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Lunar Periodicity of Prawn, *Melicertus kerathurus* (Forskal, 1775) and Bycatch Species in Trammel Nets from Izmir Bay (Aegean Sea) Turkey

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Abstract: Commercial trammel prawn nets were used during 40 nights at various phases of lunar months during May-October, 2002 period in Izmir bay (Aegean sea). The most dominant eight bycatch species and one target species (*Melicertus kerathurus*) (by numbers per fishing day) were used in the statistical analyses to compare the differences in catch numbers within each species during a standart lunar month. Using the Kruskal-Wallis test significant ($p<0.05$) differences in mean catch rates between moon phases were exhibited by *Melicertus kerathurus* ($p = 0.011$), *Bolinus brandaris* ($p = 0.001$), *Squilla mantis* ($p = 0.041$) and *Mullus barbatus* ($p = 0.033$). In contrast, *Goneplax rhomboides*, *Diplodus annularis*, *Arnoglossus laterna*, *Microchirus variegatus* and *Solea solea* showed no significant differences in catch numbers according to moon phases. Results suggest that target species and some of the most dominant bycatch species exhibit behaviour related to lunar cycle with implications for sustainable management.

Key words: Lunar periodicity, *Melicertus kerathurus*, prawn, bycatch, trammel net, Turkey

INTRODUCTION

Many marine crustaceans and invertebrates exhibit rhythms of lunar periodicity (Korringa, 1957; Naylor, 1982; 2001). A number of studies have been designed to measure catch rates in relation to moon phases and to investigate the behaviour of fish and crustacean species in relation to the lunar cycle (Griffiths, 1999; Naylor, 2001). A common approach of these studies was focused on the target species. For example, laboratory study of the effects of light on the emergence behaviour of eight Penaeid prawns (Wassenberg and Hill, 1994) lunar periodicity in catch rate and reproductive condition of adult eastern king prawns, *Melicerus plebejus* (Courtney *et al*., 1996), effects of lunar periodicity on catches of *M. plebejus* (Griffiths, 1999) lunar periodicity of prawns and bycatch in trawl fishery (Salini *et al*., 2001) and effects of lunar phase and habitat depth on vertical migration patterns of the sergestid prawn, *Acetes intermeditus* (Chiou *et al*., 2003).

Some implications for fisheries management of lunar variations in trawl catches have been noted previously but so far fisheries biologist and researchers have not taken into account of the effects of lunar cycles on catches in artisanal trammel net fisheries. The present study provides the first results of the effect of the lunar periodicity in a trammel net fishery for the target species *Melicertus kerathurus* and bycatch species, *Bolinus brandaris*, *Squilla mantis*, *Mullus barbatus*, *Goneplax rhomboides*, *Diplodus annularis*, *Arnoglossus laterna*, *Microchirus variegatus* and *Solea solea* in Izmir Bay.

MATERIALS AND METHODS

This study was carried out on artisanal commercial prawn fisheries grounds during May to October, 2002 in Izmir bay, West of Turkey (Fig. 1) using commercial prawn boat (10 m) which carried a total of 24 prawn nets. The target species, *Melicertus kerathurus* exhibit inshore migration prior to spawning between April and August (Turkmen and Yilmazyerli, 2006; Klaoudatos *et al*., 1992) permitting capture by fixed trammel nets throughout a fishing season of 6-7 months in Izmir bay for *M. kerathurus*.

Fishing operations were conducted at 20-30 m depths for 40 days during the experimental period and only cloudless nights were chosen. The nets were set from dusk till dawn for approximately 10 h.

Species composition, total numbers of the target species and bycatch species caught were recorded for all samples taken in three days around each of four phases

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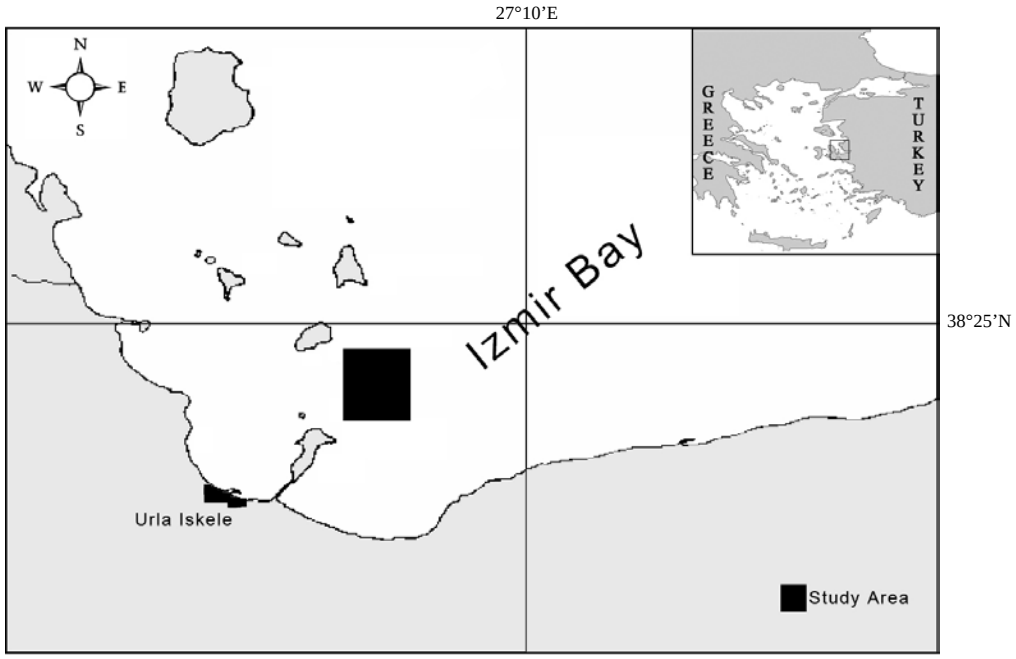

Fig. 1: Study area

of lunar periodicity, designated: New Moon, NM; First Quarter, FQ; Full Moon, FM and Last Quarter, LQ. Total 9-11 samples were obtained for each lunar phase and the mean catch values and standard errors were calculated for each species. Then, the Kruskall-Wallis test used to find whether differences in mean catch rates were apparent with respect to moon phases for the nine most abundant species. Also, CPUE (catch per unit effort) values for those of which were calculated with formula as recommended by Godoy *et al*. (2003) which was customized for moon phases in this study:

$$CPUE = \frac{\sum n}{\sum \text{Fishing trials}}$$

RESULTS AND DISCUSSION

Apart from the target species of this fishery, the prawn (*Melicertus kerathurus*) the remaining eight bycatch species counted were: *Goneplax rhomboides* (Linnaeus, 1758), *Squilla mantis* (Linnaeus, 1758), *Bolinus brandaris* (Linnaeus, 1758), *Diplodus annularis* (Linnaeus, 1758), *Arnoglossus laterna* (Walbaum, 1792), *Microchirus variegatus* (Donovan, 1808), *Solea solea* (Linnaeus, 1758) and *Mullus barbatus* (Linnaeus, 1758). *Solea solea* and *Mullus barbatus* are highly economical valued bycatch species and the rest are totally discarded species in prawn trammel net fishery.

The CPUE of caught specimen were shown in Table 1. Some of the nine species used in the analysis showed significant differences in catch numbers with respect to phases of the moon. The most common pattern of lunar-related catch rates was that in which great numbers were caught during a first quarter phase of the moon seen in five species: *B. brandaris* ($p = 0.001$), *D. annularis* ($p = 0.431$), *A. laterna* ($p = 0.752$), *M. variegatus* ($p = 0.253$) and *S. solea* ($p = 0.221$), though in only the first of these species were the first quarter catches significantly higher than the remainder. In two species the last quarter catches were greatest, namely in: *G. rhomboides* ($p = 0.807$), *S. mantis* ($p = 0.041$) with only the latter species showing significantly higher catches and even then only marginally so than at other phases of the moon. In contrast, the target species of prawn *M. kerathurus* ($p = 0.011$) and the bycatch fish *M. barbatus* ($p = 0.033$). Each showed significantly greater catches at the times of new moon. No maximum mean catch rates are observed at the times of full moon.

There has been little knowledge on the effects of moon phases on prawn and bycatch species in artisanal fisheries. However, there are crucial results that prawn abundance varies with the lunar cycle (Wassenberg and Hill, 1994; Courtney *et al*., 1996; Griffiths, 1999). Salini *et al*. (2001) found that prawns and teleost fishes showed different behavioural patterns with moon cycle

Table 1: CPUE (by number) and Standard Errors (SE) for nine species from prawn trammel nets between lunar cycles and the probabilities (p) of having significant differences with respect to phases

	No. of samplings				
Species	11 NM (SE)	10 FQ (SE)	10 FM (SE)	9 LQ (SE)	p-value
Melicertus kerathurus	25.1 (2.93)	17.4 (4.93)	14.1 (2.05)	15.5 (2.55)	0.011
Goneplax rhomboides	10.4 (1.89)	8.8 (1.58)	8.7 (1.80)	13.5 (4.25)	0.807
Squilla mantis	21.0 (4.20)	21.7 (5.42)	9.2 (1.93)	26.1 (9.84)	0.041
Bolinus brandaris	15.4 (2.20)	62.3 (12.31)	15.7 (3.60)	9.5 (2.00)	0.001
Diplodus annularis	21.9 (3.03)	25.0 (6.35)	21.6 (5.50)	23.7 (5.46)	0.431
Arnoglossus laterna	4.2 (0.79)	4.8 (1.17)	4.4 (1.61)	3.1 (1.37)	0.752
Microchirus variegatus	2.3 (0.30)	5.3 (1.44)	2.4 (0.47)	3.7 (1.44)	0.253
Solea solea	3.1 (1.09)	5.1 (1.42)	2.9 (0.77)	2.0 (0.45)	0.221
Mullus barbatus	9.7 (1.66)	4.7 (0.99)	4.0 (0.46)	7.4 (1.40)	0.033

NM: New Moon; FQ: First Quarter; FM: Full Moon and LQ: Last Quarter

and they attributed this pattern to difference in diel vertical movement of fish in the water column during different moon phases.

Wassenberg and Hill (1994) reported that nocturnal activity of eight commercial prawns depends on light intensity and these species emerges from being buried in the substrate when the light level decreases. Probability of to be seen by predators will be increased in high light intensity of moon. Therefore, to remain buried in high light levels will be the expected behaviour to avoid predation.

Penn (1984) was able to group different commercial species of the genus *Penaeus* into three broad categories: Type 1, those strongly nocturnal but often inactive or buried at night, always buried in the day and usually fished over sandy substrata. Type 2 species, those generally nocturnal, continuously active at night and being commonly associated with softer silt substrata. Type 3 shrimps rarely bury are almost continuously active and exclusively found in areas associated with river discharge where soft mud bottoms and high turbidity dominate. Bishop *et al.* (2008), detected *P. semisulcatus* and *Metapenaeus affinis* were significantly more catchable at night than during daylight. These species are in type 2 category. According to personal conversations with commercial prawn fishermen in Izmir bay, *M. kerathurus* specimens are also buried in the day just like *M. affinis* specimens which is the secondary commercial prawn of bay (Aydin *et al.*, 2009).

Patterns of lunar cycles which affect amount of prawn catches may differ depending on fishing gears. In the present study the researchers used passive fishing gear in contrast to Courtney *et al.* (1996) and Griffiths (1999) who used active fishing gear (trawl). Trawl caught higher catches during full moon phase, although in this case, trammel net caught minimum quantity of prawn.

The catch per unit efforts of *Penaeus esculentus* and *Metapenaeus ensis* in trawl fishery had significant differences between moon phases and their highest catch observed during last quarter and full moon, respectively

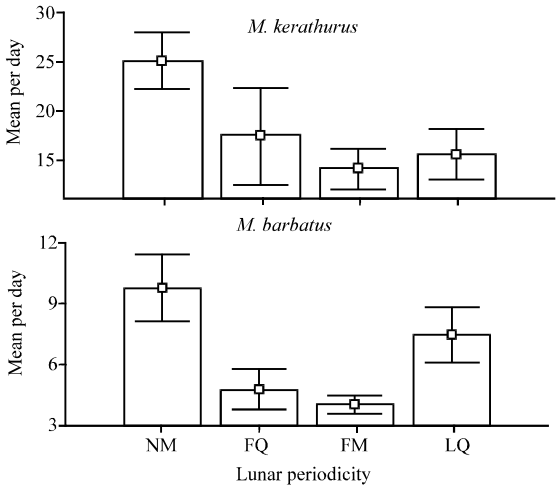

Fig. 2: Mean per day catches of *M. kerathurus* and *M. barbatus* according to moon phases

(Salini *et al.*, 2001). Beside these results Courtney *et al.* (1996) reported that *Penaeus plebejus* presented the highest catch values in the trawl fishery during full moon. Opposite to these results, *P. plebejus* had the highest catch during the new moon in scoop net fishery (Griffiths, 1999). A similar finding was provided from the present study that prawn (*M. kerathurus*) catches were the highest during the new moon. Although, one of the most important commercial bycatch species *M. barbatus* was caught higher in this period too (Fig. 2). In the catching method of the passive fishing gears, target species have to encounter the gear that are not actively moved by humans or machines while the organisms are being captured (Lagler, 1978). These results are also support that prawns are caught more in the new moon period in the trammel net fishery and also support prawns are more active in the new moon period than the full moon. *S. mantis* and *G. rhomboides* are two of the most abundant crustacacea species in prawn trammel net fishery in Izmir bay (Metin *et al.*, 2009). While the individuals of *S. mantis* are commercial in the Western

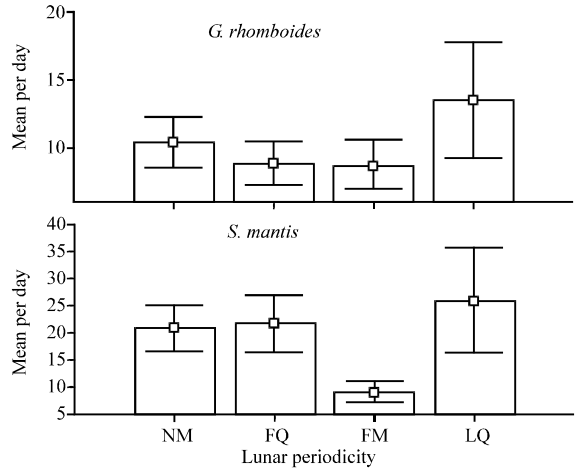

Fig. 3: Mean per day catches of *G. rhompoides* and *S. mantis* according to moon phases

part of Mediterranean (Aydin, 2010), they are discarded just like *G. rhomboides* individuals. According to CPUE values, lowest catch period of them are also full moon (Fig. 3). According to these, it could be said that usage of prawn trammel nets in full moon period help to reduce discard ratio.

CONCLUSION

A total of 72 species were determined in prawn trammel net fishery and 46 of them were discarded (Gokce and Metin, 2007). Height of the guarding nets that were used in the lead line of prawn trammel net consist an important criterion for by-catch reduction (Metin *et al*., 2009). The relationship between the lunar periodicity and the catch composition is an important issue to be better understood for by-catch species which have very close relationship with sustainable fisheries management. Together with technical modifications of fishing gear, it is necessary to investigate the correlations between biological parameters such as sex, ovarian development and length and physical parameters such as water depth, temperature and light intensity for marine animals which have cyclical behaviour rhythms in future studies.

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