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Discontinuous distribution of *Alepisaurus ferox* Lowe, 1833 (Alepisauridae, Teleostei) in the Indian EEZ as revealed by the tuna longline survey

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Distribution pattern of longnose lancetfish, *Alepisaurus ferox* Lowe, 1833 in the Indian Exclusive Economic Zone had been analyzed for the period January 2005 to December 2007. While longnose lancetfish is caught from almost all the areas surveyed in the Bay of Bengal and Andaman and Nicobar waters, it is is not caught from areas north of latitude 16°24′N of the Arabian Sea. Discontinuous distribution of longnose lancetfish in the Indian EEZ can be related to the existence of perennial Oxygen Minimum Zone in the northern Arabian Sea. Present study also consists the results of preliminary studies on the biology of this species.

[**Keywords:** Bycatch, longlining, Exclusive Economic Zone, discontinuous distribution, Oxygen Minimum Zone.]

Introduction

Longnose lancetfish, *Alepisaurus ferox* Lowe, 1833 is one of the most common bycatch species of the tuna longline fishery. It has a worldwide distribution, extending from 45°N to 45°S, in the open ocean pelagic ecosystems of the world oceans[1]. Silas and Pillai[2, 3] reported catch of *A. ferox* from the Lakshadweep Sea. Kapoor *et al*.,[4] had included this fish in their compilation on fish biodiversity in the Indian waters. There are no detailed information on the distribution, abundance and biology of this species in the Indian EEZ. Fishbase[5] reported its occurrence in India as 'questionable'. Article 119, b of the United Nation Convention on the Law of the Sea (UNCLOS)[6], urges the States to "take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened". Hence an attempt was made by Fishery Survey of India to study the abundance and distribution pattern of longnose lancetfish in the Indian EEZ. Presnt study also consists results of preliminary studies on the biology of this species.

Materials and Methods

The Fishery Survey of India (FSI), currently operates four tuna longline survey vessels from Mumbai, Chennai and Port Blair Bases to study distribution and biology of tunas and allied resources in the Indian EEZ. Data gathered onboard the four tuna longline survey vessels of FSI during 2005-2007 were anlaysed for studying the distribution pattern and biology of longnose lancetfish. The vessels, MFV *Matsya Vrushti* (OAL 37.5m, GRT 465t), and MFV Yellow Fin (OAL 36.0m, GRT 290t) based at Mumbai surveyed the West coast (Arabian Sea), while other two vessels, MFV *Matsya Drushti* (OAL 37.5m, GRT 465t) and MFV Blue Marlin (OAL 36.0m, GRT 290t) attached to Chennai and Port Blair Bases of the Institute surveyed the Bay of Bengal and Andaman and Nicobar waters of the Indian EEZ respectively. Conventional Japanese multifilament longline with five hooks in a basket was operated from the vessels *MFV Yellow Fin* and *MFV Blue Marlin*. Other two vessels operated monofilament longline gear with seven hooks per basket. Every month, each of these vessels are deployed for voyages of 20 days duration, and about 15 longline operations are conducted in each voyage, operating an average of 9000 hooks. In each day operation, the shooting of the line commences before sunrise and is completed in about 2-2.5 hours. On an average, 600 hooks are operated in a day. Immersion time of 5-6 hours is allowed and hauling is done in the afternoon starting from the initially shot end.

Onboard, the longnose lancetfish, *Alepisaurus ferox* Lowe, 1833 [(Plate 1 (a) and (b)] was identified by the characters described by Goode and Bean[7]. All the fish specimens caught during the survey voyages were subjected to morphometric measurements. Fish

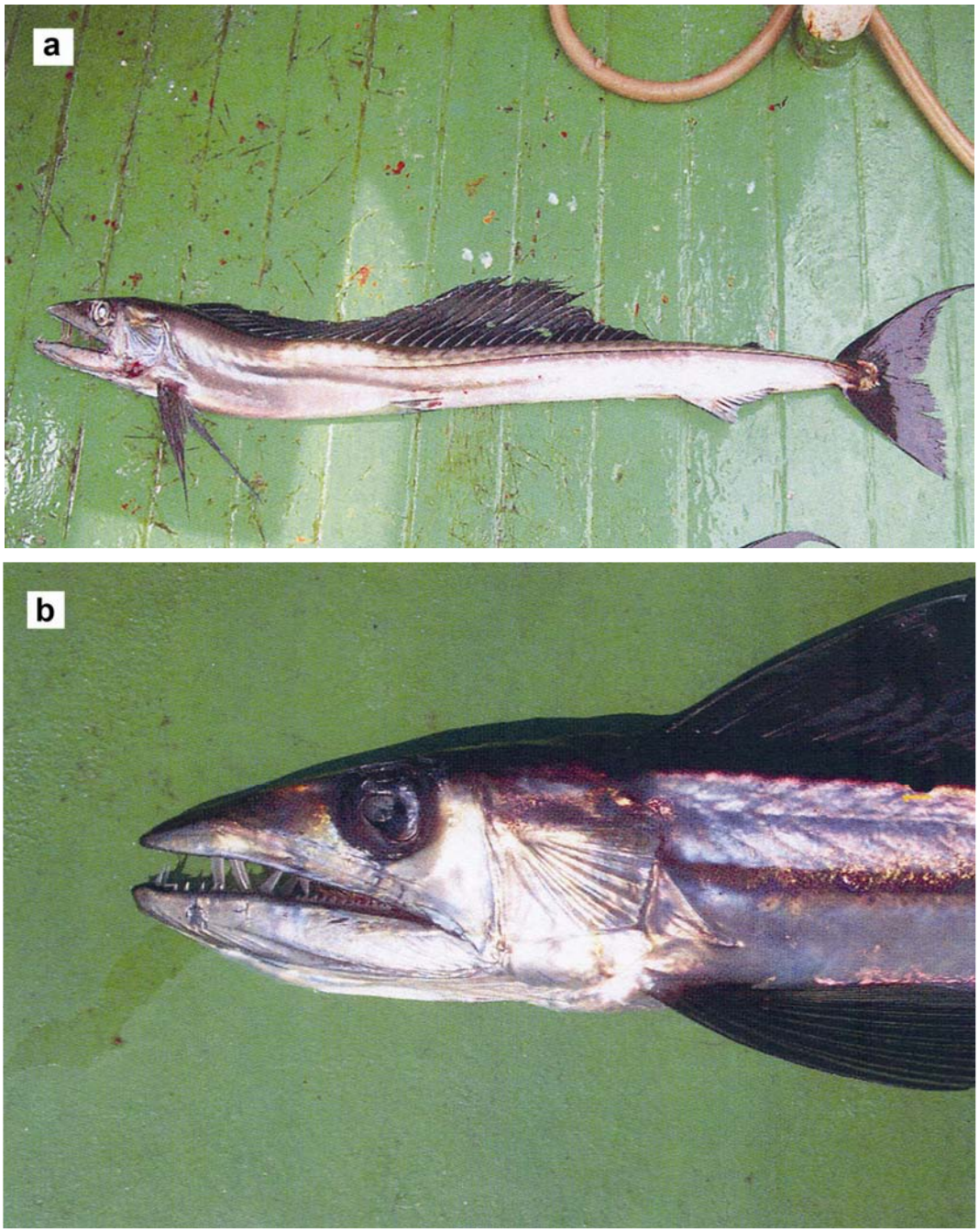

Plate. (a) and (b)—Longnose lancetfish *A. ferox* Lowe, 1833 hooked onboard research vessel, *MFV M. Vrushti*

were dissected out to study their sex, maturity stages, stomach condition etc. Gonads and guts were preserved in properly labeled polythene bags and kept in frozen condition (−20°C). Standard protocols were followed for studying the reproduction and food and feeding habit in the shore laboratory. Diet was assessed using percent occurrence by number (%N), percent frequency of occurrence (%F), and percent occurrence by weight (%W) of prey items. The quantitative importance of each prey group in the diet was determined by the Index of Relative Importance, IRI[8] defined as;

IRI = %F (%N+%V)

Where, (%N) = the percentage by number, (%F) = the percentage by frequency of occurrence, (%V) = the percentage by volume. In the present study, weight was used (%W) instead of volume (%V). To

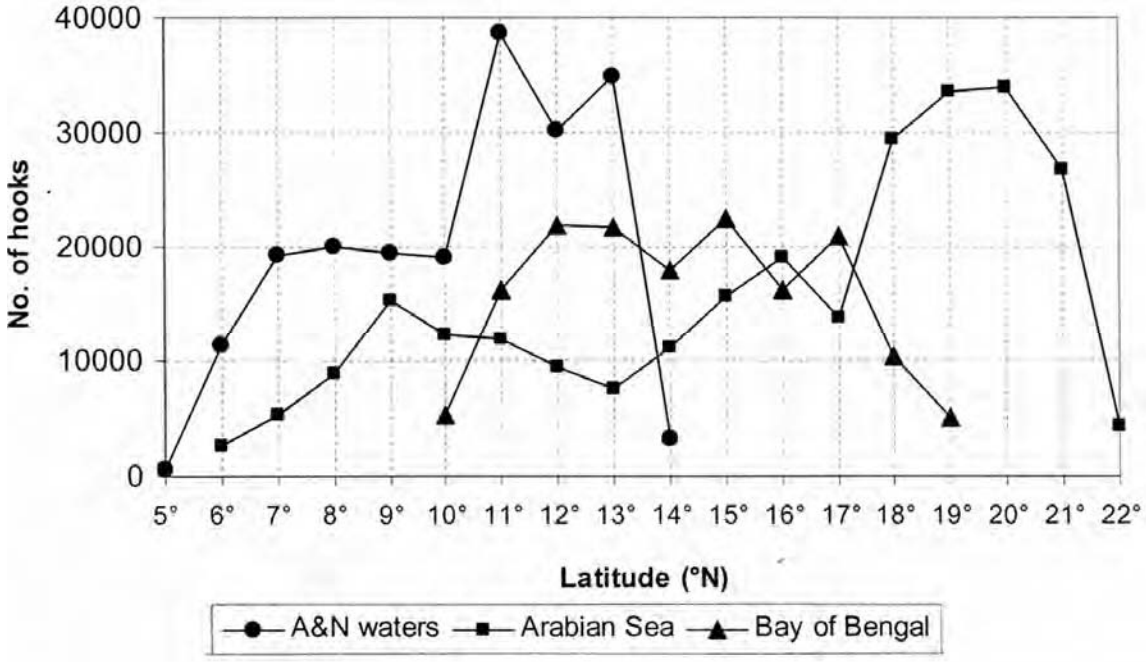

Fig. 1—Latitude-wise number of hooks operated in different regions of the Indian EEZ

facilitate diet comparison, IRI was standardized to %IRI. This modified index has been expressed as $\%IRI = (IRI/\sum IRI) \times 100$.

In order to study the distribution and abundance of the species, the Indian EEZ is divided into three regions *viz*., Arabian Sea, Bay of Bengal and Andaman and Nicobar waters. Data gathered during the period January 2005 to December 2007 were treated separately for these three regions. Abundance data were analysed for studying the area-wise and latitude-wise distribution, abundance and percentage contribution of longnose lancetfish. Abundance index is expressed in terms of Hooking rate (HR), number of individuals caught per 1000 hooks operated for sampling.

Results

During the study period, these four longliners had operated, 261002 hooks were operated in the area Lat. 6°N-23°N of the Arabian Sea, 158492 in Bay of Bengal (Lat. 10°N-19°N) and 196820 in the Lat. 5°N-14°N of the Andaman and Nicobar waters (Fig. 1). The hooks operated in each latitude ranged between 625 and 38720.

Total 208 specimens of *A. ferox* were hooked during the study period, registering a hooking rate of 0.34 individuals per 1000 hooks. This species constituted about 4.2% of the total catch recorded by number. Sampling stations from where the species was hooked (Fig. 2) indicates that though this fish is fairly evenly distributed in the Bay of Bengal and Andaman and Nicobar waters, being caught from almost all latitudes surveyed. Whereas the distribution in the Arabian Sea presents a different picture. This species is not caught from the area north of Latitude 17°N and its northern limit of distribution in the Arabian Sea revealed from the present study was Lat. 16°24'N. HR recorded from different latitudes and their percentage contribution to the total catch registered from these areas (Figs 3-5) also shows this trend in their abundance indices. In the Arabian Sea, total number of specimens belonging to this species hooked was 96 registering a HR of 0.37. Latitude-wise analysis of abundance indices revealed that the maximum abundance was in the southern latitudes, thereafter showing a decline in abundance towards north. The maximum abundance was recorded from the Lat. 7°N (3.04) followed by 8°N (1.67) and 9°N (1.17). This species contributed 4.69% of the total catch from this area. In the lat. 7°N, this species alone constituted 51.61% of the total catch while its contribution to the total catch from the Lat. 8°N was 15.96%. The two vessels, *Yellow Fin* and *Matsya Vrushti* had extensively surveyed the northern

Arabian Sea (Lat. 17°N-23°N), by operating 141713 hooks in this area but could not hook even a single specimen of this fish.

From the Bay of Bengal region of the Indian EEZ, 25 individuals of this species were hooked during the study period, registering HR of 0.16, contributing 1.93% to the total catch recorded from this particular area. The HR registered in the Lat. 13°N (0.37) was maximum, followed by 15°N (0.22) and 19°N (0.19). In the latitude 13°N, this species constituted 4.68% of

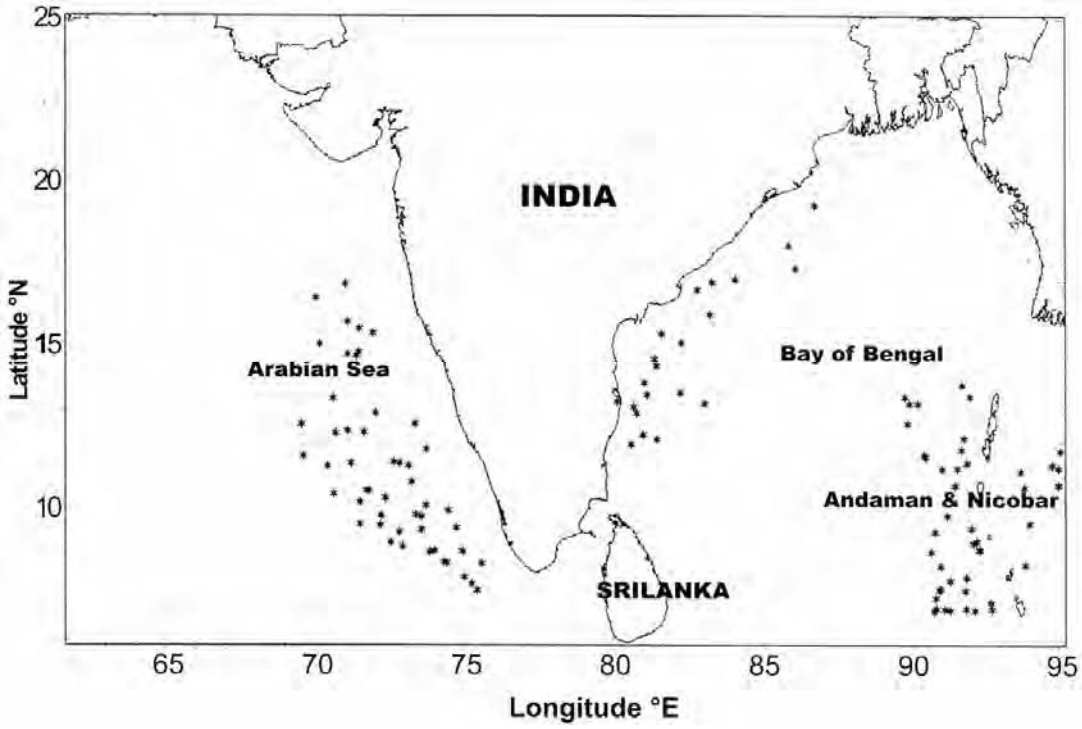

Fig. 2—Map showing the sampling stations where *A. ferox* were hooked

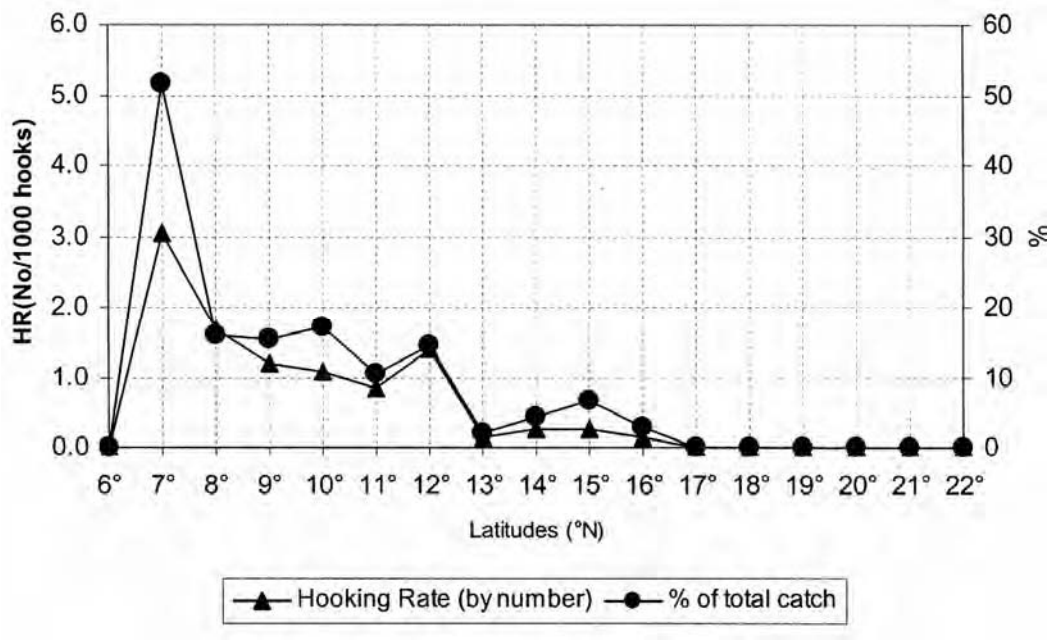

Fig. 3—HR and percentage contribution of *A. ferox* to the total catch recorded from the Arabian Sea

the total catch while its contribution to the total catches from the Lat. 12°N and 19°N were 3.00% and 2.17% respectively. The HR from other latitudes was not remarkable.

In the Andaman and Nicobar waters, this species contributed to 5.43% of the total catch recorded, registering a HR of 0.44. *A. ferox* was more abundant in the southern latitudes, 7 and 6°N, registering HR of 1.09 and 1.06 respectively (Fig. 4). This species contributed 15.19% of the total catch hooked from the Lat. 6°N while its percentage contribution to the total catch of latitude 7°N was 11.11%. Catch of this species from Lat. 10°N also was impressive (HR-0.42, 5.52% of the total catch).

The Total Length (TL) of specimens caught during the study period was in the range of 97-143 cm, while

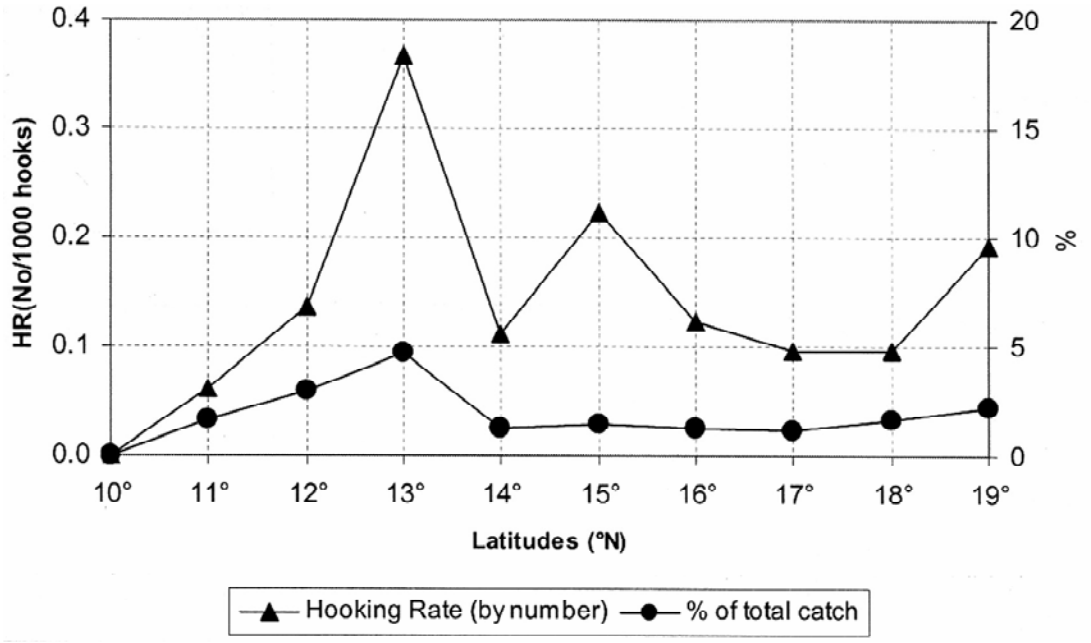

Fig. 4—HR and percentage contribution of *A. ferox* to the total catch recorded from the Bay of Bengal

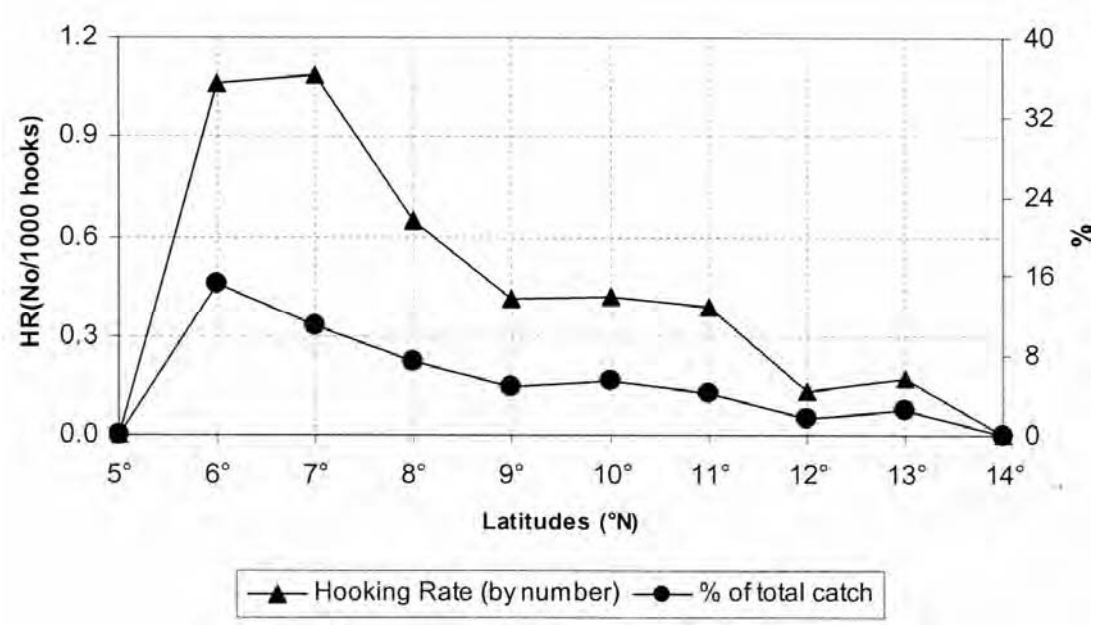

Fig. 5—HR and percentage contribution of *A. ferox* to the total catch recorded from the Andaman & Nicobar waters

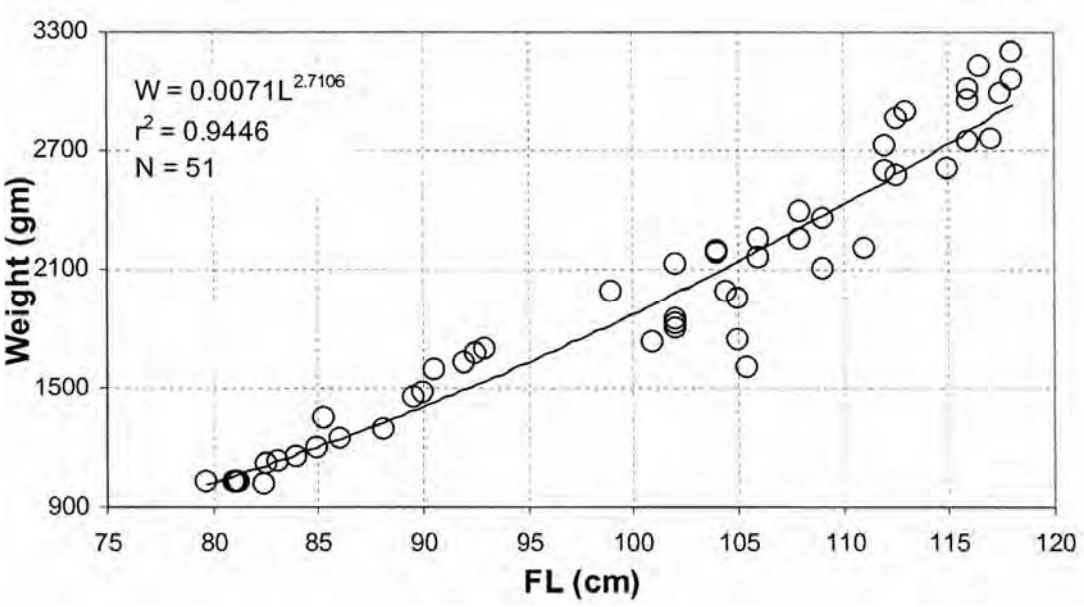

Fig. 6—Length-weight relationship of *A. ferox* caught from Arabian Sea

their weight was in the range of 1.3-3.2 kg. Attempts were made to correlate the FL (cm) of 51 individuals caught from the Arabian Sea with their weight (g) and, as furnished in Fig. 6, the length-weight relationship calculated during the present study is given by the formula,

$W = 0.0071FL^{2.7106}$ ($r^2 = 0.9446$)

Large mouth and sharp teeth of the longnose lancetfish indicates a predatory mode of life while the morphology of mouth indicates the columnar feeding habits. The food engulfed was found to be well preserved in the stomach enabling the identification of food items because of their digestive characteristics. Food is first stored in the stomach and digestion takes place in the intestine, as pointed out by Rofen[9]. Diets of 51 individuals of *A. ferox* collected from the Arabian Sea were studied during the study period. Out of these, 12 individuals (23.53%) were found to be with empty stomachs. The sampled individuals were in the FL range of 69-118 cm, an average weight of 2.94 kg. The total food weight recovered from the stomachs of the samples with non-empty stomachs was 2217.8 g, which shows that the average weight of stomach contents present in the stomachs of individuals was 43.49 g. The average fullness index (or Repletion Index) of the longnose lancetfishes caught during the present study was 14.78 g per kg of lancetfish.

Group-wise analysis of the diet of *A. ferox* (Table 1) revealed that, the crustaceans were the main component of the food of this species (%N – 78.83, %W – 59.07, %F – 71.80 and %IRI – 86.50), followed by cephalopods (%N – 12.61, %W – 24.95, %F – 46.15 and %IRI – 9.95), finfishes (%N – 6.31, %W – 15.36, %F – 12.82 and %IRI – 3.54) and synthetic materials like pieces of polythene bag and Polypropylene (PP) rope. (%N – 2.25, %W – 0.62, %F – 1.77 and %IRI – 0.02). Swimming crab, *Charybdis smithii* was the single largest component of diet of *A. ferox.* This species alone contributed 76.68% to the total number of food items, 24.95% to the total weight of food items, while it was a part of food of 71.80% individuals of *A. ferox* caught during the study period having non-empty stomachs. The %IRI of this species was 95.50. *Sthenoteuthis oualaniensis* was the second dominant food item, which contributed 3.604% to the total number of food items, 9.29% to the total weight of food items, while it was a part of food of 17.9% individuals of *A. ferox* and the %IRI calculated for this species was 1.47. The other dominant food items were, *Ancistrocheirus lesueurii* (%N – 1.35, %W – 9.39, %F – 7.69 and %IRI – 1.24) and *A. ferox* (%N – 3.15, %W – 7.90, %F – 10.26 and %IRI – 1.07) itself.

The reproduction biology of the species shows that all the specimens collected were either indeterminants, or females in different stages of maturity. Histological examinations of the gonads were not attempted as part of the present study.

Table 1—Prey species consumed, their percentage contribution to the diet in terms of number, weight and occurrence and the IRI calculated to the individual food item of *A. ferox*

Prey family	Prey species/group	%N	%W	%F	%IRI
Ancistrocheiridae	*Ancistrocheirus lesueurii*	1.351	9.39	7.69	1.236
Argonautidae	*Argonauta hians*	1.802	1.82	7.69	0.081
Bolitaenidae	*Japetella diaphana*	0.45	0.07	2.56	0.000
Histioteuthidae	*Histioteuthis hoylei*	2.252	0.56	10.3	0.019
Histioteuthidae	*Histioteuthis* sp	0.901	0.59	5.13	0.011
Ommastrephidae	*Sthenoteuthis oualaniensis*	3.604	9.29	17.9	1.467
Thysanoteuthidae	*Pholidoteuthis* sp	0.901	1.84	5.13	0.062
	Digested squids	0.45	0.02	2.56	0.000
	Unidentified Octopus	0.901	1.37	5.13	0.038
	Cephalopods	12.61	24.9	46.2	9.951
Portunidae	*Charybdis smithii*	75.68	58.2	71.8	95.497
Nannosquillidae	*Acanthosquilla* sp	2.703	0.82	15.4	0.035
	Megalopa larva	0.45	0.01	2.56	0.000
	Crustaceans	78.83	59.1	71.8	86.496
Alepisauridae	*Alepisaurus ferox*	3.153	7.9	10.3	1.070
Berycidae	*Beryx splendens*	0.45	0.14	2.56	0.001
Bramidae	*Brama brama*	0.45	0.99	2.56	0.018
Exocoetidae	*Hirundichthys coromandelensis*	0.45	5.82	2.56	0.447
Tetraodontidae	*Lagocephalus lagocephalus*	0.45	0.02	2.56	0.000
Tetraodontidae	*Lagocephalus* sp	0.901	0.02	2.56	0.000
	Dig fish	0.45	0.46	2.56	0.005
	Finfishes	6.306	15.4	12.8	3.535
	Polythene bag	1.351	0.46	7.69	0.010
	Polypropylene rope	0.901	0.16	5.13	0.002
	Synthetic materials	2.252	0.62	5.13	0.019

Discussion

The present study confirms the presence of *A. ferox* in the Indian EEZ. It establishes the discontinuous distribution of the species in the Arabian Sea part of the Indian EZ as it was not caught in the area north of Latitude 16°24'N. Many Scientists have reported contrasting oceanographic features of the Southern and Northern Arabian Sea and the existence of well-pronounced Oxygen Minimum Zones (OMZ) in Northern Arabian Sea[10,11,12,13,14]. This anomaly is attributed to Indian Ocean's unusual geography, i.e., mainly the presence of Asian land mass that restricts its northern expanse to the tropics and to a smaller extent, a porous eastern boundary which allows exchange of water with the Pacific Ocean in low latitudes. Due to this phenomenon, bottom waters with O_2 level <0.5 ml/l (22µM) and <0.2ml/l (9µM), are estimated to cover about 1.15×10^6 and 0.76×10^6 km^2 in this area[11]. Therefore, presence of this perennial OMZ in the mesopelagic oceanic waters of Northern Arabian Sea can be related to the absence of longnose lancetfish in the areas north of 16°24′N in the Arabian Sea part of Indian EEZ. Madhupratap *et al*.,[14]. The catch of coastal fishery of the Arabian Sea, had pointed out drastic difference in the fisheries of Southern and Northern Arabian Sea part of Indian EEZ. About 100% of the Bombay duck, 81% of the croakers and 75% of the ribbon fishes are reported to be caught from Northern region while on the other hand, 78% of clupeids, 72% of perches, 84% of carangids and 85% of mackerels are caught from southern region. Orlov and Ul'chenko[1], while analyzing onshore records of this species in the north Pacific ocean postulated that the lancetfish mortality may be related to sharp changes in oceanic conditions related with La Niña events. The present study indicates that discontinuous distribution of longnose lancetfish in the Indian EEZ can be related to the existence of perennial OMZ in the northern Arabian Sea.

Length-weight relationship of this species calculated during the present study is given by the formula, $W\ (g) = 0.0071FL(cm)^{2.7106}$. Though high degree of correlation ($r^2 = 0.9446$) is indicative of

good fit of relationship between length and weight of this species, absence of smaller specimens (<80 cm, FL) and very large fish (>118 cm, FL) in the samples used for length-weight relationship studies, which may be due to the selective characteristics of the hooks used for catching, might have affected the results. Uchiyama and Kazama[15], while calculating the length-weight relationship of *A. ferox* caught from Central North Pacific has given the length-weight relationship by the formula W (kg) = $0.00000601421FL(cm)^{2.75849}$. Deviation in the value of exponent 'b' from the ideal value of 3 is not surprising due to the fact that this fish grows faster in length than in weight as in the case of many other anguilliform fishes.

Food and feeding studies conducted during the present study revealed that swimming crab, *C. smithii* is the most preferred food of *A. ferox*. Potier *et al*.,[16] also identified *C. smithii* as the most preferred food item of *A. ferox* caught from Seychelles waters. As observed in the present investigation, many of the lancetfish collected from the Suruga Bay, Central Japan also were also found to feed upon a number of synthetic materials[17] indicating that they are voracious feeders. Cannibalism in this species, as pointed out by many workers[16,18,19,20,21] was established in the present study also. The lancetfish is more an ambush-type hunter than an active predator[22]. Haedrich [18] and Haedrich and Nielson[19], suggested that the lancetfish is a diurnal feeder with a foraging activity that is limited to the upper 300m of the water column, based on the lack of myctophids in the diet composition. The present study also confirms with these findings and indicates columnar feeding habit of the species.

Since all the individuals caught during the study period were either indeterminants or females in different stages of maturity, it is inferred that the species could exhibit hermaphroditism. Silas[2] also reported the same observation on lancetfish caught from Indian Ocean. Gibbs[23] and Mead[24] independently discovered that *Alepisaurus* is hermaphroditic. Smith and Atz[25] reported that gonads of adolescents are hermaphroditic, testicular part of gonad well separated from ovarian region lies dorsal to the ovary. But there is no proof that the species is a functional hermaphrodite[26].

All these features, cannibalism, hermaphroditic mode of reproduction together with the discontinuous distribution established by the present investigation, make *A. ferox* an interesting species. Though this fish has no economic value as the flesh is watery and usually not consumed by humans, it plays an important role in the pelagic trophic structure of the world oceans, sharing the same forage species with tunas and billfishes and preyed upon by opah, sharks, albacore, yellowfin tuna, and fur seals[27].

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