trawling: a Case Study along Sindhudurg District, Maharashtra *Ela Journal of Forestry and Wildlife* 6(1): 301-307

Date of Publication:
31-3-2017

ISSN 2319-4361

Referee: Shridhar Rajpathak

Square mesh codend covered with small mesh webbing (white) to retain escapees

Abstract

Tropical trawling fisheries are often implicated with the generation of large quantities of by-catch. The Sindhudurg coast of Maharashtra is an important trawl landing centre along the West coast and about 317 trawlers operate from three major landing centres of this region. Square mesh codends are widely tested and recommended as effective gear based on technical measure for the reduction of by-catch, often constituted by juveniles of commercially important species, and affecting the fishery.

This paper reports the results of a study conducted along the Sindhudurg coast using square and diamond mesh codends of 30 mm size and 1.25 mm thickness. A total of 38 hauls using diamond mesh and 44 using square mesh codends were used for the analysis. The mean CPUE – Catch Per Unit Effort, (kg.h.$^{-1}$) for diamond mesh (18.77) and square mesh codend (19.48) fitted trawls, were not significantly different (Kruskal-Wallis chi-squared = 0.058711, df = 1, p-value = 0.81). The increase in the mean length of 12 out of the 15 commercially important species studied increased by 7.85%. The rate of escape was 0.76 kg per hour, from the square mesh codends, which is 3.9% of the total catch (2,142.4 kg) retained and valued at INR 28.5 per haul. By-catch generated per haul, was significantly higher during the months of December (43.5±9.3 SD) and January (56.3±17.1 SD) and the by-catch during months of September, October and November were less than 20.0 kg/haul.

The study concludes that installation of square mesh codends did not affect the performance of the gear. The selection properties of the trawl net improved and no significant loss was incurred due to the use of square mesh codends. Though, mesh size optimization for

multiple species in the codend and the modelling for the future value of the escapees were not worked out, based on the analysis carried out, it is recommended that traditional diamond mesh codends can be replaced with square mesh codends, as an easy and inexpensive technical measure for management of trawl fisheries along the Sindhudurg coast.

Keywords: by-catch, Sindhudurg, trawling, square mesh, codend,

Introduction

Trawling generates significant quantities of by-catch (Pramod, 2010, Boopendranath, 2011) and also affects the integrity of the sea bottom (Collie, et al., 2000; Usha et al., 2010). The global discards have been estimated at 7.3 million tonnes by Kelleher, (2005) and trawling has the highest proportion of discards compared to any other fisheries. Davies et al., (2009), had re-estimated the global by-catch at 38.5 million tonnes, which was about 40.4% of the total global catch.

George et al. (1981) estimated by-catch in Indian shrimp trawl fisheries at 3,15,902 tonnes per annum which formed 79.18% of the total shrimp trawl landings in India. Najmudeen & Sathidhas (2008) have estimated the annual economic loss due to juvenile fishing by trawlers, along the Indian coast at US$ 15,686 million. Pramod (2010) has estimated the discards from the Indian trawl fisheries to be 56.3% of the total marine catch. Dineshbabu et al., 2014 have reported that the low value by-catch (LVB) from trawlers increased from 14% to 25% during the period 2008 -2011.

A large number of technical measures have been proposed and undertaken to reduce the incidence of by-catch (Broadhurst, 2000; Hall et al., 2000; Steele et al., 2002, Boopendranath et al., 2013). Among these, the use of square mesh codends is very popular, due to its conceptual simplicity and the ease of installation by the fishers (Ragonese & Bianchini, 2006). The mesh lumen (opening) of the diamond meshes tend to close during fishing due to various forces acting on the net, whereas the square meshes remain open and retain their shape, thus allowing non-targeted catch like small fish and juveniles to escape through the mesh openings. Studies using square mesh codends in India, have demonstrated the improvements in the selection properties (Kunjipalu, 1994; Madhu et al., 2010, Madhu et al., 2016).

The coast of Sindhudurg District, with a total fish production of 24,000 tonnes, is an important trawl fishing ground along the west coast of India (CMFRI, 2010). Sindhudurg District has a total of 317 trawlers and the Length overall (L_{OA}) of these vessels range from 12-15m. The majority of the vessels are fitted with 104 HP marine diesel engines and exclusively use codends of mesh size between 15-25 mm in the codend. There are no reports of by-catch generated by trawlers along the Sindhudurg coast, but the discards along the Maharashtra coast have been reported to vary between 68,807 – 1,11,268 tonnes forming 8%-15% of the total catches, and is constituted by juveniles of commercially exploited species (Pramod, 2010).

There are studies on the selection properties of trawlers along the North-west coast; however, reports regarding selection properties of trawlers along the Maharashtra coast are limited. The objective of this study is to conduct a comparative study using diamond and square mesh codends in the traditional trawling grounds off the Sindhudurg coast and evaluate the results in terms of ecological benefits.

Materials and methods

The study was carried out along the Sindhudurg coast of Maharashtra during September 2014 to January 2015. The three fish landing centres of the Sindhudurg District viz., Vengurla, Malvan and Devgad were selected for the study. A traditional trawlnet, locally called *Disco net,* was selected for installation, the square mesh codend with a mesh size of 30 mm and twine thickness of 1.25 mm thickness. Only the codend (the last portion of the trawl net, where the catches accumulates) was changed and the design and the operational parameters were not altered. A codend cover with a mesh size of 10 mm and the length and circumference of approximately1.5 times the codend size, was stitched to the square mesh codend to retain and quantify the escapees from the square mesh codend (Madhu et al., 2010). The catch data and length measurements were made by project staff by on-board participation.

The catch landed on the deck after each haul was quantified and a representative sample, not less than 20% of the catch, was retained for species identification and length-weight measurements. Length was measured to the nearest centimetre and weights to the nearest gram. The catches, in weight or number, was expressed as Catch Per Unit Effort (CPUE) which is the catch retained or escaped per hour of trawling.

Results and discussion

A total of 82 valid hauls (38 hauls using diamond mesh and 44 using square mesh codends) were used for the analysis. The total time spend during the trawling operations were 205 hours (110 hours using square and 95 hours for diamond mesh codend). The mean CPUE ($kg.h.^{-1}$) for the diamond mesh (18.77) and square mesh codend (19.48) fitted trawls, were not significantly different (Kruskal-Wallis chi-squared = 0.058711, df = 1, *p*-value = 0.81) Table 1. This shows that the installation of the square mesh codend did not affect the performance of the trawl system and is in accordance with studies that showed no change in the gear performance by using square mesh codend (Guijarro and Massuti, 2006; Lucchetti, 2008;Mohammed et al., 2011).

The length frequencies of 15 major species (Table 2), showed that 12 species retained in square mesh, had higher mean total length with an average increase of 7.85%. The largest positive difference in the length was observed for *T.lepturus* (39.4%) and the least for *Nemipterus* sp. (0.76%) (Fig. 1). The mean length of *Ariomma indicum* (-10%), *Megalaspis cordyla* (-11.3%) and *Caranx* sp. (-15.1%) captured in the square mesh codend was lower in square mesh codends. Studies have proved that the square meshes are more selective for carangids species along Kerala coast (Remesan et al., 2010; Leela et al., 2013). It is reported that only flat bodied fishes do not benefit from change in mesh shape (Fonteyne and M'Rabet, 1992). The catch rates of the above three species were small and may not be an actual representation of the catches, resulting in contrasting results.

The escapet from the square mesh codend was 0.76 $kg.h^{-1}$ and was constituted by juveniles of commercially important species (Table: 2). Escaped juveniles in the range of 1.8-4.6 kg per hour from 40 mm square mesh codend was reported from Gujarat coast (Mohamed et al., 2010). The slightly lower average recorded in this study, could be due to the result of 30 mm mesh used, instead of 40 mm. The list of the major species that escaped from the codend, with their escapement rates is given in Table: 3.

A total of 83.6 kg of juveniles, with a rate of 0.76 kg per hour, were released by the square mesh codend. This is about 3.9% of the total catch (2,142.4 kg) retained in the square mesh codend. The escapees, due to their small size cannot be commercially utilized and fall into the category of by-catch, with a value realization of INR 15 per kg. The value of the catch excluded was approximately INR 28.5 per haul. Results from commercial operations using square mesh codends along Gujarat coast by Mohamed et al., (2010), have reported an escapement between 1.8-4.6 kg/hour and valued between INR 4.1 – 18.0. The difference in the escapement could be due to the different codend mesh size used (Madhu et al., 2015) and also due to the spatial variation in the species profile of by-catch (Dineshbabu, et al., 2014).

The total by-catch generated by the trawlers during different months was also calculated for the period. The by-catch was low during the months from September (12.9±2.7SD kg/haul) to November (17.4±8.1 SD kg/haul). The quantity of by-catch generated was significantly higher during the months of December (43.5±9.3 SD) and January 56.3±17.1 ($p<0.01$). The variation in by-catch between other months was not significantly different ($p>.05$) Figure: 2. The total by-catch generated by other designs of trawls used for shrimp trawling (locally called *chalu* fishing) is much more than fish trawls (Personal Observations). This is the first report of the quantity of incidental by-catch generated by fish trawls operating along the Sindhudurg coast. Pramod, (2010) based on surveys along Maharashtra coast had reported the discards between 8-15% of the total catches. The catches from the present study showed incidental catches between 8.5 – 46.9% of the total catches during post-monsoon season. The difference could be due to the increased landings of incidental catches, for use in poultry industry as reported by Dineshbabu, et al. (2014).

Table 1: The catches recorded in the diamond, square and codend cover during the study

Codend type	Portion of trawlnet	CPUE ($kg.h.^{-1}$)
Diamond mesh	Codend	18.77
Square mesh	Codend	19.48
	Codend cover	0.76 (3.9%)

CPUE-Catch Per Unit Effort

Conclusion

The catches in trawls installed with square and diamond meshes showed no significant variation and hence it can be assumed that use of square mesh codend

did not alter the geometry of the net. The use of square mesh codends increase the mean length of fishes in the codend by an average of 7.85% indicating that smaller individuals escaped from the square mesh codend, thereby improving the selectivity. The rate of escape of the juveniles from square mesh codends was 0.76 kg per hour, with a value of INR 28.5, which worked out to about 0.12% of the value of catch in codend. Though not quantified scientifically, the fishers operating the trawlnet with square mesh had experienced lesser drag which translates to savings in fuel, which can significantly affect the adoption of the technology, since fuel contributes to more than 70% of the recurring cost during fishing.

This study concludes that square mesh codends can be used instead of traditional diamond mesh codends in the fishery, as an easy and inexpensive technical measure for management of trawl fisheries in the region. Targeted works to popularize this technology and awareness regarding the loss incurred by catching small fishes will help immensely in adoption of this technology.

Limitations

The present study has concentrated only on the value of the juvenile fishes that had escaped and the present value of the escapees. The value of the juveniles of commercially important species will be much higher

Table 2. The mean length (cm) of major species captured in the diamond and square mesh codends.

Species	Diamond #	Square #	Escape*
Caranx sp.	24.4	20.7	5.6 (3.5-6.6)
Pampus argenteus	21.7	22.4	-
Trichiurus lepturus	47.4	66.1	21.8 (7.6-27.4)
Rastrelliger kanagurta	16.7	17.9	6.6(4.5-9.0)
Sepiella inermis	10.7	12.1	3.2(2.5-4.2)
Parastromateus niger	14.3	15.6	3.2(2.7-3.9)
Epinephelus sp.	11.8	13.2	7.1(4-9.9)
Ariomma indicum	12.4	11.1	5.9(4.5-9)
Nemipterus sp.	13.3	13.4	4.1(2.9-6)
Thryssa sp.	14.2	14.9	7.8(6.2-10)
Megalaspis cordyla	22.1	19.6	8.2(7-9)
Atule mate	16.6	19.4	5.6(2.8-8.7)
Sciaenids	14.9	19.2	6.3(2.9-10)
Sardinella longiceps	14.1	15.9	8.9(5.4-17)
Uroteuthis (P) duvauceli	13.6	14.5	5.1 (2-9.2)

= Average length (cm), *=length range (cm)

Table 3: CPUE of juveniles that escaped from the square mesh codend

Species	CPUE (kg/h)	Nos./h
Sciaenids	0.140	4
Decapterus sp.	0.130	15
Thryssa sp.	0.108	9
Rastrelliger kanagurta	0.107	4
Stolephorus sp.	0.056	3
Uroteuthis (P) duvauceli	0.081	10
Sardinella longiceps	0.046	8
Ariomma indicum	0.042	1
Trichiurus lepturus	0.026	4
Epinephelus sp.	0.011	2

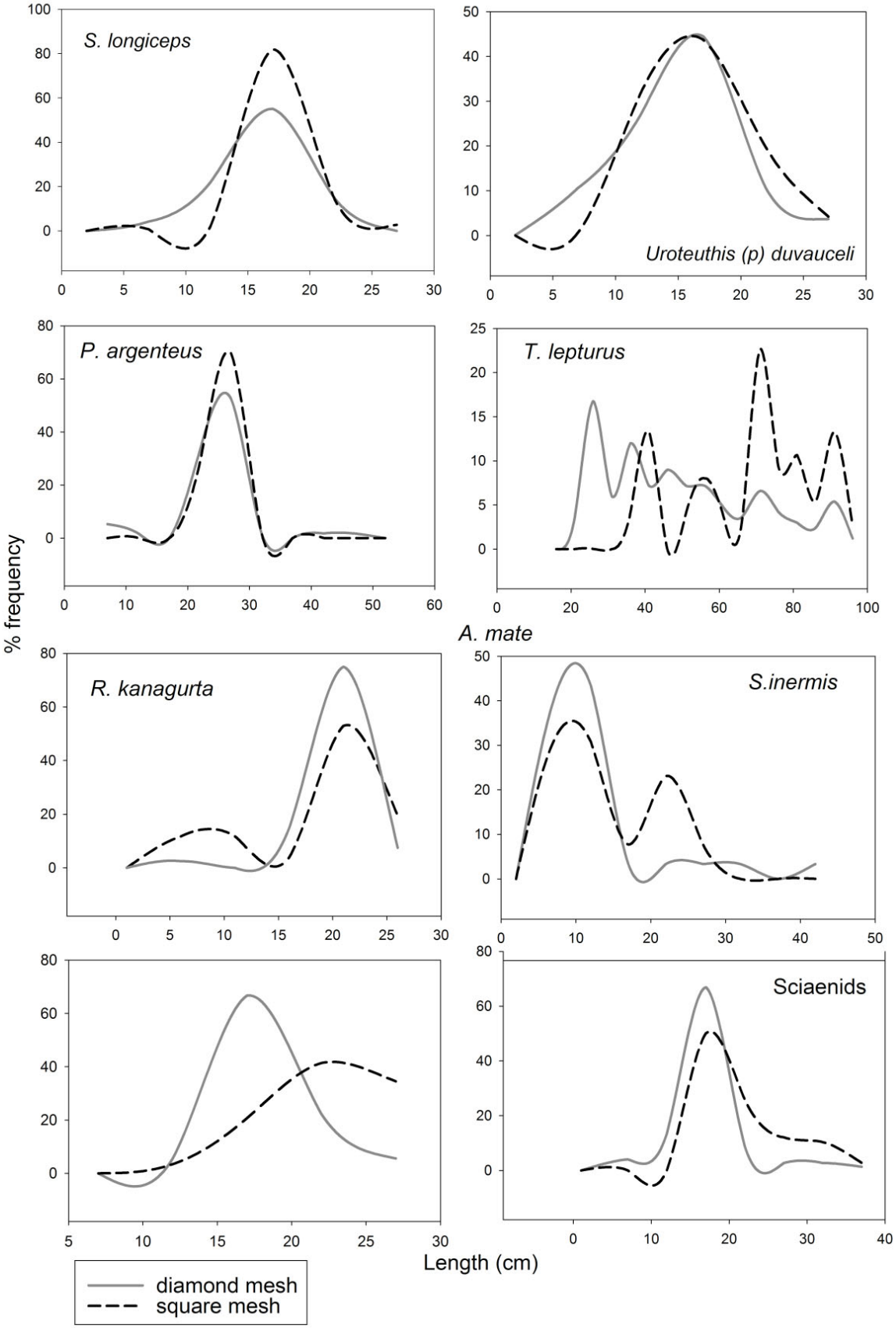


Fig: 1. Size- frequency distribution of major species reatined in the diamond and square mesh codends.

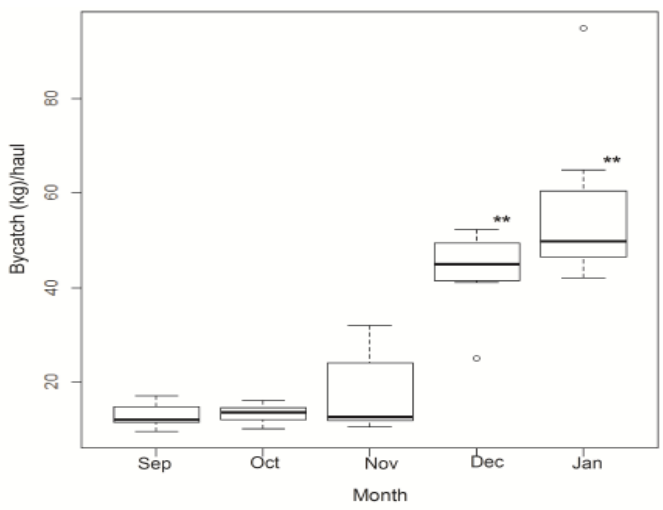


Fig. 2 Variation in the by-catch observed during the study period. The means which are significantly different are indicated as (**). The open circles are outliers and the box represents 25% and 75% quartiles. The thick line in the box is the mean.

if they are allowed to grow. Modelling techniques like Virtual Population Analysis (VPA) to estimate the future weight and value were not carried out in this study. The selectivity of individual species was also not evaluated. Since the fishery industry is of multi-species nature, the selection of an optimum mesh size would require considerations both in terms of value and the assessment of stock of the targeted species.

Acknowledgement

The authors acknowledge the funding from the GOI-UNDP-GEF project "Mainstreaming Coastal and Marine Biodiversity Conservation into Production Sectors in Sindhudurg Coast in Maharashtra". The authors from CIFT are thankful to the Director, CIFT for granting permission to publish this work. The help rendered by Mr. Sharad Mahadev Dhuri, Mr. Babi Redkar and Mr. Sailestine Bento Fernandesby helping with their vessel for data collectionis kindly acknowledged. Authors also thank Saurabh Salvi, Prashant Dudwadkar, Harshal Redkar and Harshwar Khavale for helping in on-board data collection.

Reference :

Broadhurst, M.K. (2000) Modifications to reduce bycatch in prawn trawls: A review and framework for development. *Reviews in Fish Biology and Fisheries* 10(1): 27-60.

CMFRI, (2010)*Marine Fisheries Census, India, 2010*. Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, Government of India (GoI) and Central Marine Fisheries Research Institute, Kochi, Part II, 2011, 331p.

Davies R.W.D., Cripps S.J., Nickson A., Porter G. (2009) Defining and estimating global marine fisheries bycatch. *Marine Policy* 33: 661–672.

Dineshbabu, A.P., Radhakrishnan, E.V., Thomas, S., Maheswarudu, G., Manojkumar, P.P., Kizhakudan, S,J., Pillai, S.L., Chakraborty, R., Jose, J., Sarada, P.T., Sawant, P.B., Philipose, K.K., Deshmukh, V.D., Jayasankar, J., Ghosh, S., Koya, M., Purushottama, G.B. and Dash, G. (2014) An appraisal of trawl fisheries of India with special reference on the changing trends in the bycatch utilization. *Journal of the Marine Biological Association of India* 55(2): 69-78.

Fonteyne, R. and M'Rabet, R. (1992) Selectivity experiments on sole with diamond and square mesh codends in the Belgian coastal beam trawl fishery. *Fisheries Research* 13 (3): 221-233.

Guijjaro, B. and Massuti, E. (2006) Selectivity of diamond and square-mesh codends in the deepwater crustacean trawl fishery off the Balearic Islands (western Mediterranean). *ICES Journal of Marine Sciences* 63: 52-67.

Hall, S.J., Alverson, D.L. and Metuzal, K.I. (2000) By-catch: Problems and Solutions. *Marine Pollution Bulletin* 41(1-6): 204-219.

http://www.rufford.org/rsg/projects/mayuresh_gangal, assessed on 25.08.2016

Jeremy S. Collie, Stephen J. Hall, Michel J. Kaiser and Ian R. Poiner, 2000 A quantitative analysis of fishing impacts on shelf-sea benthos.*Journal of Animal Ecology* 69: 785-798.

Kelleher, K. (2005) Discards in the World's Marine Fisheries: An Update, FAO Fisheries Technical Paper. No. 470, FAO, Rome

Kunjipalu, K. K., Varghese, M. D. and Kesavan Nair, A. K. (1994) Studies on square mesh codend in trawls 1. Studies with 20 mm meshsize. *Fishery Technology* 31:112-117.

Leela Edwin, Thomas, S.N., Pravin, P., Remesan, M.P.

and Boopendranath M.R. (2013) Trawl codend selectivity of Torpedo Scad, Megalaspis cordyla (Linneaus, 1758). *Fishery Technology* 50: 351-353.

Lucchetti, A. (2008) Comparison of diamond – and square-mesh codends in the hake (*Merlucciusmerluccius* L. 1758) trawl fishery of the Adriatic Sea (central Mediterranean). *Scientia Marina* 72(3):451-460.

Madhu V.R., Meenakumari, B. and Satyen Kumar Panda (2010) Trawl codend selectivity estimates for Goldband Goatfish. pp. 340-345. In: Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., (eds), *Coastal Fishery Resources of India: Conservation and Sustainable Utilisation*, Society of Fisheries Technologists (India), Cochin. 894p.

Madhu, V.R., Raphael, L., Meenakumari, B. (2015) Influence of Codend Mesh Size on Bycatch Composition of Two Trawls Operated Off Verval, Gujarat, India. *Fishery Technology* 52(4):228-236.

Madhu, V.R., Remesan, M.P. and Meenakumari, B. (2016) Trawl selectivity estimates of Thryssa dussumieri (Valenciennes, 1848) in Square and Diamond Mesh Codends. *Fishery Technology* 53(2): 105-109.

Mohamed, K.S., Pravin, P., Asokan, P.K., Madhu, V.R., Ghosh, S.,Vivekanandan, E. and Meenakumari, B. (2010) Assessment of Economic loss due to use of legal codend mesh in Multi-day trawlers in Gujarat. pp. 360-369. In: Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., (eds), *Coastal Fishery Resources of India: Conservation and Sustainable Utilisation*, Society of Fisheries Technologists (India), Cochin. 894p.

Pramod, G. (2010) *Illegal, Unreported and Unregulated Marine Fish Catches in the Indian Exclusive Economic Zone*, Field Report, Policy and Ecosystem Restoration in Fisheries, Fisheries Centre, University of British Columbia, BC, Vancouver, Canada, 30 p.

Ragonese, S. and Bianchini, M. L. (2006) Trawl selectivity trials on the deep-water rose shrimp (*Parapenaeus longirostris*) in Sicilian waters.*Hydrobiologia* 557:113-119.

Reeves, S. A., Armstrong, D. W., Freyer, R. J.and Coull, K. A. (1992) The effects of mesh size, cod-end extension length and cod-end diameter on the selectivity of Scottish trawls and seines. *ICES Journal of Marine Sciences* 49: 279-288.

Remesan, M.P., Pravin, P. and Boopendranath, M.R. (2010) Trawl Codend Selectivity in respect of Razorbelly Scad. pp. 360-369. In: Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., (eds), *Coastal Fishery Resources of India: Conservation and Sustainable Utilisation*, Society of Fisheries Technologists (India), Cochin. 894p.

Steele, P., Bert, T.M., Johnston, K.H. and Levett, S. (2002) Efficiency of bycatch reduction devices in small otter trawls used in the Florida shrimp fishery. *Fishery Bulletin* 10 (2):338-350.

Usha Bhagirathan, B. Meenakumari, K. V. Jayalakshmy, S. K. Panda, V. R. Madhu · D. T. Vaghela, 2010 Impact of bottom trawling on sediment characteristics—a study along inshore waters off Veraval coast, India. *Environmental Monitoring and Assessment* 160:355-369.

Juveniles of Fish and Squid that were caught in the outer net

Mangrove Crab *Scylla serrata* stock enhancement by Ranching, Pen and Tide fed Impoundments in mangrove ecosystem of Sindhudurg District, Maharashtra through empowerment of traditional fishermen

P. Anilkumar
The Marine Products Export Development Authority, MPEDA House, Panampilly Nagar, Kochi-682036
(E-mail: anilkumarp@mpeda.gov.in)

Citation: Anilkumar P. (2017). Mangrove Crab *Scylla serrata* stock enhancement by Ranching, Pen and Tide fed Impoundments in mangrove ecosystem of Sindhudurg District, Maharashtra through empowerment of traditional fishermen

Ela Journal of Forestry and Wildlife 6(1): 308-316

Date of Publication:
31-3-2017

ISSN 2319-4361

Referee: Nitin Kakodkar

Keywords:
mangrove crab; ranching; mangrove; pen

Abstract
Mangrove Crab Scylla serrata (Forskal, 1775) also known as Green Crab or Giant Mud Crab is a highly exploited species from estuarine and mangrove ecosystems in the Indo-West Pacific region. The commencement of live crab export has created an improved interest in the production of mud crabs through aquaculture. The present study aims at the stock enhancement of mangrove crabs through ranching and eco-friendly rearing in pen / tide fed impoundments in the mangrove ecosystems of Sindhudurg district, Maharashtra for strengthening the livelihoods of the traditional fishermen. Stocking of the crablets collected from MPEDA-RGCA hatchery, Tamil Nadu was done in

Bri

the selected sites during the months of January–March 2014, January–March 2015 and September–October 2015 under 3 phases and harvest carried out during the months of June-November 2014, June–October 2015 and April–June 2016 respectively. Proficiency in carrying out the culture of mangrove crabs in pen was imparted to the traditional fishers. Mud crab resource is a natural resource of our country. Mud Crab culture in an eco-friendly manner has a potential to augment the socio-economic status of the coastal communities including poor fishermen and educated unemployed youth.

Introduction

The GOI-UNDP-GEF project on "Mainstreaming coastal and marine biodiversity in to production sectors in Sindhudurg coast, Maharashtra" is implemented by the Forest Department, Government of Maharashtra with the Regional Office MPEDA, Mumbai. Viable fishery projects which could be implemented in the Sindhudurg district were discussed and during the field visits by MPEDA officialsthe need for stock enhancement of mangrove crabs and mangrove crab fishery improvement program were realized.

Scylla serrata (Forskal, 1775) (Portunidae), commonly known as the Mangrove Crab or Green Crab, has an immense market potential all over the world, particularly in South East Asian Countries. This crab is sold live in international markets. India earns foreign exchange to the tune of around US $50 Million by exporting live Mud Crabs captured from the low□lying coastal belts across the country. Hence, natural stocks of mangrove crab in the country are under constant pressure. The major reason for this is non-availability/inconsistent availability of crab seeds (Crab Instar / Crablet). Besides exploitation of natural stocks, particularly, juveniles are also dwindling owing to habitat loss due to several reasons including rapid urbanization in the coastal belts.

MPEDA - RGCA has opened the avenues for commercialization of mud crab hatchery technology leading to organized Mud Crab Aquaculture in the coastal areas of the country, by providing alternate livelihood options to the weaker sections of the society and strengthening the soft shell crab production base for live export.

Objectives:

The main objectives of this project are:

1. Improving the livelihood of traditional fishers through stock enhancement of mangrove crab by way of sustainable and eco-friendly rearing in pen/tide fed impoundments in 15 villages of Devgud, Malvan and Vengurla Talukas of the Sindhudurg district.
2. Ranching of mangrove crablets for the enhancement of natural stock and simultaneous conservation of mangrove fauna and flora.
3. To conduct awareness and training programs on the stock enhancement program in the coastal villages of the Sindhudurg district.
4. Disseminate the results of the project through videos, leaflets, manual, and reports and by conducting workshops/trainings for continuation and replication of the model in other regions.

Methodology

Stock Enhancement Program on Mangrove Crab in Mangrove Pens and Tide Fed Farms in Sindhudurg District has been initiated with aid from UNDP and the Forest Department, Government of Maharashtra for the benefit of traditional fisher folk. At present, crab instars (3 – 5 mm) produced at RGCA hatchery are reared in nursery for a period of 30 – 35 days and transported for taking up farming activities. However, transport of instar and crablets for long distance on regular basis is not feasible for large scale farming in future.

As a first step, RGCA experts visited a few villages in at Malvan, Sindhudurg district, during June 2013 and gave a presentation on Mangrove crab to the local fishermen. Subsequently, a group of fishermen from Sindhudurg was sent on an exposure visit to RGCA mangrove crab hatchery and farm. Subsequently, the training was given to a batch of 15 fishermen on mangrove crab farming in RGCA facilities in Tamil Nadu and the UT of Puducherry in August 2013. Preliminary surveys in the 3 talukas, namely Devgad, Malvan and Vengurla of the Sindhudurg district were conducted by RGCA experts in the first week of October 2013. A series of consultations were organized in more than 20 villages in the second week of October 2013 by NETFISH to sensitize and identify potential beneficiaries as well as tentative situable sites.

Project Area:

The project has been carried out in the mangrove forests of Devgad, Malvan and Vengurla Talukas in the coastal regions of Sindhudurg district of Maharashtra.

Beginning of the project:

The project was sanctioned on 27th November, 2013 and preparatory work commenced immediately. Self-Help groups were identified and suitable sites were selected. As the project was aimed at fishery enhancement and mangrove conservation, the traditional fishermen were given the know-how to perform pen culture of mangrove crab using seed produced at MPEDA-RGCA hatchery in Tamil Nadu. Thirty five farmers were trained for the first phase of the project. In addition, 65 farmers were trained for the second phase and 35 for the third phase of the crop.

I. First crop stocking

a. Total sites (Pens/Ponds):

Several sites were surveyed by officials from Regional Office, MPEDA along with RGCA and NETFISH officials in the three proposed Taluks of Sindhudurg district. Based on the topographical conditions, water sources, tidal amplitudes and the attitude of the self-help groups, seven sites were finally selected in two taluks of Sindhudurg district during the first phase and the details are as follows:

1. **Malwan taluk –** Tarkarali, Debag 1st, Devbag 2nd and Hadi ,
2. **Devgad taluk -** Veerawadi, Wadathar and Rameswar.

The operation started in December, 2013. Efforts were also taken to extend assistance to one or two groups of fishermen in Vengurula Taluka. But due to difficulty in administrative clearances, assistance could not be extended to the entire taluka during the first

phase. Out of the seven sites identified and selected, culture operations at Tarkarali, Devbag 1st site and Devbag 2nd site in Malwan taluka were totally in pen structures in open waters whereas Hadi farming was totally a tide fed impoundment with 3 ponds. In the case of Devgad Taluk, culture operations at Veerawadi and Wadathar were totally in pen structures whereas at Rameswar, one acre culture was in open water pen and another one acre was in tide fed impoundment.

It was decided that two pens of one acre each should be fixed at each site and three ponds at Hadi should be utilized during the first phase. However, due to difficulty in getting suitable sites at Wadathar, only one of the two planned pens was fixed and utilized. Based on the site selection and agreement on the structures, orders were placed for purchase of garden fencing nets and silpaulin sheets for installation at the sites. The material received was distributed to each group and technical officials were allotted to each site to coordinate with the groups in fixing the pen structures. Due to limitations in transporting all the required crablets at one time from RGCA facility, it was planned to proceed with the stocking of seeds from January 2014 onwards in a phased manner at the sites, after the completion of fixing of garden fencing nets.

2. Stocking of crablets:

a. Hadi- Malwan Taluk

The first batch of crablets was stocked on 24th January, 2014 by transporting crablets (n=5,100f) from RGCA facility for releasing in the Hadi ponds. A survival rate of 98.52 % was recorded before stocking the ponds. Being the first of its kind initiative under the UNDP project, officials from UNDP, Forest Department-mangrove cell from New Delhi, Andhra Pradesh and Maharashtra participated in the stocking program.

b. Tarkarali- Malwan Taluk

Subsequently, 2,270 crablets were stocked at Tarkarali on 9th of February, 2014. As the crablets were found to have escaped from the pen structures, additional stocking with 1,200 crablets was made on 4th of March 2014 in the same pen structures after necessary repairs. Average survival rate recorded over both the stockings was 91.82%.

c. Devbag, 1st site - Malwan Taluk

2,170 crablets were stocked on 9th February, 2014 in two pens at the previously identified sites, recording a survival rate of 88. 94 %.

d. Devbag, 2nd site - Malwan Taluk

One batch of , 2,100 crablets was transported on 23rd February, 2014 from RGCA facility and stocked in two pens. As some animals escaped from the pens, subsequent re-stocking was made on 4th March, 2014 by transporting 1,400 crablets to compensate the loss. Average survival rate over both the stockings was 93.34%.

e. Rameswar- Devgad Taluk

A total number of 3,600 crablets were transported on 24th February, 2014 and stocked in one open water pen and one pond based pen. The survival rate was 95.28% at the time of stocking.

f. Wadathar- Devgad Taluk

Due to the identification of only one pen site, 850 crablets were transported and stocked on 4th March, 2014 with a survival rate of 82.40 % at the time of stocking.

g. Veerawadi – Devgad Taluk

One batch of 2,430 crablets was stocked on 23rd February, 2014. Additional stocking of 1,400 crablets was done to compensate for the loss due to damage in the net fencing. The survival rate recorded was 84.07%. As per the instructions received from RGCA, crablets were fed with trash fish. The feeding was administered based on the anticipated biomass in all the site. Growth of crablets was monitored and reported on a fortnightly basis.

ii Second crop:

After the completion of the first crop and monsoon, efforts were taken for identifying new groups in the three Talukas for implementing the second phase of the project.

a. Selection of new sites:

Based on the interest and suitability of the site conditions, around 10 sites were visited by RGCA/ MPEDA officials. However, due to administrative and technical issues only the following new sites were selected and finalized in the three Talukas:

1. Malwan Taluka:

- Kolamb - open water pens.
- Aachara - open water pens.

2. Vengurula Taluka:

- Shiroda-Dongriwada - pond based pens.
- Venguruala - pond based pens.

3. Devgad Taluka:

- Mithbhav - pond based pens.

b. Old selected sites:

Name of the site	Area (acres)	No. of crabs stocked	% Survival	No. of crabs harvested	Total weight harvested (kg)
Wadatar	0.8	700	43.71	306	89.27
Rameshwar	2	3430	0.73	25	5.52
Hadi	3	5024	21	1047	115.45
Tarkarli	2	1101	56.3	620	80.75
Devbaug 1	2	1930	11.2	216	13.56
Devbaug 2	2	1307	2.3	30	8.29
Veerawadi	1				Discontinued due to rat problems
Total	**12.8**			**2312**	**312.84**

Among the seven old sites, due to lack of interest from the group members of Devbag 1st site and Devbag 2nd site along with difficulty in getting a suitable location by Veerawadi group members, action was not taken at these 3 sites. However, members of the group from Hadi, Tarkarli, Wadathar and Rameswar have agreed to continue their activities during the second phase.

Therefore, it was decided to stock five new sites and four old sites during the second phase for which action was initiated by the procurement of garden fencing nets and other materials for stocking of the crablets. Training sessions were organized for all members of the new sites at Malwan and Devgad areas.

c. Preparation of new /old sites:

Materials received for the modification of the old sites and development of new sites was distributed to all the group members for initiating the preparatory activities in all the sites simultaneously so as to complete the activities before the second week of January in 2015. In order to avoid technical lapses, modifications were suggested to the group members of old sites with clear instructions, stating that all the aspects should be completed before stocking. It was also decided that sites which had complied with installation in all aspects would be stocked on priority.

d. Stocking status:

In order to overcome the problem of escape of smaller size crablets from the pen structures, it was decided to do nursery rearing for 40-50 days and then provide bigger size crablets of more than 4 cm carapace size at all the sites. Accordingly, it was decided to promote nursery rearing units at one or two places for which two entrepreneurs were identified. However, one of the entrepreneurs backed out of the process at the final stage. Therefore, nursery rearing was undertaken only at one place on a trial basis by providing 20 hapas and 12,000 crab instars from the RGCA facility. The animals had grown to the required size of more than 4 cm by the fourth week with an anticipated survival rate of more than 46%. But due to the delay in receiving the garden fencing nets and silapulin sheets, nursery rearing had to be extended for another four weeks which resulted in a low survival rate of 25%.

Due to severe cyclonic storms along the East Coast during December 2014, water quality parameters changed significantly which badly affected the crab instar production in RGCA facility. This resulted in a delay in the supply of instars from RGCA facility to the nursery rearing facility at Sindhudurg. The beneficiary who conducted nursery rearing expressed his disinterest in continuing the activity. Hence, for further stocking, the crablets were directly lifted from RGCA facility.

i. **Kolamb:** The fixing of garden nets along with catwalks, trenches, feed trays, shade nets etc, in 1 acre area was completed at Kolamb, crablets from the nursery rearing unit at Mithbhav were harvested and 2,947 crablets was stocked at Kolamb in November, 2014. As another pen was made ready by the group at a later date, the next batch of 1,304 crablets was brought from RGCA. A survival rate of 96.24% was recorded in this batch and 1,255 crablets were stocked in number.

ii. **Vengurula:** As Vengurula site was ready in all aspects, 6,000 crablets were stocked on 12th January, 2015. Survival rate of the crablets at the time of stocking was 93.39% n= (5,603). In the next batch 2,225 crablets were transported for stocking in the balance pen area on 4th March, 2015, which recorded a 96.45% survival rate and 2,146 crablets were stocked.

iii. Shirodadongriwada: 6,248 crablets were transported to the site on 19th January, 2015 where 93.10% survived and finally 5,817 crablets were stocked. Later, the Department of Forests, Maharashtra stocked crablets in one of the ponds in Navi Mumbai, whereas the Honourable Chief Minister of Maharashtra, stocked 600 crablets that were transported from Shiroda to Navi Mumbai.

iv. Aachara: 2,373 crablets were received on 1st March, 2015 with a recorded survival rate of 99.1% accounting for 2,352 crablets which were stocked. Another batch of 1,972 crablets was also stocked at this site on 22nd March, 2015.

v. Mithbhav: 2,787 crablets were received on 1st March, 2015 for stocking in two pen structures at Mithbhav. Survival rate recorded was 90.78% and 2,530 crablets could be stocked.

vi. Rameswar: 2,380 crablets were airlifted from RGCA on 10th of March, 2015 for stocking in one pen at Rameswar which recorded survival of 98.07% and thereby 2,334 crablets were stocked.

The stocking was completed by the last week of March 2015. One pen each at Aachara, Rameswar and Mithbhav were not stocked due to shorter duration for culture operations (2-3 months). Due to the delay in the availability of the crablets from RGCA, it was decided to stock Tarkarali, Wadathar and Hadi during September/October 2015.

iii. Third phase of crop:

It was planned to start mangrove crab culture in fifteen sites during the third phase of the project. However, only fourteen sites could be stocked as per schedule. The fifteenth site could not be stocked due to lack of interest of the self-help group. A new site was selected for the same and the preparatory work was underway for stocking the site. Fourteen stocked sites are progressing well and partial harvests are being done in these sites. An expert from the Phillipines visited the sites during the middle of the crop and the suggestions were incorporated in the culture as far as possible.

iv. Fourth phase of the crop:

Noticing the results from the third crop, some of the beneficiaries have shown interest to continue the next crop which will take additional 8-10 months. But the main constrain would be the availability of seed. Moreover, technical support is also required during the fourth crop. Therefore, it is proposed that UNDP may support the cost of seed as well as continuation of Technical Officer for one more year. It was planned to start mangrove crab culture in fifteen sites during the third phase of the project. However, only fourteen sites could be stocked as per the schedule. The fifteenth site could not be stocked due to lack of seed. A new site was selected for the same and the preparatory work was completed for the fifteenth site.

Results and Discussion

i. First crop

a. Harvesting of the sites:

A total of 2,312 crabs weighing 312.80 kg were harvested during the first crop. The summary of the first crop is tabulated below.

b. Major constraints:

- Non-availability of crablets of more than 4 cm carapace size for stocking in pen structures probably reduced the survival percentage and biomass.
- Pen areas exposed during low tides resulted in increasing vulnerability of animals to higher temperatures during summer months as well as to predators, mainly birds, which resulted in low survival rate.
- Presence of bandicoots at Veerawadi resulted in damage of the pen structures. As a result, the entire stock escaped to the open water which led to the discontinuation of culture operations. However, this possibly improved the stock in the open waters and the livelihood of the local fishers to certain extent.
- High tide level at one site (Devbag 1st site) might have resulted in the escape of the animals during the spring tide which was overlooked due to the lack of sufficient information while fixing the garden pen structures.
- Competition for food from con-specifics and predators perhaps resulted in lesser growth of the stocked animals in open water pen structures and finally on the biomass.
- Lack of cooperation from the group members to adhere to the instructions and guidelines issued by the technical officers/RGCA officials

ii. Second crop

a. Harvesting of the sites:

A total of 1,155.69 kg crabs were harvested during the second crop. The summary of the second crop is tabulated below:

Name of the site	Area (acres)	No. of seed stocked				Total weight harvested (kg)
		Stock 1	Date	Stock 2	Date	
Kolamb	1.00	2947	24-11-14	1255	4-3-15	210.20
Vengurla	2.50	5603	13-1-15	2146	4-3-15	420.84
Shiroda	2.00	5817	19-1-15			269.89
Rameshwar	2.00	2334	10-3-15			
Mithbav	1.75	2530	1-3-15			147.87
Achara	2.00	2352	1-3-15	1972	22-3-15	106.89
Total	**11.25**	**21583**		**5373**		**1155.69**

b. Major constraints:

Following are some of the constraints encountered.

- Since the available culture period was a maximum of 5 months only, chances of animals growing to marketable size (300g) seems difficult.
- Marketing of smaller sized crabs have to be explored for viability of the culture operations.
- If the culture operations are to be continued during monsoon months, trash fish availability may be difficult due to fishing ban.
- If culture operations continued, harvesting can be undertaken only after September.

c. Remedial action and future courses of action.

- To prevent the escape of the crablets from the garden fence nets as observed during the first phase, smaller size nursery rearing nets were suggested and procured which were provided to all the groups for installation during the second phase.
- More number of smaller nurseries in pen/unit area is installed during the second phase instead of one large nursery area which will reduce cannibalism considerably among the stock and the animals will get more space to grow. Through this method even the availability of feed to the animals will be more due to reduced stocking numbers per nursery area.
- Hideouts comprising PVC pipes, old tiles etc are installed from the nursery stage itself so as to provide shelter to the animals that will reduce cannibalism considerably and improve the survival rate of animals.
- Feeding trays are used from the first day onwards to monitor the growth of the animals.
- To reduce the adverse effects of temperature, trenches have to be made in the pen structures and nursery rearing units along with shade nets/coconut leaves.
- To provide stocking of bigger sized crablets of more than 4 cm carapace width, nursery reared seed was used at one site. Though it was intended to provide bigger sized crablets to all the selected sites, due to lack of interest expressed by the nursery rearing group, other sites were provided with nursery reared seeds of smaller size. However, it would be better if one or two nursery rearing units are initiated for continuous supply of the bigger sized crablets.
- Possibilities of soft shell crab production technology can result in better returns to the group members that would motivate them considerably.
- Explore the possibility of pellet feed to avoid over dependence on the trash fish from the capture fisheries, because there is no consistency in the availability of trash fish especially during monsoon.

iii. Third crop

The details of the crop are tabulated below.

a. Constraints and remedial action taken:

- Unavailability of required number of seeds at the time of the second phase (two cyclone affected hatchery seed production):- Nursery rearing of crab instar was done in Sindhudurg (Nivati, Vengurla) to insure timely supply of crablets. Total 15,147 crablets were stocked from Nivati nursery i.e. 29.08% of the total stocking in the third phase.
- Group conflicts and ownership issues: From third crop onwards we have kept the restriction of reimbursement amount as per the procurement committee recommendations so that some money from SHG's may be involved (approximately 5%). For resolving group conflict, regular meetings were held with SHG members. However, this being the last phase of project, expert guidance on group management and cooperative business management needs to be given.

Sr. No.	Name of site	DOC	Expected survival from nursery	Avg CW	Avg. Wt	pH	DO	Sampling date	Daily feed	Cumulative feed	Remark
1.Vengurla-I Rawool	Pen 1	166/158	51%	11.5cm	481.81gms	8.5	5.3mg/l	04/05/2016	17.5kg	4615.4kg	
	Pen 2		55%	9.1cm	253.33gms				12kg		
	Pen 3		54%	10.1 cm	337.72gms				15kg		
	Pen 4		53%	8.1cm	204gms				20kg		
	Pen 5		54%	6.5cm	77.14gms				6kg		
2.Vengurla-II Malbaari	Pond	151	58%	8	115gm	8.5	4.1mg/l	21/04/2016	17kg	1423kg	
3.Parule	Pen I and II	196	50%	12.9	518.52	8.5	4.1	05/04/216	39kg	5861kg	
4.Nivati	Pond	182	61%	9.8	345	8.5	4.8	04/05/2016	24kg	2200kg	
5.Shiroda	Pen I	237	50%	9.2CM	325.5gms	8.5	4.2mg/l	09.05.2016	30.5kg	6717.3kg	They have harvested (n=508) 256.1kg Rs.128065
	PenII	237	50%	8.5cm	296.5gms						
	Pen III	204	50%	7.9 cm	156.9gms						
	Pen IV	204	50%	7.8cm	239.7gms						
6.Aadari								30/04/2016			Sampling not done group members not collecting crabs
7.Kolamb								30/04/2016			Sampling not done group members not collecting crabs
8.Achara 2								30/04/2016			Sampling not done group members not collecting crabs
9.Achara 1		227/210/194	51%	13.1	435.6g	8		20/04/2016	42		(n=38). Of crab sold Rs 12000/-
10.Mithbav	pond 1		54%	10cm	188gms	9	3.8mg/l	07.03.2016	18kg	1809kg	
	pond 2		59%	8.9cm	131gms	9	3.5mgl		12kg		
11.Tambeldeg	Pen I	152	53%	13.21	354.8	Low tide	Low tide	25.03.2016	23kg		
12.Morve	Morve Pen 1	116	57%	7.5cm	116.3	8		31.03.2016	11kg	1781kg	
	Morve Pen 2	96	51%	5.9cm	42.8	8			7kg		
13.Wadatar	Pen I	176	53%	12.5	330.7	8		21/03/2016	27		
14.Taramumbri	Pen I	145	55	8.9	144.6			23.03.2016	17kg		

- Feed and Feeding issue: - The availability of Trash fish/Low cost fish will become a big issue in the near future as two fishmeal plants have just started. We have already started trial of artificial feed in the demonstration ponds.
- Farmers need weekly or monthly income:- MPEDA has started soft shell crab demonstration with its funds at Vengurla, where farmers stocked a total of 856 crabs from 26th December, 2015 to 31st March 2016 and harvested 160 soft shell crabs, weighing 20.348 kg (Rate offered by buyer was Rs. 650-700/ kg) with mortality of 43 crabs.
- Achara I, Achara II, Parule, Nivati and Shiroda have started partial harvesting. Shiroda is leading with regard to an harvest of 508 crabs, weighing 251 kg (Rs.1,28,065/-); Wadatar with 50 crabs weighing 16.7kg (Rs 9,000/-); Parule had 81 crabs weighing 31kg (Rs. 16,280/-); Tambaldeg produced 34 crabs, weighing 20.6kg (Rs.11360/-); Achara I produced 72 crabs weighing 38.3kg (Rs 15,000/-).
- For Aadari and Kolamb, no co-operation from SHGs members was received. We have organized two

meeting in UNDP office, From Aadari site four group members have taken responsibility for further crop production. Whereas in Kolamb, two persons from Malvan were interested in taking up responsibility for feeding and sampling of the current status of the fourteen sites given below.

- In Achara, during the visit on 5th February, 2016, it was informed that they found the foot print of some people in the pen and they have doubts that some people are poaching their crabs. We arranged meeting of all group members on 8th February, 2016 and suggested them to lodge a complaint with local police station against entry of unknown persons so that they can be watchful during their regular patrolling and copy of that letter should be marked to UNDP and MPEDA. However, no action was taken in this regard. Also, partial harvesting has also been initiated at the site.
- During regular visits, the net was found to be damaged in Taramumbri and Tambaldeg. SHG members repaired the damaged net by the next day (next low tide). Tambaldeg group members informed that local crab hunters/fishers found 100 crabs outside the pen over two days.

b. Visit by Experts from Philippines:

Miss Emilio Quinitio, an expert of crab farming from the Philippines, visited Mangrove crab hatchery sites and gave her recommendations for improvement.

Challenges:-

Group Dynamics:-

- Internal problem within the groups and within the farmers.

Feed and Feeding:-

- Improper feeding and less availability of feed (Trash/ low cost fishes) in near future are expected because of the introduction of new fish meal plants in the district.

Harvesting:-

- The farmers were not confident of harvesting techniques during the first phase, however, they have gained confidence about harvesting crabs and are doing the same quite easily.
- Necessity of partial harvesting in highly cannibalistic crab culture is not understandable by most the SHG members in spite of our advice, which will may lead in drastic reduction in the survival rate.

Summary of soft shell mangrove crab demonstration model:

Soft shell crab demonstration was fully funded by MPEDA (3.54 lakhs) as a pilot project in Sindhudurga district, Maharashtra, for the first time in India. It was launched at Vengurla on 26th December, 2015 with a total of 1000 boxes fixed on PVC pipe frame in 0.5 acre area. A total of 1,028 crabs were stocked up to 6th June, 2016. The crabs were fed with trash fish equivalent to 5% of their body weight. The crab boxes were observed daily at 4 hour interval by 2 helpers and 1 biological trainee (in two shifts, one person in the morning and one person at night). Water parameters were recorded over 4 to 5 days interval, including salinity (25-36 ppt), temperature (28-33 ^{0}C), acidity (8 - 8.5 pH in units) and Dissolved Oxygen (DO) (4.8 - 5.7 mg/l). Total harvested yield till date was 1468.53 kg with a mortality of 65 crabs (7.74 kg), escape of 26 crabs (3.163 kg). The farmers were provided with forward linkages with exporters and soft crabs of approximately 100 gm size were sold at Rs.700/- per kg. Seeing the production, farmers from various states especially from Andhra Pradesh have visited the demonstration farm.

Angria Bank- An untold story of underwater world

Baban Ingole
CSIR-National Institute of Oceanography,
Dona Paula, Goa 403004
(Email: baban.ingole@gmail.com; baban@nio.org)

Citation: Ingole Baban (2017). Angria Bank- An untold story of underwater world

Ela Journal of Forestry and Wildlife 6(1): 317-321

Date of Publication:
31-3-2017

ISSN 2319-4361

Referee: Nitin Kakodkar

Introduction

Coral ecosystems have always attracted attention of people from a wide cross section of the society from students, researchers and general public due to the exotic marine life that exists around them by offering fascinating opportunities for scientific studies as well for leisure and tourism. This spectacular ecosystem is also known as 'complete ecosystem' that sustains various kinds of marine organisms without giving out any waste and is also considered as ecological 'hotspot' due to its vulnerability to climate change and human intrusion.

One location that hosts such an ecosystem is Angria Bank, a shallow underwater plateau off the central west coast of India, where amateur divers have discovered 'an underwater paradise', but it lacks a systematic study to assess and map the marine biodiversity in the area. Hence, the CSIR-National Institute of Oceanography Dona Paula Goa, formulated a multi-disciplinary study funded by the GOI-UNDP-GEF Sindhudurg project for assessing and mapping the biodiversity of Angria Bank coral reef in the marine ecosystem of Maharashtra'.

Angria Bank, a submerged plateau located ~70 nautical miles west of Vijaydurg, Ratnagiri and Malvan in the Konkan region along the west coast of India is predictably have rich marine biodiversity. However, very few published reports demonstrate the extent of its species richness (Alcock, 1898; *Ambiye* et al, 1992; Nair et al., 1966;1967; Nair & Qasim, 1978;Untawale et al., 1989). Even though we do not know much about the marine living resource of the area the shallow submerged bank is being exploited for fishery and other activities (e.g. Indian Naval practices). In order to confirm the abundance of coral and associated biota, a detailed oceanographic expedition was conducted in January 2014 to study the Angria Bank Ecosystem with reference to ecology of coral and associated flora and fauna with the expectation that the scientific information and data generated may help in conserving the unique living resources through globally accepted best management practices.

The scientific team of CSIR-NIO Goa comprised of navigators, underwater divers, oceanographers, surveyors,

technicians and Govt. officials of UNDP conducted the first detailed oceanographic exploration on the *RV Sindhu Sadhana* during January 2014.

This scientific study entitled "Biodiversity Mapping of Angria Bank in the Marine Ecosystem of Maharashtra" is based on oceanographic observations and an underwater survey conducted in the Angria Bank provided first-hand information on the biodiversity of the submerged plateau based on the biological sampling, underwater visual observations and videogeography. Although the taxonomic identification is preliminary and may need further confirmation the data generated using morphological and molecular methods approves the vastness of the coral and associated biodiversity of Angria Bank and will be useful in guiding future studies of this underexplored coral reef ecosystem using an integrated approach.

Material & Methods

Study area: The submerged plateau of Angria Bank is approximately 39 km in length and 17 km wide, with an average water depth of ~20 m. The initial underwater survey conducted by echo sounding and side-scan sonar data revealed the presence of prominent shelf edge reefs concentrated mostly in the central and southern parts. Their depth of occurrence varied between 85 and 136 m. The reefs were reported to be 1–12 m high and 0.1–2.6 km wide (average 700 m). Earlier studies suggest that the coral community has started developing on the bank after the holocene sea-level rise few thousand years ago and coral growth continues today (Nair & Qasim 1978 and references there in).

Methods: Following the bathymetric chart and echo-sounder the team reached the centre part of the Angria bank where the ship wreck is marked on the hydrographic chart, which was the designated reaching point. The fishing trawler that was used as support vessel also reached near the ship. Some of the Scuba diving equipments were transferred on the fishing trawler from the ship and initially first diving was conducted from the fishing trawler followed by the rubber boat.

Overall the sea condition was rough but with good underwater visibility. The underwater diving, water, plankton sample and sediment collection was carried out from 5.1.2014 to 9.1.2014 covering 15 dive locations. Details of the sampling locations area shown in Figure 1.

The coral survey conducted by SCUBA divers by underwater video and photo-transect method for the 15 dive location. The plankton and water samples were collected using standard oceanographic gears. The sediment samples

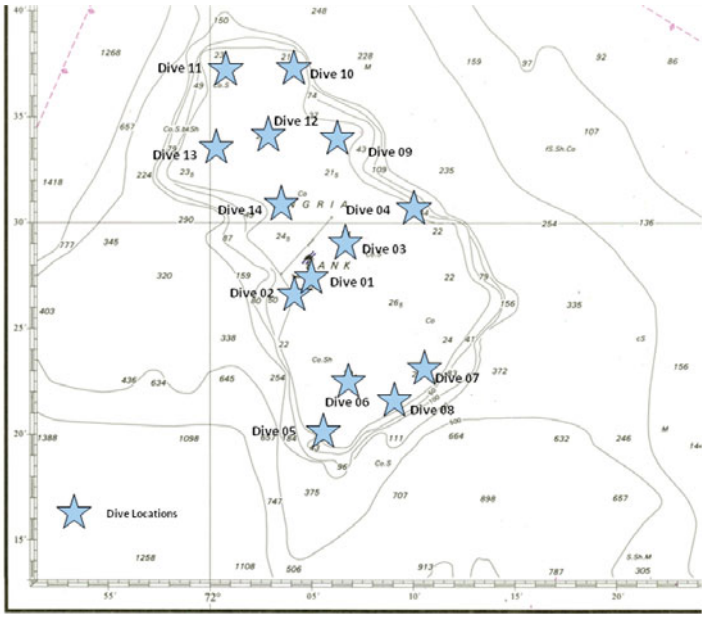


Figure:1 location of scuba diving () and oceanographic sampling

were also collected using grab samples and used to study the diversity of meio- and macrofauna. A total over 200 species have identified till this report is finalized and few more are being identified The identified list includes seaweeds, sponges, ctenophores, hard and soft corals, sea anemones, jellyfishes, gastropods, polychaete worms, echinoderms, tunicates and fishes. Two major benthic habitats of seaweed and coral were identified during the present study. Scuba dive number 2,5,7,8,9,11 & 13 were the corals dominant sites whereas the remaining dive sites were dominated by seaweeds. The major benthic habitat distributions suggested that wherever corals were dominant seaweed community was absent and vice versa (Figure 2).

The dive sites located on the western side of the bank has rocky coralline bottom and eastern side has sandy bottom with calcareous deposits and middle part of bank showed the mixed terrain. The seaweeds are slightly higher in concentration in the middle, east and western side of Angria bank. However, hard and soft corals are highly concentrated in the west and eastern side stations. The terrain properties of Angria bank show the strong influence of biological distribution. The predominant coral habitat D5, 8 & 9 supports more associated biological communities of invertebrates and vertebrates such as sponges, soft corals, sea anemones, polychaetes, gastropods, echinoderms and fishes. The macrofaunal abundance varies from 89 – 800 ind.m^{-2}. The meiofaunal diversity was characterised by Nematodes, copepods, polychaetes, amphipods, tardigrades, cumaceas, ostracods, turbellarians and chitons.

Results & Discussion

Water quality: CTD was deployed for temperature and salinity measurements and water collection. Temperature, salinity, DO, pH, phosphate, silicate and chlorophyll *a* at stations 1 and 2 sampled during the December cruise showed unique variation. In general the temperature at both the stations (1 & 2) varied between 27.75 and 27.92°C with marginally higher temperatures (0.1 to 0.2°C) observed in the surface layers. In contrast the salinity showed a reverse trend and varied between 35.9 and 36.1 at these stations. At station 2 (Fig.6b) though marginal, the salinity showed a sudden increase in salinity below 35 m metres indicating a different water mass. DO at both the stations varied between 4 and 4.65 ml/L with the maximum concentrations observed at sub-surface depths. On the other hand pH in the study area varied between 8.06 and 8.32 with decreasing trends below surface. Both nitrate and nitrite (data not shown) were below detection limits at the study area. The concentrations of phosphate and silicate were also generally low with average concentrations of 0.4 µM and 2.9 µM respectively. Chlorophyll-*a* maxima were observed at 20 m and 25 m at station 1 and 2 respectively, which coincides with the DO maxima indicating production of DO due to primary production.

During the January cruise the pH varied between 8.06 and 8.25. While surface nitrate at most of the stations were below detection limits, the maximum nitrate (0.37 µM) was observed at station W12/D12. Similarly nitrite concentrations were also near the detection limits. Surface phosphate concentrations at the study side varied between 0.2 µm and 0.42 µM. However, surface silicate concentrations were relatively higher in comparison to the December cruise and varied between 3.74 and 11 µM. The chemical/biogeochemical parameters measured during both the cruise generally indicate that the area is pristine with no anthropogenic influence.

Coral and associated biota

The data of studied dive sites of Angria Bank suggests two major benthic habitats of seaweed and coral habitat is identified from this region.

Corals are tiny multicellular, invertebrate animals that belong to the phylum Cnidaria. They are some of the oldest animals on the planet; have been surviving on the Earth by building limestone ($CaCO_3$) reef structures. The scleractinian or hard/stony corals that live in colonies are usually associated with the shallow water tropical limestone reefs. Coral reefs are restricted to sunlight, crystal clear, shallow tropical/subtropical waters between 10-30 meters depth where temperature is at least 18°C with the optimum temperature range from 23°C to 27°C, where the average salinity is 36ppt and where there is no or little

sedimentation from river runoff. They dominate shallow tropical environments between the latitudes 25°S and 25°N longitude.

Coral Reef diversity and abundance

Phylum cnidaria is represented into 35 genra and 57 species. Hexacorallia was represented by 25 genra with 39 species under 3 order, 16 family. Zoanthidae, Mussidae and Poritidae were families often common. *Goniastrea*, *Porites* and *Zoanthus* were common in primary level, *Astreopora*, *Goniopora*, *Montipora*, *Symphyllia* in secondary and *Platygyra*, *Pocillopora* in third level of the study area. Helioporacea contains one genus and species were found. Dominat coral genera are shown in Figure 3

Soft coral (Alcyonacea) has four families, six genus and fourteen species were found. *Clavularia*, *Lobophytum* and *Sinularia* species were commonly found. Sea anemone (Actininaria) contain three genus, species were found under two family. The jellyfish (scyphozoan) contains one genus and species. The echinoderm includes 8 genus and 9 species under 6 family, *Petasometra clarae*, *Diadema antillarum* and *Linckia laevigata* are often common.

Crabs diversity:

Fish diversity

Eighteen fish species belonging to 15 genera under 4 Orders and 13 Families were identified. *Chaetodon*, *Heniochus* and *Lutjanus* were highly dominant. Other common in occurrence were Ctenopora, Sea slug, polychaete worms and tunicate. Ctenopora and Jellyfishes were present in dive D3 and Tunicate present in D7. The invertebrate diversity as assessed through video photography was 42 Families, 57 Genera and 81 species. The common vertebrate includes tunicate and fishes were found under 14 Families, 16 Genera and 19 species. All together 100 species, 73 genera and 56 families are found at the Angria bank.

Seaweed diversity

Rhodophyta (red algae), Chlorophyta (green algae) and Ochrophyta (brown algae) were found. In which green and brown algae are common than the other. The seaweed contains 8 genus and 9 species under 6 family, *Stoechospermum*, *Halimeda* and *Codium* are often common. *Dictyota* & *Padina* species are present only in Dive13 and 14, respectively. Porifera and ctenophora contains two genus and species.

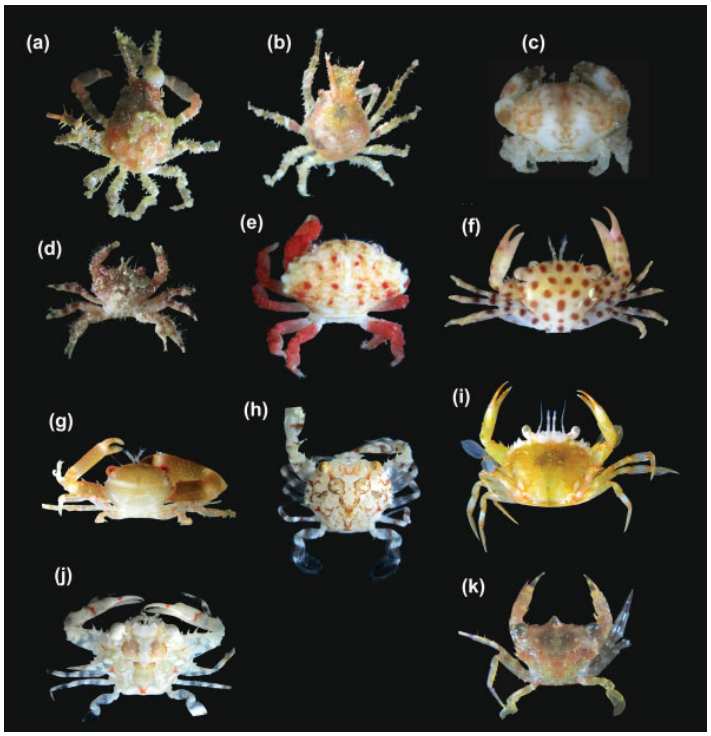


Plate 1. Reef-associated brachyura identified from the Angria banks (live colouration) : (a) *Hyastenus brockii* (b) *Thusaenys irami* (c) *Serenius ceylonicu* (d) *Pilodius flavus* (e) *Liomera monticulosa* (f) *Trapezia tigrina* (g) *Tanaocheles bidentata* (h) *Cycloachelous granulatus granulatus* (i) *Portunus (Portunus) convexus* (J) *Portunus (Xiphonectes) macrophthalmus* (k) *Thalamita gatavakensis.*

IUCN Red list Category:

Species list was compared to the IUCN red list species. Accordingly the species were categorized as Not Threatened (NT), Vulnerable (VU) and Least Concern (LC) categories are found in the phylum of Cnidaria. Least Concern (LC) and Data Deficient (DD). In future, long-term study of these sites can gives the better knowledge of this area.

Anthropogenic pressure:

The Angria Bank is located ~70nm away from the shore line of Ratnagiri, Vijaydurg and Malvan coast. The developmental activities with increasing population along these coastal regions show the high stress on the coastal biodiversity and its ecological balance. For example, the Malvan coast fish catching is more rapidly increased since 1978 to 2000 and the catch amount is 5363 to 13,433 tonnes, respectively (ICMAM, 2001). It is all due to the exhaustive fishing activities and trawling operation around the coast and core zone areas leads to the over exploitation of juveniles. Further it leads to destroy the breeding and nursery ground of this present study area.

Suggestions for Resource Management in the

Table 1: List of the coral and associated fish species (NT:Not Threatened; V: Vulnerable; LC: Least Concern; Data Deficient)	
Cnidaria (Corals)	
Acanthastrea lordhowensis	**NT**
Acanthastrea maxima	**NT**
Favia maxima	**NT**
Favia rosaria	**VU**
Favites chinensis	**NT**
Galaxea fascicularis	**NT**
Goniastrea aspera	**LC**
Goniastrea australensis	**LC**
Goniastrea thecata	**NT**
Goniopora columna	**NT**
lobophyllia corymbosa	**LC**
Montipora verrucosa	**LC**
Montipora confusa	**NT**
Platygyra lamellina	**NT**
Platygyra pini	**LC**
Pocillopora verrucosa	**LC**
Porites branneri	**NT**
Porites lobata	**NT**
Symphyllia agaricia	**LC**
Heliopora coerulea	**VU**
Echinoderm	
Bohadschia graeffei	**LC**
Fishes	
Cephalopholis nigripinnis	**DD**
Chaetodon collare	**LC**
Epinephelus adscensionis	**LC**
Heniochus acuminatus	**LC**

Angria Bank

The proper guidelines to be implement to the fishing activities. Apply the some other alternative living option for the fisherman society during the fish spawning season. The strict enforcement of fish catch per boat, restrict certain gears, net size to be seriously regulated by the fishery survey of India. The costal guard should regulate the core zone and buffer zone rules and regulations. The pollution control board to keep on monitoring of sewage disposal and quality control check etc. The continuous monitoring of the biodiversity with the above said aspects can improve the surrounding water quality and its coastal biodiversity and its ecological status.

Mumbai to Goa coastal regions are industrial rich belt area. It consists of four major shipyards and ports of Bharati, Rajapur, Vijaydurg and Chowgule's Jaigad presence along

this coastal region. In addition to this Oil and gas exploration, oil spill accidents and shipyard wastage can increase the load of stress into this region and the Maharashtra government has the plan to promote the additional 20 minor ports from this region. Thus all the shipping related activity may harmful or increase the stress in the coastal biodiversity. The major thermal power plant hot water discharge may affect the surrounding biota.

Suggestions for Resource Management in the Angria Bank

The proper guidelines to be implement to the fishing activities. Apply the some other alternative living option for the fisherman society during the fish spawning season. The strict enforcement of fish catch per boat, restrict certain gears, net size to be seriously regulated by the fishery survey of India. The costal guard should regulate the core zone and buffer zone rules and regulations. The pollution control board to keep on monitoring of sewage disposal and quality control check etc. The continuous monitoring of the biodiversity with the above said aspects can improve the surrounding water quality and its coastal biodiversity and its ecological status.

References

Alcock A. (1898) Materials for a carcinological fauna of India, No. 3. The Brachyura Cyclometopa, Part I. The family Xanthidae. Journal of the Asiatic Society of Bengal 67 (II), No. 1, 67–233.

Ambiye, V. and Untawale, A.G. (1992). Deep water marine algal flora of the submerged banks off west coast of India. Oceanography of the Indian Ocean. Ed. by: Desai, B.N., 247-252p.

Nair, K.V.K., Bhattathiri, P.M.A. and Chhapgar, B.F. (1966). Angria Bank expedition general hydrpgraphic and chemical features. SCNO, IIOE NL, V.4, p.8 (Abstract).

Nair, K.V.K. and Bhattathiri, P.M.A. (1967). Current measurements at Angria Bank in the Arabian Sea. SIO, IIOE NL, V.4, p.23 (Abstract).

Nair, R.R. and Qasim, S.Z. (1978). Occurrence of a bank with living corals off southwest coast of India. Indian Journal of Marine Sciences, V.7, pp.55-58.

Untawale A.G., Reddy C.R.K. and Ambiye V.D. (1989) Marine algal flora of submerged Angria Bank. Indian Journal of Marine Sciences 18, 207–209.

Mass propagation of RET Mangrove species: Biodiversity Implications

*Niranjana S. Chavan, **N. Vasudevan, [1]Tarnnum M. Mulla, and [2]Mehaboob D. Nadaf

*[1,2]Department of Botany, Shivaji University, Kolhapur;
*Email-nsc_botany@unishivaji.ac.in
**CCF Mangrove Cell, Mumbai.

Citation: Chavan, N., Vasudevan, N., Mulla, T., and Nadaf, M. (2017). Mass propagation of RET Mangrove species: Biodiversity Implications.
Ela Journal of Forestry and Wildlife 6(1): 322-328

Date of Publication:
31-3-2017

ISSN 2319-4361

Referee: Madhav Gogate

Abstract

Conservation of mangrove species is difficult as they grow in various saline and tidal gradients. Conservation attempts thus require a multidisciplinary approach viz. taxonomy, distribution, phytogeography, autecology, population biology and ecophysiology. Protocols for conservation of some Rhizophoraceae members and *Avicennia* species are available. However, *in situ* and *ex situ* conservation methods have been standardized for endangered and rare species like *Cynometra iripa, Xylocarpus granatum* and *Heritiera littoralis*. Now, it is globally accepted that mangrove ecosystems need to be conserved. Conservation practices mainly involve protection, preservation and regeneration of mangroves. It is thus essential to have a thorough understanding of mangrove ecosystems prior to the designing of any conservation methods. Along the west coast of Maharashtra, such attempts were carried out for critically endangered mangrove species. In the present study emphasis is given mainly on propagation and conservation of *C. iripa, X. granatum, H. littoralis, C. odollum*, *B .gymnorhiza*, *B. cylindrica R. apiculata* as the species are vanishing very fast along the sites of West coast of Maharashtra.

Key words- Conservation, Critically endangered, Mangroves, estuary, *Xylocarpus granatum, Cynometra iripa, Heritiera littolaris*

Introduction

Mangroves are rapidly deteriorating due to unplanned developmental activities throughout the globe. Thus, conservation of mangroves is of foremost importance. The present attempts have special reference to mangroves of India, in general, and the west coast of Maharashtra, in particular. The most successful species for mangrove afforestation is *Rhizophora mucronata* throughout India, followed by *Avicennia marina* and *Ceriops tagal*. An integrated approach towards conservation of threatened species should have six

Table 1. Month wise collection of mangrove germplasm

June-July-August	Collection of mature fruits of *Cynometra iripa (*Achara)
June-July	Collection of mature fruits of *Xylocarpus granatum* at Achara
July- August	It was slightly late because of rain; very few seeds of *Heritiera littoralis* were obtained at *Nivati-Khavane*
June –July	*Rhizophora apiculata,* (Achara, Ratnagiri), *Bruguiera cylindrica* (Goa)
July –August-September	*Bruguiera gymnorhiza, Ceriops tagal, Kandelia candel (*Achara,Panavali,Ratnagiri)
October-November	*Barringtonia racemosa*, *Acanthus ilicifolius*, *Cerbera odollum* (Achara, Malvan,Nivati ,Honnavar ,Vengurla,Sindhudurg) *Aegiceras corniculatum,*
October-November-December	*Sonneratia alba,S,caseolaris, Salvadora persica, Exocoecaria agallocha, Lumnitzera racemosa*
April-May-June	Rhizophoraceae members, Associate species collection
Developmental Programs	1. Nursery establishment at Kolhapur (Shade house) 2. Nursery establishment at Achara 3. Germplasm collection and maintenance at Parwadi and Jamdul 4. Establishment of mangrove conservatory at Department of Botany, Shivaji University, Kolhapur (Polyhouse) 5. Monitoring at all sites till the end of the project 6. Transportation of well established saplings and distribution to various sites in the Sindhudurg district. 7. After care will be taken by the forest department. 8. Training/workshop/awareness programs for the forest staff, local inhabitants, fishermen.

aspects - documentation of individual taxon, provision of effective and appropriate legislation, preservation in their natural habitat, garden cultivation, research in biological parameters of plants as well as education of both, the public and botanists (Given, 1981). For the coast of Maharashtra, the documentation of mangrove species (Chavan, 2013) and categorization based on the IUCN red list guidelines is done by Bhosale (2002). Aspects such as distribution, occurrence and association have been studied by Desai (2011). Some Rare-Endangered-Threatened RET species have been studied by Gokhale and Chavan (2013). Estuary wise differences in responses of some species were observed on the coast of Maharashtra. It is realized during present work that recalcitrant seeds require special attention with respect to germination and further establishment. Therefore, trials have been attempted to conserve the species *in-situ* and *ex-situ*. Simple techniques have been developed for mass propagation of species viz. *C. iripa*, (rare) *X. granatum,* (rare) along the coast of Maharashtra (Bhatt et. al, 2011). *Heritiera littoralis* has been recored from the endangered habitats along the creeks of Sindhudurg distrct, Maharashtra (Shaikh *et.al,* 2011). While *R. apiculata, B. gymnorhiza* are vanishing fast from the west coast of Maharashtra.

Material and Methods

A thorough survey was carried out along the estuaries of west coast of Maharashtra. The Sindhudurg district is rich in biodiversity as major RET species are restricted to few sites only (Achara and Nivati). From these sites germplasm was collected season wise (Table.1). For RET mangrove species *in-situ* and *ex-situ* trials were performed by selecting sites at Achara, Mithbav and the conservatory at Department of Botany, Shivaji University, Kolhapur. All recalcitrant seeds are characterized by their large size and high moisture content. Seeds were maintained species-wise (Fig.1). Preservation of these seeds is an important aspect, hence mature fruits of *Cynometra* were kept in moist gunny bag till their root initiation and subsequently transferred to poly-bags and trainers filled with cocopeat and soil. Seeds of *Xylocarpus* were kept in wet bags soaked in water for a day and immediately transferred to polybags for germination. *Heritiera littolaris* seeds are very hard and therefore they were soaked in freshwater for 48 hours prior to being transferred to poly-bags containing soil and coco peat for germination. Germination was recorded after one month of sowing; survival rate was recorded till establishment in conservatory as well as along the sites of Sindhudurg district of Maharashtra.

Fig.1 Recalcitrant Seeds/Fruits of mangrove species

X. granatum

H. littolaris

C.iripa

Along with RET species some associate members and species like *Aegiceras coriculatum, Excoecaria agallocha, Acanthus ilicifolius and Rhizophora* sps. were collected and experimented for their performance.

Results and Discussion:

Experimental design- The studies can be broadly grouped into two categories

1) Nursery experiments - Preliminary germination, sprouting and growth studies

2) Trial plantation of mangroves in the Sindhudurg sites.

1) Nursery experiments

Two mangrove nurseries were established, one at the site of Parwadi (Achara) and other at an intertidal area of Jamdul (Achara) in the Sindhudurg district of Maharashtra. These two sites were monitored to evaluate the preliminary performance of mangrove species under tidal and non tidal conditions. Figure 2 indicates propagation of *B. cylindrica, B. gymnorhiza, X. granatum* at Jamdul site. Initiation was recorded after 3 weeks. However, cuttings of species like *Acanthus ilicifolius, Excoecaria agallocha* and *Salvadora persica* were successfully trialed at inland site, Parwadi (Fig.3)

One mangrove nursery (conservatory) was simultaneously established in the botanical garden of Shivaji University, Kolhapur under fresh water conditions.

Total 4,230 propagules/seeds were sown in poly-bags and soil beds during June 2014 to June 2015. The corresponding data on germination and growth was compiled after nine months. After nine months, a total of 3,800 seedlings survived (Table-2). The survival

Fig-2 Jamdul site-Achra

Fig-3 Parwadi Nursery

rate obtained at Parwadi was 89.83%. This was good performance at the coastal site where the seedlings were irrigated with fresh water only. After establishment, all these saplings were transferred to the Mithbav sites. In September 2015, all the saplings were transferred to the Mithbav site. At Jamdul site, *B. gymnorhiza, B. cylindrica,*

Fig-4 Conservatory of Mangrove Established in Botanical Garden of Shivaji University, Kolhapur

R. mucronata, R.apiculata, A. corniculatum, A. marina, X. granatum and C. iripa seeds/fruits/propagules were sown in poly-bags. The poly-bags were irrigated with fresh water, where flooding was not possible due to elevated land. There were a total of 2,500 saplings in the intertidal area at Jamdul. There was flooding of daily tides. However, the rate of survival after 3 months was poor, 32.4%, because of daily tides that lead to flooding.

The poly-bags of mangrove species raised at same sites which were irrigated with fresh water showed better performance and higher survival. Out of 7,840 saplings, 7,210 saplings were well established till January 2016. The survival percentage was 91.96%. This was the best performance of the germination and survival of saplings.

The mangrove nursery was developed away from the coastal area and was maintained under fresh water irrigation. Total 1,08,301 saplings were raised in poly-bags,trainers and beds for 17 mangrove species. The rate of germination and the rate of survival were found to be maximum under fresh water irrigation (90.48%). A total of 98,000 seedlings survived till the month of April 2016. Owing to the rise in temperature, the survival rate had declined. Now there are 52,000 saplings ready for plantation. The declining rate of survival was possibly because of heat shock.

2) Trial plantation of mangroves in Sindhudurg sites.

Trial plantation at Jamsande (Devgad) and Achara (Jamdul) sites were undertaken, where 10 seedlings, each 1 year old, of *Cynometra irpa, Xylocarpus granatum* and *Heritiera littoralis* were planted at 2 different estuaries. *Xylocarpus granatum* initially survived, with a 90% survival rate obtained in the upstream region. However, there was a subsequent 20 % decline in the survival rate. The frequency of tide is also more at the Jamsande site. At Jamsande site, there

Fig-5 Saplings transferred to Jamsande, Devgad

Table 2: Viability retention time of Cynometra iripa in different seed storage media with potential effects on the germination

Sr. No.	Seed storage Media	Viability retention time period in days	Effects on the seed and germination process
1.	Control (Seeds/ fruits were kept in trays)	21	Seed were dried
2.	Gunny bags	24	Seeds became slightly slimy and brown
3.	Blotting paper	24	Germination started in storage, followed by the drying the seeds
4.	Dry garden soil	21	Infested by saprophytic fungi, microbes, blackening of seed coat started
5.	Cow dung	21	Infested by saprophytic fungi microbes, seed coat attacked by fungi
6.	Ash	30	Seed drying and hardening
7.	Areca-nut coir	36	Germination started in storage, increment of the radicular end was observed.
8.	Rice hull	28	Germination started in storage, increment of the radicular end was observed. Further, the seeds shrivelled.
9.	Ragi hull	21	Germination started in storage, increment of the radicular end was observed. Further shrivelled. Few seedlings survived.
10.	Coco peat	64	Germination started in storage followed by heavy growth of radical. Plumular axis remained small. Seedling could be successfully transplanted on soil. Survival percentage was 65%

Table – 3: Growth performance of various mangrove species showing the height and the number of leaves after 12 months - *Xylocarpus granatum*

Sr. No.	Height of Plant (cm)	No. of leaves
1.	43	11
2.	57.2	11
3.	50.6	10
4.	35.1	7
5.	41	4
6.	38.9	10
7.	30.4	11
8.	32.6	6
9.	41.4	12
10.	38.2	6

Table- 4. Growth performance of various mangrove species showing height and number of leaves after 12 months- *Heritiera littoralis*

Sr. No.	Height of Plant (cm)	No. of leaves
1.	33.5	16
2.	28.2	14
3.	22.5	19
4.	30.7	12
5.	33.4	13
6.	30.6	11
7.	41.2	12
8.	31.1	11
9.	44.3	13
10.	17.3	8

Fig-6: Plantation site Jamsande, Devgad

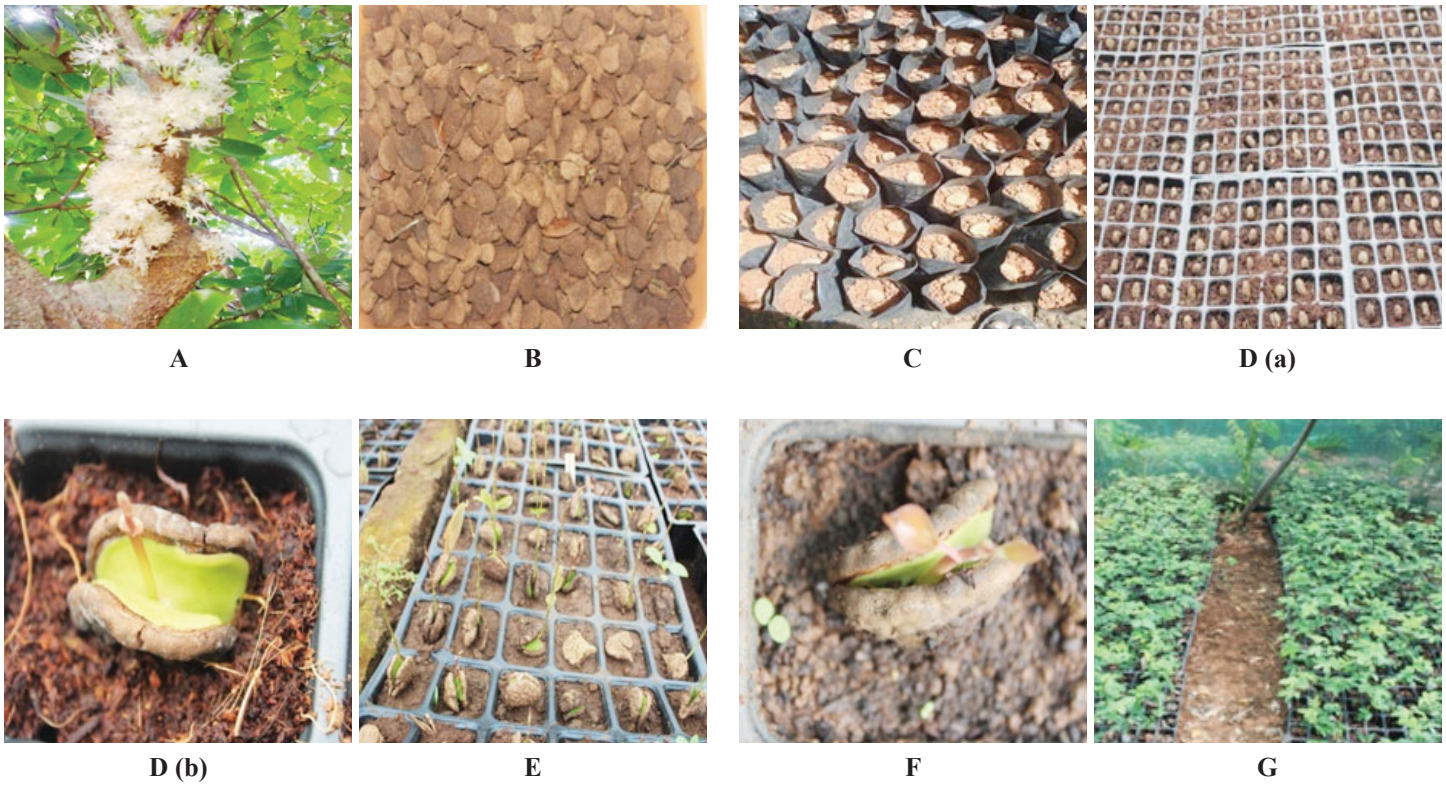


Fig 7-A. Shows the Habit, B. Seeds of C. *iripa* C. Seeds grown under soil culture D (a), D (b). Coco peat culture E. Soil + coco peat culture F. Initiation of leaf G. Healthy seedlings under soil + coco peat culture

was only 2% survival rate recorded for all three species. The downstream region is not suitable for plantation of RET species (Figure.5).

The present results are on similar lines to the statements made by Anonymous, 1989, Bhosale, 2013, Gokhale and Chavan 2013. It is suggestive that the high tidal region, muddy places and the downstream areas should be avoided for the conservation of *Xylocarpus*. As *Xylocarpus* and *Cynometra* are associated members. *Cynometra* favors low tidal frequency and well drained gravelly soil.

Nursery techniques were developed for three mangrove species i.e. for mass propagation. The experimental results have shown various results with different mediums. Trainers filled with 1:1 soil + coco peat obtained with 98% germination. The poly-bags filled with soil and coco peat alone, showed 85% germination and sprouting for *C. iripa* as well as *X. granatum*. Mature fruits of *Cynometra iripa* started initiating roots immediately within a week in the soil and the coco peat media. Shoot formation was observed within 2 weeks. Best results were observed in the coco peat and soil trainer technique. The fruits of *H. littolaris* germinated within 4 weeks and the survival percentage was found to be 70%. Well established one year old seedlings of *H. littlaris,* obtained an height up to 1 foot with a maximum 12-14 leaves. These seedlings also grow well under fresh water conditions and are suitable for plantation. There are various methods of propagation.

Concluding remarks

X. granatum seedlings are harder than *C. iripa*. *Cynometra iripa* favors low tidal frequency and well drained soil. It requires a shady moist place. August last week to September are the best months for plantation of RET species. However, June and July are suitable for mangrove nursery development and establishment. The results of this present work suggests that trainer as well as poly-bag techniques are the best methods for mass propagation of RET mangrove species. *Cynometra iripa* seedlings are very sensitive. These seedlings should be carefully handled during transport and transplantation. Any damage to the root system results in the mortality of the seedling. *Xylocarpus* seedlings are comparatively more tolerant than *Cynometra.* Thus, transplantation of *Xylocarpus granatum* is easier than *Cynometra*. *Cynometra* requires more freshwater and

very less salinity. The conservation of these species is possible only in habitable sites of the individual. *Heritiera littoralis* fruits were successfully sprouted after one month under nursery condition. It is luxuriantly growing in the botanical garden of Shivaji University, Kolhapur under freshwater condition.

Trainer as well as poly-bag techniques are more appropriate for mass propagation of mangroves with the coco peat and soil media. Standardization of mass propagation of RET species is an initiating step towards the conservation of mangroves along the west coast of Maharashtra, especially for rare , endangered mangrove species.Similar attempts have been made for Rhizophoraceae members which are vanishing fast along the coast of Maharashtra..

Acknowledgements

Authors thank the CCF (Chief Conservator of Forest) N. Vasudevan, Mangrove Cell, Mumbai, Forest and UNDP Staff for providing facilities. Thanks are also due to GOI-UNDP-GEF Project for financial assistance.

References

Anonymons 1989, State of report on mangrove ecosystems, Govt. of India, Department of Science & Technology, New Delhi.

Bhatt J. R., Macintosh D. J., Nayar T. S., Pandey C. N. and Nilaratna B. P., 2011, Towards Conservation and Management of Mangrove Ecosystems in India, ISBN 978-2-8317-1263-5: pp 12.

Bhosale L. J. 1990, Human impact on primary productivity and regeneration of mangroves of Maharashtra. Final report, Department of Environment, Govt. of India, New Delhi :pp 278.

Bhosale L. J. 2002. Categorization of mangroves of Maharashtra based on IUCN red list of guidelines and germplasm preservation of threatened species. Final report submitted to Ministry of Environment and Forest, Govt. of India, New Delhi.

Bhosale L. J. 2013. Salient features of mangroves and their conservation. In: Mangroves of India, Their Biology and Uses. ZSI, MoEF, Govt. of India. J. R. Bhat, Ramkrishna, M. Sanjappa, O. K. Ramadevi, B. P. Nilaratna, K. Venkataramna.

Chavan N. S. 2103 New area records and associated from west coast of Maharashtra, India. Seshaiyana 2013; 21(2):2-3.

Desai M. N. 2011 Autecology of a mangrove species *Cynometra iripa* Kostel. Ph.D. Thesis submitted to Shivaji University, Kolhapur

Given D. R.1987, Threatened pants of New Zealand. Documentation in a series of islands. In: The biological aspects of rare plant conservation. Hugh Synge (ed.) John Wileg and Sons.

Gokhale M. V. and Chavan N. S., 2013. Conservation of critically endangered mangrove species *Xylocarpus granatum* Koenig., *Cynometra iripa* Kostel along the coast of Maharashtra,In: Mangroves of India. Their Biology and Uses. ZSI, MoEF, Govt. of India. J. R. Bhat, Ramkrishna, M. Sanjappa, O. K. Ramadevi, B. P. Nilaratna, K. Venkataramna.

Shaikh S. S., Gokhale M. V. and Chavan N. S., 2013, A report on the existence of H. littoralis Dry and on the coast of Maharashtra. The Bioscan 6 (2): 293-295.