Available online at: www.mbai.org.in doi: 10.6024/jmbai.2017.59.2.1924-06

Indigenous knowledge used in stake net (*wan*) fishery practiced along the Ratnagiri coast of Maharashtra

L. S. Uskelwar*, V. H. Nirmale, B. P. Bhosale, S. Y. Metar[1] and N. D. Chogale[1]
College of Fisheries, Ratnagiri, Maharashtra, India.
[1]Marine Biological Research Station (Dr. BSKKV), Ratnagiri- 415 629, Maharashtra, India.

*Correspondence e-mail: laxman.uskelwar333@gmail.com

Received: 20 Sep 2016 Accepted: 25 June 2017 Published: 10 Dec 2017

Original Article

Abstract

The study of Indigenous knowledge rooted in local communities has potential to provide research guidelines aimed at benefiting the user group. Concerted attempts should be made to document, compile and validate the Indigenous knowledge in fisheries before it is lost with the advent of modern knowledge and urbanization. The stake net fishery is an important traditional fishery practiced in the estuarine waters of Ratnagiri district. The present study was conducted to analyze the use of Indigenous knowledge in management of stake net fishery. A total of 100 fishermen essentially involved in stake net fishery in Ratnagiri district constituted the sample size. Snow-ball method was employed for selecting the respondents across the randomly selected villages. Accordingly, a combination of personal interview and non-participant observation method was used for data collection. The study has documented rich, varied and potential IKs associated with the management of stake net (wan) fishery. The Indigenous knowledge on dimensions of stake net, fishery season, time of preference for stake net operation, effect of lunar cycle and wind direction and method of fish exploitation has been documented in the present study.

Keywords: *Indigenous knowledge, stake net fishery (wan), Ratnagiri district.*

Introduction

Tropical, small scale fisheries, which feed and provide income to millions of people around the world (Zeller *et al.,* 2007; Pauly, 2006; McGoodwin, 1984; Berkes *et al.*, 2001) are especially difficult to manage in proper scientific manner based on optimum yield. The fishers by virtue of living in close proximity of the nature to harness natural resources possess strong Indigenous knowledge system. The corpus of this knowledge combined with involvement of local institutions is used in management of most of the small scale coastal fisheries. The definition of Indigenous knowledge has been variously construed by different authors. The main ones being the local knowledge, indigenous knowledge, traditional ecological knowledge, indigenous skill and ethnoscience (Ruddle, 1991). All terms have got conceptual and semantic problems. To avoid ambiguity we have used the terminology Indigenous knowledge. Indigenous knowledge is defined as the knowledge which has been accumulated by the people over generations by observation, experimentation and by handing over of older generations experience and wisdom in any particular area of human endeavor (Odhiambo, 1990). It is also defined as the systematic body of knowledge acquired by local people through accumulation of experiences, informal experiments and intimate understanding of the environment in a given venture (Warren and Rajsekharan,

1993). Knowledge held by people considered to be indigenous to a place, usually in contrast to Western European colonialism and expansion (Stevenson, 1996). This Indigenous knowledge or IK covers a wide range of subjects such as agriculture, food preparation, education, institutional management, natural resource management, health care and many other subjects. The generation of indigenous knowledge has been a matter of survival for the fishers who use it to overcome their specific localized problems. The knowledge of ecology and fish behavior (Johannes, 1981), weather and oceanographic conditions, navigation (Worsley, 1971), fishing methods (von Brandt, 1972), vessel design and propulsion, processing and trade has been effectively used by the fishers to harness the local resources in a sustainable way. The main focus of working with indigenous knowledge is to understand and apply this knowledge, while considered to be outside the conventional system, can complement and be useful to scientific knowledge.

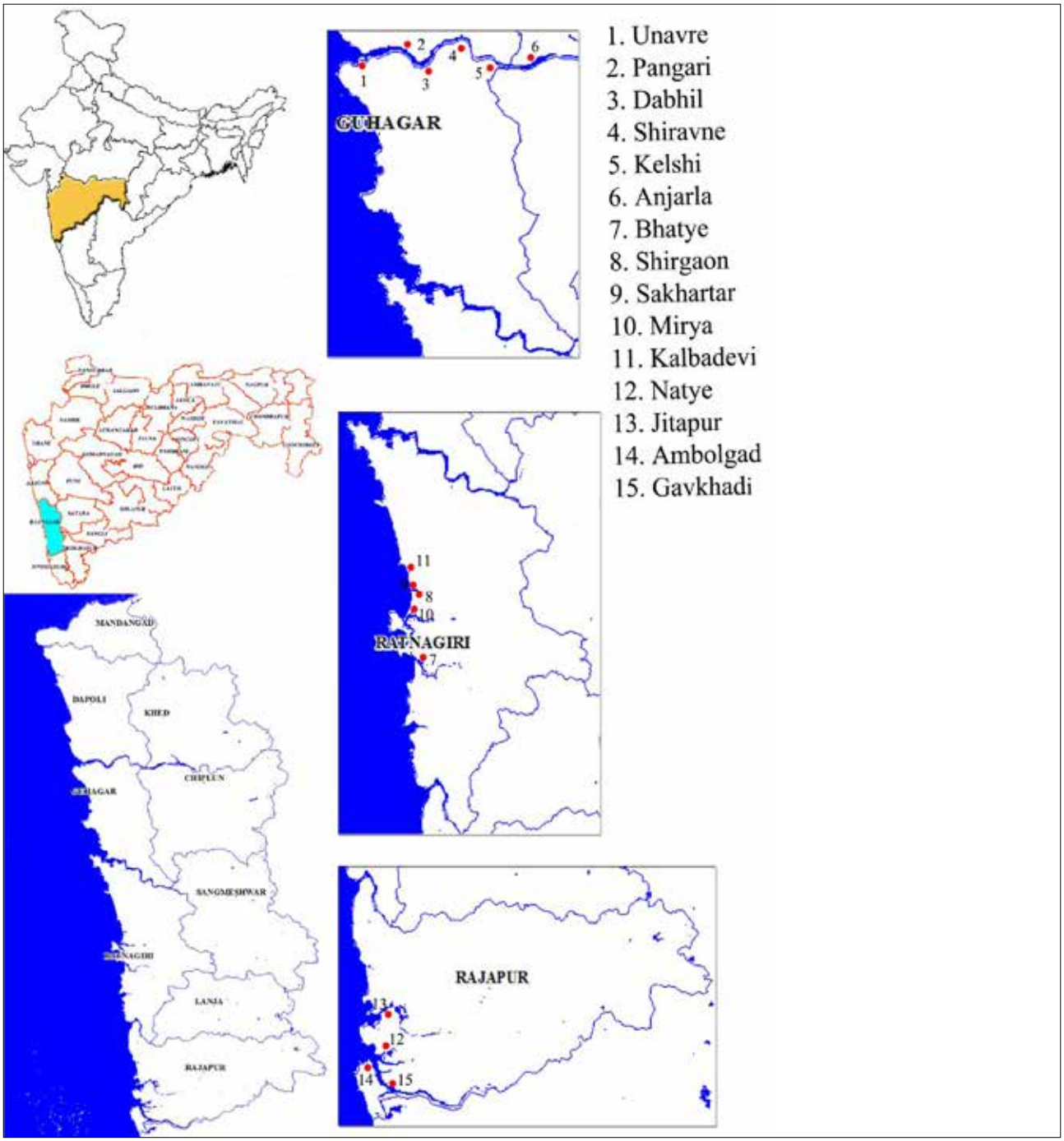

Fig. 1. Location of the study area.

Although more and more development professionals have come to realize the potential of IK, it remains a neglected field. Stake net fishery is one of the prominent traditional fisheries practiced along the estuarine villages of Ratnagiri. It is popularly termed as wan fishery in the district and the sites where the stake nets are fixed are traditionally owned by a family of fisherman in a village. Stake nets target the brackish water fishes native in estuarine environment which are an important source of fish protein during lean season. The fishery is practiced by a group of fishermen in a village. These fishermen mostly harbor valuable indigenous knowledge which they put to use in managing the fishery. Exploring this knowledge will generate useful database and focus on the essential research needs. Similarly the knowledge will be helpful in information, assessment and management of the fishery in the region. In the above context the present study was conducted to study the indigenous knowledge of fishers engaged in wan fishery and analyze the rationale behind its use.

Material and methods

The study was carried out in Ratnagiri district of Maharshtra (Fig. 1). Ratnagiri district is endowed with 167 km of coastline. The selection of the study was based on purposive sampling. Major portion of total fish landings of the district is contributed by marine sector. The total fisher population of Ratnagiri district is 25243 while rural estuarine fisher population is about 1328 (Anon, 2003).

The stake net (*wan*) fishery is practiced popularly by a group of seven fishers in the fishing villages dotting the estuaries along the coast of Ratnagiri. 15 fishing villages *viz*., Bhatye, Shirgaon, Sakhartar, Mirya, Kalbadevi, Natye, Jaitapur, Ambolgad, Gavkhadi, Unavre, Pangari, Dabhil, Shiravne, Kelshi and Anjarla situated along the coast of the district were selected randomly for the purpose of collecting data for the study. A total of 100 fishers were interviewed for the study with the help of semi-structured interview schedule designed by incorporating all the items on which the information was required. 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, 1987). Snow-ball method is non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances. It is a useful tool for building network and increasing the number of participants (Goode and Hatt, 1952). Information gathered from the fishers was quantified as percentage of interviewees the mentioned a given answer to asked questions. The majority of respondents/participants often mentioned answers to particular question were considered as reflecting aspects of indigenous knowledge. The findings of the study were also supported by non-participant observation and documentary evidences. PIC (Prior Informed Consent) was taken from the fishermen (about 100) with their names, village names and ages.

Results and discussion

Profile of respondents

The profile characteristics of respondents are given in Table 1. Age-wise distribution of respondents shows that majority (96%) belong to the middle age category followed by 1 and 3 percent in old and young categories, respectively. This reveals that as the fishing is labor intensive elderly persons are not actively involved. Similarly younger generation seems less interested in the fishery and are employed elsewhere. Over half the total number of respondents (56%) had a formal schooling up to primary level, followed by 17% fishers who were educated up to high school, were able to read and write and 10% were able to read only. Majority of the fishermen had better access to schooling in the respective villages. Majority of respondents were Hindus belonging to different sub castes such as *Bhandari* (46%), *Bhoi* (38%), *Kunbi* (6%) and *Maratha* (3%). Seven percent of fishers were Muslims. Indigenous knowledge is rooted in local culture and customs which in turn varies as per the community. It is evident from the data presented in Table 1 that 45% of the respondents were having fishing experience between 11 to 20 years followed by 39% and 16% had experience up to 10 years and more than 20 years, respectively. Thus most of the fishermen were well experienced in using the indigenous knowledge related to the stake net fishery.

Dimensions of stake net

A stake net is a long wall like net consisting of a number of rectangular pieces of nettings joined together. The pieces of nettings are joined together by a very peculiar simple method.

Table 1. Profile characteristics of respondents (n=100)

Sl. No.	Profile characteristics	Categories	Respondents	
			Frequency	Percentage
1.	Age	Young (up to 30 years)	01	01.00
		Middle age (31 to 50 years)	96	96.00
		Old (more than 50 years)	03	03.00
2.	Education	Illiterate	-	-
		Read only	17	17.00
		Read and write	10	10.00
		Primary school	56	56.00
		High school	17	17.00
		College	-	-
3.	Community	Bhandari	46	46.00
		Muslim	07	07.00
		Bhoi	38	38.00
		Kunbi	06	06.00
		Maratha	03	03.00
4.	Experience in fishing	Up to 10 years	39	39.00
		11 to 20 years	45	45
		More than 20 years	16	16

The ends of two nettings are kept on each other in such a way that an entire column of meshes of one netting lie superimposed on the entire column of meshes of the other netting. A nylon rope of about half centimeter width and slightly longer than the height of the nettings is passed through the superimposed meshes in a zig-zag manner. The ends of the rope are tied to the net by a knot. The data in Table 2 presents the dimensions of stake nets operated by the fishermen. A cursory look at the Table 2 reveals that majority of the fishermen of Ratnagiri district (79%) use pieces of netting (6 -7 ft x 15-20 ft) joined together to form entire stake net. About 15 such pieces of total length of 225 feet (34%), 20 pieces of total length 300 feet (26%) followed by 25 pieces of total length 375 feet (19%) are used in a stake net fishery. Similarly 21% fishermen use pieces of nettings (10-12 ft x 20-22 ft) joined together to form stake net. In this case also 15 pieces of total length 330 feet (10%), 20 pieces of total length 440 feet (6%) and 25 pieces of total length 550 feet (5%) are used in stake net fishery. The dimensions of single piece of netting and the length of entire stake net depend upon the extent of intertidal area exposed during the low tide and presence of suitable sites known as *doh/tas/khajan*. If more area is exposed during low tide and if it consists more than two *doh*/*tas*/*khajan* sites the dimension and length of netting will be increased accordingly. The height of the single piece of netting is so decided based on the fact that when the net is erected during low tide about two-third net should be submerged in the water.

Mesh size of stake net: In the present study it was found that invariably all the fishermen (100%) use a mesh size of 3-4 cm for the entire length of stake net. The particular mesh size is uniform in all the stake nets sampled in the present study. It is evolved over years of experience and experimentation by the fishermen and assumed to catch all the fish trapped by the stake net.

Table 2. Dimensions of stake net (n=100)

	Dimensions of stake net	Frequency	Percentage
1	Height 6-7 feet and width 15-20 feet per piece of netting	79	79.00
i	15 pieces (total length 225 feet)	34	34.00
ii	20 pieces (total length 300 feet)	26	26.00
iii	25 pieces (total length 375 feet)	19	19.00
2	Height 10-12 feet and width 20-22 feet per pieces of netting	21	21.00
i	15 pieces (total length 330 feet)	10	10.00
ii	20 pieces (total length 440 feet)	06	06.00
iii	25 pieces (total length 550 feet)	05	05.00

Table 3. Indigenous methods of fish exploitation

Gear used for harvesting	Frequency	Percentage
Pag	40	40.00
Shisha	30	30.00
Zile	30	30.00

Maintenance of nettings: The maintenance of stake net is invariably carried out by replacing the torn part of the net with new one by stitching. To ensure the durability, washing and drying is regularly done after each operation. The pieces of nettings are removed one by one and are washed properly in creek water (97%). The nettings are removed by untying the knot of the rope which holds them together. These nettings are washed in the adjacent creek water to remove adhering dirt and extraneous material and are thereafter dried. A few fishermen (3%) carry the entire stake net to their home, and wash the nettings with fresh water before drying. Less dirt and extraneous material are adhered to the stake nets which are operated slightly near to the seashore rather than estuarine/mangrove intertidal area. Such nets are carried to the home and washed with freshwater after removing the pieces of nettings (Fig. 2a, 2b and 2c).

Number of stakes used in *wan*: Almost all fishers (100%) in Ratnagiri district use 4-5 stakes of 10-15 feet height per piece of netting. 100-130 (66%) such stakes are used in entire stake net followed by 140 -160 stakes (20%) and 30-40 stakes used in stake net (14%). The height of the stakes is so decided that it withstands the force of receding water after being driven into the bottom while sufficient numbers are used to keep the net erect in upright position.

Material used for the stakes: Mangroves (*Avicenia marina*) are used for making the stakes used in the stake net fishery. This particular mangrove species is abundantly found in the mangroves of Ratnagiri district (Naskar and Mandal, 1999). Stakes of suitable length can be made out of this variety. As opined by the fishermen, mangroves are salt tolerant and the stakes made out of them are more durable.

Preferred nature of bottom of stake fixing: The stakes are driven into the muddy bottom in the intertidal region. The stakes are manually fixed 1-2 feet deep into the bottom by hand. The muddy bottom in the intertidal region is preferred which facilitates the driving of stakes manually by hand.

Maintenance of stake: Almost all fishers replace the damaged, bent or broken stake with new one as and when required. The damaged, bent or broken stakes can be conveniently replaced by new ones as the stakes are made out easily from the local mangrove variety.

Site selection for *wan* operation: The areas characterized by the presence of two to three 1-2 feet deep, 3-20 ft wide water

Fig. 2(a). Removing the stake net, (b) Separating the pieces of net (c) Washing the net

channels wherein water is retained during the lowest low tide are selected for stake net operation by the fishers. When water from intertidal area has receded after low tide they form the potential sites where the water level is maintained. Obviously the fishes which move in with the tidal currents are trapped in these channels once the net is erected and are harvested using suitable gears when the intertidal area gets exposed. *Doh* or

Fig.3. Doh/Khajan/Tas

khajan or *tas* thus play an important role in selecting the sites for stake net operation (Fig. 3).

Ownership of *wan* fishing ground: Stake net fishing grounds are traditionally or historically owned by a particular fishermen family in villages situated on the banks of estuary. The ownership of fishing grounds is non-negotiable and is based on mutual tacit understanding among the fishermen. The resource allocation however is not legally recognized in most cases. The fishing grounds are identified with the help of certain landmarks such as presence of mosques, cremation grounds, bridges, etc present near the vicinity. On an average about ten such fishing grounds are present in each of the sampled villages.

Number of fishermen involved in *wan* fishery: In the present study it is found that a total of 5-6 fishermen are involved in operation of each stake net. Stake net operation involves various stepwise activities. The number of fishermen should be sufficient enough to carry out these activities. The members belong either to the same fishermen family (62%) or are hired for stake net operation (38%). If fishermen are hired for the job they are given suitable remuneration or a part of the catch.

Stake net operation: The entire stake net operation is quite labor intensive. At first a small channel is dug with the hand along the entire stretch on which stake net is to be erected during low tide. The pieces of nettings are joined together as described elsewhere and one side of the stake net is laid lengthwise on the channel. The stakes are driven into the muddy bottom of this channel through meshes of the net which pushes the net along with it in the channel. The channel is then filled with mud. Stones already kept nearby are sparsely placed on the side of the stake net at a particular distance from each other. Stones are also kept along the other side of the net in front of each stake to avoid the net from being getting disturbed later during the progression of high tide. All these activities

are carried out during low tide. During the start of high tide stones are placed densely close to each other on the buried part of the net. If in case more stones are required they are bought from the vicinity. The stake net is laid on the bottom throughout the progression of high tide. When the water starts receding during the start of low tide the stake net is erected by a group of 2 - 3 fishermen. The net is lifted from one end by hand by removing the stone, held upright and tied to the stake with a piece of rope. The process is repeated till the entire net is erected and fixed to the stakes. The entire net is fixed to the stakes usually at height of about one to one and half feet less than original height of the nettings. This is done to slacken the net to a certain limit. Two - three hours are required to erect the net. Care is taken to ensure that a single piece of netting faces the *doh* or *khajan* or *tas*. Net is kept erected till the end of low tide. Finally fishes are collected from *Doh* or *Khajan* or *Tas* with the help of suitable gear. It is evident from the entire operation that fishers by experience and experimentation have evolved a perfect stepwise method to drive the stakes and set the net on the ground, to keep intact the net during high tide progression, to erect and tie the net to the stakes (Fig. 4a and 4b).

Preference of timing for fishing: About 80% of fishers reported that *wan* fishing is carried out during early morning (2 am - 7 am) coinciding with the favorable tides where as 20% fishermen who prefer to carry out the operation during evening (4 pm- 9 pm). The stake net operation is tide dependant. Fishers through their intricate association with the environment know the availability of fishes during different phases of the day coinciding with favorable tide. By their observation they have noted relatively higher catches when the *wan* is operated during early morning or late evening. According to Nomura (1958) many fish species are active during the twilight of morning and evening. To corroborate the observation of the fishermen further scientific investigations are required.

Frequency of *wan* operation in a day: Invariably all fishers operate *wan* only once in a day. As noted elsewhere the entire stake net operation is quite labor intensive and lengthy, it is carried out only once in a day.

Catch composition and seasonal abundance: The catch obtained in *wan* fishery comprises of catfishes (*shingti),* sardine (*tarli*), *Hyporhamphus* spp. (*tole*), dhoma, mullets (*boyare*), mud crabs, *Scylla serrata* (*khekda*), shrimps (*kolambi*), lady fishes, *Sillago sihama* (*Renvey*), *Lethrinus* spp. (*Palu*), snappers (*tamboshi*), *Siganus* spp. (*mutri*), *Gerres* spp. (*shetki*) and *Etroplus suratensis* (*kalundri*). The observation of the fishermen on catch composition is evidenced by scientific reporting and most of the above fishes are found in estuaries are known to enter the estuaries (Zhingran, 1978; Bal and Rao, 1990; Kurian and Sebastian, 1993; De, 2011; Talwar and Kacker, 2013). De (2011) has reported that most of the finfishes and shrimps reported above are available almost throughout the year in the estuaries of Karnataka. The total catch comprising of above species is reported to be low during summer, medium during winter and high during monsoon by all the fishers. Zhingran (1978) reported that fisheries in the estuaries of Nethravati along southwest coast are important during southwest monsoon. The primary productivity, nutrient content and plankton productivity in estuaries is reported to be high during southwest monsoon. The planktivorous fishes may therefore are abundantly found during monsoon. The catch is reported to be high during monsoon by the fishermen may also be related to the fact that the sheer volume of water filtered through the stake net during monsoon is comparatively much more thereby bringing in more fish. Total ingress of finfish and shrimps may be more during high tides in monsoon resulting in more catches (Krishna Kumari *et al.,* 2002).

Fig.4(a). Laying of net on the bottom during low tide (b). Erecting the stake net

Species wise seasonal abundance: Multiple views are expressed by fishers on the Indigenous knowledge (IK) related to species wise seasonal abundance. For the sake of convenience in interpretation, responses from fishermen accounting for 50% and more are only presented in this section. The catch of mullets is reported to be moderate (79%) in summer and high in winter (94%). Majority of fishers (97%) reported high catch of mullets (30-40 kg) in monsoon, 15-20 kg in winter and 8-10 kg in summer. 3% of fishermen reported low catch of catfishes in summer. The catch of catfishes is stated to be moderate (77%) during winter and high (97%) during monsoon and low during summer (59%). The catch of shrimp is reported to be low during summer and winter by 64% and 61% of the fishers respectively. The mud crabs is found in low quantity (52%) in summer while 58% fishers noted high catch during monsoon. The catch of *tole*, *Hyporhamphus* spp. is reported to be moderate during winter (50%) and high during monsoon (62%). *Renvi* is caught in low quantities during summer (56%) and the catch is high during monsoon (50%). The catch of *Paalu*, *Lethrinus* spp. is higher during monsoon (63%). While the catch of snapper, *tamboshi* is also reported to be high during monsoon by 50% of respondents. As stated elsewhere fishermen by virtue of their close association with the environment and regular observation of the catch over the years have got intricate knowledge on the season wise availability of the various species to the stake net. The empirical observation of fishers however requires further scientific studies.

Indigenous method of fish exploitation: Basically three types of indigenous gears are used to exploit the entrapped fish in stake net fishery *viz.*, *Pag, Shisha* and *Zile. Pag* is made up of one-two ft long conical netting of mesh size 2-3 cm. This netting is attached to circular metal frame of 1-2 ft diameter. The metal frame is bent into a circular shape and approximately two feet of frame projects straight outwards. This projected part is inserted into a bamboo pole of about 3 ft long (Fig. 5a). *Shisha* comprises of fine meshed netting about two ft long attached to a wooden frame of about 4 ft diameter (Fig. 5b). *Zile* is a rectangular shaped net of approximately 2 x 4 ft with having mesh size of 3 - 4 cm. Two bamboo poles are attached to the two shorter sides of the net (Fig. 5c). The *zile* is dragged forward in the *doh* with the help of one hand while other hand is used to hold the netting at the crossed side so that fish do not escape through the net. All these gears are used to collect the entrapped fishes in the channels during low tide. The gears are simple in design, easy to operate in the channels and convenient to collect the fishes. The added advantage of *zile* is that the gear can be folded and carried easily. The design of most of the gears in traditional fisheries is standardized after years of trial and error by the fishermen (Nirmale *et al.*, 2007; Nirmale *et al.*, 2012; Gangan *et al.*, 2013)

Fish storage: Fishers make use of indigenous gear locally known as *zaabli* for fish storage before its marketing or further disposal. *Zaabli* is trapezoidal in shape with a mesh size of 1 - 2 cm. A small rope is attached at the top end which passes through meshes in a zig- zag way and forms a purse when the meshes are pulled closer (Fig. 6). The storage capacity of *zaabli* is around 10-12 kg. The fishes are stored

Fig.5(a). *Pag* (b). *Shisha* (c) *Zile*

in *zaabli* and carried to home. *Zaabli* is simple in design and easy to operate.

Effect of lunar cycle on *wan* fishery: The rising and ebbing tides in intertidal area ensures the success of stake net operation. The operation of the stake net is subject to tidal amplitude and makes exclusive use of tidal energy. Lunar cycle which dictates the tides play a major role in its operation. Invariably all the fishermen have uniform view on the effect of lunar cycle on the stake net fishery. Accordingly fishermen have reported that the stake net operation is carried out during 9th day (*navmi*) to 3rd day (*tritiya*) of lunar cycle. Further they have also stated that more catch is obtained in stake nets during new moon day and full moon day. During 9th day (*navmi*) to 3rd day (*tritiya*) of lunar cycle including spring tides notable water force is

Fig. 6. *zaabli*

seen. Similarly the difference between high and low tide is considerable during these days. In fact, the stake fishery is operational only during these days. During the remaining days of lunar cycle very less force to water is noted and tides generate very slow currents. More catch is obtained in stake net during new moon day and full moon day is related to the fact that during this period, the pull of the sun on the water is in the same line as that of moon. Thus the effect is combined causing unusually high tides bringing in more fish. The effect of lunar cycle in *dol* net fishery and bivalve fishery has been earlier reported wherein the lunar cycle wields similar kind of influence (Nirmale *et al.*, 2007; Nirmale *et al.*, 2012; Gangan *et al.*, 2013).

Observance of closed season: Respondents reported that they do not follow closed season in *wan* fishery. The stake net fishery though influenced by lunar cycle, monsoon and other weather conditions is operational throughout the year.

The present study has generated important database related to the use of indigenous knowledge in *wan* fishery in the district. The knowledge pertaining to the selection of fishing ground, *wan* operation, species composition and seasonal abundance, effect of lunar cycle on the fishery, the allocation of resources, etc. will be helpful in designing appropriate management intervention. Scientific studies on catch composition and seasonal abundance in the stake net fishery will be helpful in devising optimum mesh size for stake net and can suggest replacing the use of stakes with ecofriendly and durable poles.

References

Anon, 2003. *Marine Fishermen Population Census,* (Maharashtra State, India), p. 30-32.

Bailey, K. D. 1987. Document Study. In : K. D. Bailey, (Ed). *Methods of Social Research*, New York, The Free Press. p. 293-319.

Bal, D. V. and K. V. Rao. 1990. *Marine Fisheries of India*. The Tata McGraw-Hill Publishing Company Limited, New Delhi., 471 pp.

Berkes, F., R. Mahon, R. Pollnac and R. Pomeroy. 2001. *Managing Small-Scale Fisheries: Alternative Directions and Metods*. Ottawa, Canada, IDRC Press. 310 pp.

De, P. K. 2011. *Handbook of fisheries and aquaculture*. Indian Council of Agricultural Research. New Delhi, p. 208-237

Gangan, S. S., S. Y. Metar, V. H. Nirmale, N. D. Chogale, A. K. Balange, M. S. Bhalekar and R. Pai. 2013. Indigenous knowledge in the management of Bivalve Fishery of South Konkan coast of Maharashtra, India. *Indian J. Trad. know.,*12(1): 72-79.

Goode, W. J. and P. K. Hatt. 1952. Methods of Social Research, McGraw Hill, New York, p. 23-25.

Johannes, R. E. 1981. *Word of the Lagoon: Fishing and Marine Lore in the Palau Distric*t of Micronesia. University of California Press, Berkeley, 320 pp.

Krishna Kumari, L., P. M. A. Bhattathiri, S. G. P. Matondkar and J. John. 2002. Primary productivity in Madovi-Zuaria estuary in Goa. *J. Mar. Biol. Ass. India*, 44 (1&2): 1-13.

Kurian, C. V. and V. O. Sebastian. 1993. *Prawn and prawn fisheries of India*. Hindustan Publishing Corporation, p. 105-201.

McGoodwin, J. R. 1984. Some examples of self-regulatory mechanisms in unmanaged fisheries. FAO Fisheries Report 289, Supplement 2: 41-61, Rome, FAO.

Naskar, K. and R. Mandal. 1999. *Ecology and biodiversity of Indian Mangroves*. Daya Publishing house, Part I and II. p. 10-120.

Nirmale, V. H., B. S. Sontakki, R. S. Biradar, S. Y. Metar and S. L. Charatkar. 2007. Use of indigenous knowledge by coastal fishery folk of Mumbai district in Maharashtra. CIFE, Varsova, Andheri West, Mumbai. *Indian J. Trad. Know.,* 6(2): 378-382.

Nirmale, V. H., S. S. Gangan, B. M. Yadav, P. Durgale and K. M. Shinde. 2012. Traditional knowledge on Mud Crab; Ethno ecology of *Scylla serrata* in Ratngiri coast. *Indian J. Trad. Know.,*11(2): 317-322.

Nomura, M. 1958. Some knowledge on behavior of fish school. Symp. Pap. 8th Sess. IPFC/C58/ Sym. 23, 2pp.

Odhiambo, T. 1990. You can fix indigenous knowledge, 6(1): 3-5, ILEIA, The Netherlands.

Pauly, D. 2006. Major Trends in Small-Scale Marine Fisheries, with Emphasis on Developing Countries, and Some Implications for the Social Sciences. *Maritime Stud., (MAST),* 4(2):7-22.

Ruddle, K. 1991. The Transmission of Traditional Ecological Knowledge. Paper presented at the Second International Conference of the Association for the study of Common Property, University of Manitoba, Winnipeg.

Stevenson, M. C. 1996. Indegenous Knowledge in Environmental Assessment. *Arctic,* 49(3): 278-291.

Talwar, P. K. and R. K. Kacker. 2013. *Commercial sea fishes of India*. Hindustan Publication Corporation of India Delhi. p. 44-120.

von Brandt, A. 1972. *Fish catching method of the world,* Fishing News (books) Ltd. West Byfleet, UK, p. 280-285.

Warren, D. M. and Rajshekaran, 1993. Putting local knowledge's to good use. International Agricultural Development, 13(4): 8-10.

Worsely, P. 1971. Knowledge: What Different Peoples Make of the World, (Profile Books, London), 65 pp.

Zeller, D., S. Booth and D. Pauly. 2007. Fisheries Contribution to the Gross Domestic Product: Underestimating Small-Scale Fisheries in the Pacific. *Mar. Resour. Econ.*, 21:355-374.

Zhingran, V. G. 1978. *Fish and Fisheries of India,* Hindustan Publishing Corporation of India, New Delhi, 853 pp.