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Influence of lunar phases on fish landings by gillnetters and trawlers

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ABSTRACT

Observations made on new moon, full moon and during both quarters revealed variations in total catch as well as individual species catch in gillnetters and trawlers. Gillnet catches of sardines and mackerels showed a gradual increasing trend from new moon to full moon and then a decline towards the new moon whereas, barracuda and tuna catches exhibited an increasing trend from full moon to new moon. The catches of seerfish and sailfish were high during full moon to new moon quarter and were nominal during full moon. In trawl catches, during the first half of new moon and full moon days, *Fenneropenaeus indicus* and *Penaeus semisulcatus* were caught in large numbers and *Fenneropenaeus merguiensis* dominated the later half. *Metapenaeus monoceros* and *Penaeus monodon* were caught in lesser quantities. Maximum catch per unit effort (CPUE) for gillnetting and trawling were recorded during new moon (52.35 and 9.97 kg h^{-1}) and minimum values during full moon quarter (2.5 and 1.63 kg h^{-1}). Larger size groups were dominant during new moon for all species and the differences were significant ($p<0.01$). Significant variations in total catch during different lunar phases were noticed for fishes caught by gillnetting as well as the shrimps caught by trawling.

Keywords: Fish landings, Lunar phases, Gillnetters, Shrimps, Size variation, Trawlers

Introduction

Most of the organisms exhibiting lunar periodicities are marine inhabitants. The high tidal amplitude at the times of new moon and full moon and low tidal amplitude at quarter moon affects the life of many marine organisms. The striking nature of these lunar periodicities is well illustrated by the fluctuations in the abundance of species which are not correlated with temperature or other known environmental parameters. Many fishermen strongly believe that lunar gravitational fluctuations influence the success of fishing. Often fishermen are able to locate schools of small fishes by the glow of phosphorescent plankton in seawater. In lagoons and estuaries, primary and secondary maxima of fish catch rates have been observed on new moon and full moon days respectively which has been strengthened with the findings of several researchers (Mohan and Kunhikoya, 1987; Salini *et al.,* 2001; Aswani and Hamilton, 2004; Lowry *et al*., 2007; Ghosh *et al*., 2008; Das *et al.,* 2009; Poisson *et al*., 2010). Catches of certain species have been reported to be higher and more numerous during full moon than during the darker phase of the lunar cycle (Stamatopoulos, 1992; Courtney *et al.,* 1996; Das *et al.,* 2009). It has been reported that shrimps, when fished at night can be caught in greatest quantities at new moon (Kangas and Sporer, 2001; Salini *et al*., 2001; Nandakumar, 2004; Dixon and Hooper, 2008; Macbeth *et al*., 2008). Generally, shrimps are nocturnal in behaviour and have a burrowing nature in sediment to avoid predators. Because of this, in the relative darkness of the new moon, when they are actively feeding above the substrate, they are more likely to be caught by trawl nets (Salini *et al*., 2001).

Gillnetting and trawling are the most common fishing gears in India (Annam *et al*., 2004). Gillnet fishermen all over the world have recognised that visibility of nets, combined with turbidity of water and currents are important in determining the fishability. Furthermore, the catchability of gillnets during night is related to lunar calendar, the largest catches being usually made during cloudy nights or during the dark moon phase (Aswani and Hamilton, 2004). Shrimp trawling contributes a lion share of shrimp catch in the country (Annam *et al*., 2004). Along with shrimps, good amount of other organisms are also caught as bycatch. The present study was undertaken to investigate the productivity and size variations in catches from gillnetting and trawling during different lunar phases.

Materials and methods

Two landing centers were selected in Cuddalore District along the northern coast of Tamil Nadu, India; Annankoil (79^0 46' E; 11^0 29' N) for studying fish landings and Mudasalodai (79^0 40' E; 11^0 15' N) for studying shrimp landings (Fig. 1). Around 70 FRP mechanised boats

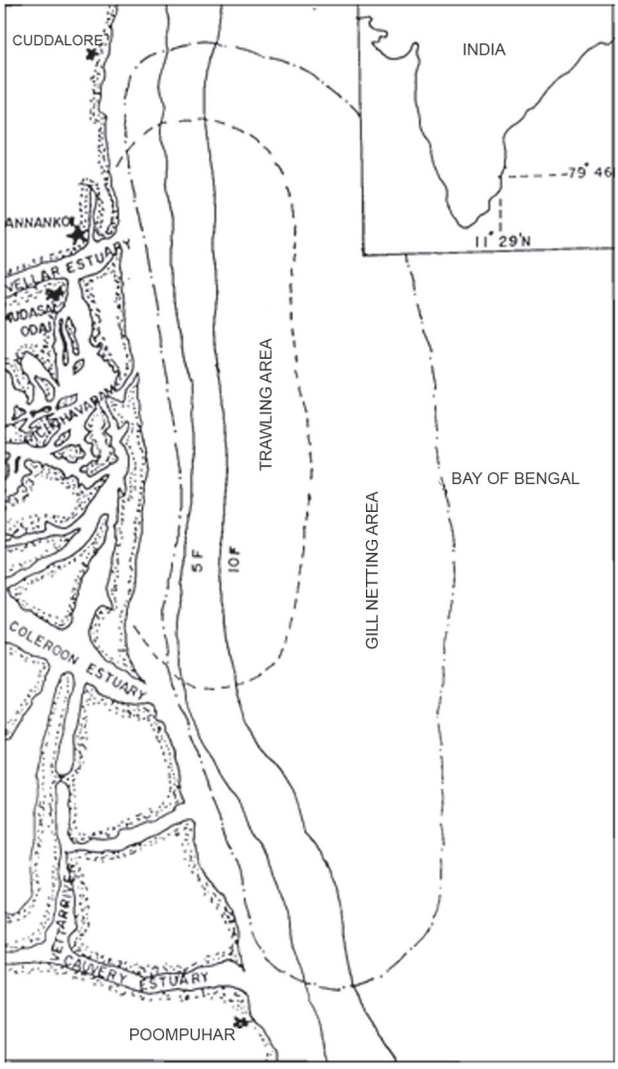

Fig. 1. Study area showing gillnetting and trawling grounds

(20- 30 HP) with an overall length (OAL) of 7 m and 100 catamarans, having an OAL of 5 m with 2-4 HP engines are operated from Annankoil Landing Centre. Both these crafts are gillnetters with mesh size of nets ranging between 38 and 145 mm. Nylon nets having a mesh size of 38 mm (500-600 m length x 8 m width) was generally used for sardine fishery and 70 mm (500-600 m x 9 m) was used for mackerel and mullet fishery. Cotton nets with 110-125 mm mesh size (1500-1650 m x 7 m) was generally used for large fishes and 135-145 mm (1500-1650 m x 8 m) was used exclusively for pomfrets. Fishing was carried out from Cuddalore to Poompuhar along the coastline of about 60 km. In Mudasalodai Landing Centre, around 75 stern trawlers (OAL 8 m with 350-370 HP engines) are operated daily, basically for shrimp resources, along a coastline stretching about 30 km between Parangipettai and Pazhayar.

Observations relating to abundance of species and fishing effort were made on every alternate day of lunar cycles during pre-monsoon season (April- September) of 2000 -2002. The information was organised by lunar phases using five days for each phase [full moon (Full M), full moon quarter (Full MQ), new moon (New M) and new moon quarter (New MQ)]. All the fishes and shrimps landed during the study period were identified, grouped and their total catch (kg) recorded. Fishing effort for each vessel was calculated by summing the number of hours fished by each vessel. Catch per unit effort (CPUE) was estimated by dividing the total catch for the day of each species by the total effort (kg h^{-1}). Among the fishes landed through gillnetting, six commercially important fishes namely, *Rastrelliger kanagurta, Sardinella longiceps, Mugil cephalus, Apolectis niger, Euthynnus affinis* and *Scomberomorus commerson* were selected for studying size variations. From trawl catch, five species of shrimps *viz*., *Fenneropenaeus indicus, Fenneropenaeus merguensis, Penaeus monodon, Penaeus semisulcatus* and *Metapenaeus monoceros* were selected. Animals which have crossed their size at first maturity were measured for total length (TL) and total weight (TW). Data were analysed for central tendency as well as variability by standard statistical methods. Student's t- test was used to compare size variations during New M and Full M days. For comparison of fishing success in each phase of the moon, analysis of variance (ANOVA) test was used.

Results and discussion

As many as 35 species were caught by gillnets. The total fish catch in percentages recorded during different lunar phases is shown in Fig. 2. Sardines and mackerels showed a gradual increasing trend from New M to Full M and then a decline towards the New M. Whereas, barracuda and tuna catches exhibited an increasing trend from Full M to New M. The catches of seerfish and sailfish were high during Full MQ to New MQ and catches were nominal during Full M. Gillnet landing observations in relation to lunar periodicity revealed that more number of fish species was caught on Full M and New M days. Comparing landings of Full M and New M days, higher landing was recorded on New M days ($p < 0.01$) and significant ($p< 0.01$) variation in fish catch during different lunar phases was evident. Fishes caught by gillnetting were more abundant in number as well as in species caught on New M than on Full M days. Lower catches during Full M periods could be attributed to avoidance of gear due to higher light intensity (Di Natale and Mangano, 1995. For gillnetters high values were noticed on New M (52.35 kg h^{-1}) and lowest values on Full MQ (2.5 kg h^{-1}). Fishing effort was high during New M and was low during Full M days (Fig. 3).The mean total length (TL) and

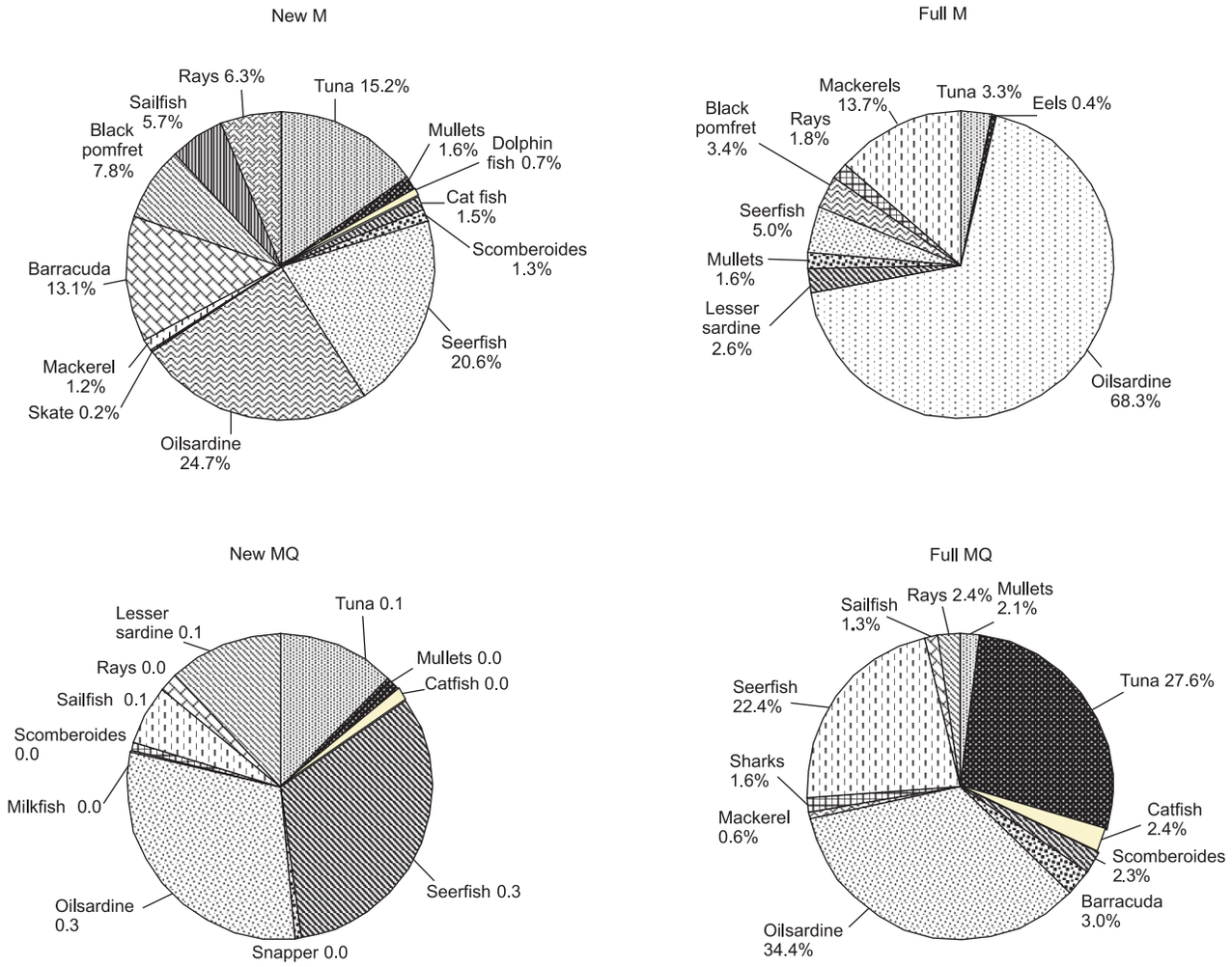

Fig. 2. Percentage of total catch of fishes landed during lunar phases

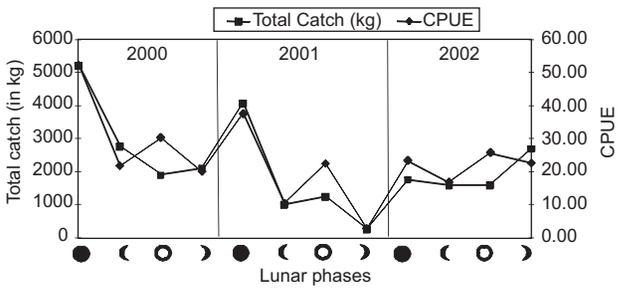

Fig. 3. Total catch and CPUE of fishes caught by gillnetters in 2000- 2002

standard deviation of all six species studied showed considerable difference on New M as well as Full M days (Table 1). Larger size groups were dominant during New M for all species and differences were significant ($p<0.001$) (Table 2).

In commercial light fishing operation using purse seine gear in Ghana, Bannerman and Quartey (2004) reported that herring, sardines, anchovies, squids, mackerels and fishes belongs to tuna family are caught with light attraction. In the present study, the major groups of fishes which exhibited light attraction response were sardines, mackerel, anchovies and carangids during gillnetting. This has been reported earlier by Mohan and Kunhikoya (1987) and Das *et al.* (2009). Tuna, seer fish, barracuda, pomfret and sailfish were found to be more active during waning moon. Similar variations in catch of these fishes have been reported earlier (Ponce-Diaz *et al*., 2003; Lowry and Williams, 2008; Poisson *et al*., 2010) . They assumed that the effect of lunar phases on catchability can impact vertical migrations of primary food source (bait species) of these fishes and modify the accessibility of the fish to the fishing gear.

Comparing total landings and effort, catch was found to decrease from New M to Full M irrespective of fishing effort. A positive relationship between lunar phase and CPUE was observed . Decrease in catch on Full M days

Table 1. Mean of length along with size groups of fishes caught in gillnetters during new moon and full moon phases

Species		New M	Full M	Size group (mm)	New M	Full M
R. kanagurta	Mean	206.8	200.3	194-200	27	40
N = 70	SD	5.189	5.308	200-206	24	19
				206-212	11	6
				212-218	8	5
S. longiceps	Mean	176	169.4	163-166	16	35
N = 70	SD	2.131	2.26	166-169	28	26
				169-171	16	11
				171-174	10	8
M. cephalus	Mean	324.3	317.5	289-300	14	24
N = 70	SD	9.2	9.651	300-311	22	21
				311-322	30	24
				322-333	4	1
A. niger	Mean	418.2	399.9	335-363	7	22
N = 70	SD	35.775	35.575	363-391	23	24
				391-419	28	17
				419-447	12	7
E. affinis	Mean	462.5	450.9	362-408	5	19
N = 70	SD	49.7	86.127	408-454	27	21
				454-500	32	26
				500-546	6	4
S. commerson	Mean	894.4	882.6	820-854	10	16
N = 70	SD	43.127	42.779	854-888	18	25
				888-922	28	22

SD = Standard deviation

Table 2. Size variation of fishes and shrimps caught during new moon and full moon phases

Species	Fishes		Shrimps		
	Variables	't' value	Species	Variables	't' value
R. kanagurta	TL x TL	16.785*	*F. indicus*	TL x TL	12.451*
N = 70			N = 50		
S. longiceps	TL x TL	26.352*	*P. monodon*	TL x TL	9.437*
N = 70			N = 50		
M. cephalus	TL x TL	13.209*	*P. semisulcatus*	TL x TL	13.740*
N = 70			N = 50		
A. niger	TL x TL	18.126*	*F. merguiensis*	TL x TL	14.328*
N = 70			N = 50		
E. affinis	TL x TL	8.327*	*M. monoceros*	TL x TL	8.628*
N = 70			N = 50		
S. commerson	TL x TL	10.652*	*p <0.001		
N = 70					

can possibly be due to the increased visibility of the netting as well as the influence of moon light on fish behaviour and distribution of its prey species. Similar findings were also reported by Di Natale and Mangano (1995). Generally fishing intensity is more during the darker fortnight . Fishing trips begin progressively later during the period from New M to Full M and the strategy is reversed after Full M. Such fishing tactics was also observed by Aswani and Hamilton (2004). Larger size groups of fishes were found to be more on New M than on Full M days. Such variations

in catch rates between adult fish species with lunar phase can be explained by ontogenetic variation in the ability to migrate, with juveniles or smaller ones effectively restricted in their ability to track movements of the deep scattering layer with lunar phase (Graham *et al*., 2007; Lowry *et al*., 2007).

the later half. *M. monoceros* and *P. monodon* was caught in lesser quantities. During both the quarters, *F. indicus* and *F. merguiensis* showed maximum landings and *P. semisulcatus*, *P. monodon* and *M. monoceros* were caught in minimum quantities. Maximum CPUE for shrimp trawl was recorded on New M (9.97 kg h^{-1}) and minimum

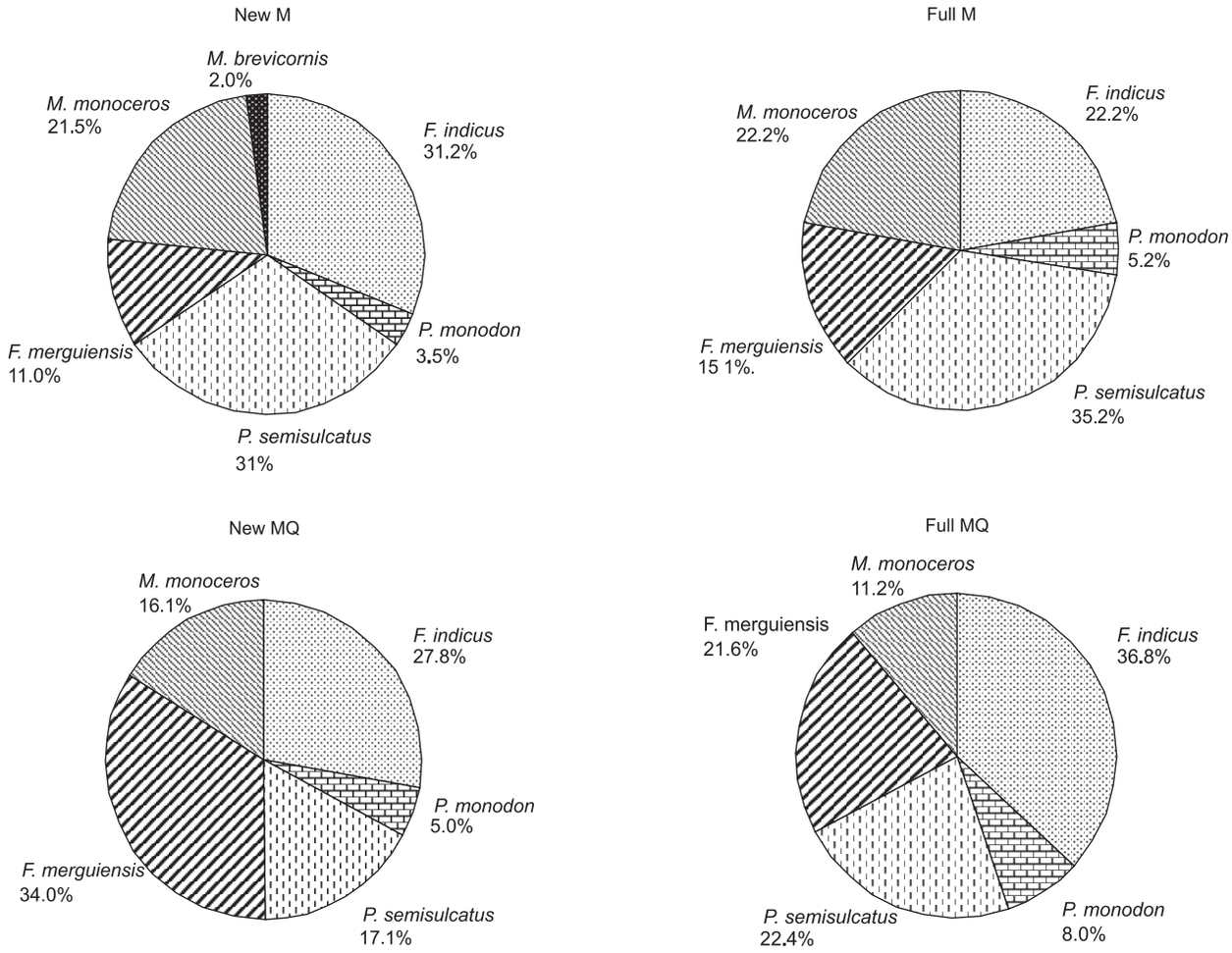

Fig. 4. Percentage of total catch of shrimps caught during lunar phases

In trawl landings, 6 species of shrimps were caught in different lunar phases along with fishes and other invertebrates as 'bycatch'. The penaeid shrimps caught by trawling were *F. indicus, P. monodon, F. merguiensis, P. semisulcatus, M. monoceros* and *Metapenaeus brevicornis*. Shrimp landings showed remarkable differences during the lunar cycles (Fig. 4). Higher catches were observed during New M days ($p< 0.01$). Because of lesser light intensity, they are very active on New M than Full M days as reported earlier (Wassenberg and Hill, 1994; Kangas and Sporer, 2001; Salini *et al.,* 2001; Nandakumar, 2004; Dixon and Hooper, 2008; Macbeth *et al*., 2008). During the first half of New M and Full M days, *F. indicus* and *P. semisulcatus* were landed in large numbers and *F. merguiensis* dominated on Full MQ (1.63 kg h^{-1}) (Fig. 5). Comparatively, New M, New MQ and Full M were more productive than Full MQ. Such lunar periodicities were also reported for other crustaceans (Chatterjii *et al*., 1994; Ghosh *et al*., 2008). However, high catch of king prawns, *Melicertus latisulcatus* was reported by Courtney *et al.* (1996) during Full M. A comparison of mean and standard deviation of total length (TL) showed that larger shrimps were caught on New M than Full M (Table 3) and the size differences were statistically significant ($p< 0.001$) (Table 2).

In the present study, it was also noticed that seven or eight days from New M and Full M are good fishing periods. Similar observations were made by Verghese (1994) in

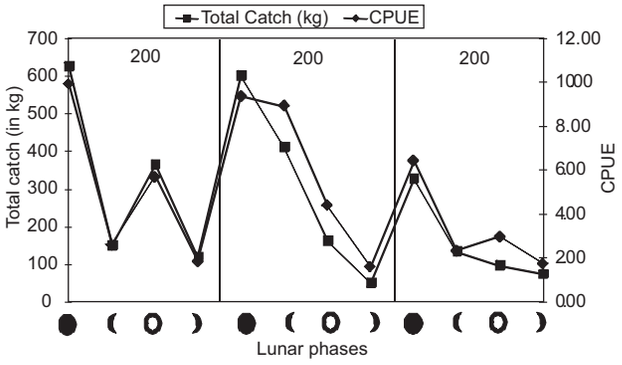

Fig. 5. Total catch and CPUE of shrimps caught by trawlers in 2000- 2002

by Griffith and Wigglesworth (1993) in shrimps *Litopenaeus vannamei* and *Litopenaeus schmitti*. Similarly, Farbridge and Leatherland (1987) described relative growth patterns associated with New M and Full M in rainbow trout, *Salmo gairdneri* and coho salmon, *Oncorhynchus kisutch*. Furthermore, the occurrence of more number of large sized fishes during lunar phases may also be correlated with the lunar periodicity in abundance of forage food availability. Relationships between lunar phase and catch rates derived in this study from commercial fishing data is useful to predict the catchability of various species and to prepare schedules for fishing trips.

Table 3. Mean length along with size groups of shrimps caught in trawlers during new moon and full moon phases

Species		New M	Full M	Size group (mm)	New M	Full M
F. indicus	Mean	157.4	152.9	138-147	27	40
N = 50	SD	9.169	8.9	147-156	24	19
				156-165	11	6
				165-174	8	5
P. monodon	Mean	185.7	180	148-170	16	35
N = 50	SD	14.5	15.679	170-192	28	26
				192-214	16	11
				214-236	10	8
P. semisulcatus	Mean	175.7	169.1	142-156	14	24
N = 50	SD	10.952	12.979	156-170	22	21
				170-184	30	24
				184-198	4	1
F. merguiensis	Mean	149.6	143.8	127-138	7	22
N = 50	SD	9.222	10.945	138-149	23	24
				149-160	28	17
				160-171	12	7
M. monoceros	Mean	137.3	133.3	111-123	5	19
N = 50	SD	10.66	12.45	123-135	27	21
				135-147	32	26
				147-159	6	4

SD = Standard deviation

shrimp trawling by the outriggers in the north-east coast of India and Dixon and Hooper (2008) in the Gulf of Spencer in South Australia. The variations in shrimp catch during New M and Full M as noticed in this study may be influenced by inward and outward migrations. The significant differences between the mean of total length on New M and Full M confirmed that the New M days aggregated large sized animals than the Full M days.

The catch during New M with large sized fishes and shrimps indicate correlation between New M phase of lunar cycle and growth of fishes as well as shrimps. This link between the growth pattern and lunar cycle was discussed

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