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Distribution and biology of *Chlorophthalmus bicornis* Norman, beyond 250m depth off the south west coast in the Indian EEZ

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Abstract

The distribution and biology of *Chlorophthalmus bicornis* (Famiily: Chlorophthalmidae) were studied based on the samples collected from the trawling operations conducted onboard FORV *Sagar Sampada* in her five cruises (Lat. 7° N - 20° N) during 1999-2002. Length–weight relationship of the species can be expressed as $W= 2.79\ L^{2.88}$. This is a carnivorous species, feeding mainly on crustaceans and squids. Spawning was continuous as manifested by the presence of mature fishes in all trawling operations. Being a multiple spawner, truly spent specimens were scarcely found. The ovaries fall in the stages III to IV. The shoals were characterized by the preponderance of males.

Key words: *Chlorophthalmus bicornis*, biology, distribution and abundance, Indian EEZ

Introduction

Ever since the declaration of the Exclusive Economic Zone in 1976 a number of fishery resource surveys have been conducted in the seas around India to delineate the deep sea resources and indicate their scope for exploitation from the continental shelf edge beyond 250m depth. The potential yield from the Exclusive Economic Zone (EEZ) of country has been estimated to be around 3.9 million tonnes or at the best 4.5 million tonnes in 1990 as against the exploited quantity of 2.7 million tonnes in 2003 (Anon, 2003). The fishery surveys onboard FORV *Sagar Sampada* were aimed at charting out the fishing grounds and to locate the deep-sea fishery resources in the Indian EEZ for exploitation to meet the increasing demand for seafood.

Recently, Venu and Kurup (2000a) have reviewed the distribution and abundance of Chlorophthalmids from EEZ of India. *Chlorophthalmus punctatus* (Gilchrist, 1904), and *C. bicornis* (Norman, 1939) are two very common and abundant species of this family present in the Indian waters. These fishes, commonly known as the "green eyes" are circumglobal in their distribution in temperate and tropical regions (Fischer and Bianchi, 1984). They form bathydemersal schooling over the continental shelf and upper slope over mud and clay bottom at a depth ranging from 50 - 1000 m (Khan *et al.*, 1996; Al Sakaff and Esseen, 1999). The present paper deals with the spatial and bathy-

metric distribution, abundance and biology of *Chlorophthalmus bicornis* from the west coast of India

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Material and methods

The materials for the present study were collected from the experimental trawling operations conducted onboard FORV *Sagar Sampada* along the west coast of India during her cruises (June 1999 - February 2002) in the Indian EEZ. The upper continental slope region (Lat. 7° – 20° N) was surveyed. Cruise Nos.196, 174 and 197 conducted in June, July and August were treated as samples belonging to monsoon period while No.183 in April and No.189 in October-November were considered as representing the pre-monsoon and post-monsoon. 38m High Speed Demersal Trawl II and 45.6m Expo- model Demersal Trawl were used for fishing at depth varying from 200 to 750m. Fishing was done at 95 stations and the total catch and species composition and effort expended 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). Catch per unit of effort at different stations was calculated against the hours spent for fishing during each fishing operation. The fishes caught were identified up to the species level following Fischer and Bianchi, (1984). Random samples were collected from each haul for biological analysis. A total of 460 specimens of both sexes were analyzed separately for their length-weight relationship, food and feeding habits, sex ratio and stages of maturity.

The total length in cm and weight in gram of individual fishes taken were used to study the length-weight relationship following Le Cren, (1951). The length related Chi-square analysis of sex ratio was performed following Rao (1983). Feeding intensity was studied by grading the stomach as full, ¾ full, ½ full, ¼ full, trace and empty. The different food organisms were sorted out and the occurrence was determined (Hyslop, 1980). The occurrence of each item is summed, scaled down to give the percentage composition of the diet. The 5-stage classification (Qasim, 1973) was used to quantify the maturity stages.

Results and discussion

Distribution and abundance

C. bicornis, distributed all along the survey area showed a waning progression in abundance and was not represented beyond 12°N latitude (Table I). These mesopelagic fishes were found abundantly at depths ranging from 201 to 400m. High-density pockets were located along the latitudes 8° - 9° N and 11° - 12°N at depth varying from 301-400m and 201-300m. Sivakami *et al.* (1998) reported the potential yield of *Chlorophthalmus* spp. to

Table 1. *Spatial and depth-wise distribution of* C.bicornis *off southwest coast of India*

Lat	Long	Depth (m)	Catch (kg)	CPUE kg/hr	Total catch (kg)
07°11′	77°04′	218	1	2	65
08°37′	75°39′	320	2	2	40
08°40′	15°32′	305	5	5	179
08°42′	75°39′	300	1030	1030	6100
08°42′	75°43′	332	95	127	417
08°52′	75°50′	330	3	3	39
08°54′	75°33′	335	9	9	48
			1145	178	6888
09°00′	75°48′	330	10	10	72
09°04′	75°50′	330	1	2	40
09°05′	75°40′	350	1	1	55
09°11′	75°51′	285	2	2	32
09°14′	75°47′	365	10	15	61
09°15′	75°41′	400	8	8	184
09°19′	75°47′	315	5	3	304
09°28′	75°42′	330	20	10	123
09°34′	75°38′	319	2	2	97
09°38′	75°36′	330	2	2	134
			62	5	1102
10°23′	75°28′	300	4	4	250
10°25′	75°26′	309	3	3	11
10°39′	75°18′	320	3	1	18
			10	2	279
11°20′	74°49′	240	200	240	1085

be 81,328 t along this region. The average CPUE along 11°- 12° latitude was 240 kg hr^{-1} and 196 kg hr^{-1} at 8° – 9° N. Highest catch per single haul of *C. bicornis* was 1030kg from a depth of 300m in the station at 08° 42′ 46 N and 75° 39′ 72 E followed by 240kg at 11° 20′ 09N during October – November. Along 7° - 8°N latitude the species was very sparse indicating a CPUE as low as 1.7 kg hr^{1}. Even though the CPUE was found to be moderate, 9° – 10° N latitude was the only area where the species was present in all the three depth zones. Catches in the Latitude 10° – 11° N showed its distribution only in the 301- 400m-depth zone. Philip *et al.* (1984) also reported that *Chlorophthalmus* spp. were predominant in 300-400m depth along the southwest coast. Oomen (1985) identified certain pockets at depth of 200-450m off Cape Comorin, Trivandrum and north of Cochin as target fishing grounds for its commercial exploitation. Sulochanan and John (1988), James and Pillai (1990), Sudarsan (1993) and Khan *et al.* (1996) reported maximum abundance of *Chlorophthalmus* spp. in depth zone III.

Length-weight relationship

The logarithmic regression equations for Length-weight relationship was:

Pooled: Log W = -1.91+ 2.88 log L,

Females: Log W = -1.77+ 2.77 log L and

Males: Log W = -2.0+ 2.95 log L

The length- weight parameters showed that the growth was more or less allometric.

Food and feeding

Feeding intensity in *C. bicornis* was found irrespective of the sex and seasons to be poor (Fig. 1). In males, the feeding

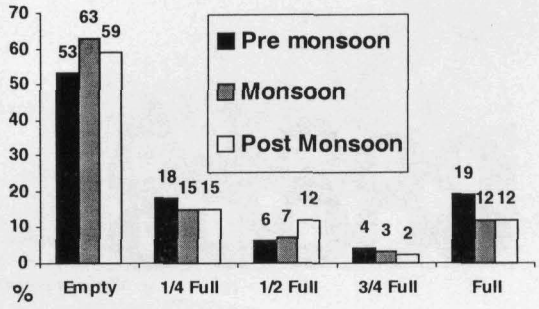

Fig. 1. *Feeding intensity in* C. bicornis

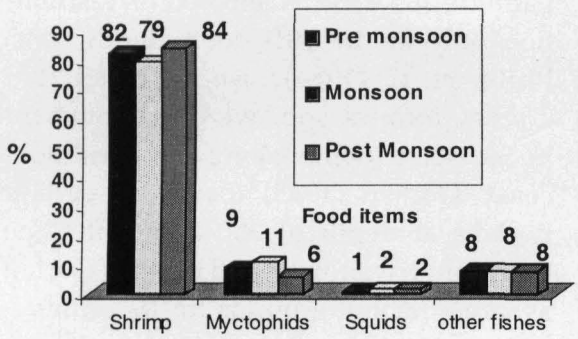

Fig. 2. *Percentage composition of food items of* C.bicornis *during different seasons*

intensity was less in all the seasons. Occurrence of high percentage of empty stomachs may be due to scarcity of food in the surrounding environment. Also it may be due to regurgitation of stomach contents resulting from the struggle during the dragging of Trawl net (Venu and Kurup, 2002b).

C. *bicornis* is a carnivore. The composition of the diet was similar in all the seasons (Fig.2). Crustaceans constituted the major food item, which was mainly comprised of deep-sea shrimps. Fishes were the second in abundance, mainly represented by myctophids. Squids were also present at very low percentages in the diet, however they were conspicuously absent from the gut of juvenile fishes. Shrimps dominated in the diet composition irrespective of seasons and sex. Myctophids formed the second major category in pre–monsoon and monsoon seasons. Fish remains formed the third major category. From the gut contents it appeared that high-density pockets of deep-sea shrimps co-exist in the latitudes and depth zones at which *Chlorophthalmus* species were found in abundance. The dietary composition of these species was found to be similar with other deep sea species like *Halaelurus hispidus, Eridacnis radcliffei* and *Iago omanensis* (Nair and Appukkuttan, 1973); *Priacanthus hamrur* (Philip, 1994); *Centroscyllium fabricii* and *Etmopterus princeps* (Klara, 2001) and *Psenopsis cyanea* (Venu and Kurup, 2002b).

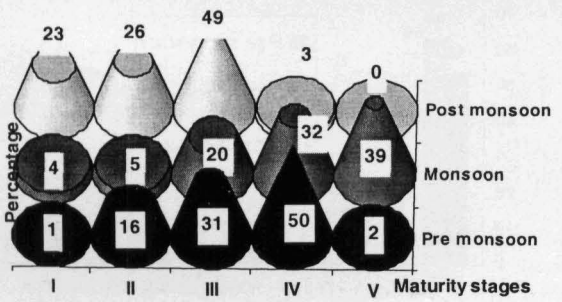

Fig. 3. *Maturity stages of* C. bicornis

Sex ratio

Sexes are not distributed equally and males out numbered females in all the three seasons. . The sex ratio (M:F) during the pre-monsoon, monsoon and post-monsoon was 1:0.88, 1:0.89 and 1:0.91 respectively. Length related chi -square analysis showed no significant variation from the hypothetical 1:1 ratio. Also males dominated in all length groups during all the seasons except in 18.5cm size during monsoon.

Maturity and spawning

Maturation was found to be a continuous process as indicated by the regular occurrence of mature fishes. The species is a multiple spawner. The ripening and ripe stages of ovaries were found to be at

varying percentage during the pre-monsoon, monsoon and the post-monsoon periods (Fig. 3). The pre-monsoon period marked a very high percentage of female in the ripening (31%) and ripe (50%) stage, while the juveniles and the truly spent fishes were represented in very low percentages of 1% and 2% respectively. With the commencement of the monsoon season there was a marked increase in the truly spent individuals (39%). The juveniles constituted 4% of the population and ripe, ripening and recovering spent fishes formed 32%, 20% and 5% respectively. In the post-monsoon season however, truly spent fishes in the population were completely absent, and the juveniles constituted 23%, while recovering spent specimens formed 26%. On the other hand, the ripening stage accounted for 48%, while only 3% of the specimens were found matured. High percentage of ripe females during the pre-monsoon season, truly spent individuals in the monsoon season, and dominance of recovering spent and ripening stages and presence of high percentage of juveniles in the post- monsoon season clearly indicated that the spawning of *C. bicornis* is during the monsoon season.

It was observed that fishes of comparatively smaller size were abundant in depth zone II and bigger sized fishes in zone III. This concurs with the findings of Khan *et al.* (1996) on *C. agassizi, Cubiceps natalensis, Psenopsis cyanea* and *Neoepinnula orientalis* whereas large sized and mature females occupied deeper areas. Philip (1994) also reported a distinct pattern of depth wise distribution in *Priacanthus hamrur* on the basis of the maturity stages and sex of the fishes. Immature specimens were abundant in areas below 50m and showed an inverse relationship with depth. Thus, the mature forms and the spent individuals were usually concentrated beyond of 200m depth indicating that these fishes used to spawn in deeper waters.

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