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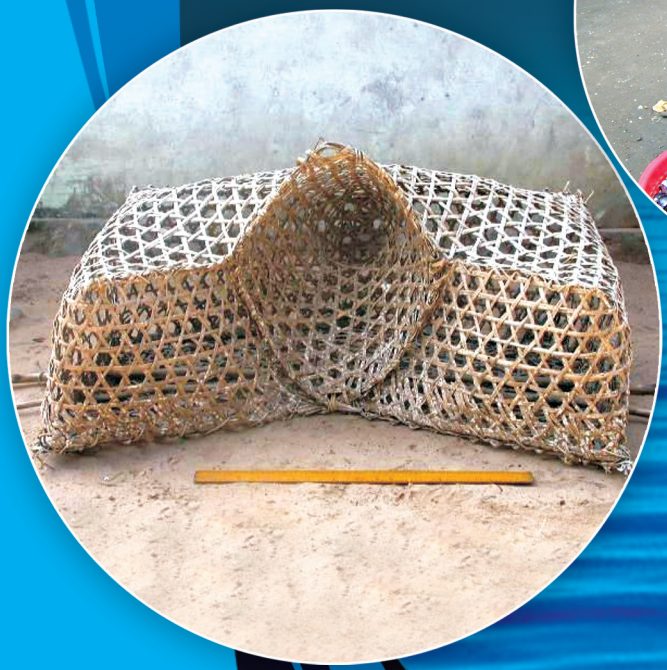

Technical and Extension Series

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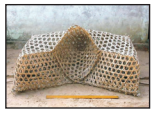

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The Marine Fisheries Information Service : Technical and Extension Series envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers, and transfer of technology from laboratory to field.

An overview of marine fisheries in India during 2007

K. Ramani, P. L. Ammini, J. Srinivasan, S. Haja Najeemudeen, M. R. Beena, K. P. George, M. B. Seynudeen, G. Subbaraman, K. Anandan, Lata L. Khambadkar, Sindhu K. Augustine, D. Pugazhendi*, N. Rudhramurthy*, S. Subramani*, S. Seetharaman*, H. Kather Batcha* and S. Sankaralingam*

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Fisheries sector in India plays an important role in the country's economy and it supports the livelihood of millions of people. India is having 8,129 km of coastal length with 2.02 million sq. km of Exclusive Economic Zone (upto 200 m depth) and 0.452 million sq. km of continental shelf area. Total marine fish production in the year 2007 was about 2.89 million t in which mechanised sector contributed 68%, motorised sector 28% and non-mechanised sector 4%. An increase of 7% was noticed as compared to the all India landings of the year 2006.

An account of the percentage contribution of each maritime state towards different assemblages found in India, is given in Table 1.

Table 1. Percentage contribution of the maritime states towards different assemblages

State	Assemblage			
	Crustaceans	Demersals	Pelagics	Molluscs
West Bengal	6.94	8.39	8.44	1.00
Orissa	5.61	7.12	4.60	1.71
Andhra Pradesh	8.14	8.10	6.89	2.41
Tamil Nadu	8.53	17.38	15.50	11.64
Pondicherry	0.12	0.27	0.72	0.36
Kerala	12.60	12.01	27.76	23.11
Karnataka	8.23	8.33	11.39	9.70
Goa	0.35	1.58	5.13	0.19
Maharashtra	20.51	11.22	7.49	18.11
Gujarat	28.97	25.60	12.08	31.77

Kerala ranked first in fish production during 2007 with 21% contribution followed by Gujarat and Tamil Nadu contributing 19% and 15% respectively to the total landings. Considering the gearwise all India landings, in the mechanised sector, trawlnets contributed 41%, dolnets 9%, purseseines 7% and gillnets 6%. In the motorised sector, gillnets contributed 15%, ringseines 8% and all the gears in the non-motorised sector contributed 4%.

Major resources landed along the Indian coast are oilsardine (17%), penaeid prawns (7%), perches (6%), croakers (6%), carangids (5%), non-penaeid prawns (5%), ribbonfishes (5%), Bombayduck (4%), cephalopods (3%), seerfishes (2%) and pomfrets (2%). The distribution of Indian mackerel (*Rastrelliger kanagurta*) in different maritime states, along with the annual landings of the states is depicted in Fig. 1.

In the mechanised sector, units operated per day along the Indian coasts during 2007 were as follows: multiday trawlnets 1,364, single day trawlnets 1,948, gillnets 1,461 and dolnets 1,443. Purseseine operations per day maintained the same decorum as that of 2006 with 250 units. Trawlnet operations were more in Tamil Nadu with about 3.82 lakhs, followed by Kerala with 2.73 lakhs. The number of unit operation of gillnets was higher in Maharashtra with 2 lakhs and in Andhra Pradesh with 1.17 lakhs. Unit operations of dolnets in Maharashtra were

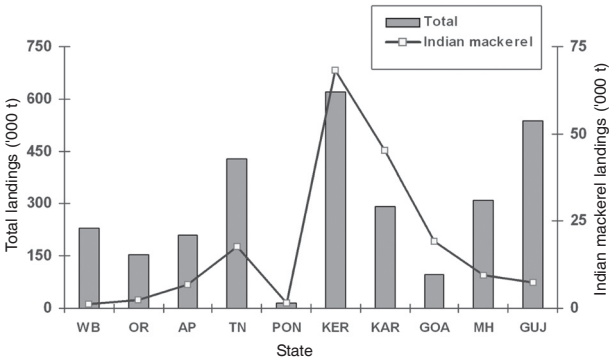

Fig. 1. State-wise landings of *Rastrelliger kanagurta* along with total annual landings of the states

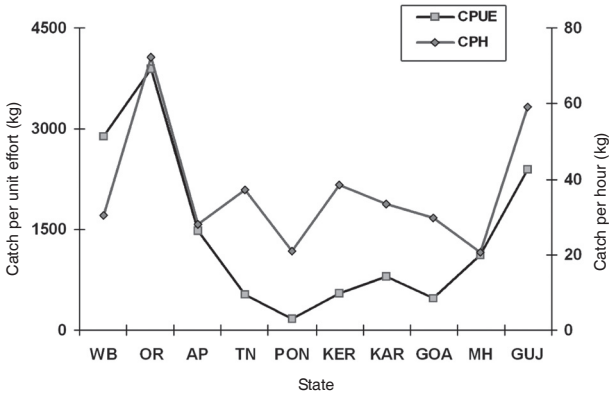

Fig. 2. Effort details of trawlnets operating along the coasts of different maritime states

3.18 lakhs and in Gujarat about 2.1 lakhs. In the motorised sector, the number of unit operations of gillnets in Tamil Nadu was 21.88 lakhs. Operations of motorised ringseine units in Kerala were about 1.66 lakhs and that of motorised hooks and lines in Tamil Nadu were about 2.94 lakhs. Artisanal units were more in operation in Tamil Nadu and Andhra Pradesh.

Considering the catch per unit effort (CPUE) of trawl landings in India, Orissa ranked first with 3,889 kg followed by West Bengal with 2,881 kg, Gujarat with 2,388 kg and Andhra Pradesh with 1,488 kg. Details of effort expended by trawlnets operating along the coasts of different maritime states, are given in Fig. 2.

An account of the contribution pattern of different maritime states of India during 2007 is presented.

West Bengal

West Bengal, the northern most maritime state in the east coast of India, is located between 21°38' - 27°10' N latitude and 85°38' - 89°38' E longitude, with a coastal length of 158 km. Here, marine fishing activity is limited to 70 m depth zone. Ban period on fishing in the state was from 15th April to 31st May during 2007. The state contributed 2.29 lakh t towards the total marine fish production of the country during 2007. In the mechanised sector, the production was 82%, while from the motorised sector, it was 15% and non-mechanised landings were only 3% of the total landings. Multiday operations of trawlers and gillnetters were regular phenomenon during the fishing season of July-February. Handtrawl operations were also seen in the multiday fishing scenario from 24 Parganas District. The main resources available during the period were hilsa shad (22%), Bombayduck (15%), other clupeids (10%), croakers (9%), non-penaeid prawns (7%), pomfrets (6%) and catfishes, anchovies and penaeid prawns (5% each). Percentage contribution of the major resources in different gears is given in Table 2.

Table 2. Percentage contribution of the major resources in different gears in West Bengal

Gears / Resources	Mechanised				Motorised			Non-motorised
	TN	GN	BN	HL	GN	BN	HL	
Hilsa shad	0	79	0	0	21	0	0	0
Bombayduck	3	27	36	0	21	12	0	1
Other clupeids	34	46	11	0	4	0	0	5
Croakers	52	16	21	1	1	3	0	6
Non-penaeid prawns	0	0	74	0	0	4	0	22
Pomfrets	21	71	1	0	7	0	0	0
Penaeid prawns	64	0	24	0	0	10	0	2
Catfishes	30	50	2	10	4	0	3	1
Anchovies	57	3	26	0	1	10	0	3
Ribbonfishes	33	31	25	0	4	6	0	1
Seerfishes	7	56	0	0	37	0	0	0

TN - Trawlnet, GN - Gillnet, BN - Bagnet, HL - Hooks and line.

Demersal resources contributed 27% to the total landings followed by pelagics 60%, crustaceans 13% and contribution by molluscs was negligible. Main species which contributed to each category were as follows:

Hilsa shad	*Tenualosa ilisha*
Bombayduck	*Harpadon nehereus*
Croakers	*Otolithes* spp., *Johnius* spp., *Protonibea diacanthus*, *Otolithoides biauritus*, *Johnieops* spp. and *Nibea maculata*
Non-penaeid prawns	*Acetes* spp. and *Plesionika* spp.
Pomfrets	*Pampus argenteus*, *P. chinensis* and *Parastromateus niger*
Catfishes	*Arius thalassinus*, *A. tenuispinis*, *Osteogeneiosus militaris*, *Pangasius pangasius* and *Plotosus limbatus*
Anchovies	*Coilia dussumieri* and *Setipinna taty*
Penaeid prawns	*Solenocera hextii*, *Metapenaeopsis stridulans*, *Metapenaeus affinis*, *M. brevicornis*, *M. monoceros*, *M. dobsoni*, *Parapenaeopsis hardwickii*, *P. stylifera*, *Parapenaeus* spp., *Penaeus canaliculatus*, *P. indicus* and *P. monodon*
Clupeids	*Amblygaster leiogaster*, *Chirocentrus nudus*, *Stolephorus commersonii*, *S. indicus*, *Thryssa mystax*, *T. dussumieri*, *Ilisha megaloptera*, *Opisthopterus tardoore*, *Raconda russeliana*, *Escualosa thoracata*, *Dussumieria acuta* and *Anodontostoma chacunda*
Ribbonfishes	*Lepturacanthus savala* and *Trichiurus lepturus*
Seerfishes	*Scomberomorus guttatus.*

Among different types of gears operated, maximum contribution was by gillnets employed in both mechanised and motorised sectors. In the mechanised sector, gillnets contributed 40% and in the motorised sector, the contribution was 10% to the West Bengal landings. Mechanised trawlnets were doing multiday operation and they kept aloof from single day operations during 2007. Multiday operating trawlnets spent on an average, 67 h in fishing whereas the hand operating trawlnets operated during October - December were engaged in fishing for more than 110 h. Contribution of multiday trawlnets was 23%. Next important gear was the bagnet (Behundi jal). Mechanised bagnets contributed 18% towards the total landings of the state whereas the bagnets in the motorised sector contributed only 4% and the non-motorised bagnets contribution was 2%. Mechanised hooks and lines and shoreseines contributed 1% each. There were stray landings by stake nets also. March to June was the closed season for West Bengal fishery. Nearly 97% of the total landings occurred during the fishing season and the remaining 3% was landed during the closed season by the artisanal gears. Fig. 3 gives a picture of West Bengal landings along with the landings of the highly exploited hilsa shad during January - December 2007. More than 56 % of the total hilsa shad landings were during August 2007.

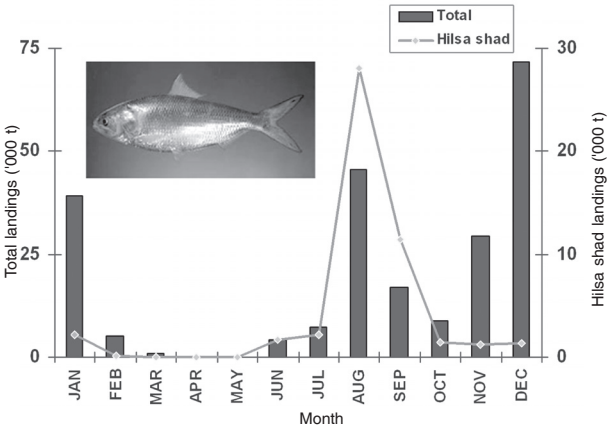

Fig. 3. Landings of hilsa shad and total landings of West Bengal during January - December 2007

Orissa

Orissa is located between 17° 48' - 22° 34' N latitude and 81°24' - 87°29' E longitude. Length of the coastline is 480 km. Coastal fisheries within 40 km from the shore have been the main focus of the fishing activity of the state. Commercial fishing gears are trawlnets and driftnets/gillnets. Traditional gears are hooks and lines and shoreseines. During 2007, marine fish landings in the state crossed 1.5 lakh t. The main gears operated were trawlnets, driftnets/gillnets, hooks

and lines, ringnets and bagnets. Major resources found in the fishery were croakers (14%), penaeid prawns (11%), ribbonfishes (9%), carangids (9%), sardines (8%), anchovies (6%), catfishes (4%), pomfrets (4%), silverbellies (3%), other clupeids (7%) and non-penaeid prawns (3%). Table 3 shows the percentage contribution of the major resources in different gears.

Table 3. Percentage contribution of the major resources in different gears in Orissa

Gears / Resources	Mechanised		Motorised				Non-motorised
	TN	GN	GN	HL	RN	BN	
Croakers	81	8	11	0	0	0	0
Penaeid prawns	94	0	5	0	0	0	1
Ribbonfishes	59	1	37	0	0	2	1
Carangids	44	16	28	7	1	0	4
Sardines	0	0	32	0	7	0	61
Anchovies	86	2	7	0	0	1	4
Other clupeids	38	11	47	0	0	0	4
Catfishes	56	15	9	19	0	0	1
Pomfrets	55	28	16	0	0	0	1
Silverbellies	48	1	3	0	0	0	48
Non-penaeid prawns	73	0	0	0	0	11	16

TN - Trawlnet, GN - Gillnet, HL - Hooks and line, RN - Ringnet, BN - Bagnet

The main gear of Orissa fishery was trawlnets. Except sardines, all resources were mainly caught by this gear. Sardines and silverbellies were caught by artisanal gears. The important resources found in driftnets/gillnets were pomfrets, carangids, catfishes and croakers. Different species which contributed to the important resources are given below:

Croakers — *Pennahia macrophthalmus*, *Johnius carutta*, *J. dussumieri*, *Otolithes cuvieri*, *O. ruber*, *Nibea maculata*, *Otolithoides biauritus* and *Protonibea diacanthus*

Penaeid prawns — *Solenocera crassicornis*, *Metapenaeus dobsoni*, *M. affinis*, *M. monoceros*, *Metapenaeopsis stridulans*, *Parapenaeopsis hardwickii*, *P. maxillipedo*, *P. sculptilis*, *P. stylifera*, *Penaeus indicus*, *P. merguiensis*, *P. monodon* and *P. penicillatus*

Ribbonfishes — *Trichiurus lepturus* and *Lepturacanthus savala*

Carangids — *Megalaspis cordyla*, *Selar crumenophthalmus*, *Scomberoides commersonianus*, *S. lysan*, *Alepes melanopterus*, *A. djeddaba*, *Caranx ignobilis*, *C. sem*, *Decapterus russelli*, *Alectis indicus*, *Carangoides armatus* and *Atropus atropus*

Sardines — *Sardinella fimbriata*, *S. gibbosa* and *S. longiceps*

Catfishes — *Arius dussumieri*, *A. caelatus, A. jella, A. platystomus, A. tenuispinis, A. thalassinus* and *Osteogeneiosus militaris*

Pomfrets — *Parastromateus niger*, *Pampus argenteus* and *P. chinensis*

Silverbellies — *Leiognathus bindus*, *L. equulus*, *L. fasciatus*, *L. splendens* and *Secutor insidiator*

Non-penaeid prawns — *Acetes indicus* and *Nematopalaemon tenuipes*

Anchovies — *Setipinna taty*, *Coilia dussumieri*, *Stolephorus devisi*, *S. commersonii* and *S. punctifer*

Other clupeids — *Chirocentrus dorab*, *C. nudus*, *Thryssa mystax*, *T. dussumieri*, *Raconda russeliana*, *Pellona ditchela*, *Ilisha filigera*, *I. megaloptera*, *I. melastoma*, *Tenualosa toli*, *Escualosa thoracata*, *Dussumieria elopsoides*, *D. acuta*, *Anodontostoma chacunda* and *Megalops cyprinoides.*

Mechanised trawlnets contributed 62% of the total landings of the state. Multiday trawl catch was more than eight times of the catch delivered by the single day operating trawlnets. Even though the catch/unit of multiday trawlnets was 4,951 kg, their catch/hour contribution was only 67 kg. Single day trawlnet, on the other hand, ranked first with 236 kg of catch per hour. While the multiday trawlers spent more than 70 h in fishing, single day trawlers were engaged in fishing for only 6 h. Single day trawlers were found to be more efficient than multiday trawlers. Driftnets/gillnets in the mechanised sector and non-motorised sector contributed 6% each towards total catch and in the motorised sector, their contribution was 18%. The non-motorised sector comprising of hooks and lines, shoreseines, bagnets and ringnet contributed 9% towards Orissa landings. Hooks and lines in the motorised sector contributed 3% towards the total landings. Monthwise contribution of croakers with respect to the monthly total landings is depicted in Fig. 4.

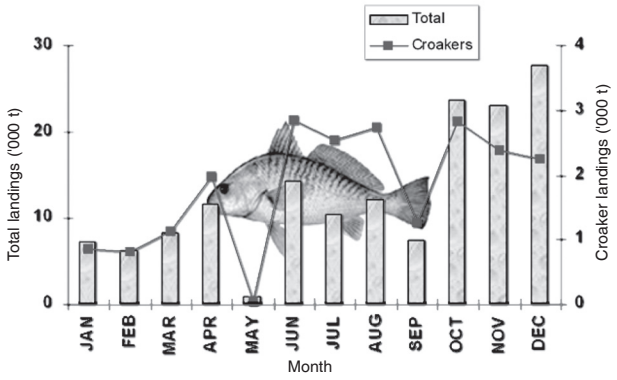

Fig. 4. Month-wise contribution of croakers with respect to monthly total landings in Orissa

June to February was the most productive season in Orissa. During 2007, mechanised sector contributed 68% of the total landings followed by motorised sector 23% and the remaining 9% was from traditional sector. During the fishing season, 86% of the total landings of the state was accrued. Regarding the districts of Orissa, Jagathsinghpur which included Paradeep Fishing Harbour, was the main contributor towards the state's annual landings. Ban on fishing was imposed from April 15 to May 31 by the state government for the first time at Paradeep Fishing Harbour during 2007.

Andhra Pradesh

Andhra Pradesh, having 974 km of coastal length is situated between 12°41' - 22° N latitude and 77° - 84°40' E longitude. Coastal districts of Andhra Pradesh - Srikakulam, Vijayanagaram, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore - are also known as the northern sircars. The continental shelf area of Andhra Pradesh, forming 31,000 sq. km, is rich with many varieties of prawns, carangids, perches, croakers and elasmobranchs. During 2007, marine fish landing of Andhra Pradesh was 2.08 lakh t.

The main gears operated during the period were trawlnets, driftnets/gillnets, seinenets and hooks and lines. Their share towards the total landings of the state were trawlnet (46%), driftnet/gillnet (38%), seinenets (9%) and hooks and lines (7%). More than 80% of the trawl landings were by multiday operations. Catch per unit of multiday trawlnets were 1,776 kg and that of single day operations were 872 kg. Comparing the catch per hour of multiday (25 kg) and single day (50 kg) operations of trawlnets, it is felt that single day operations were more beneficial to the fisherfolk of Andhra Pradesh. Shoreseines in the motorised sector earned, on an average, 1,139 kg and their catch per hour was 185 kg. Percentage contribution of the major resources in different gears is summarised in Table 4.

Nearly 49% of the total landings were by the mechanised sector followed by motorised sector (30%) and the remaining 21% by the artisanal sector. The important species of the major resources available along Andhra coast were as follows:

Penaeid prawns	*Solenocera crassicornis*, *S. hextii*, *Aristaeomorpha woodmasoni*, *Aristeus semidentatus*, *Metapenaeopsis* spp., *Metapenaeus affinis*, *M. brevicornis*, *M. dobsoni*, *M. monoceros*, *Parapenaeopsis stylifera*, *Penaeus indicus*, *P. japonicus*, *P. merguiensis*, *P. monodon*, *P. semisulcatus* and *Trachypenaeus curvirostris*
Carangids	*Rachycentron canadum*, *Alepes* spp., *Alectis indicus*, *Atropus atropos*, *Carangoides* spp.,

Table 4. Percentage contribution of the major resources in different gears in Andhra Pradesh

Resources \ Gears	Mechanised			Motorised					Non-motorised
	TN	GN	HL	GN	HL	SS	PS	BS	
Penaeid prawns	85	3	0	3	0	0	2	0	7
Croakers	60	5	1	13	1	1	1	0	18
Stolephorus spp.	38	0	0	7	0	0	6	0	49
Sardines	12	0	0	5	0	10	27	1	45
Other clupeids	19	2	0	41	0	0	7	1	30
Carangids	54	3	1	13	2	0	3	0	24
Seerfishes	6	11	0	62	11	0	0	0	10
Ribbonfishes	72	1	0	9	0	1	0	0	17
Perches	68	2	0	18	4	1	0	0	7
Pomfrets	43	6	0	43	1	0	1	0	6
Elasmobranchs	24	7	6	35	25	0	0	0	3
Crabs	62	9	0	11	0	1	0	0	17

TN - Trawlnet, GN - Gillnet, HL - Hooks and line, SS - Shoreseine, PS - Purseseine, BS - Boatseine

	Caranx ignobilis, *C. sexfasciatus*, *C. sem*, *Megalaspis cordyla*, *Scomberoides commersonianus*, *S. lysan*, *S. tol*, *Selar boops*, *S. crumenophthalmus*, *Selaroides leptolepis*, *Seriolina nigrofasciata*, *Decapterus russelli*, *Mene maculata* and *Coryphaena hippurus*
Perches	*Argyrops spinifer*, *Priacanathus* spp., *Apogon* spp., *Ambassis* spp., *Lates calcarifer*, *Sillago sihama*, *Nemipterus japonicus* and *N. mesoprion*
Croakers	*Chrysochir aureus*, *Johnieops sina*, *Johnius belangerii*, *J. carutta*, *J. dussumieri*, *J. macropterus*, *Kathala axillaris*, *Nibea maculata*, *N. soldado*, *Otolithes ruber* and *Protonibea diacanthus*
Elasmobranchs	*Carcharhinus dussumieri*, *Rhizoprionodon acutus*, *Sphyrna zygaena*, *Rhina ancylostoma*, *Rhynchobatus djiddensis*, *Dasyatis microps*, *D. kuhlii*, *Gymnura* spp., *Himantura bleekeri*, *Aetobatus* spp., *Aetomylaeus* spp., *Rhinoptera* spp., *Mobula diabolus, Narcine timle* and *Torpedo marmorata*
Pomfrets	*Pampus argenteus*, *P. chinensis* and *Parastromateus niger*
Ribbonfishes	*Lepturacanthus savala* and *Trichiurus lepturus*
Other clupeids	*Anodontostoma chacunda*, *Dussumieria acuta*, *Escualosa thoracata*, *Tenualosa ilisha, Hilsa kelee*, *Ilisha* spp., *Opisthopterus tardoore*, *Pellona ditchela*, *Chirocentrus dorab*, *C. nudus*, *Chanos chanos* and *Raconda russeliana*
Seerfishes	*Scomberomorus commerson*, *S. guttatus* and *S. lineolatus*
Crabs	*Calappa lophos*, *Scylla serrata*, *Portunus pelagicus*, *P. sanguinolentus*, *Charybdis cruciata* and *Varuna litterata*
Sardines	*Sardinella longiceps, S. albella, S. fimbriata* and *S. gibbosa.*

Monthly landings of penaeid prawns along with the monthly total marine fish landings of Andhra Pradesh during 2007 is given in Fig. 5.

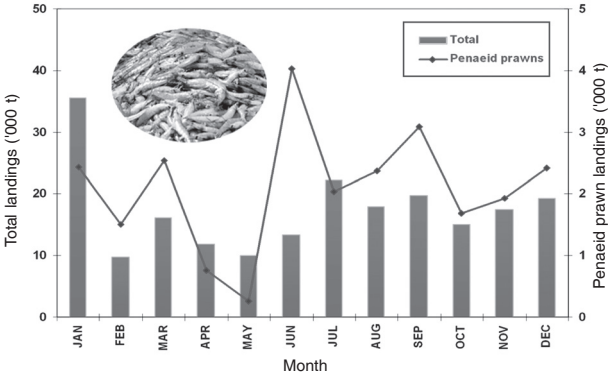

Fig. 5. Monthly landings of penaeid prawns along with the monthly total marine fish landings of Andhra Pradesh

July to January was the productive season of the Andhra fishery. More than 60% of the catch was landed during this period. Penaeid prawn landing was maximum during June with 4,034 t. Ban on motorised and mechanised fishing vessels of Andhra Pradesh was imposed by the state government during the period 15 April – 31 May in 2007.

Tamil Nadu

Situated between 8°5' - 13°35' N latitude and 76°15' - 80°20' E longitude, Tamil Nadu is the southern most maritime state of India. With 1,076 km coastline and 41,400 km^2 continental shelf, the state accounts for 13% of India's coastline and 9% of the continental shelf respectively. The state is bordered with the Bay of Bengal and Palk Bay in the east, the Gulf of Mannar in the south-east, the Indian Ocean in the south and the Arabian Sea in the south-west. Ban on fishing in the state was from 15 April to 31 May during 2007. In the mechanised sector, the production was about 50% while in motorised sector, it was about 45% of the total Tamil Nadu landings. In the traditional sector, it was only 5% of the total Tamil Nadu landings. July-September was the most productive season (30%) followed by October-December (27%). The lean period was from April to June (18%). The main resources available in Tamil Nadu were oilsardine (15%), other sardines (11%), silverbellies (11%), penaeid prawns (4%), Indian mackerel (4%), crabs (3%) and *Stolephorus* spp. (3%). Percentage contribution of the major resources in different gears is given in Table 5.

Demersal resources contributed 30% of the total landings followed by pelagics (59%), crustaceans (8%) and molluscs contributing only 3%. Main species contributing to each category were as follows:

Oilsardine	*Sardinella longiceps*
Silverbellies	*Gazza minuta*, *Leiognathus berbis*, *L. equulus*, *L. lineolatus*, *L. splendens*, *Secutor insidiator* and *S. ruconius*
Other sardines	*Sardinella albella*, *S. fimbriata*, *S. gibbosa*, *S. sirm* and *S. leiogaster*
Perches	*Psammoperca waigiensis*, *Cephalopholis sonnerati*, *Epinephelus merra*, *Terapon* spp., *Priacanthus* spp., *Sillago* spp., *S. sihama*, *Scolopsis* spp., *Lutjanus* spp. and *Nemipterus bipunctatus*
Other clupeids	*Tenualosa ilisha*, *Dussumieria acuta*, *Escualosa thoracata*, *Hilsa kelee*, *Pellona ditchela*, *Coilia dussumieri*, *Stolephorus bataviensis*, *S. macrops*, *Thryssa dussumieri* and *Chirocentrus dorab*
Indian mackerel	*Rastrelliger kanagurta*
Penaeid prawns	*Solenocera crassicornis*, *S. hextii*, *Aristeus semidentatus*, *Metapenaeopsis andamanensis*, *M. stridulans*, *Metapenaeus affinis*, *M. brevicornis*, *M. dobsoni*, *M. monoceros*, *Parapenaeopsis stylifera*, *P. uncta*, *Penaeus indicus*, *P. japonicus*,

Table 5. Percentage contribution of the major resources in different gears in Tamil Nadu

Gears / Resources	Mechanised				Motorised							Non-motorised
	TN	RS	HL	PS	GN	HL	PS	RS	BN	TN	Others	
Oilsardine	8	3	0	1	59	0	9	8	6	0	4	2
Silverbellies	90	0	0	0	8	0	1	0	0	0	0	1
Other sardines	21	0	0	0	62	0	6	1	0	1	0	9
Perches	62	0	2	0	15	15	0	0	0	1	0	5
Other clupeids	36	0	0	0	45	0	10	0	1	0	0	8
Indian mackerel	11	1	0	0	78	1	0	1	3	0	0	5
Penaeid prawns	79	0	0	0	16	0	0	0	0	1	0	4
Crabs	36	0	0	0	44	0	0	0	0	1	0	19
Stolephorus spp.	17	0	0	0	39	0	0	0	13	0	0	31

TN - Trawlnet, RS - Ringseine, HL - Hooks and line, PS - Purseseine, GN - Gillnet, BN - Bagnet, Others - Combined gears

	P. merguiensis, *P. monodon*, *P. semisulcatus* and *Trachypenaeus curvirostris*
Crabs	*Calappa lophos*, *Scylla serrata*, *Portunus* spp., *P. pelagicus*, *Charybdis cruciata* and *C. natator*
Stolephorus spp.	*Stolephorus bataviensis*, *S. commersonii*, *S. devisi* and *S. indicus.*

Fig. 6 gives a picture of the monthly total landings of Tamil Nadu along with the landings of silverbellies whose contribution was maximum with 6,591 t in November and minimum with 118 t in May 2007. The red toothed trigger fish namely *Odonus niger* occurred in large quantities at Tuticorin Fisheries Harbour, Madras Fisheries Harbour, Colachel, Rameswaram and Kanyakumari during 2007.

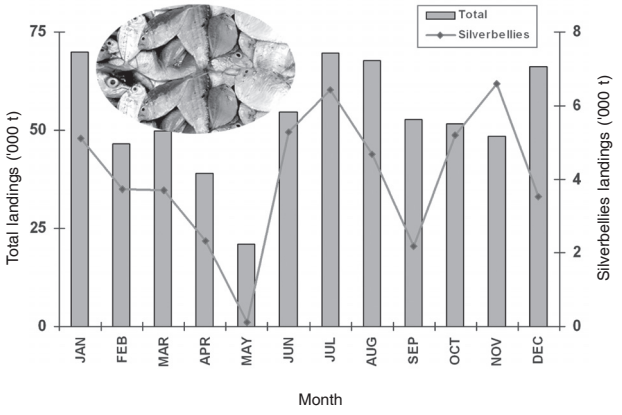

Fig. 6. Monthly total landings of Tamil Nadu along with the landings of silverbellies

Pondicherry

Pondicherry, the smallest maritime union territory of India has about 45 km coastline lying within 11°56' N latitude and 79° 53' E longitude. Fishery is an important occupation in the social scenario of Pondicherry. During 2007, Pondicherry contributed 14,271 t to the all India landings. Considering the sector-wise landings, motorised sector contributed 85% of the total landings followed by mechanised sector 13% and artisanal sector 2%. Seasonal contribution was more or less the same in 2007. Table 6 shows the percentage contribution of major resources in different gears.

The important species of the major resources available along Pondicherry were as follows:

Oilsardine	*Sardinella longiceps*
Indian mackerel	*Rastrelliger kanagurta*
Other sardines	*Sardinella gibbosa* and *S. sirm*
Carangids	*Rachycentron canadum*, *Atropus* spp., *Decapterus russelli*, *Selaroides* spp. and *Nemipterus* spp.
Seerfishes	*Scomberomorus commerson*, *S. guttatus* and *S.lineolatus*
Flyingfishes	*Exocoetus volitans*
Penaeid prawns	*Metapenaeopsis stridulans*, *Metapenaeus affinis*, *M. dobsoni*, *Penaeus indicus* and *P. monodon.*

Table 6. Percentage contribution of the major resources in different gears in Pondicherry

Gears / Resources	Mechanised	Motorised									Non-motorised
	TN	GN	HL	TN	PS	SS	DGN	RS	BN	Others	
Oilsardine	0	41	0	0	53	0	0	0	0	5	1
Indian mackerel	0	54	3	0	0	0	0	43	0	0	0
Other sardines	0	31	0	0	8	0	44	17	0	0	0
Carangids	6	26	56	0	0	0	2	1	9	0	0
Scomberomorus commerson	0	48	49	0	0	0	0	3	0	0	0
Flying fishes	0	0	0	0	0	0	100	0	0	0	0
Other clupeids	19	38	0	0	0	1	25	0	0	0	17
Silverbellies	58	28	0	0	0	0	12	0	0	0	2
Penaeid prawns	82	14	0	3	0	0	0	0	0	0	1

TN - Trawlnet, GN - Gillnet, HL - Hooks and line, PS - Purseseine, SS - Shoreseine, DGN - Driftnet/gillnet, RS - Ringseine BN - Bagnet, Others - Combined gears

Monthly landings of oilsardine along with the monthly total landings of the state is depicted in Fig. 7.

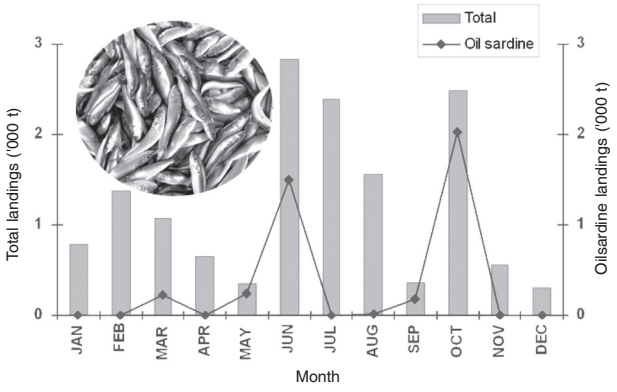

Fig. 7. Monthly landings of the oilsardine along with monthly total landings of Pondicherry

Maximum landing of oilsardine was during October 2007 and the minimum landing was during December 2007.

Kerala

Kerala, the southern most state in the west coast of India, is situated between 8° 18' - 12°48' N latitude and 74° 52' - 77° 22' E longitude. The sea bordering the state is rich with marine organisms. The state's contribution to all India marine fish landings was 21% during 2007. Different gears which contributed to this effect were trawlnets (25%), ringseines (16%) and combined gear operations of hooks and lines along with trawlnets and gillnets (3%) in the mechanised sector. In the motorised sector, ringseines contributed 33%, driftnets/gillnets 13%, boatseines 4% and hooks and lines 3%. Non-motorised sector as a whole contributed 2%. Different gears which operated in the artisanal sector were driftnets/gillnets, boatseines, shoreseines, hooks and lines and katchal (scoopnets). Major resources landed during 2007, were oilsardine (40%), mackerel (11%), penaeid prawns (7%), threadfin breams (5%), scads, *Stolephorus* spp., tunnies and cephalopods (4% each), soles (3%), croakers, ribbonfishes, seerfishes and other carangids (2% each).

Contribution of pelagics to the total landings of the state was 73% followed by demersals (14%), crustaceans (9%) and molluscs (4%) during 2007. Catch per unit effort of multiday trawlers during 2007 was 1,030 kg while it was 198 kg for single dayers. Catch per hour of multiday operations was 40 kg and the same for single day operations was 33 kg. Catch per unit effort of purseseines, hooks and lines, ringseines and other multigear combinations, crossed 2 t in the mechanised sector. In the motorised sector, ringseines were having maximum catch per unit effort (1,236 kg). Percentage contribution of the major resources in different gears is given in Table 7.

Major species which contributed to each category were as follows :

Oil sardine	*Sardinella longiceps*
Mackerel	*Rastrelliger kanagurta*
Penaeid prawns	*Metapenaeus dobsoni*, *M. monoceros*, *M. affinis*, *Solenocera hextii*, *S. choprai*, *Aristeus alcocki*, *Metapenaeopsis andamanensis*, *Parapenaeopsis stylifera*, *Penaeopsis jerry*, *Penaeus indicus*, *P. monodon*, *P. semisulcatus* and *Trachypenaeus curvirostris*

Table 7. Percentage contribution of the major resources in different gears in Kerala

Gears / Resources	Mechanised						Motorised					Non-motorised
	TN	PS	HL	RS	GN	Others	RS	GN	HL	BS	TN	
Oilsardine	1	0	0	20	0	0	62	12	0	3	0	2
Stolephorus spp.	23	0	0	1	0	0	46	1	0	27	0	2
Threadfin breams	79	0	0	0	0	21	0	0	0	0	0	0
Scads	33	0	0	1	0	5	26	3	8	21	2	1
Indian mackerel	2	1	0	42	0	0	32	19	2	0	0	2
Tunnies	0	0	1	30	1	12	0	24	32	0	0	0
Soles	60	0	0	0	0	0	0	32	0	0	6	2
Penaeid prawns	80	0	0	4	0	0	8	1	0	1	6	0
Cephalopods	86	0	0	0	0	3	0	0	4	7	0	0

TN - Trawlnet, PS - Purseseine, HL - Hooks and line, RS - Ringseine, GN - Gillnet, BS - Boatseine
Others - combined gears

Threadfin breams	*Nemipterus japonicus* and *N. mesoprion*
Scads	*Decapterus russelli* and *D. macrosoma*
Stolephorus spp.	*Stolephorus commersonnii*, *S. punctifer* and *S. devisi*
Tunnies	*Euthynnus affinis*, *Auxis rochei*, *A. thazard*, *Katsuwonus pelamis*, *Sarda orientalis*, *Thunnus albacares* and *T. tonggol*
Cephalopods	*Sepia aculeata*, *S. pharaonis*, *Sepiella inermis*, *Loligo duvaucelli* and *Octopus* spp.
Soles	*Cynoglossus macrostomus*, *C. bilineatus* and *Synaptura commersoniana*
Croakers	*Johnieops* spp., *Johnius* spp., *Nibea maculata* and *Otolithes* spp.
Ribbonfishes	*Lepturacanthus savala* and *Trichiurus lepturus*
Seerfishes	*Scomberomorus commerson* and *S. guttatus*
Other carangids	*Alectis ciliaris, A. indicus, Alepes djeddaba, A. mate, A. melanopterus, A. para, Atropus atropos, Carangoides malabaricus, Caranx ignobilis, Megalaspis cordyla, Elagatis bipinnulata, Scomberoides commersonianus*, *S. lysan*, *Selar crumenophthalmus*, *Seriolina nigrofasciata* and *Trachinotus blochii.*

The monthly oilsardine landings along with the monthly total landings of the state during 2007, is shown in Fig. 8.

Oilsardines exploitation was heavy during July-November period, the peak of which was in October 2007 with 44,692 t. Ban on mechanised fishing vessels was in force from 15 June to 31 July. In order to observe complete fishing ban, all the main harbours were closed during this period in 2007.

Karnataka

Karnataka, lying on the west coast, which is having a prominent place in the fisheries map of India, plays an important role for the development of the

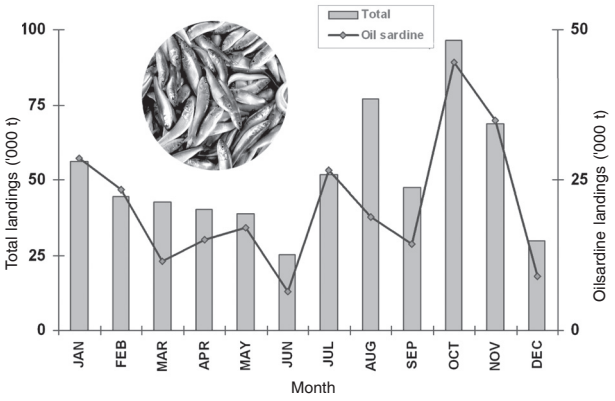

Fig. 8. Monthly oilsardine landings along with the monthly total landings of Kerala

fishery sector of the country. The state is confined roughly within 11°.5' N to 18°.5' N and 74° E to 78°.5' E. The state contributed to one tenth of the total fish production of the country with 2.92 lakh t during 2007. Mechanised sector contributed 79%, motorised sector 19% and non-mechanised sector 2%.

Trawlnets and purseseines were the major gears contributing to fishery of Karnataka. Besides single day trawls, multiday trawls were operated especially in Mangalore and Malpe fishing harbours. In other harbours *viz*., Bhatkal Bunder, Ganguli Bunder, Kasarkode, Tadri and Karwar, mostly single day trawlers were operated. Trawl landings during 2007 accounted 44% and purseseines 34% of the total landings of the state. In the motorised sector ringseine contributed 10% and gillnets 9% of the total landings.

The main resources landed in the Karnataka coast were oilsardine (33%), Indian mackerel (15%), threadfin breams (7%), stomatopods (6%), ribbonfishes (5%), penaeid prawns (5%), and cephalopods (4%). Percentage contribution of the major resources in different gears is shown in Table 8.

Contribution of group-wise assemblages to the marine fish landings of the state were: pelagics 64%, demersals 21%, crustaceans 12% and molluscs 3%.

Main species which contributed to each category are as follows:

Oilsardine	*Sardinella longiceps*
Indian mackerel	*Rastrelliger kanagurta*
Threadfin breams	*Nemipeterus bipunctatus*, *N. mesoprion* and *N. japonicus*
Stomatopods	*Oratosquilla nepa*

Table 8. Percentage contribution of the major resources in different gears in Karnataka

Resources \ Gears	Mechanised		Motorised				Non-motorised
	TN	PS	GN	RS	SS	TN	
Oilsardine	2	73	3	19	0	0	3
Indian mackerel	5	49	27	16	0	0	3
Threadfin breams	99	0	1	0	0	0	0
Stomatopods	99	1	0	0	0	0	0
Other clupeids	35	36	11	13	1	0	4
Ribbonfishes	96	1	1	2	0	0	0
Penaeid prawns	75	1	19	3	0	1	1
Cephalopods	100	0	0	0	0	0	0

TN - Trawlnet, PS - Purseseine, GN - Gillnet, RS - Ringseine, SS - Shoreseine

Other clupeids — *Thryssa* spp., *Stolephorus waitei*, *Sardinella fimbriata*, *S. albella*, *S. gibbosa*, *S. brachysoma*, *S. melanura*, *Amblygaster leiogaster*, *Opisthopterus tardoore*, *Hilsa Kelee* and *Tenualosa* spp.

Ribbonfishes — *Trichiurus lepturus* and *Lepturacanthus savala*

Penaeid prawns — *Penaeus indicus*, *Parapenaeopsis stylifera, Metapenaeus dobsoni, M. monoceros*, *M. affinis* and *Solenocera choprai*

Cephalopods — *Sepia* spp., *Loligo duvaucelli* and *Octopus* spp.

In Karnataka, the fishing season starts from September and ends with May and during this period nearly 94% of the landings were accounted in 2007. State government imposed the fishing ban from 10th June to 15th August for mechanised and outboard engine operated crafts. In 2007, landings were high (39%) during October-December followed by January-December (34%). Monthly oilsardine and total fish landings in Karnataka during 2007 is shown in Fig. 9.

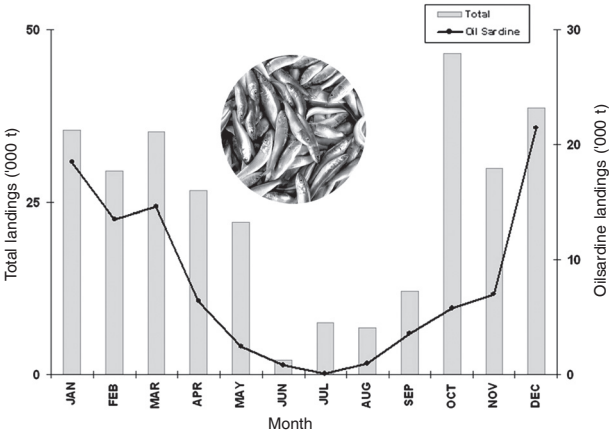

Fig. 9. Monthly oilsardine landings and total fish landings in Karnataka during 2007

Goa

Goa, having a coastal length of 104 km, is located on the western coast of the Indian Peninsula between the northern latitudes 15°48' - 14°53' and eastern longitudes 74°20' - 73°40'. The state has a moderate temperature showing negligible variations during different seasons. South-west monsoon brings rain in Goa between June and September.

Goa contributed 3% to the total fish production of the country with 97,000 t during 2007. Mechanised sector contributed 90%, motorised sector 8% and non-mechanised sector 2%. Trawlnets, purseseines and gillnets were the major gears operated in Goa. Single day trawlers and multiday trawlers were operated in the major fishing centres. The contribution from purseseines was remarkable with about 75,000 t. Trawl landings during 2007 accounted for 13% and purseseine 77% of the total landings of the state. In the motorised sector, gillnet contributed 8% of the total landings.

The main resources landed in Goa coast were oilsardine (49%), Indian mackerel (20%), carangids (6%), *Auxis* spp., perches, catfishes and other sardines (3% each). Percentage contribution of the major resources in different gears was as shown in Table 9.

Group-wise assemblages of marine fish landings of the state were: pelagics 86%, demersals 12%, crustaceans 2% and molluscs less than 1%. Main species contributed to each category were as follows:

Oilsardine — *Sardinella longiceps*

Indian mackerel — *Rastrelliger kanagurta*

Carangids — *Megalaspis cordyla*, *Decapterus russelli*, *Scomberoides*

Table 9. Percentage contributiion of the major resources in different gears in Goa

Resources \ Gears	Mechanised			Motorised	Non-Motorised
	TN	PS	GN	GN	
Oilsardine	1	96	0	0	3
Indian mackerel	0	72	1	26	1
Carangids	29	66	2	3	0
Auxis spp.	0	95	0	5	0
Perches	90	4	1	1	4
Catfishes	3	92	0	5	0
Other sardines	1	99	0	0	0

TN - Trawlnet, PS - Purseseine, GN - Gillnet

	commersonianus, *S. lysan*, *S. tala* and *S. tol*
Auxis spp.	*Auxis rochei* and *A. thazard*
Catfishes	*Arius* spp. and *Osteogeneiosus militaris*
Perches	*Nemipterus japonicus*, *N. mesoprion* and *Epinephelus diacanthus*
Other sardines	*Sardinella albella*, *S. brachysoma*, *S. dayi*, *S. fimbriata*, *S. gibbosa*, *S. melanura*, *Amblygaster clupeoides*, *A. leiogaster.*

In Goa, fishing season starts from September and ends in May and during this period nearly 96% of the total landings were accounted. Fishing ban for trawl and other mechanised as well as outboard engine fitted crafts were observed from 10th June to 15th August. Fish landings were on the higher side during the period October - March, 2007.

Monthly oilsardine landings and the total landings in Goa during 2007 are shown in Fig. 10.

The maximum landings of oilsardine were during February 2007 and the lean period was June-July.

Maharashtra

Maharashtra with a coastal length of 720 km is located between 15° 52' - 21° 34' N latitude and 72° 56' - 80°30' E longitude. The state ranks fourth among the maritime states of India in respect of marine fish landings. Fishing takes place almost throughout the year. As in the west coast, ban on trawl fishing is imposed from 10th June to 15th August (monsoon season) in Maharashtra. Trawl fishing

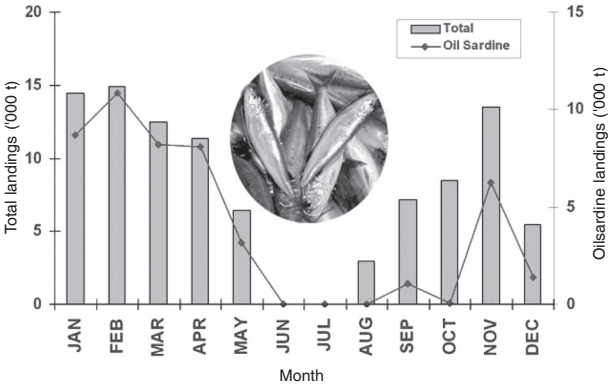

Fig. 10. Monthly oilsardine landings and total landings in Goa during 2007

would come to a halt during this period. The contribution of Maharashtra towards the total marine fish production of the entire Indian coast during 2007 was 11%. Mechanised sector of this region was having a share of 96% of the total landings while motorised sector put its share at 1%. The rest of 3% was the contribution from non-mechanised sector. Multiday operations of trawlers and gillnetters was a regular phenomenon in 2007. Landings of handtrawl operations were also recorded. Total marine fish production of Maharashtra region were dominated by penaeid prawns (14%), non-panaeid prawns (12%), oilsardine (9%), Bombayduck (9%), croakers (9%), perches (5%), ribbonfishes (4%) and cephalapods (4%). Table 10 gives the percentage contribution of the major resources in different gears.

Pelagic resources have dominated the total landings with a contribution of 40%, followed by crustaceans with 28%, demersal resources with 26% and molluscs with a contribution of 6%. Main species which contributed to each category are listed below:

Penaeid prawns	*Parapenaeopsis stylifera*, *P. sculptilis*, *Metapenaeus affinis*, *M. dobsoni*, *M. kutchensis*, *M. brevicornis*, *M. monoceros*, *Metapenaeoposis andamanensis*, *M. stridulans* and *Penaeus merguiensis*
Non-panaeid prawns	*Acetes indicus* and *Nematopalaemon tenuipes*
Bombayduck	*Harpadon nehereus*
Croakers	*Otolithoides biauritus*, *Johnius* spp., *Johnieops* spp., *Protonibea diacanthus* and *Otolithes cuvieri*

Table 10. Percentage contribution of the major resources in different gears in Maharashtra

Gears / Resources	Mechanised						Motorised	Non-motorised
	TN	DOL	GN	PS	BN	HL	GN	
Penaeid prawns	88	10	1	0	0	0	0	1
Non-penaeid prawns	9	85	3	0	3	0	0	0
Croakers	65	26	8	0	0	0	1	0
Bombayduck	23	76	1	0	0	0	0	0
Ribbon fishes	88	9	3	0	0	0	0	0
Cephalopods	99	1	0	0	0	0	0	0
Threadfin breams	100	0	0	0	0	0	0	0
Catfishes	27	4	69	0	0	0	0	0
Sharks	42	11	33	13	1	0	0	0
Coilia spp.	44	43	12	0	1	0	0	0
Indian mackerel	13	1	19	38	0	0	24	5

TN - Trawlnet, DOL - Dolnet, GN - Gillnet, PS - Purseseine, BN - Bagnet, HL - Hooks and lines

Perches	*Nemipterus japonicus*
Ribbonfishes	*Trichiurus lepturus*
Cephalapods	*Loligo duvaucelii, Sepia pharaonis* and *S. aculeata*
Catfishes	*Arius dussumieri*
Sharks	*Carcharhinus* spp. and *Scoliodon* spp.
Coilia spp.	*Coilia dussumieri*
Mackerel	*Rastrelliger kanagurta*

Major share to the landings, among the gears was of multiday trawls contributing to 41% of the total landings. Mechanised dolnets with a contribution of 34% came next to multiday trawl. The share of mechanised gillnets was 10%. Contribution of single day trawl was at 6% while in the case of purseseines, it was 4%. October-December period was found to be more productive than others seasons.

From Fig. 11, it can be seen that the maximum penaeid prawn landings was in September with 9,659 t but total landings of the state was maximum during October 2007 with 45,939 t.

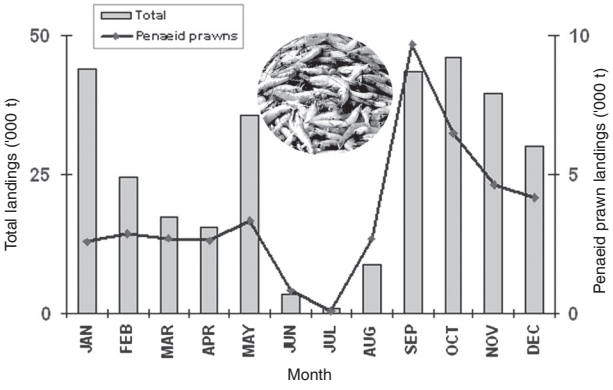

Fig. 11. Monthly penaeid prawn landings along with monthly total landings in Maharashtra

Gujarat

Gujarat, the northern most maritime state of India, is having 1,600 km coastline and 2.4 lakh km EEZ lying within 20°32' - 25° 25' N latitude and 68°32' - 76° 70' E longitude. There are five major harbours and three dolnet operating centres and four zones in Gujarat. During 2007, the marine fish landings of Gujarat was estimated to be 5.38 lakh t. Contributing 18.63% to all India landings, Gujarat occupied the second position among the ten maritime states of India. The mechanised sector contributed 88% of the total landings of Gujarat, whereas the motorised sector contributed 11% and the artisanal sector registered only 1%. Different gears contributing to the fishery in the mechanised sector were multiday trawlnets (45%), single day trawlnets (8%), dolnets (30%), gillnets (4%) and hooks and lines contributing less than 1% to the total landings. In motorised sector, gillnets contributed 11%, hooks and lines 1% and contribution of dolnets was nominal. Artisanal gears operated only in the Jamnagar coast and it contributed only 1% to the total landings. The catch per unit of multiday trawlers was 3,804 kg and catch per hour was 60 kg whereas for single day trawlers, CPU and CPH were 783 kg and 53 kg respectively. The major resources landed during 2007 were non-penaeid prawns (13%), croakers (12%), ribbonfishes (10%), Bombayduck (8%), cephalopods (6%), clupeids (6%), penaeid prawns (5%), catfishes (5%), threadfin breams (4%), other perches (4%) and carangids (4%). The percentage distribution of major resources in different gears is given in Table 11.

Table 11. Percentage contribution of the major resources in different gears in Gujarat

Resources \ Gears	Mechanised			Motorised			Non-motorised
	TN	DOL	GN	GN	HL	DOL	
Non-penaeid prawns	37	63	0	0	0	0	0
Croakers	42	40	4	13	1	0	0
Ribbonfishes	87	8	0	5	0	0	0
Bombayduck	3	94	0	1	0	2	0
Cephalopods	99	1	0	0	0	0	0
Clupeids	39	32	9	17	0	0	3
Penaeid prawns	55	42	0	0	0	0	3
Catfishes	31	38	11	18	1	0	1
Threadfin breams	100	0	0	0	0	0	0
Other perches	95	0	2	2	0	0	1
Carangids	45	1	8	44	1	0	1

TN - Trawlnet, DOL - Dolnet, GN - Gillnet, HL - Hooks and lines

Pelagic resources contributed 37% to the total landings followed by demersal resources (35%) and crustaceans (22%). Contribution of molluscs was only 6%.

During 2007, fishing ban for trawlers and other mechanised vessels as well as outboard engine fitted crafts, was observed from 10th June to 15th August.

Considering the three dolnet operating centres namely Jafrabad, Rajapara and Nawabander, 62% of the Bombayduck landings and 60% of the non-penaeid landings were from these centres. The major species included in each group were as follows:

Non-penaeid prawns	*Acetes* spp., *A. indicus*, *Nematopalaemon tenuipes* and *Exhippolysmata ensirostris*
Croakers	*Johnius* spp., *Otolithes* spp., *Otolithoides biauritus* and *Protonibea diacanthus*
Ribbonfishes	*Eupleurogrammus* spp., *Lepturacanthus savala* and *Trichiurus* spp.
Bombayduck	*Harpadon nehereus*
Cephalopods	*Sepia elliptica*, *S. pharaonis*, *Sepiella* spp., *Loligo* spp. and *Octopus* spp.
Clupeids	*Tenualosa* spp., *T. ilisha*, *T. toli, Ilisha megaloptera, Sardinella* spp., *Coilia dussumieri, Thryssa mystax* and *Chirocentrus dorab*
Penaeid prawns	*Solenocera crassicornis*, *Metapenaus affinis*, *M. kutchensis*, *M. monoceros*, *Parapenaeopsis* spp., *P. stylifera*, *P. hardwickii* and *P. sculptilis*
Catfishes	*Arius* spp., *Osteogeneiosus* spp. and *O. militaris*
Threadfin breams	*Nemipterus* spp.
Other perches	*Epinephelus* spp., *Priacanthus* spp., *Lethrinus* spp., *Pomadasys* spp., *P. kaakan* and *Argyrops spinifer*
Carangids	*Caranx* spp., *Decapterus russelli*, *Megalaspis cordyla*, *Scomberoides commersonianus*, *S. lysan* and *Coryphaena hippurus*

Fig. 12 shows that the maximum landings of croakers was recorded in October 2007 (25,400 t) and the fishing period was from September to May.

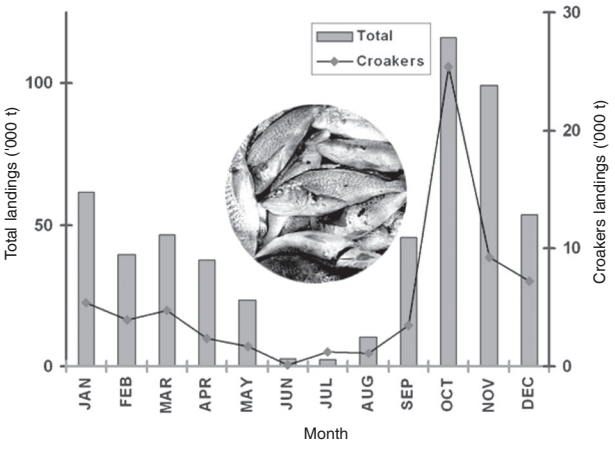

Fig. 12. Monthly croaker landings along with total marine fish landings in Gujarat during 2007

A model for responsible black clam fisheries at R-Block in Vembanad Lake, Kerala

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Kuttanad is a stretch of low-lying land of about 110,000 ha along the banks of Vembanad Lake and Pamba River tributaries. It encompasses vast stretch of backwaters, bordering human settlements, mangrove forests and rice fields. Four major rivers such as, Pamba, Meenachil, Achankovil and Manimala discharge into this region. It has the distinction of being one of the few areas in the world, where paddy farming is carried out below the sea level. The area is quite famous for its fishery for clams, pearlspot (*Etroplus suratensis*), snakehead (*Channa* spp.) and freshwater prawns (*Macrobrachium* spp.).

The black clam, *Villorita cyprinoides,* is the major clam resource in Vembanad Lake with an annual production of 50,275 t. The clam meat is locally consumed and also used as a feed supplement in animal feeds while the shell is largely used in the lime and cement based industries.

R-Block is an island in Kuttanad Taluk (Fig. 1) reclaimed from the Vembanad backwaters with mudwall embankments. About 200 fishermen from Kavalam village are involved in the black clam fishery of Kuttanad backwaters surrounding R-Block.

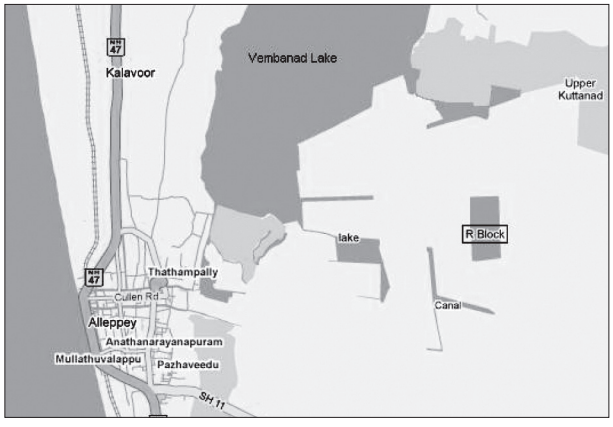

Fig. 1. Map showing R-Block

Fishery of *V. cyprinoides*

Fishery of *V. cyprinoides* exists in R-Block region since 1950. Clam fishery is done throughout the year with peak fishing season from February to May. The Kavalam Black Clam Industrial Co-operative Society was established in 1994 to co-ordinate the clam fishing and trading activities of R-Block. During 2006-'08, an estimated total 2,100 t of black clam shells were collected at the society. According to the records maintained by the society, the total shell production during 2008 was estimated as 690 t with the highest production of 84 t recorded in May and lowest of 35 t in July. The average shell production per month during 2008 was 58 t. The number of fishing days varied from 12 in July to 26 in May 2008 with an average of 22 fishing days per month. Details of the black clam shell production at R-Block during 2008 are given in Table 1. A random assessment revealed that black clams of length 29-59 mm APM (Antero-Posterior Measurement) contribute to the fishery. Besides black clams, pearl producing freshwater bivalves such as *Lamellidens marginalis* and *Parreysia corrugata* also contribute to the bivalve fishery of R-Block.

Table 1. Shell production and number of man days involved at R-Block in 2008

Month	Shell production (kg)	Number of man days
January	46000	1760
February	51000	2046
March	58000	2100
April	76000	2300
May	84000	2548
June	39000	1292
July	35000	996
August	53000	1659
September	54000	1968
October	81000	2325
November	51000	2093
December	62000	1914

Fishing method

The crafts engaged in clam fishing are plank-built canoes of about 26 feet length. At times, two or three canoes are tugged together by a mechanised boat to the fishing site. Clam fishing is usually done by hand picking or hand dredging with scoopnets having small mesh sizes, in other areas of Vembanad Lake. However, the method of fishing followed at Kavalam is unique and is efficient in screening out the young seed clams. The fishermen use a special type of basket locally called "kakkakoodu". The clams are wedged out using two iron spades and collected into the "koodu" (Fig. 2). The fishermen themselves make the "koodu" with galvanised iron frames and split bamboo. There are separate "koodu" for shallow and deep waters. The "koodu" used in shallow water is either cylindrical or conical. The basic shape is framed by welding 8 mm GI pipes together. The basket-like basic frame consists of two GI rings interconnected by two GI rods welded opposite to each other. The cylindrical "koodu" has a height of 25 cm with a diameter of 24 cm. GI square mesh of 2 cm is welded to the bottom ring, which remove seed and juvenile clams. Bamboo splits of 1 cm width are placed 2 cm apart and attached around the base frame using nylon twines. The conical "koodu" (Fig. 3) has a height of 38 cm with an upper and lower diameter of 21 and 13 cm respectively. Two splits are tied together at the bottom, which spread apart at the top thus making the conical shape. It also has GI square mesh at the base. The fishermen tie these "koodu" with the help of nylon/coir ropes around their waist into which they collect the clams. The "koodu" used in deeper waters

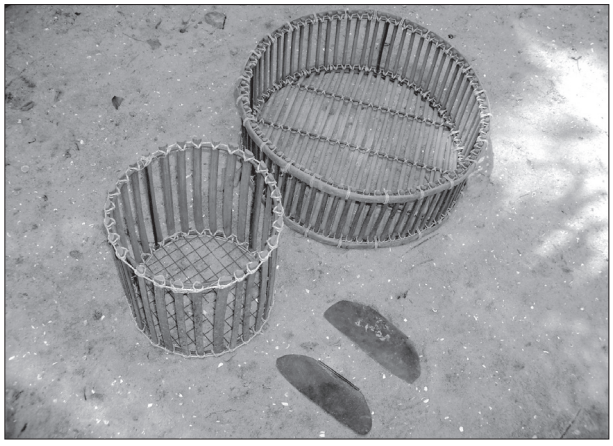

Fig. 2. Cylindrical "koodu" with spades

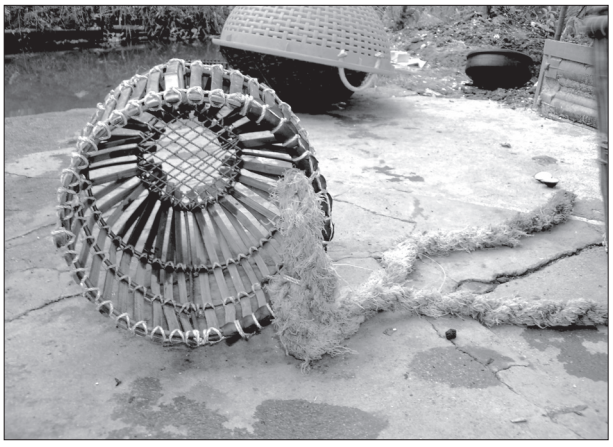

Fig. 3. Conical "koodu"

at a depth of 15 ft or more is 16 cm high with a diameter of 45 cm. The splits are of 5-6 mm thickness and are placed at a gap of 2 cm on the sides and at the bottom. One "koodu" costs around Rs. 400/-. The collected clams are washed to remove the seed clams and other waste materials before transferring to the canoe.

The fishermen go to the clam beds as early as 4 am and return home at about 2 pm. Once the catch is brought, further cooking and meat separation is mostly done on the same day in their households.

Utilisation

Women are actively involved in the processing of clams. The clams are washed thoroughly once again in the backwaters. Then the clams are boiled in large aluminium containers for 15 min using firewood or dry coconut leaves. Afterwards, the cooked whole clams are transferred to "koodu" once again and shaken in a revolving fashion to separate the meat and shell (Fig. 4). The meat is collected below the "koodu' on a plastic sheet while the shells remain in the 'Koodu'.

The meat costs around Rs. 50-60/kg and is sold directly to consumers on the same day. The major customers are resorts, home stays and toddy shops in Kuttanad area. The meat is also sold to households. The shells are sold through the Kavalam Black Clam Lime Shell Industrial Co-operative Society at Rs. 1,350-1,500/- per tonne.

The use of large meshed implements by R-Block fishermen to fish black clams ensures that small juvenile clams are not caught and they have an opportunity to

Fig. 4. Separation of cooked clam meat

grow and reproduce before capture. This ensures sustainability of the fishery, besides assuring fishermen a higher average price for the uniformly large size clams fished. Other black clam fishing communities in Vembanad Lake have to follow similar measures for sustainable management of black clam fishery of the entire lake. However, these fishermen at R-Block need the assistance of scientific and fishery management organisations to scale up their activities. Training programmes in depuration, hygienic processing and value addition need to be imparted among the fishermen to uplift their social as well as economic status.

Prevailing problems of black clam fishing in Kuttanad

Though the clam fishery exists in R-Block area since last few decades, the fishermen encounter various problems associated with their resource, environment and trade. The fishers are unable to meet the consumer demand for clam meat, especially during tourist season. Various factors adversely affect the recruitment levels and catch per unit effort of black clams in this region. They are detailed in their order of importance in Table 2.

Table 2. Problems affecting black clam fishery at R-Block and suggestions for improvement

Rank	Problems	Suggestions
1.	The pollution levels of Kuttanad backwaters pose serious threat to the resource and act as an occupational or health hazard to the fishermen at multitude levels. Pollutants range from pieces of glass bottles thrown from resorts and house boats, slaughter and hotel wastes, waste discharge from coir factories and pesticide runoff from paddy fields	Massive awareness programmes should be arranged to educate general public and visitors about protecting the delicate environment of Vembanad Lake. Kerala Pollution Control Board should set up a monitoring cell to check the pollution levels of Kuttanad and Vembanad Lake. Proactive awareness campaigns may be taken up by the Kavalam Black Clam Industrial Co-operative Society.
2.	Thannermukkom barrage was constructed to promote two crops of paddy cultivation in Kuttanad by preventing the influx of saline water. This has led to profound changes in salinity patterns of Vembanad Lake, especially in the regions south of the barrage. As a result, the survival and abundance of the black clams are affected	State agricultural department shall formulate an agricultural calendar in consultation with the fisheries department, so as to regulate farming and fishing season. The opening and closure of barrage could be decided based on the same. This will bring benefits to both clam fishermen as well as paddy farmers.
3.	Dredging for lime shell destroys the clam beds	Indiscriminate and illegal dredging practices of Kuttanad area should be controlled strictly through enforcement. Dredging licenses may be issued only after proper assessment of impact on biological and fishery resources avoiding potentially rich fishing areas and breeding grounds.
4.	Heavy infestation by aquatic weeds such as *Salvinia* and *Eichornia* affects the total ecological conditions and fishing activities	Mechanical de-weeders should be deployed in R-Block and Kuttanad for control of the aquatic weeds. Biological control methods also may be explored by the society. Proper closure and opening of Thannermukkom barrage is also helpful to control the aquatic weeds to a certain extent.

Biology of *Mactra violacea* (Gmelin 1791) from Kerala, south-west coast of India

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The surf clam *Mactra violacea* (commonly known as violet trough shell), is distributed all along the sandy beaches of north Kerala. It occurs in the surf zone, upto 75-100 m depth. It is a large clam (upto 80 mm) with high meat content and nutritive value which is collected and consumed by the local people. The biology of the surf clam was studied to understand its growth, edibility and potential for mariculture.

Monthly samples of the surf clam *M. violacea* were collected by diving and picking from the surf zone along Thalassery Beach (11.75° N, 75.49° E), off Kannur District, Kerala during 2005. Clam samples could not be collected in June and during September-December due to turbulent conditions. The total length was measured using digital vernier calipers to the nearest 0.1 mm along the antero-posterior axis and width along dorso-ventral axis. The maximum distance between the valves when they are closed was considered as height. The total weight, wet meat weight and shell weight were recorded to the nearest 0.1 g. Gonad smear was examined under the microscope to determine the maturity stages as given by Ropes (1968). The percentage edibility was studied as percentage of wet flesh weight in total weight of the clam (Durve, 1965).

The biological details are shown in Table 1. The size ranged from 38-80 mm, with modal classes in 54-56 (12%) and 56-58 (11%). The mean size was 55.6 ± 5.5 mm. The mean sex ratio was 0.7:1 (M: F), with females being dominant throughout the period of observation except during January and July. The mean meat content was 24.3±1.4% and ranged between 22.9 and 26.7%. The meat content was high during January-March, declined during April-May and again increased during July-August. The changes in the meat content were in relation to the gonadal condition. The clams were in spent stage when the meat content was low and the meat content increased when the gonads matured. The monthly variation in the gonadal condition of the clams is shown in Fig. 1. Nearly 60% of the clams were mature and 44% were spent during the period. The surf clam is a continuous breeder with peak spawning during February-April and probably another peak spawning during October-November.

Table 1. Biological details of *M. violacea*

Month	Mean TL (mm)	Mean TW (mm)	Mean T Wt (g)	Size range (mm)	Modal class (mm)	Meat (%)	Sex ratio
Jan. 05	49.6	..	26.3	42-67	48-50, 46-48	23.2	1:1
Feb. 05	61.9	51.3	49.0	40-80	56-58, 68-70	26.7	0.9:1
Mar. 05	59.9	50.0	44.0	48-79	58-60	25.2	0.3:1
Apr. 05	52.4	43.0	31.7	41-65	40-42, 56-58	23.0	0.6:1
May 05	48.6	37.1	25.1	38-67	40-42	22.9	0.2:1
Jul. 05	60.7	50.6	49.5	50-68	56-58, 58-60, 66-68	23.9	1.4:1
Aug. 05	56.0	45.6	37.7	39-68	54-56, 58-60	25.1	0.8:1
Mean ± SD	55.6	46.2	37.6	38-80	54-56 , 56-58	24.3	0.7:1
	± 5.5	± 5.5	± 10.2			± 1.4	

(TL = Total length, TW = Total width, T Wt = Total weight, SD = Standard deviation)

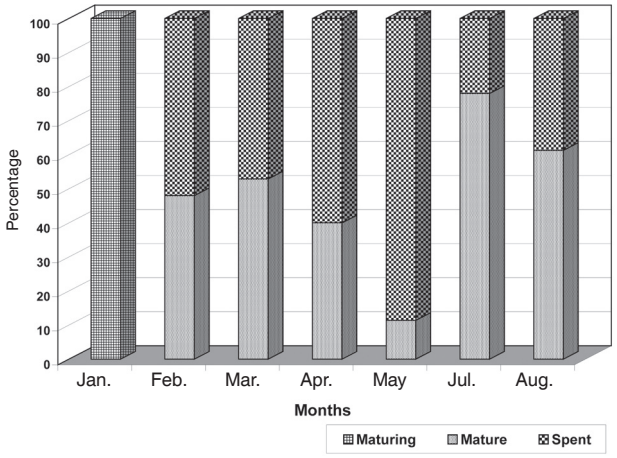

Fig. 1. Gonadal variations in female *M. violacea* during 2005

M. violacea is a large marine clam. Clams below 38 mm size were not found in the surf zone and it is therefore possible that juveniles form a habitat in deeper areas where surf action is less severe. The larger clams possess a large foot and bury deep into the sandy substrate of the surf zone and are able to withstand the frequent disturbances in the sand due to tidal effects (Gaspar *et al*., 2002). The meat content in *M. violacea* is very high ranging from 23 to 27% compared to those reported in *Meretrix meretrix* (7.6 – 16.1%), *Paphia malabarica* (8.86 to 20.8%), *Villorita cyprinoides* (6.2 – 18.76%) and *M. casta* (7.6 to 16.1%). The seasonal variation in the meat content is not marked as compared to other clam species.

Landing of the dog whelk, *Nassaria nivea* and the beak shell, *Tibia fusus* by trawlers at Tuticorin Fisheries Harbour during January-March, 2009

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At Tuticorin Fishing harbour, during peak fishing season (June-October 2009), more than 200 trawlers operate daily. During January-March 2009, the trawl catch was generally poor and the number of trawlers under operation fell by 25-30%. In January 2009, around 20 trawlers started operating for deepsea prawns and the total catch per day ranged between 800 and 2,500 kg. In addition to the prawn catch, 25 to 40 kg of gastropods were also landed regularly by each boat upto March 2009 (Table 1). Enquiries revealed that the area of operation for deepsea prawn was 40 miles from the shore, north of Tuticorin at a depth of 200-400 m. Each boat landed 60-130 kg of *Parapenaeopsis stylifera* which was sold at the landing centre for Rs. 20 per kg. The dominant species among the deepsea prawns was *Solenocera hextii* (Wood-Mason and Alcocki).

Two species of gastropods were identified in the landings - *Nassaria nivea* and *Tibia fusus* (Fig. 1 and 2). The maximum shell diameter (MSD) of *N. nivea* ranged from 0.81 to 1.40 cm and weighed 1.1 g to 5.2 g. A 15 kg basket of *N. nivea* was sold at the landing centre for Rs. 200/- and *T. fusus* for Rs.150/-.

Fig. 1. Catch of *Nassaria nivea* and *Tibia fusus*

Fig. 2. *Nassaria nivea*

The gastropod shells were sent to Kanyakumari for making ornamental items and decorating materials. The total landing of gastropods was estimated as 16.2 t in January, 14.7 t in February and 18.2 t in March 2009. The catch of these gastropods and deepsea prawns help to sustain the trawl fishery at the time of poor catches. Also, there exists scope for developing a seasonal shell craft industry at Tuticorin which will give additional income to the local fisherwomen. Although this is a regular phenomenon every year at the Tuticorin Fisheries Harbour, this has not been reported earlier.

The length-weight relationship of *N. nivea* was worked out as: Log W = -0.40095 + 1.934758 log L and Log W = 0.2433 + 1.444192 log MSD.

Table 1. Details of catch landed at Tuticorin Fisheries Harbour during January - March, 2009

Month	Trawl units	Total catch (t)	Quantity landed (t)			Total gastropods (t)
			Deepssea prawns	*Nassaraia nivea*	*Tibia fibia*	
January '09	480	1529	28.800	8.064	8.160	16.224
February '09	462	979	60.270	7.791	6.905	14.696
March '09	550	1020	47.250	9.625	8.575	18.200
Total	1492	3528	136.320	25.480	23.640	49.120

Fishing methods in coral reef areas of the Gulf of Mannar

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Fishing methods being practised in the reef areas of the Gulf of Mannar for finfishes are trawling, gillnetting, fishing by hooks and lines and traps. Out of these, the most important device is trawling by which the most diverse and the highest quantity of finfishes are being landed from coral reef areas in this region.

Trawling

Trawling in this area is being carried out by a special type of trawl net called roller net, locally known as 'Roller madi' (Fig.1 and 2).

Fig. 1. Roller net

Fig. 2. Roller net showing rollers

It is a modified type of net developed by the Central Institute of Fisheries Technology for operating in uneven grounds. The gear is attached with rollers or wheel-like structures on the foot rope. The rollers or wheel-like structures are made up of wood or rubber. Unlike ordinary trawlnets, this net can easily roll over the coral reef or rock without much damage to the net. The mesh size of the cod end is around 20 mm. Usually, for fishing, the fishermen leave the shore by 1300 – 1500 hrs and come back by 1030 -1630 hrs the next day. The depth of operation

varied between 12 and 100 m. The crafts used are trawlers with 9.5 to 12.5 m length, fitted with an inboard engine of 116-188 HP. Around 100 units operate per day in this region. Every year, the fishing season starts by September-October and will be over by 15th April of the succeeding year, along with the commencement of trawl ban. Fishing days are about 14 days in a month. From January onwards, pair-trawling with bigger rollers attached to the net is also being practised in this area. It is a blessing that nature itself has imposed a closed fishing period from 15th April to September-October period as the Gulf of Mannar remains rough during this period.

Gillnetting

Bottom-set gillnet is being operated in the reef areas of this region. This is locally known as 'Mandal valai'. It is nothing but a rectangular piece of net, set at the bottom with weights and floats. This type of fishing is practised throughout the year in the Gulf of Mannar. Nets with different mesh sizes, 100 - 200 mm are being operated in this area to catch fishes along with lobsters and chanks. The craft used are boats with 9.5 – 13 m length fitted with an inboard engine of 20 – 65 HP. When the catch is poor, they may stay in the fishing ground for 3-5 days together to get a reasonable catch and hence there is no fixed time of departure from shore or for arrival. On an average, 25 units are landed per day. Fishing days are about 12 days in a month. They normally operate at a depth of 12-85 m.

Hooks and lines

Fishing with hooks attached to a single line (Fig. 3) or a series of lines with hooks attached to a long line at regular intervals are practised.

Fig. 3. Hook and line

This gear is being operated by fishermen from Kanyakumari, Colachel and Muttom area. Fishing season is from October to April every year. The baits used are live fishes (*Sardinella sirm*, *Dussumieria acuta etc*.). It is believed that big fishes are being attracted by the smell of blood. The crafts used for this type of fishing are fibre glass boats of length 7-12 m fitted with an outboard engine having 8-10 HP. More than 100 units operate per day in this region. Usually they operate this gear at a depth of 24-84 m. The fishermen may leave the shore early in the morning and come back by evening or they may start by evening and return by morning. Also, they may stay in the fishing ground for more time if catch is poor. Fishing days are about 26 days in a month.

Traps

Fishing by traps, locally known as 'koodu' are extensively used in this area (Fig. 4).

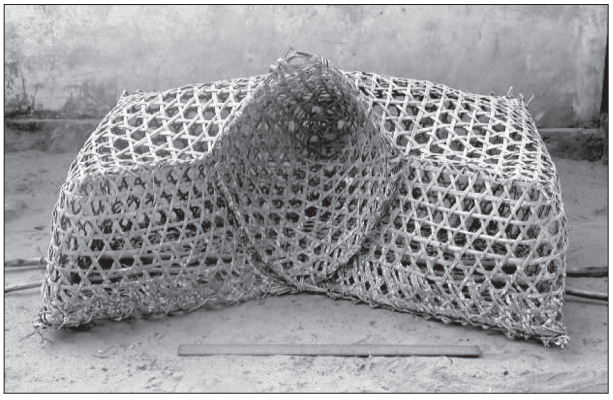

Fig. 4. Fish trap

Three types of traps are in use according to the number of openings present. They are traps with one, two and three openings and out of these, trap with one opening is being used by majority of fishermen. The most commonly used material for the construction of traps is *Acacia planifrons*, locally called 'odai tree'. Fishermen lay the traps in a fishing ground at the bottom with the help of stones after introducing the baits. The commonly used baits are shrimp heads. After about 24 h, the catches are taken out and traps are again left in the ground after introducing the bait and this process will continue. After 10 or 12 days, the traps are taken to the shore for cleaning and sundrying to make them more durable. Around 600 traps are being operated in this area. In most of the centres, it is operated throughout the year and fishing days are 26-27 in a month.

Indigenous modification in dolnets operated along the Saurashtra coast

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The dolnetters of Jaffrabad, Rajapara and Nawabunder were using stone heaps as anchors for fixing their submerged dolnets. This process was very tedious and costly. Recently an innovation in this method was devised by fisherfolk from Jaffrabad in which they used long steel pipes hammered to the bottom of the sea in place of stones they used earlier. Since this process is much more flexible and durable, all the dolnetters of Jaffrabad, Rajapara and Nawabunder have adopted it.

The structural details are as follows:

- Length: 12-14 ft.
- Width: 3-4 inches
- Cost: Rs. 1,800-2,200/pipe
- Weight: 40-50 kg
- Three rings welded on the outside of pipe for safe anchorage at the bottom.
- Heavy loaded ring used on the upper side of pipe for load safety.
- Two pipes used for one net.
- Pipes anchored in muddy area instead of rocky area.
- Pipes dismantled at the end of each fishing season and reused in the next season.

Indigenous modification in dolnets along the Saurashtra coast

Table 1. Comparative benefit of steel pipe technology

Stone anchors	Steel pipe
Laborious and costly	Easy and cheap
Changing of fishing ground is difficult	Changing of fishing ground is very easy
Cannot be used in the next fishing season	Removable and reusable in the next fishing season
Net damage more	Net damage very less
Fishing operations not flexible	Flexibility in fishing operations