Proceedings of the Second Workshop on Scientific Results of *FORV Sagar Sampada*

Editors

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Department of Ocean Development
Government of India
New Delhi
1996

Department of Ocean Development (DOD)
Government of India
Mahasagar Bhavan, Block No-12
C.G.O. Complex, Lodi Road
New Delhi-110 003
India

ISBN : 81-900656-0-2

Citation Styles

For entire volume

Pillai, V.K. Abidi, S.A.H., Ravindran, V., Balachandran, K.K. & Agadi, V.V. (Eds.) 1996. *Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada*, (Department of Ocean Development, New Delhi), pp. 564.

For individual article

Goswamy, S.C. & Shrivastava, Y. 1996. Zooplankton standing stock, community structure and diversity in the northern Arabian Sea, In: *Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada*, edited by V.K. Pillai, S.A.H. Abidi, V. Ravindran, K. K. Balachandran & V.V. Agadi, (Department of Ocean Development, New Delhi), pp. 127-137.

Designed and Printed by:

Publications & Information Directorate
Council of Scientific & Industrial Research
Pusa Campus, New Delhi-110 012
India

Proc. Second Workshop Scient. Resul. FORV Sagar Sampada, 1996, pp. 271–284

Distribution and abundance of the genus *Vinciguerria* (Gonostomatidae) in the DSL of Indian EEZ with a note on the biology of *Vinciguerria nimbaria*

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ABSTRACT

In the DSL fish biomass one of the dominant genus was *Vinciguerria*, represented by three species such as *V. nimbaria, V. attenuata* and *V. poweriae*. The occurrence of *Vinciguerria* was frequent in northwest and southwest area of EEZ at varying depths. The average number per haul in Isaac Kidd mid water trawl (IKMT) was 149 in day and 191 in night collection. *Vinciguerria nimbaria* has accounted for more than 95% of the total catch of the genus. Its total length varied from 10-56 mm. The length weight relationship is log W = -5.5691 + 3.1676 log l. Invariably the species fed on copepods, ostracods, cladocerans, appendicularians euphausiids, chaetognaths, fish larvae etc. with variations in feeding intensity during day and night. About 92 % of the catch belonged to mature fishes. The species spawns only once in a year and the fecundity ranged from 140 to 770 ova in fishes of 34 - 55 mm total length.

INTRODUCTION

The bioacoustic scattering layer occurring widely in world oceans is an important ecosystem which supports a wide assemblage of meso-zooplankton, micro- and macro- nekton. The availability, abundance and vertical migrations of many epi- and meso-pelagic fishes are influenced or controlled by the diurnal and seasonal occurrence and intensity of the preferred food organisms, macro- zooplankton, in the deep scattering layer (DSL). Although considerable efforts have gone into the study of the biocomposition, their intensity, diurnal movements, speed and magnitude of migrations, predator- prey relationship and its energetics within this ecosystem of DSL organisms from different parts of world oceans (Tucker, 1951; Alverson, 1961; King & Iverson, 1962; Pearcy, 1965; Bary, 1966; Pearcy & Laurs 1966; Taylor, 1968;

Kinzer, 1969), studies from India on the subject are limited to the works of Silas & George (1969), Silas (1972), George (1989), Menon & Prabha Devi (1990), Menon (1990), Mathew & Natarajan (1990), Kathirvel (1990), Balasubramanian & Suseelan (1990), Suseelan & Nair (1990), Mini Raman & James (1990), James & Prabha Devi (1990) Meiyappan & Nair (1990), and Pon Siraimeetan (1990). The importance of epi-and meso-pelagic fishes, preferably from the oceanic realm, is gaining importance in the light of present stagnating or declining coastal fish production. Many groups of micro-nektonic meso-pelagic resources form prey organisms to shoaling pelagics like tuna, shark etc. and as such their distribution and abundance in the oceanic waters give vital clue to the availability of the latter groups of exploitable resources. Of the several groups of fishes occurred in the DSL, the genus *Vinciguerria* is an important genera, often appears in large concentrations. Therefore, this group was selected for a detailed investigation on their distribution, abundance and biology.

MATERIALS AND METHODS

The DSL of Indian EEZ was sampled by using an Isaacs Kidd mid water trawl (IKMT) net (2.5 m) during the first 15 cruises of *FORV Sagar Sampada* in February 1985 - May 1986. The samples were collected from appropriate depths (invariably the principle layer) of DSL recorded by echo sounders. Out of 563 stations covered during the 15 cruises the net was operated from 445 stations at 3 knot speed. Among these 364 stations yielded DSL biomass at the rate of 0.1 to 38.1 ml/1000 m^3 from depths ranging from 20-540 m depending on day or night operations. The samples were sorted into different groups and the fish biomass was subjected for detailed study on species composition. One of the dominant species, *Vinciguerria nimbaria* was separated for biological studies like length composition, length weight relationship, food and feeding habits, maturity conditions, ova diameter frequency and fecundity. The stomach content of *V. nimbaria* collected from the DSL during 1985 - 86 were analysed for the qualitative and quantitative composition, the intensity of feeding in relation to day and night, season; qualitative and quantitative composition of diet in different seasons, day and night, relation between meso-zooplankton stock in the DSL and the feeding preference using standard methods (Hynes, 1950; Pillai, 1952; and Natarajan & Jhingran, 1961). Altogether 500 fishes of both sexes within the size range of 12-56 mm were utilised for the stomach content analysis. The degree of fullness of the stomach was noted as gorded; full, 3/4, 1/2, 1/4,; trace and empty. Fishes with gorged, 3/4, and 1/2 stomachs were treated as 'actively fed' and fishes with stomach 1/4, trace and empty as 'poorly fed'. The samples were pooled for 2 hourly interval for diurnal feeding intensity studies. The food organisms were identified to groups/generic level, wherever possible. The ova diameter frequency of the species at different maturity stages was worked out by using the methods of Clark (1934), Prabhu (1956).

RESULTS

In the total DSL biomass, finfishes occurred in 82% of IKMT stations and accounted for 5.4% and their abundance ranged from 0.01 to 45.5 g/1000 m^3. The genus *Vinciguerria* occurred in 90 stations, (51 night and 39 day) out of which 73 stations were in west coast and 17 in the east coast (Fig.1). Along the west coast the catch (number) per haul ranged from 1 to 2931 in night hauls and 2 to 1254 in day hauls. From the east coast its abundance varied from 1 to 7 number per haul in day and 1 to 530 in night operations.

Vinciguerria was dominant in the DSL of south west coast especially at 07°15′ N, 77°50′E (2931 no/haul);12°00′ N, 75°04′E (1254 no/haul) and 07°10′N, 76° 06′E (1110 no/haul). The average number per haul was 149 in day and 191 in night collections.

Latitude wise number per haul of *Vinciguerria* in the west coast (Table 1) has ranged from 20 to 904 in 06°N and 07° N respectively. In the day collections high catches were recorded in 12°N (1254 no) and 17°N (614 no); whereas it was found to be abundant in 07°N (1126 no) and 20°N (815 no) in night hauls. In the east coast invariably better catches were recorded in night collections at 15°N and 19°N (269 and 283 no respectively).

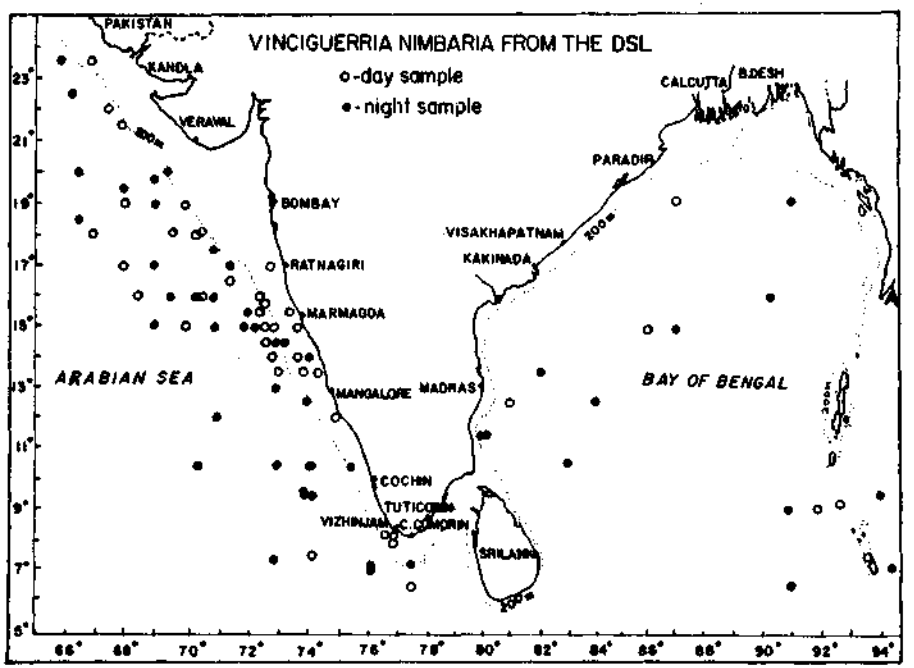

Fig. 1 - Geographical distribution of *Vinciguerria* in the DSL during day and night hauls

Table 1 - Latitude wise IKMT catch (no/haul) of *Vinciguerria nimbaria* during day and night

Latitude (°N)	Catch (no/haul)		
	Day	Night	Mean
		West coast	
23	91	308	200
22	7	274	141
21	243	-	243
20	-	815	815
19	60	60	60
18	108	4	22
17	614	137	257
16	26	51	39
15	17	20	19
14	4	51	20
13	455	65	195
12	1254	60	458
10	17	25	23
09	28	86	63
08	113	-	113
07	15	1126	904
06	20	-	20
		East coast	
06	-	10	10
07	-	189	189
09	6	3	5
10	-	91	91
11	-	60	60
12	3	-	3
13	-	14	14
15	2	269	135
19	1	283	189

Table 2 - Seasonal IKMT catch (no/haul) of *Vinciguerria nimbaria* during day and night

Months	Day	Night	Mean
		West coast	
January	-	111	111
February	-	-	-
March	-	21	21
April	22	120	81
May	-	-	-
June	-	-	-
July	128	-	128
August	26	28	27
September	75	26	56
October	97	143	120
November	1254	2931	2092
December	169	200	189
		East coast	
March	1	-	1
April	6	51	42
June	3	74	57
July	7	1	4

Vinciguerria occurred throughout the year in the west coast with particular abundance in November (2092 no) followed by December (189 no). In November the night catch was 2931 while day yielded only 12543 (Table 2).

It occurred from shallow grounds of 33 m depth to deep oceanic areas of 3878 m depth along the west coast and from 46 m to 3759 m in the east coast. Generally in occurred in the DSL from surface to 80 m depth during night and in higher depths (100 - 320 m) during day (Fig.2). Sizable stocks reside the meso-pelagic habitat of the EEZ and migrate vertically.

In the total catch of *Vinciguerria*, *V. nimbaria* was accounted for 95 % followed by *V. attenuata* and *V. poweriae*.

Biology of *V. nimbaria*

Size frequency — In the north west region from 16° - 23° N the total length of *V. nimbaria* (Fig.3) ranged from 12 - 56 mm with major modes at 32 mm (August), 16,

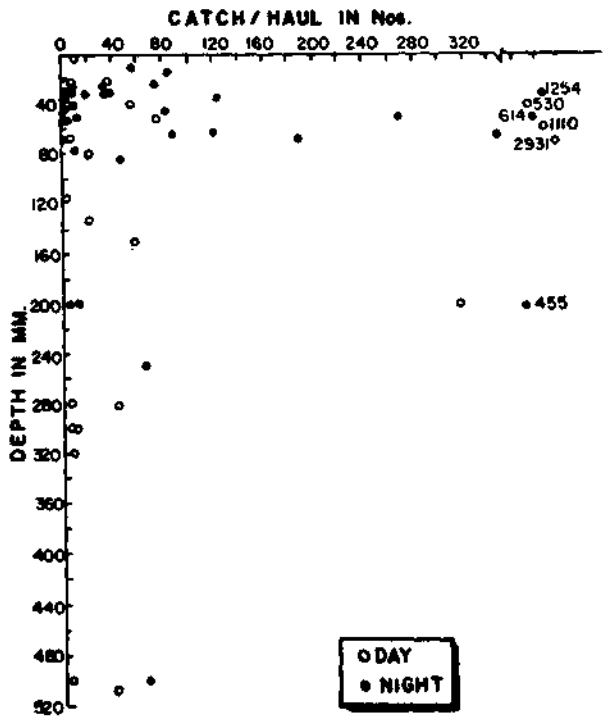

Fig. 2 - Bathymetric catch per haul of *V. nimbaria* in the DSL

20, 28, 32 and 40 mm (October) and 20, 28, 40, 44 and 48 mm (December). The length frequency in the south west region from 06° - 15° N showed a size range of 12-52 mm with several modes at 32, 40 mm (April), 32 mm (October), 36 mm (November) and 20, 24, 28 and 44 mm (December). Its size frequency from 06°N along east coast ranged from 12-36 mm in the month of April and the modes were at 16 and 28 mm. From the available data, it is possible to presume that the life span of the species is only one year.

Length-weight relationship — The length weight relationship of *V. nimbaria* (Fig.4) was established based on 300 individuals of total length 12-56 mm and weight range of 6 - 760 mg. The relationship was found to be: log W = - 5.5691 + 3.1676 log L. ($r = 0.9830$).

Food and feeding habits — The feeding intensity was generally poor during nighttime (Fig.5). In the north west region about 75% of the night catches were poorly fed, while in day catches 46% were actively fed. Along the south west region the feeding intensity was generally low compared to north west region. In this region 69% in the night catches and 78% in day catches were poorly fed. During the premonsoon the feeding intensity was found to be active (90% in day and 55% in night). In

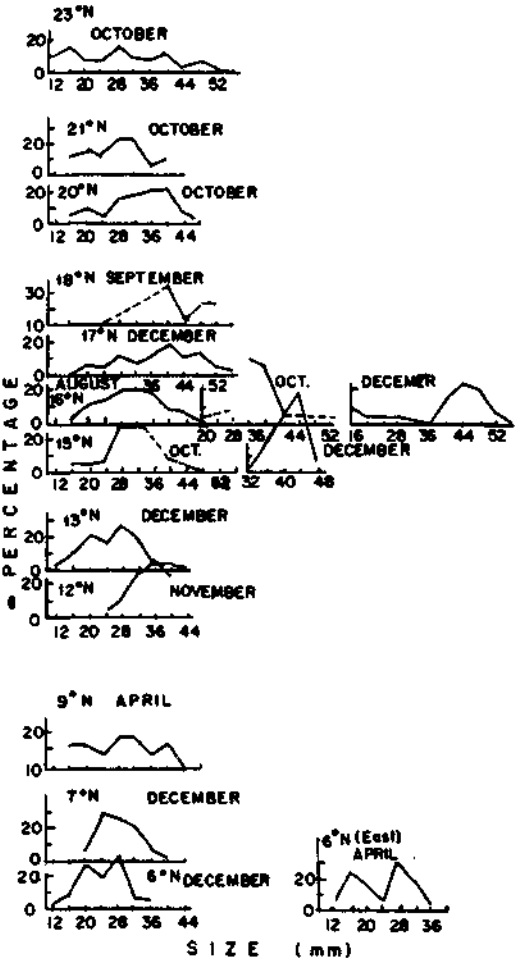

Fig. 3 - Length frequency of *V. nimbaria* in each latitude

monsoon season 90% was poorly fed during day and 20% in night- time. During postmonsoon months the feeding intensity was poor at night (96%) and active in day (36%).

During day hours the feeding intensity was high with gorged or full stomach in 0600 - 1200 hrs and 1600 - 1800 hrs. A wide variety of planktonic organisms like copepods, ostracods, fishes, chaetognaths, mysids amphipods formed the food. In night hours the feeding intensity was generally poor. During 0600 - 0800 hrs, however, 95% of the fishes were with full stomach. Invariably there was no feeding activity from 0000 - 0600 hrs although the DSL was at the surface 50m. During 0000 - 0600 hrs it fed on a narrow spectrum of planktonic organisms like copepods, ostracods, and fishes. Copepods were common in the diet at 1800 - 2200 hrs. Fishes were frequently

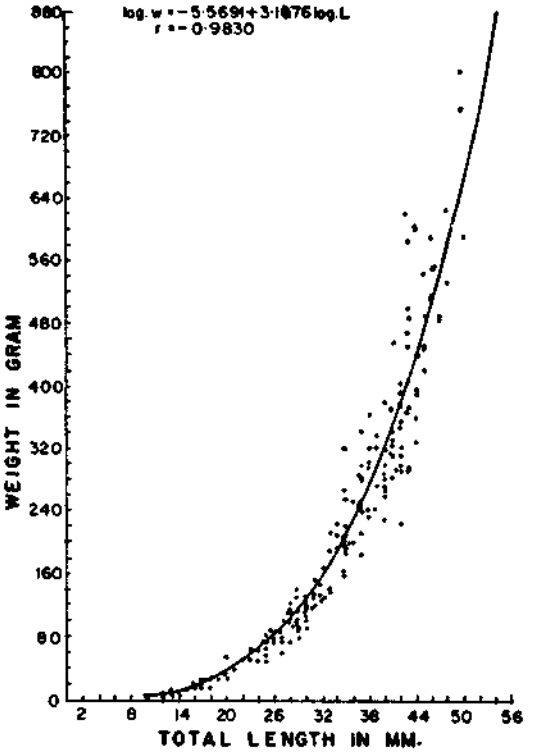

Fig. 4 - Length-weight relationship of *V. nimbaria*

preyed upon by *V. nimbaria* during 1800 - 2400 hrs. Ostracods were yet another common item encountered throughout the night (Fig.6).

Vinciguerria numbaria fed on meso-zooplanktonic organisms from DSL intensively during early and late hours of day. The major organisms on which it preyed upon were copepods, ostracods, fishes, crustacean larvae, chaetognaths, euphausiids, amphipods, mysids, appendicularians and others. *V. nimbaria* might be in middle of a fairly short food chain: phytoplankton —> microzooplankton —> copepods —> ostracods —> *V. nimbaria* —> larger pelagic predator fishes and cephalopods. The feeding activity was invariably slow in late night and minimal at depth in daytime. The seasonal feeding pattern of *V. nimbaria* showed that copepods (45.2%), digested matter (19%), ostracods (14.6%) and fishes (6.2%) were common in premonsoon months (Table 3). Similarly in postmonsoon, copepods (26.8%), digested matter (22%), ostracods (19.3%) and fishes (9.1%) were abundant food organisms. In monsoon months the most preferred food items were ostracods (22.8%), copepods (99.4%), digested crustaceans (16.7%) and fishes (14.2%).

Vinciguerria nimbaria ascend the water column along with the vertically moving meso-zooplankton during evening and descend down by morning. The abundance of the fish and their migrations might be influenced by the availability of the prey organisms. The feeding activity was generally high in the surface layers and minimal

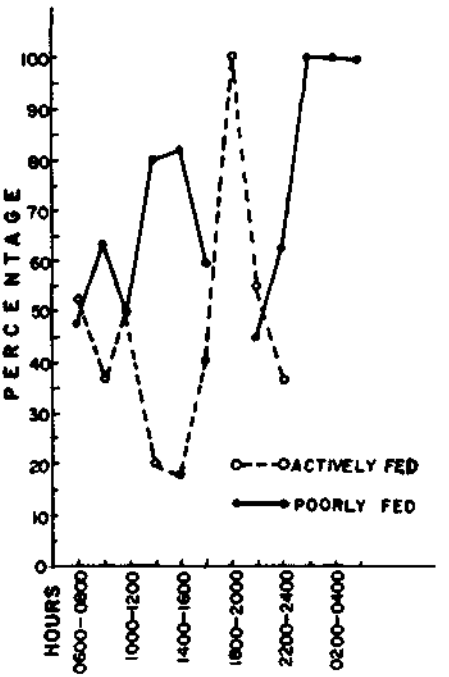

Fig.5 - Diurnal variations in the feeding intensity of *V. nimbaria*

at depth. The meso-zooplankton of the DSL was supported chiefly by euphausiids, decapods, fish eggs/ larvae, copepods, chaetognaths, pteropods, heteropods, crustacean larvae, ostracods, mysids and others. The diurnal percentage composition of various meso-zooplanktons in the DSL are shown in Fig.6. The planktonic component showed marked variations between day and night catches. The dominant meso-zooplankton in day hauls were euphausiids, decapods, fishes, chaetognaths and larval crustaceans; while the night catches were predominated by copepods, euphausiids, decapods, pteropods and heteropods, larval crustaceans and fishes. *V. nimbaria* fed selectively on copepods, ostracods, fish larvae etc. although they formed only a small fraction in the DSL zooplankton.

Reproduction — The ova diameter frequency of *V. nimbaria* showed that the species spawns only once in the spawning season, as it has only a single model size (0.7 mm) in the most mature group of ova in stages v and vi (Fig.7). Ripe females were recorded during August - December and spent fishes in October - December (Table 4). Ripe and spent males were noticed in the catches during August - October. The fecundity of *V. nimbaria* has ranged from 140 - 770 mm in fishes of 34 - 55 mm total length and the mean fecundity is estimated at 400 ova. The ripe ova were in the size range of 0.5 - 1 mm diameter with the dominant mode at 0.7 mm. The size at first maturity of this species is at 30 mm total length.

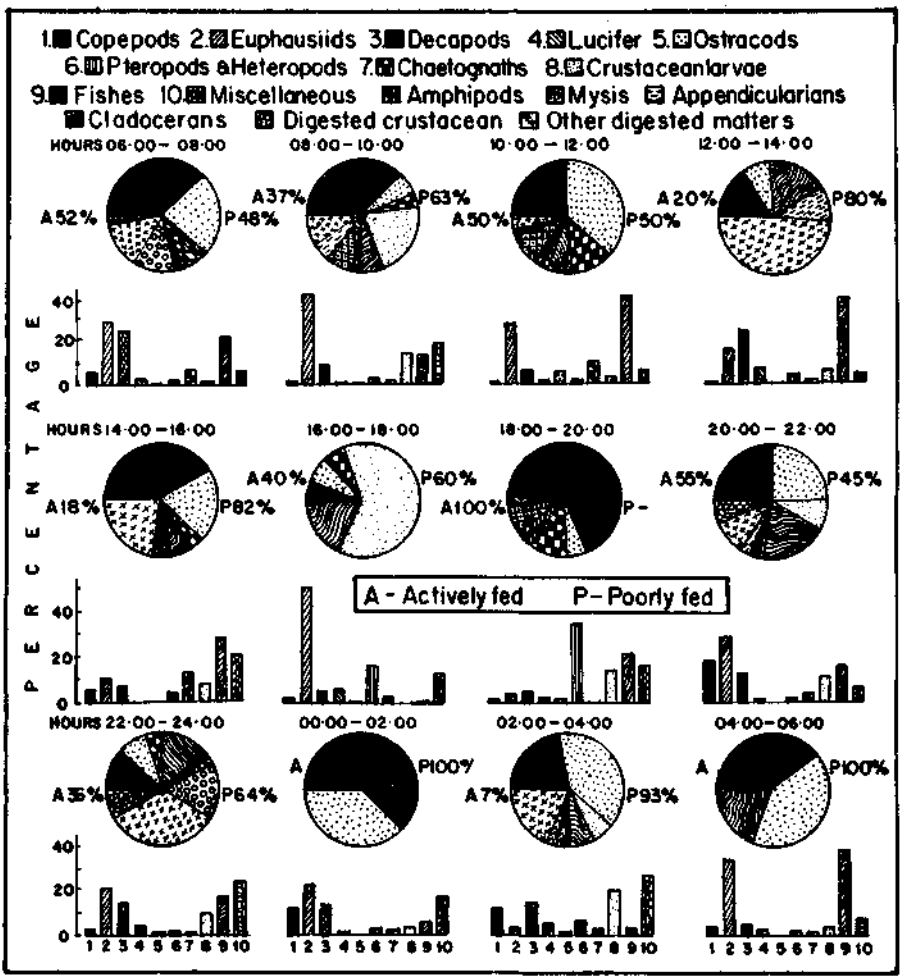

Fig. 6 - Dial variations of meso-zooplankton (percentage composition), food composition of *V. nimbaria* and its feeding intensity during day and night

DISCUSSION

In order to understand the food relationship and the rate of metabolism from the lower to higher levels in the food web of the DSL ecosystem, a study on the larger nekton, their extent and periodicity of vertical ascends and descends, bathymetric and seasonal abundance and the degree to which these organisms are predator or prey of other tropic levels is pertinent. In addition to meso-zooplankton, the DSL biocomponents include a wide assemblage of young or adults of epi- and meso- pelagic fishes and they too vertically migrate along the macro-zooplankton. Menon (1990) analysed the IKMT samples from DSL, collected during *FORV Sagar Sampada* cruises, for the biocomposition and reported the wide occurrence of *Vinciguerria* (25.7% of total

Table 3 - Diurnal and seasonal food preference of *Vinciguerria nimbaria* from the DSL

Food items	Percentage composition				
	Day	Night	Post-monsoon	Monsoon	Premonsoon
Copepods	29.5	30.7	45.2	19.4	26.8
Ostracods	15.5	23.4	14.6	22.8	19.3
Cheatognaths	3.6	2.7	3.2	6.5	2.6
Amphipods	2.7	1.0	1.5	4.7	1.9
Mysis	2.5	1.2	2.2	1.3	2.0
Euphausiids	-	2.2	-	6.7	-
Appendicularians	2.0	1.0	-	1.5	1.4
Cladecerans	-	1.3	-	-	1.3
Decapods	-	-	-	-	3.1
Crustacean larvae	8.9	2.4	1.7	-	7.7
Fishes	8.7	11.5	5.2	14.2	9.1
Digested crustaceans	3.1	5.9	4.7	16.7	2.5
Other digested matter	22.2	15.7	19.0	4.1	22.0
Miscellaneous	1.3	1.0	2.7	2.1	0.3

fish biomass) with particular dominance in night hauls. Workers like Aron (1962), King & Iverson (1962), and Percy & Laurs (1966) attributed this diurnal differential abundance as due to visual avoidance of the gear, differential speed of ascend and descend in night and day respectively, the former being slower than the latter and also better escapement and greater scatter during day.

The results of the present study indicated higher abundance of *Vinciguerria* in October - December, which agrees with the earlier findings by Silas & George (1969). They found that it occurs more in oceanic than neritic waters with high abundance during post and premonsoon months. *V. nimbaria* has higher abundance in 7, 12/13, 17 and 20 N along the Arabian Sea. This finding is consistent with the observation of George (1989) based on icthyoplankton surveys in southwest coast of India.

The biology of *V. nimbaria* was worked out based on DSL samples and the life-span of the species is estimated to be less than one year. It feeds on meso-zooplankton and migrate concurrently with them. The importance of epi- and meso-pelagic fishes from the DSL in the food of oceanic large pelagics like skipjack and yellowfin tuna are stressed by Alverson (1961), Vinogradov & Voronina (1961) and Silas (1972). The interaction between the meso-zooplankton stocks and the vertically migrating *V. nimbaria* was studied for any possible correlation. *V. nimbaria* shows preferential feeding and the feeding activity was intense in day break and

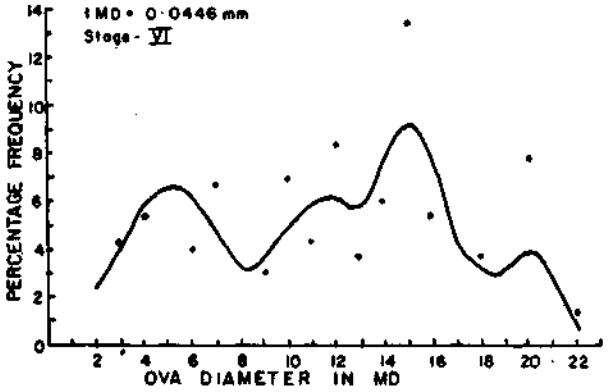

Fig. 7 - Ova diameter frequency of *V. nimbaria*

Table 4 - Monthly maturity stages (Percentage) of *Vinciguerria nimbaria* along the west coast

	Maturity stages						
	I	II	III	IV	V	VI	VII
				Females			
February	-	-	25.0	-	75.0	-	-
April	-	23.0	30.8	30.8	15.4	-	-
August	-	13.3	46.7	11.7	26.7	2.2	-
September	-	15.8	57.9	26.3	-	-	-,
October	-	6.7	31.1	31.1	18.9	6.7	5.5
November	-	-	-	76.9	23.1	-	-
December	3.0	24.2	21.2	19.8	25.8	4.5	1.5
				Males			
February	-	-	-	33.3	66.7	-	-
April	-	-	71.4	88.6	-	-	-
August	-	6.7	22.2	17.8	48.9	2.2	2.2
September	-	6.3	37.5	31.2	25.0	-	-
October	-	6.7	24.0	37.3	24.0	-	8.0
November	-	-	33.3	63.0	3.7	-	-
December	4.8	9.5	15.9	30.1	39.7	-	-

evenings, mostly at surface. The analysis of the present data indicates that the species is a visual feeder as evidenced by their intense feeding activity during day break and dusk hours, when the DSL moves in the column -descend in day break and ascend in dusk. The poor feeding in day time might be due to non-availability of the prey organism in the normal depth strata of *V. nimbaria*. During the day-light hours the DSL, preferably macro-zooplankton layer, descends far down to 400 - 500 m or more. Moreover at daytime the DSL forms several discrete layers and occupy different depths, below the predator species habitat.

ACKNOWLEDGEMENT

The authors are thankful to Dr. P.S.B.R. James, former Director, and Dr. P. Bensam, Head, Demersal Fisheries Division for encouragement.

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