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Validation of Indigenous knowledge used in the management of Bivalve fishery of South Konkan coast of Maharashtra

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Abstract

The present study was conducted to gain access to the indigenous knowledge of the fishermen engaged in the bivalve fishery practiced in the South Konkan Coast and its subsequent assessment by experts working in area of fisheries management. A total of 100 fishermen constituted the sample size of the study. The data were gathered through a combination of personnel interview and non-participant observation methods. The study has documented rich, varied and potential indigenous knowledge associated with the management of the bivalve fishery. The indigenous knowledge on variety specific habitats, fishery season for bivalves, preference timing and depth of operation, effect of different abiotic phenomenon on condition and availability of bivalves, methods of their exploitation are based by and large on scientific rationality, efficacy and use of local resources as evidenced from the ratings of the experts.

Keywords: *Valuation, indigenous knowledge, bivalve fishery practices, South Konkan.*

Introduction

Indigenous knowledge is the knowledge gained by the people in a given community over a time period by experience, experimentation and passing down to posterity the knowledge of ancestors and fore fathers. It is adapted to local culture and environment, and is dynamic in nature (Berkes, 1999). Use of indigenous knowledge allows fisherman living in discrete association with their environment to use the natural resources in a more sustainable way (Gray and Zann, 1988; Gadgil *et al.*, 1993). It is a fact that fishermen world over use the traditional knowledge to overcome specific localized problems based on their knowledge related to ecology and fish behavior (Johannes, 1981), weather and oceanographic conditions, navigation (Worsely,1971) , fishing methods (Brandt von,1972), vessel design and propulsion and processing and trade. Unfortunately indigenous knowledge is either ignored or inadequately used by the fisheries scientists (Johannes, 1978). Documentation, compilation and legitimization of indigenous knowledge assure that end-users of specific development programmes are involved in developing technologies appropriate to their needs. Hence before using in development programmes or blending with modern technology, it should be assessed on scientific terms to confirm its validity as some ITKs have become obsolete. Keeping this in view the present study was conducted to gain access in to the indigenous knowledge of the fishermen engaged in the bivalve fishery in the South Konkan region. Similarly to confirm its validity it was subjected to assessment by fishery experts working in the area of coastal fishery management.

Material and methods

Purposive sampling was used for the present study. Accordingly, two coastal districts of Maharashtra namely, Ratnagiri and Sindhudurg representing the South Konkan were selected during the period from April 2009 to November 2011. Geographically, the study area is located between 17º 02′ 43″ N latitude and 73º 16′ 57″ E longitudes to 15º 43′ 46″ N latitude and 73º 40′ 37″ E longitudes (Fig. 1). The two

Fig 1. Map of study area

districts have a combined coastline of 281 km and continental shelf area of 52000 km^2. The active estuarine fishermen population of South Konkan is about 1625 (Anonymous, 2003). The study was carried out in ten randomly selected fishing villages where the bivalve fishery is concentrated. The selected villages were *Mirya, Karla, Bhatye, Rajiwada, Jaitapur, Aronda, Shiroda, Tarkarli, Devgad* and *Vijaydurg*. A total of about 100 fishermen including 20 women were interviewed for the study. The data were collected with the help of semi-structured interview schedule designed by incorporating all the items on which the information was required. To support the findings of the study non-participant observation was carried out. The respondents were selected using the 'snow ball' method in which people from the community and the interviewees themselves indicate the people to be interviewed (Bailey, 1982).

Snow ball method is a non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances. In the present study the data on indigenous knowledge was collected from the fishermen using snowball method from each of the selected sample villages. Snowball sampling is a useful tool for building networks and increasing the number of participants (Goode and Hatt, 1952).

Data was tabulated and analyzed. Percentage analysis was used to interpret the finding of the study. PIC (Prior Informed Consent) was taken from the fishermen (about 100) with their names, village to which they belong and their respective ages. For the purpose of validity assessment of indigenous knowledge, a checklist of seven criteria was identified (Nirmale *et. al.*, 2004). The selected criteria and their operational meaning are as follows:

1. Scientific value/logic - Does the ITK/IK have any scientific background?
2. Efficacy - Does it work? Is it effective?
3. Cost effectiveness - Is it cost effective?
4. Availability of materials - Are the materials available in the locality?
5. Easy to follow - Is it easy to follow?
6. Cultural appropriateness - Is it culturally appropriate to be accepted?
7. Environmental soundness - I it safe for the environment?

The experts were requested to critically rate each of the documented ITK against the criteria and indicated their judgment for agreement (with a√) and disagreement (with X) for the same. Among the documented ITKs, only those which were commonly followed or applied were subjected to assessment. Over a period of six months, 15 experts positively responded to this exercise. For the sake of interpretation, the assessment of ITK against criteria by experts was considered the assessment indicators and accordingly were grouped as high (more than 70%), moderate (50% - 70%) and low (less than 50%). Response of experts on assessment criteria was expressed as percentages.

Results and discussion

Assessment of IK on availability of different types of bivalve species

Availability of different bivalve species and their identification by local fishermen (Table 1) have been rated high by experts on assessment criteria such as scientific value, moderate to high on efficacy, moderate to high on cost effectiveness while high on availability of materials and have been rated low on other criteria. Availability of different bivalve species and its identification by local fishermen has been rated by experts on assessment criteria such as high scientific value moderate to high on efficacy, moderate to high on cost effectiveness while high on availability of materials and has been rated low on other criteria (Table 2). Most of the scientists have rated this IK high on scientific value. Fishermen identify various clams, mussels and oysters based upon its external identifying characters particularly color, shape, size, thickness of valve (*shipe*) and markings on the shell. These characters help them to differentiate commercial varieties of bivalves easily.

Table 1. IK on availability of different types of bivalves

Sl. No.	Species	Local name	Size range (cm)	Morphological characteristics as told by fishers
A. Clams				
1.	*Paphia malabarica*	*Tasre*	2 - 4	Bivalve shell thin, horizontal markings
2.	*Meretrix casta*	*Lali mule*	21/2 - 5	Varying colored, smooth surface, slimy meat secretion
3.	*M. meretrix*	*Dhamni mule*	5 - 7.5	Varying coloured, smooth surface,
4.	*Katylesia opima*	*Wati mule*	2 - 4	Inflated, lead black coloured, roundish
5.	*Polymedosa erosa*	*Mharai*	9 - 10	Bigger & dark colored bivalve shell thick
6.	*Anadora granosa*	*Rangane mule, Adare*	5 - 6	Shell thick with vertical groove like markings
7.	*Tapus radiatus*	*Gubir*	2.5 - 5	Whitish to brown in color, minute vertical & horizontal lines
8.	*Soletellina* spp.	*Todai*	8 - 12	Elongated pale greenish to brown, shell chin & sharp edges
9.	*Villorita cyprinoides*	*Kale, Karmale*	3 - 5	Black colored, shell thick.
B. Mussels				
1.	*Perna viridis*	*Kakai, Shinane, Shidane, Wakunda*	3 - 12	Green colored bivalve shell thin longer
C. Oysters				
1.	*Crassostrea* spp	*Saad, Bud Kaalve*	12-16	Irregular surface, oval shape
2.	*Saccostrea cuculata*	*Kaalve*	2.5 - 6	Irregular surface

Table 2. Assessment of IK on availability of different types of bivalve species

Sl. no.	Species	Scientific value	Efficacy	Cost effectiveness	Easy to follow	Availability of material	Cultural appropriateness	Environmental soundness
1	*Paphia malabarica*	86.66	73.30	73.30	86.66	80.00	33.33	40.00
2	*Meretrix casta*	86.66	73.30	73.30	86.66	80.00	33.33	40.00
3	*M. meretrix*	86.66	73.30	73.30	86.66	80.00	33.33	40.00
4	*Katylesia opima*	80.00	66.66	66.66	80.00	73.33	26.66	33.33
5	*Polymedosa crosa*	86.66	66.66	53.33	80.00	80.00	20.00	40.00
6	*Anadora granosa*	86.66	73.30	73.30	86.66	80.00	33.33	40.00
7	*Perna viridis*	86.66	66.66	66.66	80.00	73.73	26.66	33.33
8	*Crassostrea* spp	86.66	73.30	73.30	80.00	73.33	26.66	33.33
9	*Saccostrea cuculata*	86.66	66.66	60.00	80.00	66.66	26.66	33.33
10	*Tapus radiatus*	80.00	60.00	53.33	66.66	66.66	20.00	26.66
11	*Soletellina* spp.	80.00	60.00	53.33	73.30	60.00	13.33	20.00
12	*Villorita cyprinoides*	86.66	73.30	73.30	86.66	80.00	33.33	40.00

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

Scientific identification of the bivalves is also based upon the characteristics similar to those used by the fishermen. Moderate to high rating on cost effectiveness and availability of materials may be attributed to easy collection of bivalves by appropriate means once the commercial species are readily identified. The different species of bivalves are available in some particular regions. Its identification and exploitation by the fishermen is subject of local expertise. Hence other assessment criteria namely cultural appropriateness and environmental soundness are not applicable to this particular aspect of IK and are rated low by the experts accordingly.

Assessment of IK on association of bivalve species with other species

Association of bivalve species with each other & other species has been rated moderate to high by experts on scientific value. It was rated low on other criteria (Table 3).

Table 3. Assessment of IK on association of bivalve species with other species

Sl.no.	Association of species	Scientific value	Efficacy	Cost effectiveness	Easy tofollow	Availability of material	Cultural appropriateness	Environmental soundness
1	Small size crabs locally known as *Gadhav/Khekade/Jui* are found in the clam cavity.	86.66	13.33	13.33	33.33	20.00	-	20.00
2	Finfishes such as *Paalu* (*Lethrinus* spp.), *Boi* (Mullets), *Shetki* (*Gerres* spp.), *Sule* (Indian Whiting), *Kaalundri* (*Etroplus suratensis*) are found in vicinity of *Tasre* and *Kaalve*	73.33	26.66	26.66	33.33	26.66	6.66	26.66
3	Presence of jelly fish locally known as *Jharm/jhar* indicate good future availability of clams	60.00	20.00	20.00	20.00	13.33	13.33	20.00
4	Presence of *Ghurap* (Gastropod) indicate abundance of *Lali* & *Karmale*	60.00	20.00	13.33	26.66	13.33	6.66	20.00
5	Abundance of green algae in intertidal water, indicate good future availability of clams	66.66	20.00	13.33	26.66	13.33	13.33	20.00

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

The presence of the Pea crab in the mantle cavity of the clams has been previously reported (Sawant and Ranade, 2002) while finfishes such as *Paalu* (*Lethrinus* spp.), *Boi* (Mullets), *Shetki* (*Gerres* spp.), *Sule* (Indian Whiting), *Kaalundri* (*Etroplus suratensis*) are native fishes of estuarine environment. Hence these IK's are rated high on scientific value by experts. IK's such as spotting of Jelly fish in the estuary with high tide locally known as *Jharm/jhar*, presence of *ghurap* (Gastropod) in intertidal areas and abundance of green algae in intertidal beds indicating good availability of clams in ensuing months are rated moderately on scientific value. Former two observations need to be scientifically investigated. Clams are filter feeders and presence of green algae in respective substratum may reflect availability of natural feed for clams. Fishers are well aware of co - existence of bivalves with other species as well species that act as indicators of bivalve abundance. Such knowledge helps them to know the availability of bivalves in coming months and also understand the condition of bivalves. All IKs in this category have been rated poor on other criteria such as efficacy, cost effectiveness, ease in following, and availability of material, cultural appropriateness and environmental soundness due to non-relevancy of assessment criteria with the particular IK.

Assessment of IK on availability of bivalves on particular habitat

Indigenous knowledge on availability of bivalve on particular habitat has been rated high by experts on scientific value. It is rated low on efficacy, ease in following, cost effectiveness, availability of materials, cultural appropriateness and environmental soundness (Table 4).

Traditional fishermen live in close proximity of their environment. They have intricate knowledge regarding the availability of different bivalves on particular habitat and most of the empirical data obtained from the fishermen is corroborated with scientific reporting. Scientific reports

Table 4. Assessment of IK on availability of bivalves on particular habitat

Sl. No.	Variety/ species*	Habitat	Scientific value	Efficacy	Cost effectiveness	Easy to follow	Availability of material	Cultural appropriateness	Environmental soundness
1.	*Saad/Bud Kaalve*	Deep submerged intertidal areas (Bottom muddy/sandy)	86.66	46.66	40.00	40.00	40.00	26.66	26.66
2.	*Shinane*	*Khadap* (rocky bed)	86.66	46.66	40.00	40.00	40.00	26.66	26.66
3.	*Kaalve*	Exposed intertidal zone (muddy/rocky areas)	86.66	46.66	40.00	40.00	40.00	26.66	26.66
4.	*Tasare*	*Retad/Karap* (course sand with small broken shell particles) buried to a depth of 5-6 inch in intertidal areas	86.66	46.66	40.00	40.00	40.00	26.66	26.66
5.	*Laali/Dhamne*	Fine sandy surface to a depth upto 2-4 inch in intertidal areas	86.66	46.66	40.00	40.00	40.00	26.66	26.66
6.	*Karmale*	Sandy area (*Pulan*) in intertidal areas	80.00	40.00	33.33	33.33	33.33	20.00	20.00
7.	*Todai*	Sandy plus muddy shore, found dispersed & buried up to one & half feet depth,	86.66	46.66	40.00	40.00	40.00	26.66	26.66
8.	*Wati*	Sandy/ muddy shore buried 2-3 inch depth in intertidal estuarine areas	86.66	46.66	40.00	40.00	40.00	26.66	26.66
9.	*Rangne*	*Chikhal mishrit valu* (sandy + muddy bottom) found dispersed & buried upto half feet depth, mouth downwards	86.66	46.66	40.00	40.00	40.00	26.66	26.66
10.	*Gubir*	Rocky beds	86.66	46.66	40.00	40.00	40.00	26.66	26.66
11.	*Mharai*	In mangrove area	86.66	46.66	40.00	40.00	40.00	26.66	26.66

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

have stated that *P. malabarica* is found on sandy bottom (Narsimhan, 2005, Sreenivasan, 1983). Apte, (1998) stated that for *Meretrix casta* 63-125 μm particle size is preferred habitat. Nayar *et al*. (1984) have reported that *Meretrix meretrix* prefers predominantly sandy bottoms. While *Anadora granosa* and *Katelysia opima* thrives well in mud flats (Rao, 1987,). *Villorita cyprinoides* usually occurs in sandy bottom with coarse sand12, 16 have stated that the species belonging to the genus *Crassostrea* occur in intertidal areas upto a depth of 7- 16 m (Bal and Rao, 1990). Fishermen know in which habitat a particular variety of clam, mussel and oyster is found and thus harvest them either by using suitable gear, hand picking or skin diving. Indigenous knowledge on availability of bivalve on particular habitat has been rated high by experts on scientific value thereby substantiating the observation of bivalve fishermen. However majority of experts have rated these IKs low (26.66% to 46.66%) on efficacy, ease in following, cost effectiveness, availability of materials, cultural appropriateness and environmental soundness. These criteria hold no relation to the availability of bivalves in particular habitat and are rated accordingly.

Assessment of IK on fishery season for bivalves

Multiple views of indigenous knowledge on fishery season for bivalves are expressed by the fishermen (Table 5). Experts have rated this particular aspect of IK high on scientific logic. Fishermen over the years through experience and keen observation have gathered knowledge regarding plentiful availability of various bivalve species in different seasons. The fishery season within and between different species of bivalves is likely to vary from one location to another. The experts opined that IK on fishery season for bivalves are relatively poor in terms of other assessment criteria. The IK is not related to any traditional technology so it is rated low on cost effectiveness, cultural appropriateness, availability of material and environmental soundness. Albeit these IKs could have been rated moderately on efficacy because it is effective in sense that fishermen make use of this knowledge and intensify the collection of bivalves in fishing season of respective species.

Assessment of IK on effect of tides on availability of bivalves

Indigenous knowledge on effect of tides on availability of bivalves was rated moderate to high on scientific value, low to moderate on efficacy while low on other assessment criteria (Table 6).

Experts have rated the IK that more catch of clams is obtained during low tide high on scientific value, moderately on efficacy and cost effectiveness while low on other assessment criteria.

Table 5. Assessment of IK on fishery season for bivalves

Sr. No.	Variety/'species*	Fishery season	Scientific value	Efficacy	Cost effectiveness	Easy to follow	Availability of material	Cultural appropriateness	Environmental soundness
1.	*Laali, Karmale*	Oct - May	80.00	46.66	26.66	26.66	33.33	40.00	13.33
2.	*Shinane*	Oct - May	86.66	46.66	33.33	33.33	40.00	40.00	20.00
3.	*Kalve/ Saad*	Throughout the year	86.66	46.66	33.33	33.33	40.00	40.00	20.00
4.	*Kalve/ Saad*	Nov - May	80.00	46.66	26.66	26.66	33.33	33.33	13.33
5.	*Laali, Wati, Dhamni*	Sept - June	80.00	40.00	26.66	26.66	33.33	33.33	13.33
6.	*Laali, Wati, Dhamni*	Throughout the year	80.00	46.66	33.33	33.33	40.00	40.00	20.00
7.	*Laali, Wati, Dhamni*	Mar - May	80.00	40.00	26.66	26.66	33.33	33.33	13.33

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

Table 6. Assessment of IK on effect of tides on availability of bivalves

Sr. No.	Effect of tides on availability of bivalve	Scientific value	Efficacy	Cost effectiveness	Easy to follow	Availability of material	Cultural appropriateness	Environmental soundness
1.	*More catch of clams is obtained during low tide*	73.33	60.00	60.00	33.33	40.00	20.00	26.66
2.	Less clams are possible to collect during high tides due to rising water but more clams are displaced from their respective beds	60.00	40.00	40.00	13.33	20.00	13.33	20.00

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

This may be true in the sense that more intertidal region gets exposed during low tide thereby making scouting and collection of clams easier. This is confirmed by the assessment of the experts. The IK that it is possible to collect less clams during high tide due to rising water since more clams are displaced from their respective beds is rated high on scientific value and low on other criteria. Swift currents during high tides disturb the substratum thereby displacing the clams but at the same time make their collection difficult due to rising water. The poor assessment of the IK on efficacy reflects that the collection of clams is ineffective during flooding and while other criteria being not related to the IK are rated poor.

Assessment of IK on effect of temperature and salinity on condition of bivalves

The IK on effect of temperature pertained to the seasonal changes in condition of bivalves. Effect of temperature relates to changes in condition of bivalves in summer and winter. The most popular aspect of indigenous knowledge in this category viz., the quantity of meat in oysters and clams is more during summer months and less during winter months is rated moderate to high on scientific value and low on other criteria.

The variation in condition of the bivalves is closely related with the spawning cycle of the bivalves rather than effect of the temperature. The former observation might be related to the onset of the spawning period of the bivalves during which there is full gonadal development. While the latter observation might be coinciding with post spawning condition of the bivalves wherein after spawning the condition of the bivalve is degraded due of deprivation of energy reserves and corresponding unfavorable conditions notably availability of food and salinity. Mohammed, (2011) has reported the spawning period of *Villorita cyprinoides*, *Meretrix meretrix* and *M. casta* to be during May-June along the West coast. Similarly the condition and percentage edibility was found to be high during January to May and remained low during August to December in *Crassostrea gryphoides* from west coast (Sawant and Ranade, 2001). Moderate to high rating of this IK on scientific value by the experts confirms the observation of the fishers. As this particular IK is an example of observation of fishermen on the biological aspect of bivalves, the other assessment criteria do not relate with this IK and are hence rated low.

Assessment of IK on the methods of storage of bivalves

To store the bivalves in fresh condition till they are sold fishers make use of *Zole/Zaabli* a conical bag of varying capacity (1-20 kg) made up of nylon twine. The bag is kept submerged in creek water with one end tied to buoy with rope. Care is taken that it remains in water all the time. Clams can be stored for one to five days in this condition. Storage of clams and mussels in *Zole/Zaabli* is rated high on scientific value, moderate on cost effectiveness and ease in following by experts and low on other criteria.

The bag with clams and mussels is kept immersed in estuarine waters and this may help the clams to remain alive for longer duration as it is stored in its natural habitat. Dual objectives of storage and short term preservation are accomplished in this way. The IK is rated moderately on cost effectiveness and ease in following. *Zole/Zaabli* is a simple gear made with the help of locally available materials and simple to operate. The other assessment criteria are not relevant to the IK and are rated poorly by the experts.

Assessment of IK on preparation of byproduct from clams

Preparation of *Mulyacha kaat* with a shelf life of six months to one year is rated high on scientific value, moderate on efficacy, cost effectiveness and ease in following and low on other assessment criteria. Most of the fishermen resort to the preparation of clam meat extract locally known as *Mulyacha kaat* with reported shelf life of about six months to one year. The extract is prepared from *Tasare* (*Paphia malabarica*). The *Mulyacha kaat* is prepared when the clams are fished in bulk quantity. Clams are steamed in a vessel on firewood with little quantity of water enough to facilitate steaming for about 15 - 30 minutes till they are entirely deshelled. The deshelled clams along with the meat inside it are then removed. The supernatant is filtered through the cloth and concentrated by Boiling up to one - sixth of its original quantity and stored in air-tight container. *Tasare* (*Paphia malabarica*) is chosen to prepare the clam extract because it is the tastier variety of clam.

Experts have rated this IK high on scientific value. The heating is carried out with the help of firewood collected from the vicinity and involves no specialized steps in preparation of the product. That's why the IK is rated moderately on efficacy, cost effectiveness and ease in following. As the preparation involves use of firewood it is rated low on environmental soundness. On the contrary it could have been rated high on the cultural appropriateness by the experts because the local technology of preparation of clam extract, *Mulyacha kaat* could be introduced to other fishing villages where bivalve fishery exists.

Assessment of IK on preservation methods of bivalves

Sun drying of clam meat with a shelf of 2-3 months is rated high on scientific value, moderate on efficacy, cost effectiveness, easy in following, availability of materials and cultural appropriateness while low on environmental soundness. It

is very cost effective, easy to follow, efficient and culturally appropriate fish preservation method practiced in a tropical country like India. It is not directly related to environmental soundness criteria as such and is hence rated low.

Assessment of IK on effect of lunar periodicity/cycle on condition/availability of bivalves

The popular aspect of IK in this category, viz. more edible oysters and mussels are available during spring tides are rated low on all the assessment criteria by the scientists. Fishermen reported that more bivalves particularly oysters and mussels are available during spring tides. Maximum difference between low tide and high tide is noted during spring tides. Due to this, a lot of space is available during low tide for collection of oysters and mussels which are found in deep inter-tidal to sub-tidal areas. Fishermen strategically make use of this knowledge and thus obtain more catch of the oysters and mussels during spring tides The popular aspect of IK in this category, that more edible oysters and mussels are available during spring tides is contradictorily rated low on all the assessment criteria by the scientists thereby indicating the need for more scientific investigation using field trips and catch records.

Assessment of IK on preference timing / depth of operation for bivalve fishing

Indigenous knowledge on preference timing/depth of operation for bivalve fishing has been rated moderately on scientific value and efficacy by experts while low on other assessment criteria (Table 7). Most of the fishermen including women prefer to collect the clams during low tide in exposed intertidal area and up to knee deep water depth. The fishermen go for bivalve fishing keeping in view the ease of bivalve collection and as per the availability of bivalves in varying depths in the intertidal region. IKs on preference timing/depth of operation for bivalve fishing are rated poor in terms of other assessment criteria by the experts because they are not directly applicable.

Assessment of IK on methods of bivalve collection / exploitation

Assessment of various methods of exploitation of bivalves is depicted in Table 8. *Aakli* is a gear made up of circular metal frame (diameter 2- 4 ft) with a conical net attached to it (3-6 ft long, Fig.2). *Aakli* is dragged along the sandy substratum

Table 7. Assessment of IK on preference timing / depth of operation for bivalve fishing

Sr. No.	Preference timing / depth of operation for bivalve fishing	Scientific value.	Efficacy	Cost effectiveness	Easy to follow	Availability of materials	Cultural appropriateness	Environmental soundness
1.	Collection of clams is carried out during low tide up to knee deep water level	66.66	53.33	40.00	46.66	40.00	13.33	33.33
2.	Edible oyster and mussels are collected in depth of 5-20 feet when low tide is in progress and water has receded up to half its magnitude till up to when high tide begins or water again raises to half its magnitude.	66.66	60.00	40.00	46.66	40.00	20.00	33.33
3.	Clams are collected at a depth of about 5-20 feet when low tide is in progress & water has receded up to half its magnitude till upto when high tide begins or water again rises half its magnitude	66.66	46.66	40.00	46.66	40.00	20.00	26.66
4.	Rock oysters are collected during low tide	66.66	53.33	46.66	40.00	46.66	26.66	33.33

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

Table 8. Assessment of IK on methods of bivalve collection / exploitation

Sr. No.	Methods of bivalve collection / exploitation	Scientific value	Efficacy	Cost effectiveness	Easy to follow	Availability of material	Cultural appropriateness	Environmental soundness
1.	Use of *Mhangare / Aakya* to collect clams.	66.66	53.33	53.33	60.00	46.66	26.66	40.00
2.	Use of *Aakli* to collect clams	60.00	46.66	46.66	53.33	40.00	20.00	33.33
3.	Hand picking of clams with the aid of knife /*koyati* (Knife like implement with sharp curved end	66.66	46.66	53.33	53.33	40.00	26.66	33.33
4.	Collection of *Saad* *with the help of *Hatodi* (hammer) and *chhinni* (small iron bar with sharp end)	53.33	46.66	46.66	46.66	33.33	26.66	26.66
5.	Collection of mussels with *taasni/parai* (2-3 ft long iron bar with sharp end)	60.00	46.66	46.66	53.33	40.00	20.00	33.33
6.	Collection of clams with aid of Indi / *Konda*	66.66	53.33	53.33	60.00	46.66	26.66	33.33

* *Response of experts on assessment criteria (n = 15) expressed as percentages*

Fig. 2. Fisherman with *Aakli*

with the help of hand. *Mhangare/aakya* (Fig.3) is made up of triangular metal frame (1-2 ft x 1-2 ft x 1-2 ft) with a conical net attached to it (5-6 ft long). Collection of oysters in sub-tidal areas is carried out by skin diving with the aid of *hatodi* (hammer) and *chhinni* , small iron bar with sharp end (Fig.4). *Taasni or paarai* is used to detach the mussels from substratum. Indi or *Konda* (Fig. 5) comprises of a bag like conical net (5-6 ft), attached to a semicircular wooden frame (4-8 ft). The frame is made of out of *nirgundi* wood stick (*Sonnertia alba* J. Smith). A pair of rope is attached to the wooden frame which acts as a sling and the ends of wooden frame are held in position by a 1-3 ft long foot rope. The net is dragged along the sandy substratum by holding the sling with hands and the foot rope between the toes.

The methods of bivalve fishing are easy and suitable to collect for a variety of clams, mussels and oysters from a particular habitat. Such methods have been evolved over a long period of time by observation, experience and experimentation. Most of these methods are therefore rated moderately on scientific

Fig. 3. Mhangare/aakya

Fig. 4. *Hatodi* and *chhinni*

Fig. 5. Indi or *Konda*

value, efficacy, ease in following and cost effectiveness by the experts (Table 8). While other criteria such as cultural appropriateness which relates to the introduction of technology to the other region and environmental soundness are rated low by the experts.

Based on the findings of the study, it can be concluded that fishers engaged in bivalve fishery possess rich and varied indigenous knowledge on various management aspects such as choice of materials and methods for bivalve fishing, preference timing/depth for fishing, preparation of byproducts, preservation method followed, their perceptions on the effect of lunar cycle, tidal fluctuations on bivalve catch, effect of temperature on condition of bivalves etc. is by and large based on scientific rationality, efficacy and used of local resources as judged by the experts. Hence such indigenous knowledge can be judiciously blended with modern scientific and technical wisdom to evolve a package of fisheries management practices that enjoys ready acceptance by the

fishermen and enhances the efficacy and sustainable use of local resources.

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