Hooks and Line Fishery Resources of India

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The paper provides information on the present status of hooks and line fisheries in the coastal waters of India based on information collated out from published accounts, unpublished project reports of CMFRI and studies conducted at selected centres. The geographic and bathymetric regions along Indian waters where the gear is in wide operation and the exploitation of different resources by the gear in various seasons are also dealt with. Hand line fishing conducted along coastal uneven grounds of coral, rocky outcrops during selected seasons by migrating fishermen and the resources vulnerable to this gear are also presented. The significance of pole and line operation for tunas in Lakshadweep waters is described. All India, state-wise and region-wise catch, effort and catch rates of groups/species exploited by hooks and line during the period 1985-89, specific bait used in each region, ecology of the fishing terrain are incorporated, along with suggestions and recommendations to conserve resources, manage and develop this fishing technique along Indian waters.

Of the several types of traditional fishing methods, the hooks and line formed one of the most dominant and economically viable fishing technique to exploit large pelagic, column and demersal predator fishes. There are about 57,000 hooks and line units in India, which is the second dominant gear for marine fishing, next to drift/gill net, with the maximum number in Tamil Nadu (39%) followed by Orissa (27%) and Andhra Pradesh (19%) (Anon, 1981).

Central Institute of Fisheries Technology made some studies (Kartha et al., 1973; Rao et al., 1989) on the effectiveness of hooks to catch predator fishes based on hook size and various prey organisms.

The studies on the line fisheries such as longline, hand line and pole and line of coastal Indian waters by mechanised and non mechanised units were attempted by several workers (Luther et al., 1982; Gopakumar et al., 1986; Lal Mohan & Nandakumar, 1988; Menon et al., 1989; Sukumaran et al., 1989, Grace Mathew & Venugopalan, 1990; Jayasankar, 1990). Studies conducted at selected centres, revealed that the gear is very effective to exploit large predator fishes such as catfishes, elasmobranches, tunnies, seabreams, perches etc. from uneven non-trawlable fishing grounds of coastal waters with coral or rocky outcrops. The paper presents all India, state-wise, centre-wise and season-wise hooks and line catch, effort, catch rates, species composition and fishing areas.

Materials and Methods

The data pertaining to this study were collected from NMLRDC of CMFRI for catch and effort. Investigations conducted by CMFRI from selected important fishing centres provided monthly catch, rate of production, species composition; geographi cal, seasonal and bathymetric yield and abundance of the major predatorfishes caught in the gear.

Results and Discussion

Three categories of hooks and line such as ong line, hand line and pole and line are in vogue and all of them are operated from non-mechanised catamaran, canoe or mechanised (OBM) catamaran, canoe or mechanised pole boats (30'). Both long line and hand line are widely operated along the coastal waters and sometimes upto 150 m depth, depending on the seasonality of the resources. The gear is well known for its effective catch of tuna, mackerel, billfishes, etc.

The species composition, along with the harvest, are given in Table 1. The species distribution analysing the landings for the years 1985-89 was estimated as 29.57% (1.7% in total fish production) with the maximum contribution by Kerala (58.1%), followed by Andhra Pradesh (14%), Maharashtra (10.7%) and Tamil Nadu (9.3%). The species-wise composition is given in Fig.1. Cat fishes formed the major constituent. Table 1 represents the statewise landings of the different species. Cat fish

Table 1. Statewise percentage contribution of major groups of fishes in long line catch (average for 1985-89) ranks in parenthesis

<table>
<thead>
<tr>
<th>Groups of fishes</th>
<th>West Bengal</th>
<th>Orissa</th>
<th>Andhra Pradesh</th>
<th>Tamil Nadu</th>
<th>Pondicherry</th>
<th>Kerala</th>
<th>Karnataka</th>
<th>Goa</th>
<th>Maharashtra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharks</td>
<td>0.7</td>
<td>9.1(3)</td>
<td>12.6(3)</td>
<td>84.9(1)</td>
<td>1.9</td>
<td>3.7</td>
<td>77.4(1)</td>
<td>14.3(4)</td>
<td>11.8(3)</td>
</tr>
<tr>
<td>Skates and Rays</td>
<td>20.7(2)</td>
<td>26.9(2)</td>
<td>4.8</td>
<td>1.6</td>
<td>1.0</td>
<td>1.6</td>
<td></td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Carasses</td>
<td>76.1(1)</td>
<td>43.6(1)</td>
<td>27.2(2)</td>
<td>0.4</td>
<td>1.9</td>
<td>14.4(3)</td>
<td>8.3(2)</td>
<td>22.8(3)</td>
<td>62.4(1)</td>
</tr>
<tr>
<td>Rock 2</td>
<td>-</td>
<td>-</td>
<td>1.9</td>
<td>-</td>
<td>2.3</td>
<td>1.3</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Snappers</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
<td>11.3(5)</td>
<td>2.1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Threadfin 3</td>
<td>-</td>
<td>-</td>
<td>7.5</td>
<td>4.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Perches 1</td>
<td>0.1</td>
<td>2.4(3)</td>
<td>17.9(3)</td>
<td>2.8</td>
<td>1.3</td>
<td>28.6(1)</td>
<td>0.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seer fishes</td>
<td>-8.4(5)</td>
<td>28.0(1)</td>
<td>1.0</td>
<td>13.2(4)</td>
<td>5.7(5)</td>
<td>5.1(3)</td>
<td>17.2(2)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mackerel</td>
<td>2.0</td>
<td>0.3</td>
<td>4.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tuna &amp; Billfishes</td>
<td>-10.1(4)</td>
<td>3.3(2)</td>
<td>3.8</td>
<td>19.2(2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carangids</td>
<td>3.6</td>
<td>8.0</td>
<td>2.2(4)</td>
<td>22.6(1)</td>
<td>22.3(1)</td>
<td>4.6</td>
<td>8.6(5)</td>
<td>0.6</td>
<td>3.0</td>
</tr>
<tr>
<td>Crotops</td>
<td>-</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other fishes</td>
<td>2.4(3)</td>
<td>7.6(4)</td>
<td>9.1(5)</td>
<td>1.1</td>
<td>20.7(3)</td>
<td>9.8(4)</td>
<td>3.4(4)</td>
<td>25.7(2)</td>
<td>0.3(4)</td>
</tr>
<tr>
<td>Total catch</td>
<td>78.7</td>
<td>607</td>
<td>3939</td>
<td>2624</td>
<td>53</td>
<td>1613</td>
<td>314</td>
<td>35</td>
<td>3016</td>
</tr>
<tr>
<td>Percentage in total hooks and Line catch</td>
<td>2.7</td>
<td>2.2</td>
<td>14.0</td>
<td>9.3</td>
<td>0.2</td>
<td>58.1</td>
<td>1.1</td>
<td>10.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Fig. 1. Species composition (%) of long line landings.
was dominant in West Bengal, Maharashtra and Orissa. Seer fish in Andhra Pradesh, sharks in Tamilnadu and Karnataka and carangids in Kerala. In other states, dominance of any particular species was not evident. The state-wise long line catch during 1985-89 period indicated high hooking rates in Tamilnadu (67.6-446.9 kg/unit), Maharashtra (114.8-362.3 kg/unit) and Gujarat (116.8-236.8 kg/unit) almost throughout the period and in Karnataka (214.9-271.9 kg/unit) during 1988-1989. Though the long line production of Kerala and Andhra Pradesh was high, the catch rate remained at 15.4-33.7 kg/unit and 18.7-27.7 kg/unit respectively. The total long line landing fluctuated from 22,100 t in 1985 to 39,375 t in 1988 showing a general increasing trend (Table 2).

Long line fishing at selected centres

The regional climatic conditions, bottom texture, condition of fishing grounds and their faunastic abundance affect the strategy of the fishing. As the non-mechanised liners cannot cope with inclement weather and unusual drift/current during monsoon months, either the fishing is carried out during pre-monsoon and post-monsoon months or the liners migrate to suitable areas, where the sea is calm.

Long line fishing in Kannur district of Gujarat produced catfish groups as the major component group. Fishing is done in shallow rocky areas within 8 km from shore (20-30 m) depth both during day and night. In each line 1000 hooks of No. 6-8 are attached at two m intervals with squids/Octopus as bait. The major species of catfishes were Tachysurus dussumieri, T.soma, T.caelatus, T.thalasius and Osteoglossum bicirrhosum in the order of abundance. In this region long liners produced high catch rates during September-April months (Sarvayta & Malli, 1991).

The long line fishing at Bombay yielded 308.5 t in 1989, the major fish groups caught were catfishes (70%) and elasmobranchs (21%). The seasonal catfish catch by the gear ranged from 0.8 t (July) to 54.9 t (November) with corresponding catch rates of 80 and 197 kg/unit effort. The last quarter of the year produced high catches of catfishes and the frequently caught species were T.dussumieri (95.5%), T.soma (2.7%) and T.caelatus (1.8%). The monthly elasmobranchs production ranged from 0.9 t (June) to 15.9 t (October). Sharks accounted for 74% and rays 26% in the total elasmobranch catch.

The long liners in Karwar operate in coastal water up to 50 m depth during October-May period with an average annual yield of 15.3 t (1979-80). The catch composed mainly of catfishes (55.1%) and elasmobranchs (44.9%). The production rate was 30.9 kg/unit effort for catfishes and 25.2 kg/unit effort for elasmobranchs.

The migratory fishermen from Kerala, recently (1987) successfully introduced the long line fishing along Karnataka (Male-Kolam) for deep sea sharks. They operate from small mechanised boats (9.7 m with 47 HP engine) during September to May in deeper waters of 100 m and above. The bait used was pieces of tuna and dolphin. During 1987-88 the estimated catch by the gear was 2000 t of shark with peak landing during November-December. The important species of sharks landed were Carcharhinus sorrah, C.melanopterus and Sphyrna lewini (43%). The return per trip was estimated to be as high as Rs.30,000 per unit. Attracted by this high returns, recently some of the local trawlers and gill netters have switched over to longlining (Sukumaran et al., 1989).

Set long line fishing for sharks along Kerala coast was practised from country craft and catamaran till 1978. This gear is now operated from mechanised crafts (Mohan Rajan, 1982).

Longliners operate regularly from two fishing centres, Vellayil and Elathur at Calicut. At Vellayil, the catch by the gear varied from 15.1 t in 1979 to 493 t in 1980. Marine catfishes formed on an average (1979-1985), 91.7% in the total fish catch of the gear. Tachysurus dussumieri accounted for 48.7% of the total catch which is followed by T.dussumieri (28.5%), T.thalasius (20.3%) and T.soma (2.3%). Their catch rate fluctuated from 132.6 kg to 210.8 kg during 1979-1985 with two peak occurrences in September-December and January-March. Sharks belonging to the species Scyliorhinus canicula (70%), Carcharhinus melanopterus (20%) also occur in substantial quantities in this gear. Fishing is carried out in depths of 10-70 m. Different sizes of hooks (No. 9-23) are used in the same line and each fishing unit carried up to 2000 hooks and fishes such as sardines, small scadids are used as bait. From 1980 motorised country crafts were used for line fishing.

At Elathur, drift long lines are operated from country crafts/OBM units in deeper waters (upto 120 m) for the exploitation of sharks. The snoods used are Donnani type as described by Rao et al., (1989). The fishing takes place round the year, except for the monsoon months, with peak catches during January- April period. Hook No. 1-4 are used with live eels cut into blood oozing pieces as bait. Major species caught are Carcharhinus limbusius (47%) and Sphyrna lewini (43%) and the less abundant species landed were C.dussumieri, C.sorrah, Galeocerdo cuvier and Rhizoprionodon acutus. During 1989 the long liners landed 367 t of sharks and the catch rate ranged from 95 kg in November to 716 kg in February. The total during 1965-75 ranged from 433 to 1638 t with a mean of 1028 t per year (Luther et al., 1982). Production of non-mechanised and mechanised (OBM) hooks and line units operated off Vizhinjam in depths of 40-50 m and 60-80 m was 229 kg and 62.5 kg respectively unit effort in 1983.

The line fishery at Tuticorin exists throughout the year and mostly carried out by traditional non-mechanised and mechanised crafts. Each fishing unit consists of 1000-1300 *Mustad* No.7 hooks. Lesser sardine and chank meat are used as bait. The liners operate off Trincomalee coast between 8°-9° S lat. at depth of 35-60 m in the coral reef area. The annual production during
1980-88 ranged from 133 t (1981) to 694 t (1985) with better landings in January, February, August and September. Perches accounted for 65.6% of the total line catch and the common species were Lepithseus nebulosus (27.3% in perch catch) Lepithseus spp. (13%), L. miniatia (9.9%), Epinephelus spp. (14.5%), Serratus spp. (22%) and Diagramma spp. (13%). Perch landing has two peak periods of occurrences in July-November and April-May. The next dominant species are sharks, carangids, catfishes, rays and other fishes in the decreasing order of yield. (Sam Bennet & Arumugam, 1989)

The long line fishermans from Tuticorin migrate towards Pamban and Mandapam region during December-March period to operate hooks and line from in board engine fitted country crafts in the reef areas of Dhanushkodi at depths of 18-25 m. Mustad No. 7 hooks is used in the longline. About 1000-3000 hooks are attached in each line and Sardinella spp. are used as bait. Lepithseus spp. accounted for 34% of the total fish yield, the next dominant predator was Lutjanus spp. (23%) followed by sharks (9.5%), rays (8.4%), Epinephelus spp. (6.9%) and Pristipomoides spp. (4.7%) (Jayashankar, 1990). The hooks and line fishery at Lawson's Bay, Visakapatnam yielded 111.4 t of fishes during 1989-90 with a catch rate of 4.2 kg/unit. The liners operate throughout the year with peak catches during March-May and September-November months. Catch was composed of predatory fishes like Scomberomorus commersoni (37.6%), S. guttatus (19.8%), Istiophorus platypterus (8.8%), Euthynnus affinis (7%), T. thalassinus (6.7%), Caranx rhodeus (6.3%) etc.

The Experimental Long Line Fishery

There was no organised commercial fishery for the resources namely, tuna, bill fishes and shark except the pole and line fishery of Lakshadweep. During the last few years the FSI ventured to explore the extent and magnitude of tuna resources in Indian seas. The results indicated that Thunnus albacares (Yellowfin tuna), T. obesus (Bigeye tuna), Katsuwonus pelamis (Skipjack tuna), and T. alalunga (Albacore) form 46.1% of the total long line catch, which is followed by pelagic sharks (41.2%), bill fishes and sail fishes (9.3%) and the remaining by dolphin fish, seer fish etc. The survey revealed that the hooking rate (number of fish/100 hooks) was 3.35 In Arabian sea followed by Arabian Sea (1.51) and Andaman sea (1.51). That the share of tuna in long line catch from Arabian Sea is as high as 49.6%, is a positive indicator for extensive long line exploitation in the high seas. Around Agatti, Kadamat at depths of 30-110 m an average hooking rate of 8.4 with 95% of the catch composed of sharks was obtained. Attracted by the high economic return from the long line operations now there are 15 units regularly operating long line from Lakshadweep (George Varghese, 1991).

Hand Line Fishing

Hand line was operated from all along the coastal waters with better catches from Andhra Pradesh, Kerala, Tamilnadu and Orissa. Rock cods formed 45.5% of the total catch followed by snappers (27.7%), sharks (14.3%), tunnies (5.5%), carangids (2.6%) and other perches. In Kerala and Tamilnadu, rock cods, snappers and sharks accounted for about 90.3% of the total hand line catch during 1982-1988 period, which is followed by elasmobranchs (4.4%) and tunas (2.9%). The hooking rate was the highest in January due to the clarity of the water in the fishing grounds during this season (Grace Mathew & Venugopalan, 1990).

About 50 hand line units operate from Pulivulla fishing village during January-April period. This gear operated from deeper waters (50-150 m) along rocky grounds off Quilon for Kalava fishing with silver bellies, Decapterus russelli etc as baits. During 1980-81 period the catch rate varied from 32.41 kg/unit and Lutjanids formed more than 72% of the total catch of the gear (Madan Mohan, 1983).

Hand line operation (Achil) is very prominent along Vighnjam waters and the catch includes Dussudania spp. (25%), lesser sardines (20%), carangids (13%), Decapterus spp. (11%) etc. Active operation of the gear is during May, June and August, when about 87% of the annual effort is expended, landing 93% of the annual catch by this gear with a catch rate of 5.4 kg to 14.3 kg/unit (Luther et al., 1982). Recently Joel et al.,(1989) described light fishing for carangids by employing 'achil' during December-January period along the waters of Trivandrum District. The OBMs canoes (about 900 units) carried out fishing during fishing night with kerosene lamps at depths of 85-110 m and yielded 100-350 kg/unit, mostly of Selar crumenophthalus. Estimated catch is about 2000 t in a fortnight period.

The hand line is operated from Tuticorin round the year and the annual landings fluctuated from 240.6 t (1982) to 378.1 t (1985) with an average of 309 t during 1980-85 period. The annual catch rate ranged from 58 kg to 85.5 kg/unit effort with a mean of 75.4 kg/unit and the best period of landing was from January-March. Threaddin breams accounted for about 36% of the total catch and the next important predator species were lethrinids (20%), Belone spp. (9.9%) sardines (10%) and carangids (6%) (Sam Bennet & Arumugam, 1989).

Pole and line fishing

The pole and line fishery is concentrated around Minicoy, Agatti, Bangaram, Perumal Par reef, Suheli par and Birsa island. It is the mainstay for tuna fishery of Lakshadweep islands, which is (1) relatively less capital oriented (2) able to harvest small schools and (3) providing self employment for nearly 5000 people. The total tuna catch in Lakshadweep by this gear fluctuated from 1116 t in 1977 to 4355 t in 1984 with a steady increase from 1981 to 1984. Skipjack tuna, Katsuwonus pelamis
As the motorised canoe and catamaran with hooks and lines can reach deeper areas for fishing operations, the yield was composed mostly of quality predator fishes, fetching high value per kg of fish. The price realised per kg of fish was the highest (Rs.6.74) for motorised catamaran with hook and line followed by motorised canoe (Rs.5.81) as against Rs.2.58 and Rs.1.28 for gill net and boat seine (Balan et al., 1989). The returns to labour was the highest (R.S.77/day/person) for motorised catamaran with hooks and line and Rs.48/day/person for canoe, whereas it was only Rs.34 and Rs.24 for gill net and boat seine respectively. The study further revealed that the passive gear operation provides employment at the minimum investment cost. John Kurian & Rolf Willmann, (1982) reported that in Kerala the investment per crew was around Rs.546-1271 for hook and line fishing, Rs.886 - 952 for boat seines, Rs.1146-3144 for gill nets and Rs.26650 for trawl net, indicating that the low energy fishing is attractive.

Appropriate technologies or any new innovations in the artisanal passive gear sector must be based on concepts, relevant to and acceptable to the communities for which they are intended. The declining fuel energy resources and its high cost point to the probability that the artisanal sector using passive gear may form the mainstream of exploitation, rather than the periphery, in future.

Recommendations

1) Diversification of low energy fishing techniques and redeployment of available mechanised units, which yielded poor returns, for hooks and line fishing.
2) Appropriate commonly available cheap baits may be introduced after a careful study on the food spectrum and preference of the component predator species regularly caught in the gear.

3) Combination of hooks and length of branch line may be determined based on a thorough study on the ecology and bathymetry of the fishing grounds, behaviour and feeding habits of the target or amenable species and the seasonal surface/depth patterns in the fishing grounds.

4) Based on the available knowledge on the seasonal, vertical and horizontal migrations towards some of the predator fishes (Catfishes, barracudas, etc.) the line fishing may be redeployed to shallow suitable grounds there by reducing fuel consumption for propulsion and the cost of operation.

5) The length of the snood may be suitably adjusted, based on the seasonal vertical ascent or descent of the demersal and column predators such as catfishes, perch, barracudas etc for increasing the rate of production.

6) Experimental behaviour studies of selected predator fishes such as catfishes, perch, seabreams and sharks may be conducted in confined environments to study their behaviour and mode of bite/attack towards different baits and hook types.

7) To reduce fuel requirements, power boats/OFM boats may be equipped with sails, whenever wind is favourable, as an alternate source of energy for fishing or propulsion or both.

8) Artificial reefs or FADs may be developed for aggregation and concentration of fish resources from where passive gears can be operated with minimum energy consumption for propulsion.

The authors are thankful to Dr. P.S.B.R. James, Director, Central Marine Fisheries Research Institute, Cochin for his kind encouragements.
Tuna Fishery Resources and their Exploitation by Low Energy Fishing Techniques

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The tuna resources landed by the small scale fishery sector in the neritic zone of the Indian EEZ evinced an increase of about 25,000 t in 1989 over that of 20,350 t in 1984. Of these, about 53% and 13% of the total tuna landings are contributed by the SW and SE coasts of India respectively in recent years. In the present communication, the recent trend of fishery for tunas along the coasts of India as a result of mechanisation of traditional fishing crafts and introduction of mechanised-cum-sail boats are quantitatively evaluated. Diversification in the small scale fishery sector is also dealt with and the resultant increased efficiency of the gear in the catch rate of tunas is discussed.

The impact of Payaos and rumpon (FADs) and Artificial reefs as tuna aggregating devices in the Indo-pacific Area is presented along with information on cost-benefits, direct operational costs (DOC), socio-economic aspects, recent trend in the decrease in fishing effort and increase in total catch and catch rate. Appropriate technologies such as low-cost fuel-flow monitoring devices, light luring purse seineing, deploying tuna aggregators, utilizing wind energy are options available for improving the efficiency of operational methods and economic utilisation of live-baits in the pole and line tuna fishery sector for the exploitation of tuna resources by low energy fishing from the coastal and insular realms of the Indian EEZ are also suggested and discussed.

Several communications in the recent past have dealt with the availability and abundance of tuna resources, both in the neritic and oceanic sectors of the Indian EEZ. Sudarshan, Pillai (1989) estimated the potential yield of skipjack and yellowfin tuna resources from around 25,000 t and according to James et al. (1989) the potential of tunas is 8,000 t in the Andaman and Nicobar waters, 50,000 t in Lakshadweep beyond 100 m depth, and about 90,000 t along the mainland coasts beyond 50 m depth. Sudarshan et al. (1988) estimated the potential yield of tunas and billfishes from the EEZ of the SW coast of India as 18,500 t.

In recent years, the tuna fishery in the Indian EEZ evinced fluctuations and oscillations since 1970, and in 1989 an all-time peak production of 45,230 t had been recorded. The average tuna production (excluding billfish landings) coastal purse seineing along the mainland of India, artisanal pole and line fishery operations around Lakshadweep producing about 5,800 t of skipjack and yellowfin tunas, operation of Govt. of India Survey/Training Vessels landing about 250 t of larger tunas, and production by chartered vessels(Taiwanese longliners) around 1,100 t of oceanic tunas.

In the present communication, the recent trend of tuna fishery in India in the small scale sector is described, and the strategies of development of this sector through low cost fishing techniques quantitatively evaluated.

Recent trend of tuna fishery in India

Tuna production in India evinced fluctuations and oscillations since 1970, and in 1989 an all-time peak production of 45,230 t had been recorded. The average tuna production (excluding billfish landings)