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Ethnoecology of Indian sand whiting, *Sillago sihama* (Forsskal, 1775) from South Konkan coast (Arabian Sea: Northwest coast) of India

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Original Article

Abstract

Ethnoecology is the cross-cultural study of how people perceive and manipulate their environments. Investigations were carried out to collect and document the local ecological knowledge on *Sillago sihama* and compare the local knowledge on biology with biological studies and published literature. A total of 100 fishers from Ratnagiri and Sindhudurg districts constituted the sample size of the study. The ethnoecological knowledge on the local name and identification of *S. sihama,* its habitat and fishery season, size at first maturity, food and feeding, and the spawning season was collected. Similarly, the local knowledge of the effect of the lunar cycle and wind direction on the availability of *S. sihama* has also been documented. The views of fishers on feeding habits, size at first maturity, and spawning season of *S. sihama* were compared with biological studies and published literature. Mann -Whitney U-test showed agreement between ethnoecology, biological studies, and published literature.

Keywords: *Ethnoecology, biological studies, comparative studies, South Konkan Coast*

Introduction

Brackish water fisheries in the south Konkan coast of Maharashtra essentially constitute small-scale tropical fisheries. The fisheries are critically important for food security, and sustainable livelihoods their catch comprising several important fish species is often consumed directly by their household or community or sold in local markets. Small-scale fisheries are often overlooked in national statistics and policies (Harper *et al.*, 2013, Tilley *et al.*, 2020). In India, brackish water fisheries are data deficient and are faced with competition for resources, over-harvesting, pollution, environmental degradation, and rapid development. No organized data on the production of an important group of brackishwater fishes is available at present. The lack of data poses a hindrance to the effective assessment of resources based on conventional catch-and-effort data. Fishing activities are developed and adapted based on local knowledge to reflect local realities, including aspects such as location, seasonality, edible parts, methods of collection, preparation, and preservation (Arthur *et al.*, 2022). Small-scale fisheries are also often able to react to the availability of particular fish, often due to the seasonality of abundance of certain species. Being able to adjust their fishing approaches and target fish based on seasonality, local abundance, and local demands and employing a wide range of fishing gear is an important aspect of small-scale fisheries (Teh *et al.*, 2012; Finkbeiner, 2015). This degree of flexibility requires a high degree of local ecological and environmental knowledge (Arthur, 2020). This local ecological knowledge is a valuable resource for development and under certain circumstances, it can be equal to or even superior to the know-how introduced by modern research. Those dependent on the small-scale fisheries sector may be empowered to participate in decision-making with dignity and respect through integrated management of the social, economic, and ecological systems underpinning the sector. Local ecological knowledge also referred to by conceptually similar terms such as local knowledge, traditional ecological knowledge, ethnology, ethnoscience, ethnoecology, and fishers' knowledge (Ruddle, 1991) can play an important role in this regard. Depending on the scope of the study the term ethnoecology is used in the present study. Ethnoecology is the cross-cultural study of how people perceive and manipulate their environments and begins with the study of species identification and classification and proceeds to consideration of peoples' understanding of ecological processes and their relationship with the environment (Berkes, 1999). The knowledge of ecology and fish behaviour (Johannes, 1981; Begossi, 2008). weather and oceanographic conditions, navigation (Worsely, 1971), fishing methods (Von Brandt, 1972), vessel design and propulsion, processing, and trade have been effectively used by the fishers to harness the local resources sustainably. Previous studies have analyzed relevant topics related to ethnoecology on the Brazilian and Mexico coast, such as fish reproduction (Silvano and Begossi, 2006), migration (Posey, 1981; Silvano and Begossi, 2005), ecology of endangered reef fish (Gerhardinger *et al.*, 2009) and nature and resource (Teran and Rasmussen, 1994; Faust, 1998; Dunning and Beach, 2004). Some of these surveys addressed both ethnoecology and biological studies of coastal fishes (Menezes and Figueiredo, 1980; Rainboth, 1996; Begossi and Silvano, 2008; Silvano and Begossi, 2010). The economy of the South Konkan region is based on rice farming, mango cultivation, cashew farming, fishing, and tourism. Several estuaries present along the coast support brackishwater fisheries. Fishes belonging to the family Sillaginidae are commonly known as ladyfish and/or sand whitings. Eight species of sand whitings are reported from India, *viz.*, *Sillago sihama*, *S. vincenti*, *S. parvisquamis*, *S. macrooolepis*, *S. argentifasciata*, *S. maculate*, *S. chandropus* and *S. panijus* (McKay, 1976; Dutt and Sujatha, 1980). Of these, the Indian sand whiting, *S. sihama* occurs commonly in the coastal waters of Ratnagiri (Sawant *et al.*, 2017). It is one of the highly-priced fishes in the coastal region of Maharashtra. *S. sihama* widely distributed throughout the tropical and subtropical waters in the western central Pacific and Indian oceans (McKay, 1999) inhabits sandy and muddy substrates in inshore areas (Satapoomin, 2005). There are no published reports on the present status of exploitation of *S. sihama* along the south Konkan coast of Maharashtra. In the present study, a comparison between ethnoecological knowledge of the biology of *S. sihama* with biological studies carried out in the laboratory and published literature has been attempted. The study would potentially enhance the biological database about *S. sihama* and would show fishery scientists some ways in which the local fishers' knowledge can be useful in addressing the management of the species in the region.

Material and methods

The study was carried out on the south Konkan coast of Maharashtra (Fig. 1). South Konkan coast of Maharashtra is flanked on the western side by the Arabian Sea and Sahyadri Ghats on the eastern side is comprised of Ratnagiri and Sindhudurg districts with a coastline of 288 km. A major portion of the total fish landings of the district is contributed by the marine sector. The total fisher population of Ratnagiri and Sindhudurg district is 99863 while the rural estuarine fisher population is about 18286 (Anon, 2015). Twenty-six fishing villages *viz.*, Bhatye, Shirgaon, Sakhartar, Mirya, Kalbadevi, Natye, Jaitapur, Ambolgad, Gavkhadi, Unavre, Pangari, Dabhil, Shiravne, Kelshi, Anjarla, Vijaydurg, Devgad, Achara, Malvan, Sarjekot, Vengurla, Sagawe, Shirse, Tarkarli, Devbag and Nivati situated along the important estuaries of south Konkan coast were randomly selected to collect ethnoecological data. A total of 100 fishers were interviewed with the help of a semi-structured interview schedule designed by incorporating all the items on which the information was required. The respondents were selected using the snowball method in which people from the community and the interviewees themselves indicate the people to be interviewed (Bailey, 1994). It is a useful tool for building a network and increasing the number of participants (Goode and Hatt, 1952). Information gathered from the fishers was quantified as the percentage of interviewees who mentioned a given answer to the asked questions. The majority of respondents' often mentioned answers to a particular question were considered as reflecting aspects of ethnoecology. The findings of the study were also supported by non-participant observation and documentary evidence. Similarly, ethnobiological studies were corroborated by biological studies carried out in the laboratory.

For carrying out the biological studies the specimens of *S. sihama* were collected from Harnai, Ratnagiri, Purngad, Vijaydurg, Malvan and Vengurla landing centres at monthly intervals. The catch from the adjacent coastal or estuarine fishing villages is brought to these landing centres for disposal. The samples were collected for a period of one year from October 2018 to September 2019. The present investigation

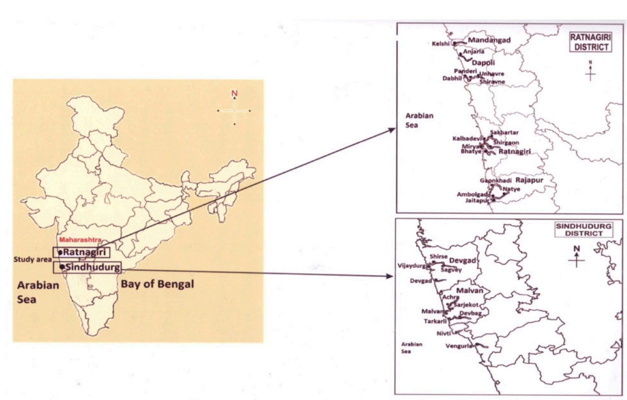

Fig. 1. Location of the study area

is based on the study of 590 specimens ranging in size from 89–282 mm total length (TL) comprising 246 males, 313 females, and 31 indeterminants. Stomach contents were analyzed by using the Point (volumetric) method (Hyslop, 1980). The fish were dissected to identify the sex and stage of maturity. For calculating the gonado-somatic index, the weight of the individual fish was noted. The gonads were removed carefully and weighed on an electronic balance after removing the excess moisture using blotting paper. Maturity stages of *S. sihama* were classified as per (Shamsan, 2008). The stages were I) Immature, II) Maturing, III) Mature, IV) Ripe, and V) Spent. Most popular views held by fishers on the biology of *S. sihama* were chosen for comparison with biological studies and published data. The statistical analysis was done by Mann-Whitney U test using SAS version 9.3 software.

Results and discussion

Ethnoecological knowledge on identification, food, feeding habits, size at first maturity, fishery season, and spawning season of *S. sihama* was compared with laboratory observations and published literature. The results are discussed accordingly. However, ethnoecology on habitat, the effect of the lunar cycle, and wind direction on the availability of *S. sihama* is compared only with published information as verification of the fishers' views requires scientific field surveys for a considerable period and was out of scope in the present investigation. The *S. sihama* is fished along the estuaries dotting the south Konkan coast. Fishers identify *S. sihama* based on its morphological characteristics particularly coloration, shape of the body, and type of dentition (Table 1). *S. sihama is* known as *renvi* in the vernacular language. As per fishers, *S. sihama* is characterized by an elongated body (*laamb*), silvery colouration (*chandi*), and sharp teeth in the mouth (*tokdar daat*). The samples of *S. sihama* were brought to the laboratory and identified using classical taxonomic keys (Fischer and Bianchi, 1984; Talwar and Kacker, 1984) with the help of various identifying characters including those told by fishers. The categories used by fishers to identify and classify fish are based on standards related to their morphology, habitat, importance in commerce and the kind of fishery (Pinto *et al.,* 2013). Many of these identifying characters/criteria are also found in guides and taxonomic identification keys (Figueiredo and Menezes, 1980; Fischer and Bianchi, 1984; Talwar and Kacker, 1984; Lessa and Nobrega, 2000; Alves and Souto, 2010; Lopes *et al.,* 2010). The local name assigned to *S. sihama* by the fishers indicates a generic monotypic arrangement. According to (Berlin, 1992), the generic taxonomy may be arranged in two ways; generic monotypic, when the generic does not possess a lower category, and generic polytypic, when it is divided in a specific way. Further under-differentiation type–I correspondence as proposed by (Berlin, 1992) is noted in the present study as folk generic taxa refer to two or more species of one genus. As the criterion adopted by the fishers to identify species is based on coloration, shape, and teeth pattern it is likely that more than one species belonging to a genera or family are accorded the same local names. However, for collecting ethnoecology on the particular species, the coloured photograph of *S. sihama* was downloaded from Fish Base (Froese and Pauly, 2004) and shown to fishers to confirm the selected species.

Fishers have expressed their views on the habitat of *S. sihama* concerning the type of estuarine bottom (Table 2). They opined that *S. sihama* inhabits estuaries having mostly muddy to sandy substrates. The sillaginids are known to enter the estuaries (Roland, 1992; De, 2011). Fishers have ecological knowledge of the availability of particular species in a specific habitat (Gangan *et al.*, 2013). This knowledge is tacitly employed by fishers to exploit resources available in a particular habitat using suitable gear. However detailed investigation on the availability of *S. sihama* on a particular substrate or bottom needs to be carried out.

Almost all fishers reported that the *S. sihama* is fished throughout the year using different gears (Table 3). They further stated that the abundance of the fish may vary during the year. In the present study, the specimens of *S. sihama* were available throughout the year and were brought to the laboratory at regular intervals for biological studies. *Sillago sihama* is reported to be available throughout the year in the estuaries of Karnataka (De, 2011). The catch of *S. sihama* in stake net fishery in more or less quantity is found

Table 1. Ethnoecology on identification of *S. sihama*

Species	Local name	Identification by fishers	Frequency
S. sihama	*Renvi*	Elongated body (*lamb*). Bodysilvery in colour (*chandi*). Mouth having sharp teeth. (*tokdar daat)*	100

Table 2. Ethnoecology on the habitat of *S. sihama*

Species	Local name	Identification by fishers	Frequency
S. sihama	*Renvi*	The fish are available inestuaries mostly on muddy to sandy waters	100

Table 3. Ethnoecology on fishery season of *S. sihama*

Species	Local name	Identification by fishers	Frequency
S. sihama	*Renvi*	Throughout the year (*varshbhar/baramahine*)	100

Table 4. Ethnoecology on food and feeding

Species	Local name	Food and Feeding		Frequency	NR*
		Feeding habit	Food items		
S. sihama	*Renvi*	*maunsahar* (Carnivore)	*Chote kide,alya*	92 (92.00)	08 (08.00)

* NR Not responded

Table 5. Average percentage composition of food items in the stomach of *S. sihama*

Food items	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Av.
Crustaceans	39.81	38.58	32.14	32.01	15.36	19.00	18.12	20.23	20.12	19.00	45.63	31.45	27.72
Polychaetes	0.00	0.00	3.70	4.16	19.32	21.18	15.80	0.00	0.00	13.00	0.00	0.00	6.43
Fish remains	14.47	6.45	11.58	18.20	16.36	0.00	19.30	20.55	27.06	15.00	18.67	11.76	14.95
Sand	0.00	6.89	8.70	8.31	17.18	18.66	15.86	19.69	14.45	15.00	0.00	11.76	11.38
Semi-digestedmatter	18.45	21.15	23.33	12.50	15.63	20.50	16.51	19.38	19.24	18.00	15.12	21.62	18.45
Digested matter	27.27	26.93	20.55	24.82	16.15	20.66	14.41	20.15	19.13	20.00	20.58	23.41	18.24

Table 6. Ethnoecology on the spawning season of *S. sihama*

Species	Local name	Spawning season(*prajanan kaalawadhi*)	Frequency
S. sihama	*Renvi*	Aug-Dec	100

Table 7. Ethnoecology on the effect of the lunar cycle on the availability/abundance of *S. sihama*

Species	Day of lunar cycle	Gear	Effect	Frequency
S. sihama	*dwadashi* (12th day of lunar cycle) to *tritiya* (3rd day of lunar cycle)	*wan*, disco net, *pag*	Morecatch	100
	navmi (9th day of lunar cycle) to *ekadashi* (11th day of lunar cycle)		Moderatecatch	100
	amavasya (new moon day) and *pournima* (full moon day)		Morecatch	100

* NR Not responded

Table 8. Ethnoecology on size at first maturity of *S.sihama*

Species	Local name	Size at first maturity			NR*
		30-60gm	50-100gm	100-150gm	
S. sihama	*Renvi*	-	22 (22.00)	58 (58.00)	20 (20.00)

* NR Not responded

throughout the year (Uskelwar *et al.,* 2017). Fishers adjust fishing approaches and target fishes as per seasonality and abundance (Teh *et al.,* 2012; Finkbeiner, 2015).

All fishers reported that the *S. sihama* is a carnivorous (*maunsahari*) fish feeding mostly on *chote kide* (small insects) and *alya* (polycheates) (Table 4). In the present study, the gut content analysis showed that crustaceans, fish remains and polychaetes formed the major food items of *S. sihama* (Table 5). Crustaceans and polychaetes are empirically referred to as c*hote kide* (small insects) and alya (polychaetes) respectively by the fishers. Fishers' views on the carnivorous feeding habit of *S. sihama* are verified by the laboratory findings. However, the presence of fishes in the gut is not reported by fishes. The feeding habit of *S. sihama* reported by fishers contradicts few published reports (Rao and Sivani, 1996; Weerts *et al.*, 1997; Sawant *et al.*, 2017) claiming this species to be an omnivore while the views of fishers on food items of *S. sihama* agree with findings of Radhakrishnan, 1957;

Table 9. Scoring matrix of fishers' knowledge concerning laboratory observations and published data

No.	Domain	Fisher's view	Laboratory observations	Published literature
1.	Identification of species			
	a) Colour : reddish–1, silvery–2			
	b) Shape : elongated–3, moderately compressed–4 b) Teeth : small/sharp teeth–5			
	Colour	2	2	2
	Shape	4	4	4
	Teeth	5	5	5
2.	Fishery season			
	Throughout the year : 1	1	1	1
3.	Size at first maturity			
	a) 100-150 gms : 1	1	1	1
	b) 150-200 gms : 2			
4.	Spawning season			
	Feb to May : 1			
	Jun to Sept : 2			
	Aug to Feb : 3	3	3	3
5.	Feeding habit			
	Carnivore : 1			
	Omnivore : 2	1	2	2
6.	Food items			
	a) Crabs/fishes/shrimps and oysters: 1	2	2	2
	b) Crustaceans/polychaetes/fish remains : 2			

Table 10. Comparison of fishers' knowledge (F) with laboratory observations (L) and published literature (P) (Mann-Whitney U test; *P<0.05*)

Profile	P value
F:L	0.7944
F:P	0.4896
L:P	0.4028

Rao and Sivani, 1996; Gowda *et al*., 1988, Shamsan, 2008 and Sawant *et al*., 2017. However, apart from crustaceans and polychaetes, *S. sihama* has also been reported to feed on crustacean larvae, clams, prawns, amphipods, diatoms, fishes and molluscs (Radhakrishnan, 1957; Rao and Sivani, 1996; Weerts, 1997; Sawant *et al*., 2017). It can be surmised that the observations of fishers concerning noting the exact food items in the gut of fish have their limitations when compared to scientific reporting. They can identify only major food items visible in the gut while dressing the fish.

Fishers opined that the spawning season of *S. sihama* is from August to December (Table 6). Higher gonado somatic index was observed for females of *S. sihama* from August to January whereas higher values for males were noted from November to December (Fig. 2). Maturity studies indicated the occurrence of individuals with ripe gonads (Stage III and Stage IV) mostly during October to February (Fig. 3). From the findings it can be inferred that *S. sihama* has got a protracted spawning season in the region lasting from August to December. The views of the fishers on the spawning season of *S. sihama* agree with the laboratory findings. The spawning season of *S. sihama* is reported to be during November from the Gulf of Mannar based on GSI studies (Jayasanker, 1991). Mirzaei *et al.* (2013) reported that *S. sihama* spawns during March-May along the south coast of Iran. The spawning season is stated to be during June-August and December- January from Pulicat Lake based on GSI studies (Krishnamurthy, 1969). Shamsan and Ansari (2010) reported the occurrence of females in advanced stages of maturity from June to December indicating the spawning season of *S. sihama* along the coast of Goa. Based on maturity studies, Vinod and Basavraja (2013) stated that *S. sihama* is a continuous breeding with two breeding seasons one during May-June and the other during August-December. The spawning season was noted to be from September to January along the Ratnagiri coast (Sawant *et al.,* 2017). In the present study, the opinion of fishers on the spawning season of *S. sihama* from the south Konkan coast agrees with the findings of Krishnamurthy (1969), Vinod and Basavraja (2013), and Sawant *et al.* (2017). The variation in the spawning season of a fish could be attributed to spatial, environmental, and stock level differences (Bandkar *et al*., 2022).

Fishers often relate the size at first maturity of *S. sihama* to weight and more bulgy individuals for a given length or minimum average size at which fishes are seen with oozing eggs are assumed to be mature by the fishers. Most of the fishers opined that *S. sihama* matures for the first time when it weighs around 100-150 gms (Table 8). The size at first maturity was estimated to be 166 mm in the laboratory corresponding to about 125 gm weight (Fig. 4). The views of fishers on the maturity of *S. sihama* are validated by the laboratory findings.

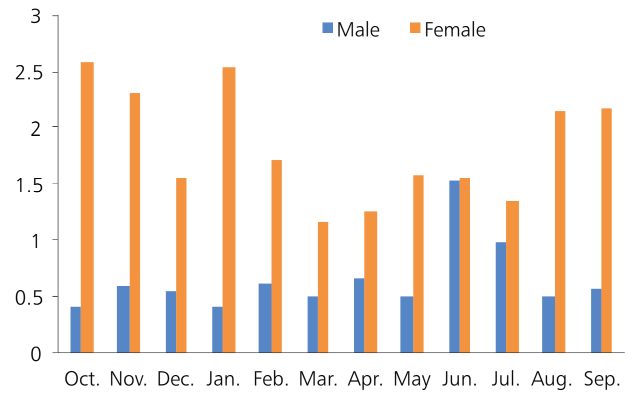

Fig. 2. Monthly GSI values for males and females of *S. sihama*

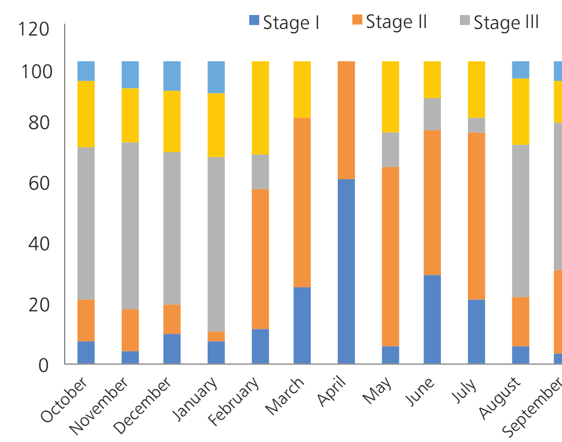

Fig. 3. Monthly variation in maturity stages (%) in females of *S. sihama*

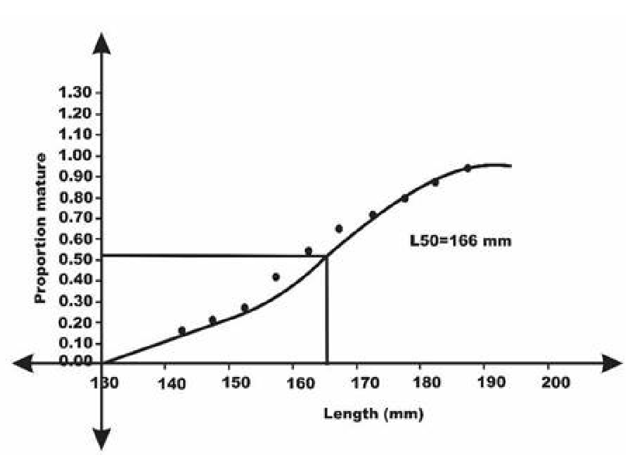

Fig. 4. Size at first maturity of *S. sihama*

Different workers have reported maturity sizes varying from 138 to 167 mm (Jayasanker, 1991; Mirzaei *et al.,* 2013; Vinod and Basavaraja, 2013; Sawant *et al.,* 2017). However, as the maturity size in terms of weight was not quoted by anyone the views of fishers could not be directly compared with published data.

Multiple views on the effect of the lunar cycle on the availability of *S. sihama* to different gears were expressed by fishers (Table 7). Fishers opined that a moderate catch of *S. sihama* is obtained during *navmi* to ekadashi. While more catch is obtained during *dwadashi* to *tritiya* and *amavasya* and *pournima* to *wan* (stake net), *disco* (gill net) and *pag* (cast net). The effect of the lunar cycle on the availability of *S. sihama* is related to the catchability of particular fish to the specific gear/gears, currents, and operation of gear concerning the lunar cycle. The effect of the lunar cycle on catch has been earlier reported for dol net fishery, bivalve fishery, and stake net fishery by various workers wherein the lunar cycle yields a similar kind of influence (Nirmale *et al*., 2007; Nirmale *et al*., 2012; Gangan *et al*., 2013; Gangan *et al*., 2016; Uskelwar *et al*., 2017). The availability of *S. sihama* concerning the lunar cycle is more pronounced in *wan* fishery. The operation of the stake net is subject to tidal amplitude and makes exclusive use of tidal energy for its success (Uskelwar *et al.,* 2017). Moderate to high catch of and *S. sihama* to stake net, as well as gill net, is reported during the days of lunar cycles when stronger current is generated due to the proximity of the sun and moon with earth. The availability of *S. sihama* to *pag* net concerning the lunar cycle needs to be further scientifically investigated.

Most of the fishers held the view that winds blowing from different directions influence the catch of *S. sihama*. Accordingly, fishers stated that winds blowing from a northerly direction (*matlai vara*) from August to November fetch more catch of *S. sihama* to *wan*, *disco* net, and *pag*. The most obvious effect of wind direction on the water is the generation of currents. Harden *et al.* (1976) stated that most fish movements and migrations are related to currents. Scientific field studies on the effect of wind direction on the catch of *S. sihama* to different gears should be carried out to verify the empirical observation of fishers. A similar view of fishers of Mumbai and Sindhudurg districts in Maharashtra wherein winds blowing from a northerly direction fetch more catch and those blowing from a southerly direction fetch less catch has been documented (Nirmale *et al*., 2004; Nirmale *et al.,* 2007).

Most popular views held by fishers on the biology of *S. sihama* were chosen for comparison with biological studies and published data. The statistical analysis was done by Mann-Whitney U test by SAS version 9.3 and revealed that the ethnoecological knowledge = fishers's knowledge (F), laboratory observations =biological studies (L) and published literature (P) profiles were statistically similar ($p > 0.05$)

Conclusion

Maintaining and enhancing the viability of brackishwater fisheries can improve the economic and social well-being of small-scale fishers, providing them with the means to address their individual and community needs. It is evident based on the findings of the present study that fishers possess valuable and valid ethnoecological knowledge on important food species which help them sustainably harness the resources and thus contribute to local food security. The knowledge base of fishers should be considered while developing management interventions suitable to address the challenges.

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