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Life History traits of Silver Roughy *Hoplostethus mediterraneus* (Cuvier) (Family: Trachichthydae) from the Continental Slope of South West Coast of India

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Distribution, abundance, sex ratio, food and feeding, maturation and spawning and length-weight relationship of *Hoplostethus mediterraneus* (Cuvier) inhabiting the continental slope of south west coast of India were studied. The data for the present study was collected from the deep sea exploratory fishing surveys conducted onboard FORV Sagar Sampada in the Arabian sea between 7° N latitude and 14° N latitude during 1999 – 2002. *H. mediterraneus* was found to be distributed in the depth range 280 – 682m. Depth wise distribution was found beyond 300m and at 8° to 10° N, it was found only in the depth zone 301 - 400m. While at 11° to 13° N, its occurrence was registered only beyond 400m. It showed a wider bathymetrical distribution (300 – 682m) in the latitude 10° - 11 ° N. Length related chi square analysis of sex ratio in *H. mediterraneus* revealed that males skewed in all length groups as well as in all seasons. Spawning season of *H. mediterraneus* coincided with pre-monsoon and monsoon seasons. Feeding intensity was found to be very less and found to be feeding on myctophids, *Aristeus* spp., *Heterocarpus* spp., squids etc. LWR obtained for the depth zones 301 – 400 m and 401-500 m are Log W = -1.06 + 2.3 Log L and Log W = -0.88 + 2.12 Log L respectively.

Key words : *Hoplostethus mediterraneus*, distribution, biology, deep sea, Length-weight relationship

Slimeheads (Trachichthyidae) are medium sized fishes occurring near the bottom in between depths of 100 to 1000 m and mostly between 250 and 600m. Many of the slime heads are cosmopolitan in distribution and some are reported to be rather abundant in certain areas (Fischer & Bianchi, 1984). *Hoplostethus mediterraneus* (Cuvier), the silver roughy is predominantly inhabits in the sea bottom at depth ranging from 250 – 700 m. This species was reported earlier from western parts of the Mediterranean, off Madeira, Atlantic coast of North America, off the European and African shores of the Atlantic from Ireland to Cape Verde, Mediterranean, Japanese seas and in India from both Arabian Sea and Bay of Bengal (Goode & Bean, 1895; Alcock (1899). The pattern of distribution and abundance of deep sea fishes in the Indian EEZ were studied previously, however the life history traits of *H. mediterraneus*

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is hither to unknown. On the other hand the biology of this species were reported from Eastern Atlantic (Golovan, 1978; Marshall & Merrett, 1977; Merrett & Marshall, 1981; Mauchline & Gordon, 1984; Gordon & Duncan, 1985, 1987), Ionian sea (D'Onghia *et al.*, 1998), Madagascar and southwest Pacific (Norfolk mountain ridge) and the continental slope of Ireland (Kotlyar, 1980) and Mediterranean (D'Onghia *et al.*, 1995; Cau & Deiana, 1982). An attempt was made to bring out the geographical distribution and abundance along the south west coast of India and also to observe the life history traits, as these are essential in working out appropriate strategies for their commercial exploitation and management of this species.

Materials and Methods

Data for the present study was collected during the deep sea fishing surveys conducted onboard FORV Sagar Sampada, Dept. of Ocean Development during June 1999 - February 2002. The upper continental slope region of 7° – 14°N was surveyed as part of Cruise Nos. 174, 183, 189, 196, 197 and 200 of FORV Sagar Sampada. Cruises 196, 174 and 197 were in the June, July and August months, which are treated as monsoon period while 183 was in April representing pre-monsoon whereas 189 was in October-November representing post monsoon. 38m High Speed Demersal Trawl II and 45.6m Expo- model demersal trawls were used for fishing in the above cruises in the depth from 200 to 750m. Fishing was done at 95 stations and the total catch, species composition and effort exerted were recorded at each fishing station. Latitude wise and depth-wise distribution and abundance of deep sea finfish resources were assessed after grouping the stations covered in each cruise into 5 depth zones of 201-300 m, 301-400 m, 401-500 m, 501-600 m and >600 m following Khan *et al.*, (1996). CPUE at different latitudes were estimated against the total number of hours spent for fishing at each depth zone (Sivakami, 1990). A total of 590 specimens ranging in size 8.3 to 19.0 cm TL and 11.71 to 66.25 g were analysed for their food and feeding habits, sex ratio and stage of maturity and length-weight relationship. The length related Chi-square analysis of sex ratio was carried out following Rao (1983). The length weight relationship is expressed by the formula $W = aL^b$ (Le Cren, 1951) where 'W' is the weight of the fish taken with an accuracy of 0.1g, 'L' is the total length measured from the tip of the snout to the dorsal caudal tip to the nearest mm. Feeding intensity was observed by visual examination and they were graded as full, 3/4 full, 1/2 full, 1/4 full, trace and empty to assess the intensity of feeding (Muthiah, 1994). Occurrence of each item was expressed as percentage of total number of stomachs examined. In order to quantify maturity stage, general appearance of ovary like fullness in the ventral cavity, size, shape and colour were taken into consideration. The five-stage classification was used to quantify the maturity stages (Qasim, 1973).

Results and Discussion

A scrutiny of the CPUE showed that the distribution of this species is mostly confined to 8° to 13°N. Though a total of 95 experimental trawling operations performed in this region, it was found only in 24 stations showing an average catch rate of 4.54 kg/h. In the latitude 8° - 9°N, four hauls were performed by exerting an effort of 3.83 h and *H. mediterraneus* was found distributed only in depth zone 301-400 m with an average catch rate of 4.77 kg/h (Table

1). Much wider distribution could be seen at 9° - 10° N with an average catch rate of 5.33 kg/h at 301- 400m zone. In 10° - 11° N, it was recorded only from 8 hauls with an average catch rate of 2.89 kg/h. At this latitude, it was characterised by a widely dispersed bathymetrical distribution ranging from 300–682 m. At 11° - 12° N, it was observed only in two hauls at 401–500 m with an average catch per effort of 7.56 kg/h, while at 12° - 13° N also it was encountered only at 401-500 m with a catch rate of 4.85 kg/h.

Table 1. Depth wise catch and CPUE of *Hoplostethus mediterraneus* along the south west coast of India

Lat °N	Long °E	Depth (m)	Time (h)	Catch (Kg)	CPUE (kg/h)
08° 37' 00	75° 39' 00	320.00	1.00	5.00	5.00
08° 40' 00	75° 32' 00	305.00	1.08	2.30	2.12
08° 42' 567	75° 43' 723	332.00	0.75	9.00	12.00
08° 52' 00	75° 50' 00	330.00	1.00	2.00	2.00
09° 00' 00	75° 48' 00	330.00	1.00	7.00	7.00
09° 04' 073	75° 50' 937	330.00	0.83	2.00	2.40
09° 05' 87	75° 41' 85	350.00	1.00	4.00	4.00
09° 19' 00	75° 47'	315.00	1.50	12.00	8.00
09° 33' 140	75° 38' 21	370.00	1.00	1.20	1.20
09° 34' 72	75° 38' 53	319.00	1.08	8.00	7.38
10° 23' 00	75° 28' 00	300.00	1.00	8.00	8.00
10° 27' 00	75° 23'	465.00	1.00	2.00	2.00
10° 32' 181	75° 19 '756	682.00	0.75	2.83	3.77
10° 38'	75° 16'	480.00	1.00	3.00	3.00
10° 39' 50	75° 18' 50	320.00	2.25	2.00	0.89
10° 40' 341	75° 15' 053	573.00	1.00	1.20	1.20
10° 56' 27	75° 07' 22	415.00	0.50	0.50	1.00
10° 56' 39	75° 07' 99	340.00	1.00	5.00	5.00
11° 06' 00	74° 59' 00	448.00	0.75	4.00	5.33
11° 58' 00	74° 21'	450.00	1.50	13.00	8.67
12° 02' 00	74° 20'	460.00	1.00	12.00	12.00
12° 38'	74° 06'	460.00	1.17	0.50	0.43
12° 52' 00	75° 56'	440.00	1.08	8.00	7.38
12° 52' 636	73° 57' 327	420.00	1.08	0.50	0.46
			25.33	115.03	4.54

Its occurrence could be registered in 13 and 9 hauls in the depth zones 301-400m and 401 – 500m respectively (Table 1). Beyond 500m, this species was recorded from two stations in the 10° - 11° N latitudes. At 301-400 m the average catch rate recorded was 4.66 kg/hr while in depth zones 401-500m and >500m was in the order of 4.79 and 2.30 kg/hr respectively. Interestingly, in the latitudes 8° and 10° N, the distribution of *H. mediterraneus* was found only in depth zone 301-400 m, in contrast, in the latitudes 11° to 13° N, it was not seen below 400 m depth. In 10° - 11° N, this species showed a much wider bathymetrical distribution (300 – 682m). Therefore, it is probable that the species shows penetration into the deeper waters while going towards the northern latitudes. Alcock (1899) recorded six specimens from off Madras, the largest measuring nearly a foot long, at 145-250 fathoms off Trincomali and off Travencore coast at 224 to 430 fathoms.

Table 2. Feeding intensity of *Hoplostethus mediterraneus*

Stomach condition	Premonsoon		Monsoon		Post monsoon		Average
	Female	Male	Female	Male	Female	Male	
Empty	81.70	57.70	62.10	53.22	63.00	55.50	62.20
Trace	2.30	4.60	4.90	9.78	10.20	11.60	7.23
1/4 full	6.80	17.30	10.38	10.56	6.50	13.70	10.87
1/2 full	8.20	12.60	10.14	13.22	4.70	2.60	8.58
3/4 full	0.00	1.60	6.25	6.00	4.80	4.30	3.83
Full	1.00	6.20	6.23	7.22	10.80	12.30	7.29

Feeding intensity in *H. mediterraneus* was found very less irrespective of the seasons (Table 2). Empty stomachs predominated in all seasons with a numerical strength of 377 among the 592 fishes examined (63.75%). Full and gorged stomachs were found to be very less in all the seasons (7.22%). In female fishes feeding intensity was very less compared to males irrespective of seasons. The least feeding intensity was found during pre-monsoon for both females and males with 81.7 and 57.7% respectively. Full stomach condition recorded was less in females compared to male fishes irrespective of seasons and post monsoon season showed high percentage of occurrence when compared to other seasons.

The food items present in the stomachs were observed to be mostly in the advanced

stages of digestion and their identification even to the genus level was difficult. The present results are comparable with that of Tientcheu & Djama (1994) in *Pseudotolithus typus* and *P. senegalensis* recorded off Cameroon coast, West Africa. While analysing the food items present in the stomachs it could be seen that *H. mediterraneus* is a carnivorous fish, feeding mostly on myctophid fishes. The dominance of myctophids were clearly discernible in the gut contents during all seasons with a percentage occurrence of even up to 82% and 48% in males and females respectively. Unidentified deep-sea shrimps were found as the second dominant food item in the stomach contents. *Aristeus alcocki, Heterocarpus* spp. and squids were the other food items observed in the stomachs (Table 3). It means that only 5 distinct food items were available in the gut of *H. mediterraneus*. In the case of coastal species, the number and diversity of the food items recorded will be very high because the prey is readily available in the surrounding environment. On the contrary, in the deeper environment, the abundance of the prey is less. So most of the deep-water fishes will have very less selectivity in food items and has to be satisfied with whatever available in the surrounding environment.

Table 3. Percentage composition of food items of *Hoplostethus mediterraneus*

Food items	Premonsoon		Monsoon		Post monsoon		Average
	Female	Male	Female	Male	Female	Male	
Myctophids	82.00	48.00	72.00	65.60	76.30	63.90	67.97
Digested shrimp	10.00	25.20	6.50	23.20	19.20	11.10	15.87
Aristeus alcocki	0.00	13.86	13.30	3.40	2.20	12.40	7.53
Heterocarpus sp.	0.00	2.94	2.60	5.80	0.00	5.40	2.79
Squids	8.00	10.00	5.60	2.00	2.30	7.20	5.85

Combined and sex wise LWR were determined (Fig. 1). The linear relationships of the total length and weight were established and are expressed as under:

Pooled **log W = - 1.35+ 2.6 log l**

Female **log W = -0.97 + 2.23 log l**

Male **log W = -1.46 + 2.6 log l**

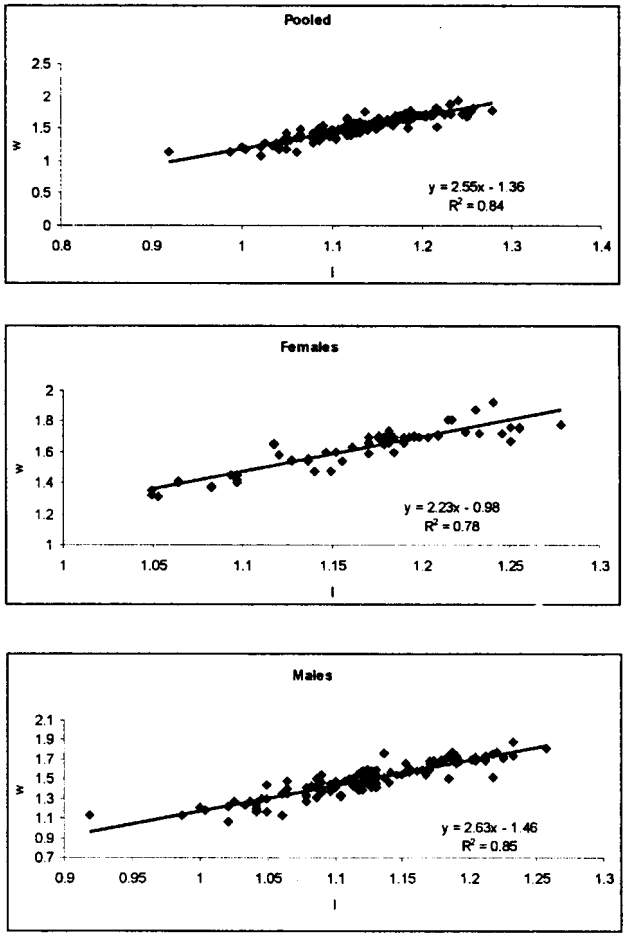

Fig. 1 Length - weight relationship of *Hoplostethus mediterraneus*

While comparing the b value computed in fishes collected from different depths it could be seen that the pooled 'b' value and that of males showed an inverse relationship with depth. Whereas in females, 'b' value was found high at higher depths when compared to its counterpart collected from lower depths.

From these results, it could be inferred that growth of *Hoplostethus mediterraneus* is allometric (Shanmugam *et al.*, 2000). The 'b' value reported in *H. mediterraneus* is on a lower side than the other deep water fishes reported by Khan *et al.*, (1996). The low b value seen in *H. mediterraneus* inhabiting at depth beyond 300 m indicate that the species may not be maintaining its dimensional equality during the growth. The growth of fish is much influenced by extrinsic factors like temperature, food availability and physico - chemical parameters prevailing in the environment. Among these depths beyond 300 m are characterised by low temperature, sparse availability of preferred food items (Mamaev & Tkachuk, 1979). The results of the food and feeding studies conducted have shown that feeding intensity was very less in all the seasons and prey availability also found to be very less. Also its distribution was found mainly in the depths beyond 300m and extends more than 650m. All these factors contribute to the allometric growth to suit the environment in which they are living.

Table 4. Season - wise Sex ratio of *Hoplostethus mediterraneus*

Pre-monsoon						
Length group (cm)	Females	Males	F : M	df	x2*	Remarks
11.5	3	6	0.5:1	1.00	0.36	Not significant
12.5	12	33	0.36:1	1.00	0.09	Not significant
13.5	10	32	0.31:1	1.00	0.02	Not significant
14.5	9	23	0.39:1	1.00	0.20	Not significant
15.5	4	16	0.25:1	1.00	0.24	Not significant
16.5	5	13	0.38:1	1.00	0.09	Not significant
17.5	1	11	0.09:1	1.00	1.73	Not significant
Total	44	134	0.33:1	1.00	0.23	Not significant
Monsoon						
Length group (cm)	Females	Males	F : M	df	x2*	Remarks
11.5	1	10	0.10:1	1.00	3.38	Not significant
12.5	9	35	0.26:1	1.00	4.43	**Significant**
13.5	13	28	0.46:1	1.00	0.28	Not significant
14.5	31	42	0.74:1	1.00	1.47	Not significant
15.5	16	18	0.89:1	1.00	1.93	Not significant
16.5	8	26	0.31:1	1.00	2.18	Not significant
17.5	8	2	4:1	1.00	8.57	**Significant**
18.5	4	5	0.8:1	1.00	0.30	Not significant
19.5	2	0	2:0	1.00	3.61	Not significant
Total	92	166	0.55:1	1.00	2.27	Not significant
Post monsoon						
Length group (cm)	Females	Males	F : M	df	x2*	Remarks
8.5	1	3	0.33:1	1.00	0.02	Not significant
9.5	2	5	0.40:1	1.00	0.15	Not significant
10.5	4	16	0.25:1	1.00	0.07	Not significant
11.5	7	26	0.27:1	1.00	0.03	Not significant
12.5	13	34	0.38:1	1.00	0.74	Not significant
13.5	8	37	0.22:1	1.00	0.56	Not significant
Total	35	121	0.29:1	1.00	0.41	Not significant

*Significance $p<0.05$

Males outnumbered females in all the three seasons. In the pre-monsoon season, M: F ratio was 1: 0.33 and in monsoon, dominance of males over females was less with a ratio of 1: 0.55 while in post monsoon the ratio was 1:0.29. Chi square analysis was carried out on the frequencies of males and females in different size groups to delineate their dominance. Though males were found dominating in all seasons, a significant dominance could not be established in the analysis (Table: 4). However, male fishes were significantly dominated with a chi square value of 4.43 in the length class 12.5 during monsoon and females outnumbered males in the size group 17.5 with a chi square value of 8.57.

The results of the present study have shown that immature and maturing female fishes dominated in the landings during pre-monsoon and post monsoon periods. While during monsoon, mature fishes were dominated the landings. Maturing fishes were found in all the seasons and mature fishes were found only during pre monsoon and monsoon. Spent fishes were found absent during pre-monsoon periods. During pre-monsoon season, females with maturing ovaries dominated with a percentage occurrence of 54.6%. Female fishes

with recovering spent ovaries were followed with 23.34%. Immature and mature fishes were found very less (Fig. 2). During monsoon, the presence of all the maturity stages could be

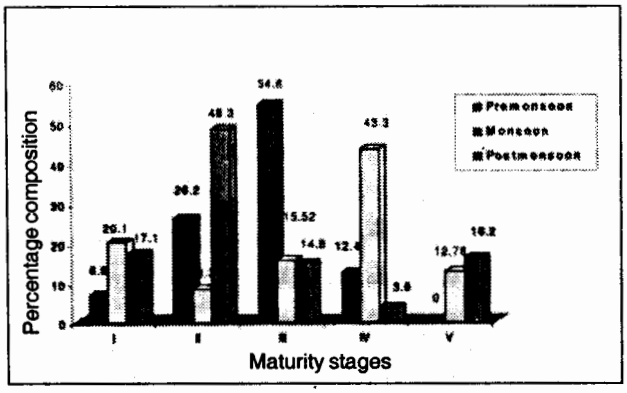

Fig. 2 Percentage composition of maturity stages of Hoplostethus mediterraneus

discernible 43.33% in ripe condition and 12.78% in spent condition.

Immature, recovering spent and maturing ovaries were recorded in the order of 20%, 8.33% and 15.56% respectively. Whereas recovering spent ovaries were found dominating during post monsoon period with percentage occurrence of 48.3% followed by immature fishes (17.1). Spent fishes were also shown a higher percentage (16.2) occurrence. Mature fishes were found in very less percentage in the landings. From the above results, it appears that the spawning season of *H. mediterraneus* coincided with monsoon season.

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