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Distribution and abundance in time and space of pelagic stingray *Pteroplatytrygon violacea* (Bonaparte, 1832)

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Pelagic stingray, formerly considered as a rare species is becoming a major bycatch of tuna longline fishery. Present study is an attempt to understand the abundance of pelagic stingray in time and space around Andaman & Nicobar Islands. General linear model has been fitted by using exploratory tuna longline survey data collected from A & N Islands. The study provided an account on the abundance and distribution pattern of the species. Present study recorded better catch rates during the new moon period and the results indicated the significant effect of the lunar cycle on the catch rate of pelagic stingray. Almost nil catch rate recorded during monsoon period was quite interesting and results showed that there is a significant effect of the monsoon on the catch rate. An increasing trend of the year wise catch rates indicates the fishing pressure on the co existing oceanic resources.

[Key words: Lunar effect on pelagic stingray, Monsoon effect on pelagic stingray, Pelagic stingray distribution, Pelagic stingray abundance, Pelagic stingray of Andaman, Pelagic stingray environment]

Introduction

The pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832) is the only species of the Family Dasyatidae which occurs in pelagic oceanic water. They are distributed throughout tropical and subtropical waters and have almost circum global distribution[1]. Stingray is a common component of longline bycatch throughout the world[2]. In India they were reported from the trawl[3], longline [4] and gill net[5] catches. Occurrence of the pelagic stingray was very rare in olden days but its catch rates in the tuna longline fishery have been increased drastically during recent years[6].

Pelagic stingray is caught as a bycatch and mostly discarded throughout the world except in some parts of Indonesia, where its meat, cartilage and tail are utilised[7]. There are reports that pelagic stingray caught in longliners are discarded at sea suffers high mortality. Fishers are wary of being stung and remove the rays from the hooks by smashing them against the side of the boat, causing severe damage to the mouth and jaws[8]. Meantime International Union for conservation of Nature (IUCN) included this species in the list of *least concern* considering its wide distribution, high reproductive rate, and lack of population decline[1].

Considering the increased catch rate of this stingray in the tuna longline fishery, an attempt has been made here to understand the distribution in time and space and the effects of environmental factors on its distribution. This vital information on the distribution and abundance of pelagic stingray will help in the formulation of the exploitation strategy. Moreover, a fishery can be developed around the Island territory for the optimum utilization of this underutilized resource as prevailed in Indonesia.

Materials and Methods

Resource survey data collected by the vessel M.V. Blue Marlin, tuna longline survey vessel attached to the Fishery Survey of India (FSI), Port Blair, A&N Islands during the period from January 2006 to December 2008 was the source of the study. Resource survey carried out following FSI (2006)[9] recorded the pelagic stingray caught during the fishing operation. Specimens caught were identified up to species level and their number was recorded separately for further calculations. Catch per unit effort (CPUE) was estimated in catch rate as number of fishes caught (successful hooks) per 1000 hooks. Distribution in space was estimated by determining aggregate catch rate of fishes caught from each 1^0 Latitude (Lat.).

The variation in the abundance of the species according to the season and lunar cycle were estimated by evaluating the effect of the monsoon and the lunar cycle on stingray catch

rate. The effect of the monsoon on the pelagic stingray was estimated by grouping the aggregate month-wise catch rates into Pre-monsoon (January to April), Monsoon (May to August) and Post monsoon (September to December) periods following Sajeevan and Rajashree (2012)[6].

The lunar periodicity in each month, mined from the Indian tide tables [10-12] were pooled into three periods according to the lunar phase as a new moon period, the waxing & waning period and full moon period. New moon period refers to new moon day ±3 days, full moon period refers to full moon day ±3 days and the in between periods were pooled as the waxing & waning periods. Aggregate catch rates recorded during these lunar phases in each season and year was separately estimated to evaluate the lunar cycle effect on pelagic stingray.

SYSTAT-13 software was used to analyze the statistical significance of the effects of the lunar cycle and monsoon on the catch rates following general linear model. Standard statistical procedures[13-14] were also employed for the analysis.

Results

Pelagic stingray constituted 11 % by number of the total fishes caught and recorded an aggregate catch rate of 0.82 during the study period. Best catch rate recorded from the Lat. 06^0 N (2.65) whereas the catch rates reduced towards the higher latitude. A clear-cut decreasing trend of catch rates towards northern latitude was noticed (Table 1.) Year wise aggregate catch rate during the study period is shown as Fig.1. Catch rate recorded during the period shown an increasing trend since 2006.

Table 1. Latitude-wise aggregate catch rate during 2006-08.

Latitude	Catch rate in one fish per thousand hooks		Latitude	Catch rate in one fish per thousand hooks	
	Total	Pelagic stingray		Total	Pelagic stingray
06^0 N	6.37	2.6525	11^0 N	8.61	0.5080
07^0 N	7.79	2.0198	12^0 N	7.52	0.4907
08^0 N	8.41	1.8285	13^0 N	5.29	0.2103
09^0 N	8.58	1.1947	14^0 N	4.11	0.4571
10^0 N	6.7	0.7908	Average	7.39	0.8396

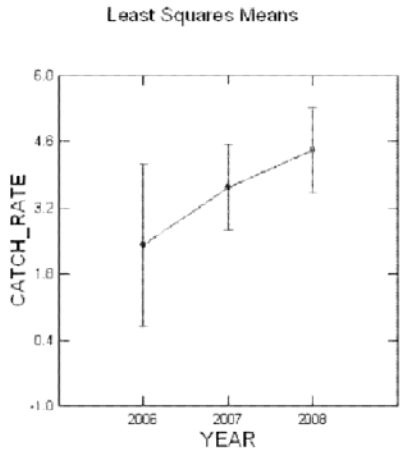

Fig.1. Pelagic stingray catch rate year wise from 2006-08

Aggregate catch rates recorded during different season are furnished as Fig. 2. As shown in Fig.2. catch rate was almost nil during the monsoon period and better catch rates were recorded during pre monsoon period and post-monsoon period. Effect of lunar cycle on catch rate is furnished as Fig.3. As shown in Fig 3. catch rate of pelagic stingray was more during new moon days and was closely followed bycatch rate of waxing & waning period. Precisely, lower catch rates were observed during full moon period and a decreasing trend of catch rates towards the illuminated phase of the moon was also noticed.

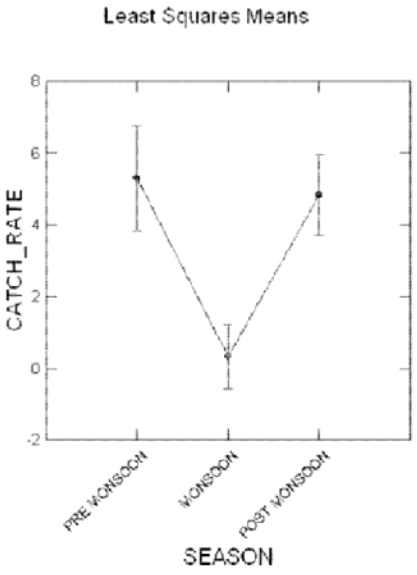

Fig.2. Effect of Monsoon on pelagic stingray catch rate

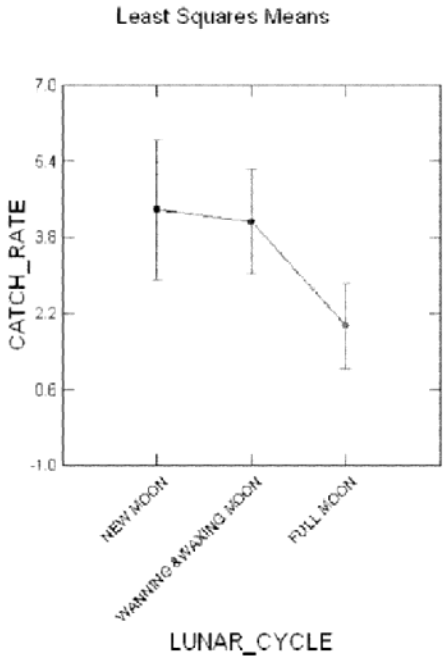

Fig.3. Effect of lunar cycle on pelagic stingray catch rate

Effect of the lunar cycle and monsoon evaluated by fitting data to the general linear model and the result is furnished as Table 2. As revealed from the Table 2., there are significant differences in the catch rates of pelagic stingray recorded during the different phases of the moon. A similar trend was noticed in the case of catch rates recorded during different seasons of the year. The cumulative effect of season and lunar cycle was also found significant.

Turkey's honestly- Significance –Difference test of aggregate catch rates showed that the full moon catch rate is significantly different from the catch rate recorded during new moon period and waxing & waning period (Table 3.). Catch rate recorded during pre monsoon & post monsoon was significantly different with the catch rate recorded during monsoon.

Discussion

The results of the present study pointed out that the catch rate of pelagic stingray which was not reported as bycatch of tuna long line fishery of Andaman[6,15-17] has drastically increased during recent years. A similar phenomenon was reported by Baum *et al.* (2009)[1] from the tropical Pacific Ocean and Northwest Atlantic. Increasing effort in pelagic fisheries, decrease in abundance of competitors and predators like tuna, billfishes, shark etc. are the reasons attributed for this phenomenon.

Table 2. Effect of Monsoon and Lunar cycle- General linear model -Analysis of variance table

Source	Type III Sum of Square	Degrees of freedom	Mean square	F-Ratio	p-value
Year	8.435	2	4.217	3.795	0.099
Season	94.999	2	47.500	42.74	0.001*
Lunar Cycle	22.846	2	11.423	10.28	0.017*
Season* Lunar Cycle	23.267	4	5.817	5.235	0.049*
Year* Season	28.740	4	7.185	6.466	0.033*
Year* Lunar Cycle	13.977	4	3.494	3.145	0.120
Error	5.556	5	1.111		

* Significant at 5% level

Table 3. Turkey's Honestly- Significance –Difference test of catch rates of lunar cycle

Lunar cycle	Lunar cycle	Difference	p-value	95% confidence interval	
				Lower	Upper
New Moon	Waning &Waxing Moon	0.254	0.925	-1.522	2.029
New Moon	Full Moon	2.450	0.033*	0.721	4.179
Waning &Waxing Moon	Full Moon	2.196	0.024*	0.529	3.863
Pre Monsoon	Monsoon	4.961	0.002*	3.233	6.690
Pre Monsoon	Post Monsoon	0.460	0.781	-1.316	2.235
Monsoon	Post Monsoon	-4.50	0.001*	-6.169	-2.83

*Significant at 5% level

Increased abundance of this species in A&N waters during recent years may be due to the same reason ie. reduction in catch rate of tuna and sharks from the Andaman waters[6]. Moreover, Ward and Myers (2005)[18] reported an increased abundance of formerly rare and smaller fishes in the recent catches from the tropical Pacific Ocean due to the excessive removal of commercially important fishes.

The present study showed that aggregate catch rates of pelagic stingray were more during the pre monsoon and post-monsoon period. Almost nil catch rates recorded during monsoon period in the present study is quite interesting. High swells and current prevailing in the monsoon period may be the reason for this poor hooking rate. Pelagic stingray may be moving exclusively on surface waters during monsoon, hence may not be attracted to the baited hooks in the water column.

Present study recorded better catch rates during the new moon period and the catch rates reduced towards the illuminating phase of the moon. This indicates that the illumination of the moon is having an inverse effect on the catch rate of stingray. During new moon days concentration of forage organism in the surface layers occurs due to their diurnal migration. This increased availability of prey organisms on the surface may attract more stingray to the area, hence results in the increased catch rate of stingray in the tuna longline gear. This pattern of feeding behaviour may be reflected as better catch rate during the new moon period and consecutive reduction towards the illuminating phase of the moon.

Conclusion

The results of the present study indicated the abundance of pelagic stingray in Andaman waters and provided the distribution pattern in time and space. Better hooking rates recorded during the new moon periods indicated that lunar cycle plays a significant role in the catch rate of pelagic stingray. The results also suggest that monsoon plays a significant role in the catch rate of pelagic stingray.

An exhaustive search of literature indicated that no study has been carried out to understand the abundance of pelagic stingray. Hence the present study is the premier one that provides information on the distribution and abundance of the species. Moreover, results of the present study endow an account of the effect of environmental factors like monsoon and lunar cycle on the distribution pattern of the pelagic stingray. The results of the present study will help the researchers to set the course for future research and may lead to formulating an exploitation strategy, conservative measures and ensure sustainable fisheries of pelagic stingray around the world.

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