



Distribution and biology of deep-sea fishes *Neopinnula orientalis* Gilchrist and von Bonde 1924 and *Psenes squamiceps* Lloyd, 1909 from west coast of Indian EEZ

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Abstract

Distribution, abundance and biology of *Neopinnula orientalis* and *Psenes squamiceps* from the continental slope region of west coast of Indian EEZ in the depth between 200 and 1000m during 1999 – 2002 are discussed. The former species is distributed mostly in the 201 – 400m depth with more representation in the region between 7° – 12° N lat and *P. squamiceps* at 250-500m in the region 8° to 14° N lat. Length-weight relationship of *N. orientalis* and *P. squamiceps* can be expressed as $W = 3.08 L^{2.27}$ and $W = 3.29 L^{2.27}$ respectively. In both the species feeding intensity was found to be very low. In *N. orientalis*, squids were found to be preferred to other food items in the post-monsoon and myctophid fishes in other seasons. While in *P. squamiceps*, shrimps dominated in the food items in all seasons. Females dominated irrespective of seasons and length groups in both the species. In *N. orientalis*, spawning period is found to be during pre-monsoon compared to the monsoon season in *P. squamiceps*.

Keywords: *Neopinnula orientalis*, *Psenes squamiceps*, distribution, biology, Indian EEZ

Introduction

The potential of marine fish resources in the Indian EEZ was estimated as 3.92 mnt. (Sudarsan *et al.*, 1990) and the exploited annual production is to the tune of 2.70 mnt (Anon, 2003). The potential of demersal resources estimated was 1.93 mnt. The coastal zone up to 50 m supports 1.28 mnt of resource potential (Vivekanandan, 2001). Most of the conventional resources are depleted due to high fishing pressure by the traditional, mechanized boats and large fishing vessels in the coastal areas up to 50m. The exploitation and utilisation of the under-exploited and unexploited resources is the only way to enhance fish production to cater the ever-increasing needs of the country.

Neopinnula orientalis Gilchrist and von Bonde 1924 (Family: Gempylidae) was reported from tropical and subtropical waters of the Eastern Indian Ocean, the Western Pacific and the Western Central Atlantic. Whereas, *Psenes squamiceps* Lloyd, 1909 (*Psenes whiteleggii* Waite, 1894) (Family: Nomeidae) was previously reported from Indian Ocean and Australian waters and inhabits in the depth 300 – 400m (Fischer and Bianchi, 1984). An attempt was made to delineate their geographical distribution and abundance along the west coast of Indian EEZ and also to investigate the biological aspects, as the information on these aspect would help in working out appropriate strategies for their commercial exploitation and management.

Materials and methods

The present study was conducted as part of the Dept. of Ocean Development sponsored research project on "Stock Assessment and Biology of Deep-sea fishes in the Indian EEZ". During the period of study, from 1999 - 2002, 11 cruises were conducted onboard FORV *Sagar Sampada* in the upper continental slope in the west coast of India with an objective to explore the unknown fishing grounds and to delineate the potential of under exploited and unexploited fishery resources. 38m High Speed Demersal Trawl II and 45.6m Expo- model Demersal Trawl were used for fishing in the above cruises at depth from 200 to 1000m. A total of 95 demersal fishing operations were conducted during these cruises. Season wise, latitude wise and depth-wise distribution and abundance of finfish resources were assessed following Khan *et al.* (1996). Catch per unit of effort was estimated following Sivakami, (1990).

The length related Chi-square analysis of sex ratio was carried out following Rao (1983). The length - weight relationship was established following Le Cren, (1951). Feeding intensity was studied following Muthiah (1994). In evaluating the importance of the various food items the occurrence method was found to be suitable (Hyslop,

1980). The maturity and spawning were quantified following Qasim (1973).

Results and discussion

Distribution and abundance

N. orientalis and *P. squamiceps* were represented in 22 stations during the survey. These species were mostly confined to 7° to 12°N lat. and found very less in the area beyond. The catch rate (c/e) of *N. orientalis* was higher (8 kg.hr⁻¹) during pre-monsoon followed by post-monsoon and monsoon. Fourteen hauls were carried out in the 8°–12° N latitude and c/e varied from 5.7 to 10.5kg hr⁻¹ with 10° to 11° N lat. recording the highest. The c/e from Lat. 14° -15° N was found to be low when compared to other areas. The distribution of the species was found to be in the 201 – 500m depth ranges (Tables 1 & 2). The c/e was the highest in depth 201 – 300m with 8 kg hr⁻¹. The area recorded a catch of 59kg in 8 hauls.

A c/e of 12 kg hr⁻¹ was recorded for *P. squamiceps* during post-monsoon. A total catch of 61 kg was realised from 6 hauls. During monsoon, the catches were high when compared to post-monsoon (94 kg in 7 hauls), however the effort was also more. This species was found abundant at Lat. 7° – 8° N and 9° - 10° N with a c/e of 20 kg hr⁻¹ while it was very low at Lat. 10° – 11° N (3.5 kg hr⁻¹) and 14° – 15° N (5 kg hr⁻¹). *P. squamiceps* was also found confined to 201 – 500m depth range.

Sex ratio

In *P. squamiceps*, no significant dominance was shown by either sex with a sex ratio of 1: 0.94 during pre-monsoon season (Table 3). During monsoon and post-monsoon seasons, females outnumbered males with a ratio of 1:1.69 and 1:2.38 respectively. Although the females showed dominance, the ratio was not significant in the higher length groups during the post-monsoon. In the pre-monsoon season, the ratio was not significant (1:0.87) for *N. orientalis*. During monsoon also the ratio was more or less same (1:0.88) and no significant varia-

Table 1. Season-wise catch (kg) and catch rate (c/e) per hr of *N.orientalis* and *P.squamiceps*

Season	<i>N. orientalis</i>		<i>P. squamiceps</i>	
	Catch (kg)	c/e (kg/hr)	Catch (kg)	c/e (kg/hr)
Pre-monsoon	56	7.9	41	6.7
Monsoon	28	4.5	94	11.2
Post-monsoon	42	5.3	61	12.1

Table 2. Depth-wise distribution of *N.orientalis* and *P.squamiceps* along the southwest coast off India

Lat.	Long.	Depth (m)	c/e(kg/hr)	
			<i>N. orientalis</i>	<i>P. squamiceps</i>
07°13	77° 00	220	10	20
09° 11	75° 51	285	6	5
10°24	75 °27	284	15	10
11° 20	74° 49	240	19	32
11° 42	74 °31	230	6	6
14° 00	73° 16	273	2	2
14°52	73 °07	250	5	7
14°54	72° 59	252	0	3
			8	10
08° 37	75° 39	320	8	9
08° 40	75° 32	305	6	3
08° 42	75° 39	305	8	15
08° 52	75° 50	330	5	6
08° 54	75° 33	335	2	3
09° 00	75° 48	330	10	11
09° 04	75° 50	330	3	2
09° 19	75° 47	315	7	43
10° 23	75° 28	304	6	2
10° 39	75° 18	320	1	0
11° 44	74° 29	317	2	0
			6	10
11° 06	74° 59	448	0	8
14° 58	72° 57	440	1	0
			1	8

tion in any of the length groups analysed were observed. Post-monsoon also showed the same trend similar to that of pre-monsoon with a ratio of 1:1.1 (Table 3).

Food and feeding

It was observed that both *N. orientalis* and *P. squamiceps* are carnivorous fishes and most of the food items present in the stomachs were in advanced stages of digestion and their identification even to the genus level was found very difficult. In both *N. orientalis* and *P. squamiceps*, more than 50% of the stomachs observed were found to be empty showing poor feeding intensity (Table 4). This result is similar to the observations made by Tientcheu and Djama (1994) that regurgitation occurred during trawling operations due to stress while dragging the net.

Table 3. Season-wise sex ratio of *N.orientalis* and *P.squamiceps*

	Length group cm	No. of fish	Ratio (M:F)	Chi-square	Significance
<i>N.orientalis</i>					
Pre-monsoon	14.5 - 26.5	166	1:0.8	0.87	NS
Monsoon	11.5 - 26.5	79	1:0.8	0.32	NS
Post-monsoon	14.5 - 26.5	133	1:1.1	0.37	NS
<i>P. squamiceps</i>					
Pre-monsoon	9.5-17.5	60	1:0.9	0.07	NS
Monsoon	12.5 - 19.5	105	1:1.6	6.94	S
Post-monsoon	12.5 - 19.5	88	1:2.3	14.73	S
Significance					p<0.05

In *N. orientalis*, full stomach condition was found only in 2% of the female fishes and 4% of the males examined during pre-monsoon season. During monsoon, stomach full condition was found in 19% and 12% of females and males respectively. While in post-monsoon, 2% of males and 4% females were found to have full stomachs. In *P. squamiceps*, full stomach condition was observed only in 15% and 8% of the females and males respectively in the pre-monsoon season. During monsoon, 22% of the males and 4% of the females analysed were found to have stomach in full condition. 100% of the females in the post-monsoon period were found to have empty stomachs and no fish was found with full stomach.

Table 4. Feeding intensity of *Neoepinnula orientalis* and *P.squamiceps*

	Pre-monsoon		Monsoon		Post-monsoon	
	F	M	F	M	F	M
<i>P. squamiceps</i>						
Empty	61.5	54.1	50.0	58.3	83.8	100
Trace	0.0	0.0	16.6	0.0	8.0	0
1/4 full	7.6	25.0	7.4	11.1	8.0	0
1/2 full	7.6	4.1	1.8	2.7	0.0	0
3/4 full	7.6	8.3	20.3	5.5	0.0	0
Full	15.4	8.3	3.7	22.	0.0	0
<i>Neoepinnula orientalis</i>						
Empty	84.6	90.7	57.1	57.8	82.8	93.3
Trace	0.0	0.0	19.0	25.0	2.8	0.0
1/4 full	11.5	2.3	0.0	5.2	5.7	0.0
1/2 full	2.5	3.4	0.0	0.0	2.8	3.3
3/4 full	0.0	0.0	4.7	0.0	0.0	0.0
Full	1.2	3.4	19.0	11.8	5.7	3.3

The preferred food items of *N. orientalis* were found to be myctophids and shrimps in the pre-monsoon and monsoon seasons and myctophids and squids during the post-monsoon. Myctophids and shrimps dominated the diet of *P. squamiceps* irrespective of seasons. In most of the coastal regions, the abundance of the organisms will be higher and prey is readily available in the surrounding environment. On the contrary, in the deeper environment, the abundance of the prey population is very less when compared to the shallower depths and coastal areas. Philip (1994) reported about 28 types of food items in the bullseye *Priacanthus hamrur* along the northeast coast of India. The distribution of the bullseye is mostly in the shallower depths in the range of 100m to 200m where the availability of the prey species are more when compared to the deeper areas. Similar dietary compositions were found in other deep-sea species like *P. hamrur* (Philip, 1994), *Halelurus hispidus*, *Eridacnis radcliffei* and *Iago omansensis* (Nair and Appukkuttan, 1973), and *Centroscyllium fabricii* and *Etmopterus princeps* (Klara, 2001) and *Psenopsis cyanea* (Venu and Kurup, 2002).

Length-weight relationship (LWR)

The linear relationship of the total length and weight was established and is expressed as:

N. orientalis

Pooled Log W = -2.2+ 3.0 Log L (R²=0.94)

Females Log W = -2.4+ 3.2 Log L (R²=0.92)

Males Log W = -2.5+ 3.2 Log L (R²=0.97)

P. squamiceps

Pooled Log W = -2.2+ 3.2 Log L (R²=0.91)

Females Log W = -2.3+ 3.3 Log L (R²=0.88)

Males Log W = -2.2+ 3.2 Log L (R²=0.97)

In both species, it was seen that the exponential value does not follow the cube law and growth was found to be allometric. The exponential value computed for females and males of *N. orientalis* was 3.2 each, which is higher than the exponential value. In *P. squamiceps* also, male and female population showed same tendency in the exponential growth as *N. orientalis* with 'b' values of 3.2 and 3.3 respectively.

Maturity and spawning

In *N. orientalis*, the pre-monsoon period was dominated by mature females (28%) in the catches followed by maturing and spent, constituting 23% and 22% respectively (Fig.1). Juvenile population was found dominated in the catches during monsoon season, which registered as much as 51% of the total landings. Also a higher percentage of spent females (28%) was recorded followed by fully matured and recovering spent (22%). During post-monsoon period, most of the females were found to be in maturing (43%) stage followed by recovering spent stage (31%). Mature and spent females accounted for 9% and 3% respectively.

In *P. squamiceps*, mature fishes were found in all the seasons and dominated in the female population especially in the pre-monsoon and monsoon seasons (Fig. 2). During pre-monsoon season, recovering spent, maturing and mature fishes were found to be present in equal proportion (26.9%) and spent females also could be identified (11.5%). Monsoon season also showed same trend as in the pre-monsoon and spent females were present in higher proportion than pre-monsoon (15%). Recovering spent females were found dominating in the catches with 30% and were followed by matured and maturing fishes (27% and 23% respectively). In post-monsoon season, maturing and recovering spent females represented higher pro-

portion with 38.7% and 35.5% respectively. Mature and immature fishes contributed to 12.9% each.

It appears that spawning is a continuous process in both the species with the occurrence of mature females in all the seasons. Dominance of mature and spent females was discernible in the pre-monsoon season followed by appearance of juveniles in the monsoon season, which clearly manifests that the spawning period of *N. orientalis* commences during pre-monsoon season. While in *P. squamiceps*, spent fishes were found in higher percentage in the pre-monsoon and monsoon seasons while immature fishes were very common during post-monsoon season when compared to other seasons. It may therefore be inferred that the spawning commences in the pre-monsoon season and continues till monsoon.

Conclusion

N. orientalis and *P. squamiceps* were found distributed along the southwest coast of India from 7° N to 14° N latitude. Both species are confined to depth ranging from 200 – 500m. Occurrence of high percentage of empty stomachs in the samples showed that the availability of food was very less in the surrounding environment. Mysidophids, shrimps and squids were the only food items present in the diet. The growth was found to be allometric in both species with 'b' values of adults as well as juveniles deviating from the hypothetical value of 3. Dominance of mature and spent females in the pre-monsoon season followed by appearance of juveniles in the monsoon season clearly indicates that the spawning period of *N. orientalis* commences in the pre-monsoon season. While in *P. squamiceps*, the presence of spent fishes in pre-monsoon and monsoon and also the high percentage of immature fishes in post-monsoon manifest that the spawning commences in pre-monsoon which continues up to monsoon. On the basis of the present study it may be concluded that both the species show

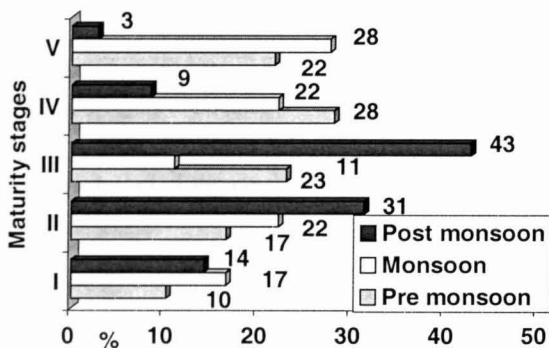


Fig.1. Season-wise distribution of maturity stages in *N.orientalis*

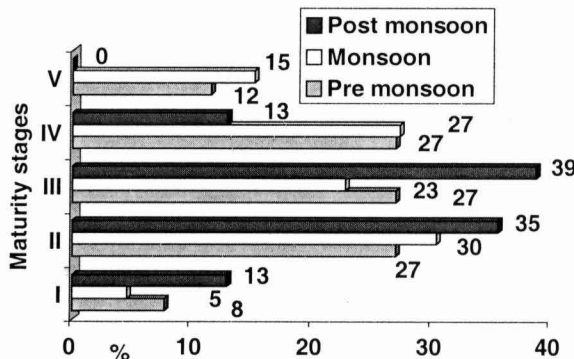


Fig.2. Season-wise distribution of maturity stages of *P.squamiceps*

potential for exploitation in the future to increase the marine fish production of the country. However, the economic viability of fishery of these two species will have to be established by conducting in-depth investigations.

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References

- Anon 2003. Annual report of CMFRI, 2002 – 2003. 135pp
- Fischer, W. and G. Bianchi. (Eds.). 1984. *FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51)*. Prepared and printed with the support of the Danish International Development Agency (DANIDA). Rome, Food and Agricultural Organization of the United Nations, Vol. I - IV.
- Hyslop, E.J. 1980. Stomach contents analysis - a review of methods and their application. *J. Fish Biol.*, 17:411-429.
- Khan, M., P.U.Zacharia, K. Nandakumaran, S.Mohan, M.R. Arputharaj, D. Nagaraja. and P. Ramakrishnan. 1996 In: Pillai, V.K., S.A.H. Abidi, V. Ravindran, K.K. Balachandran and V.V. Agadi (Eds.). *Proc. Second Workshop Scientific Results FORV Sagar Sampada*. (Department of Ocean Development, New Delhi, India), p. 331-346
- Klara, B. J. 2001 Biological aspects of two deep-water squalid sharks; *Centroscyllium fabricii* (Reinhardt, 1825) and *Etmopterus princeps* (Collett, 1904) in Icelandic waters. *Fisheries Research*, 51:247-265.
- Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*). *J. Anim. Ecol.*, 20: 201-219.
- Muthiah, C. 1994. Studies on the Fishery and biology of the lizardfish *Saurida* spp. from the Karnataka Coast. *Ph.D. Thesis*. 185pp.
- Nair, R.V. and K.K. Appukuttan. 1973. Observations on the food of deep sea sharks *Halaaelurus hispidus* (Alcock), *Eridacnis radcliffei* Smith and *Iago omanensis* Compagno and Springer. *Indian J. Fish.*, 20 (2): 575-583.
- Philip, K.P. 1994. Studies on the biology and fishery of the fishes of the family Priacanthidae (Pisces: Perciformes) of Indian waters. *Ph.D. Thesis*, 169pp, Dept. of Industrial Fisheries, Cochin University of Science & Technology, Kerala, India.
- Prasad, R.R. and P.V.R.Nair. 1973. India and Indian Ocean Fisheries. *J.Mar.Biol.Ass.India*, 15(1): 1-19.
- Qasim, 1973. An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters. *Indian J. Fish.*, 20:166-181.
- Rao, S. 1983. Comparison of the limiting efficiencies of two chi-square type tests for the circle (with Y. Yoon), *Jour. Indian Statistical Association*, 21 (1983), 19-26.
- Sivakami, S., 1990. Observations on the demersal fishery resource of the coastal and deep sea areas of the Exclusive Economic Zone of India. In: Mathew, K.J. (Ed.). *Proc. First Workshop Scientific Results FORV Sagar Sampada*. CMFRI, Cochin, 5-7 June, 1989. p.215-231.
- Sudarsan, D., M.E. John and V.S. Somavanshi. 1990. Marine Fishery resources potential in the Indian Exclusive Economic Zone – An update. *Bull. Fish. Surv. India*, 20: 27pp.
- Tientcheu, J. Y. and T.Djama. 1994. Food habits of two sciaenid fish species (*Pseudotolithus typus* and *Pseudotolithus senegalensis*) off Cameroon. *NAGA*, 17(1): 40-41.
- Venu, S. and B.M. Kurup, 2002. Distribution and biology of the deep sea fish *Psenopsis cyanea* (Alcock) inhabiting continental slope of the west coast of India. *J.Mar.Biol.Ass. India*. 44(1&2): 176-186.
- Vivekanandan, E. 2001. Sustainable coastal fisheries for nutritional security. In: Pandian, J.J., (Ed.), *Sustainable Indian Fisheries*. National Academy of Agricultural Sciences, New Delhi.p. 19-42.

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