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Studies on the Influence of Abiotic Factors in the Gonadal Index of Sea urchin *Salmacis virgulata* from the Gulf of Mannar, South East Coast of India

R. Saravanan[1*], P. Jawahar[2], T. Francis[2], B. Ahilan[2], R. Santhakumar[2] and A. Anand[3]

[1]Regional Centre of Central Marine Fisheries Research Institute, Mandapam Camp, Ramanathapuram District - 623 520, Tamil Nadu, India; stingray_mr@yahoo.com
[2]Fisheries College and Research Institute, Thoothukkudi – 628 008, Tamil Nadu, India; jawaharphd@gmail.com, t_franciz2000@yahoo.com, kamaliahilan@yahoo.com, soodasujan@yahoo.co.in
[3]Regional Remote Sensing Centre–Central (ISRO), Nagpur - 440 010, Maharashtra, India; anand_isro@rediffmail.com

Abstract

The present study was conducted to find out whether the abiotic factors in Gulf of Mannar *viz*., Sea Surface Temperature (SST) and Day light photoperiod would have an effect on the Gonado somatic index of the dominant sea urchin species *Salmacis virgulata*. A sampling survey for 20 months was conducted from October-2013 to May-2015 in Vedalai landing centre, along the Gulf of Mannar. The freshly collected sea urchin were brought to Mandapam CMFRI and their Gonado Somatic Index (GSI) was estimated. The remote sensing data of the SST from Gulf of Mannar sourced from ICOADS and the daylight photoperiod were compared with the GSI data for 20 months in order to assess the synchrony among the three parameters. The pearson correlation coefficient of the association among the GSI, SST and Photoperiod revealed that there was no significant correlation ($p>0.001$). The result of the present study revealed that the Gonado Somatic Index of *S. virgulata* is independent of abiotic factors, which is in contrast to the temperate sea urchin species, where SST and Photoperiod play a major role in gonadal development.

Keywords: Gonad Index, Gulf of Mannar, Sea Urchin, Salmacis

1. Introduction

Under the phylum Echinodermata, there are five important classes of organisms are grouped *viz*., Sea stars, Brittle stars, Feather stars, Sea cucumber and Sea urchin. The organisms of this phylum are exclusively marine and no freshwater counterpart is found so far. These marine invertebrates play a major ecological role in stabilizing the ecosystem functioning in the near shore benthic habitat. Among them sea urchin, which a pentiradial symmetry organisms is an important organism and under normal condition they feed on variety of plant materials such as sea weeds, encrusted algae and sea grasses but are tend to be omnivore and feed on animal matter if food is scarce.

The edible sea urchins are distributed among a number of families of regular echinoid. The gonads are not only the source of eggs or sperm, which are referred to as roe, but also serve as the main nutrient storage organ[1]. Gonads generally tend to be bright orange in colour in females and light yellow in males[2]. The "roe" of sea urchins have been consumed by humans since pre-historic times in many cultures around the world. The reproductive system of the sea urchin consists of five gonads, suspended by mesenterial strands[3] to the roof of both male and female urchins. Among the 800 extent species of echinoid 24 species of regular sea urchin have been reported along the Coast of Tamil Nadu. The reproductive cycles of temperate echinoid species are typically annual or semi-annual

**Author for correspondence*

and gametogenesis is considered to be influenced by factors such as seasonal changes in photoperiod, water temperature and nutrition[4]. Hence, the present study was undertaken in Gulf of Mannar, a tropical ecosystem; to assess the reproductive state of the sea urchin *Salmacis virgulata* in the wild in relation to the abiotic parameters observed over a period of 20 months since October 2013 till May 2015. The Gulf of Mannar is a large shallow bay lying between the southeastern tip of India and the west coast of Sri Lanka. It falls in the Indo-Pacific region and is considered to be one of world's richest marine biological resources. In 1986, a group of 21 islets lying off the Tamil Nadu coast between Thoothukudi and Dhanushkodi were declared the Gulf of Mannar Marine National Park. The park and its 10 km buffer zone were declared a Biosphere Reserve in 1989. The Gulf of Mannar Biosphere Reserve covers an area of 10,500 km² of ocean, islands and the adjoining coastline[5]. There are about 125 villages along the coastal part of the biosphere reserve which support about 100,000 people.

2. Materials and Methods

The present study was conducted along the Mandapam coast of Gulf of mannar and monthly sampling was carried out from Vedalai landing centre where bottom set gill net was operational. 30 individuals of sea urchin species *Salmacis virgulata* have been routinely collected for twenty months since October 2013 till May 2015 to study the gonado somatic index. The collected sea urchin were transported to the Central Marine Fisheries Research Institute (CMFRI), Mandapam laboratory in sea water. The total weight of the sea urchin was measured to the nearest 0.001g, only after draining water from its test. The sea urchin use water to maintain hydrostatic pressure inside test, hence the drained weight is used. The sea urchin test was opened using a scalpel and the five gonads (Figure 1) are removed one after another with care and weighed. This gonad weight is compared with the total drained weight of the whole urchin to arrive at the gonadosomatic index[6,7] as follows;

$$GSI\ (\%) = \text{Wet weight of gonad (g)} / \text{Total wet weight of sea urchin (g)} \times 100$$

The Gonadosomatic Index (GI), which measures the relative changes in weight in the gonads over time, was used on urchins as early as 1934[8], and is based on the assumption that maturation and breeding coincide with maximum gonad weight. A total of 600 individuals of sea urchin *Salmacis virgulata* were collected during the 20 month period from October 2013 to May 2015 and the differences in mean GSI were evaluated[9].

Figure 1. Five gonads of sea urchin S.virgulata

The data on the Sea surface temperature and atmospheric temperature was obtained from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS)[10] for the period of 20 months since October –2013 to May-2015. The day length photo period was collected from the http://www.sunrise-and-sunset.com/ for the study period from October-2013 to May-2015[11]. Pearson correlation coefficients of monthly mean GSI with photoperiod and effect of Sea Surface Temperature (SST) on mean GSI was assessed by calculating Pearson correlation coefficient for the sea urchin, *Salmacis virgulata.* All statistical analysis was performed using SPSS V.20.

3. Result

The Pearson correlation coefficient was assessed using SPSS V.20 software. The analysis indicated that the strength of the association between SST and Mean monthly gonad index was not very high ($r = 0.259$) and the correlation co-efficient is not highly significant ($p>0.001$) (Table 1). Similarly the correlation between photoperiod and mean monthly gonad index was also not very high

(r = 0.103) and that the correlation co-efficient is not highly significant (p>0.001) (Table 2). The studied population of *Salmacis virgulata*, a major peak of gonad index was observed in February, April and September followed by a spawning period. (Figures 2&3)

4. Discussion

The Gulf of Mannar is Calm during April to September and experiences both the monsoon. The environmental conditions, especially temperature and photoperiod, and the food availability influence the gamete maturation and spawning of marine invertebrates[12]. Analysis of SST data from Gulf of Mannar clearly showed a winter cooling of surface water to a level of 4 degrees lower between summer and winter (Figures 4–13). The sea urchin *Centrostephanus rodgersii*, is a temperate sea urchin species coincide its gonadal maximum development with the increase of photoperiod[13]. However the gametogenesis in sea urchin is either stimulated by short days or suppressed by long days[14]. Other environmental factor regulating gametogenesis development in sea

Table 1. Correlation between SST and Mean GSI in *S. virgulata*

		SST	MeanGSISV
SST	Pearson Correlation	1	.259
	Sig. (2-tailed)		.270
	N	20	20
MeanGSISV	Pearson Correlation	.259	1
	Sig. (2-tailed)	.270	
	N	20	20

Table 2. Correlation between Photoperiod and Mean GSI in *S. virgulata*

		Photoperiod	Mean GSISV
Photoperiod	Pearson Correlation	1	.103
	Sig. (2-tailed)		.667
	N	20	20
MeanGSISV	Pearson Correlation	.103	1
	Sig. (2-tailed)	.667	
	N	20	20

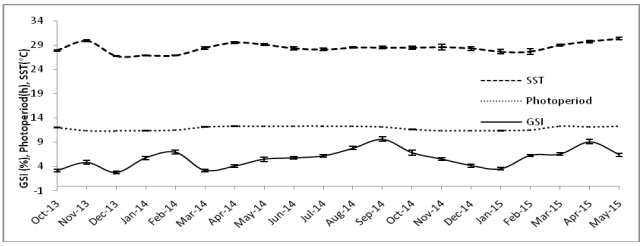

Figure 2. Comparison of monthly mean GSI of *Salmacis virgulata* with mean SST and day light photoperiod in the Gulf of Mannar during the study period

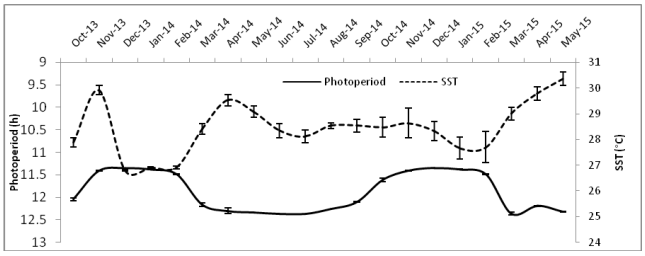

Figure 3. Comparison of SST and Photoperiod during the study period in Gulf of Mannar

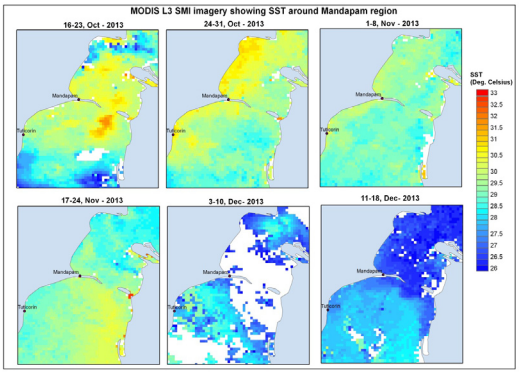

Figure 4. SST Map of Gulf of Mannar and Palk bay during October to December 2013

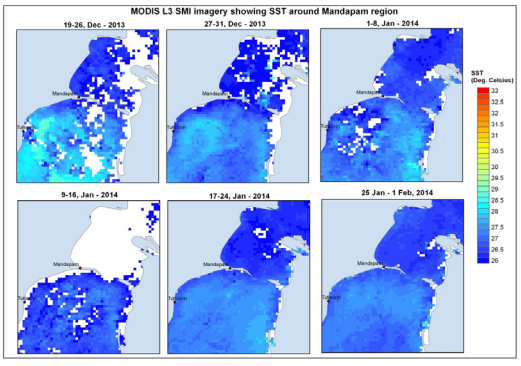

Figure 5. SST Map of Gulf of Mannar and Palk bay during December 2013 to February 2014

urchins is the change in Sea Surface Temperature. There is not a significant correlation between gonadal maturation and monthly water temperature in the sea urchin species *Loxechinus albus* from Beagle Channel[15]. On the contray, in the sea urchin *Arbacia lixula* from Mediterranean the gonadosomatic index follows a seasonal cycle which peaks in May-July and attains its lowest values in October-November every year[9]. Similar peaks in GSI of *S. virgulata* was also observed in the study period in February, April, August and September months. However the seasonal cycle

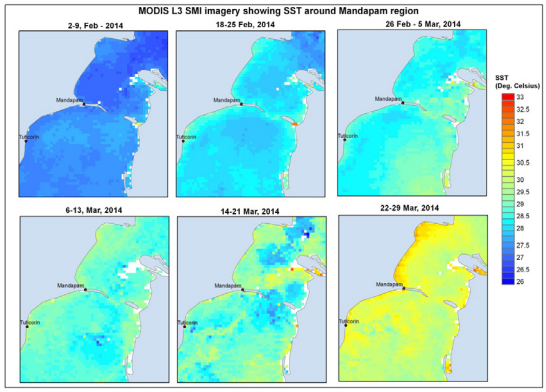

Figure 6. SST Map of Gulf of Mannar and Palk bay during February 2014 to March 2014

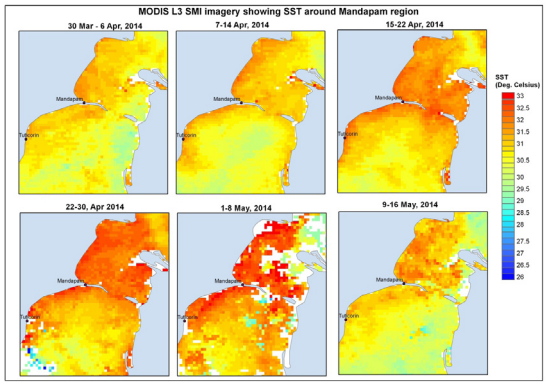

Figure 7. SST Map of Gulf of Mannar and Palk bay during March 2014 to May 2014

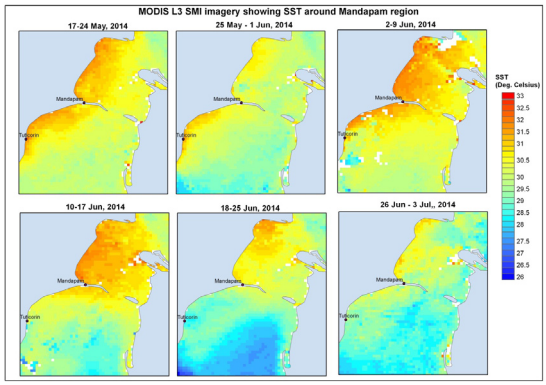

Figure 8. SST Map of Gulf of Mannar and Palk bay during May 2014 to June 2014

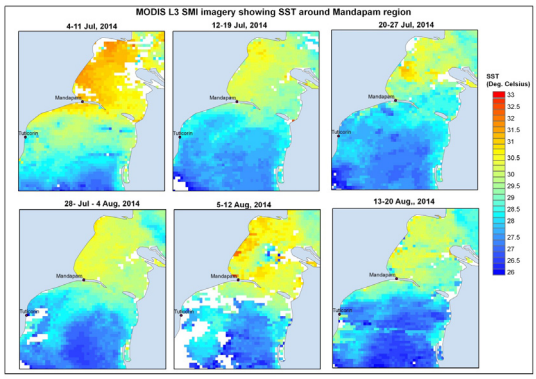

Figure 9. SST Map of Gulf of Mannar and Palk bay during July 2014 to August 2014

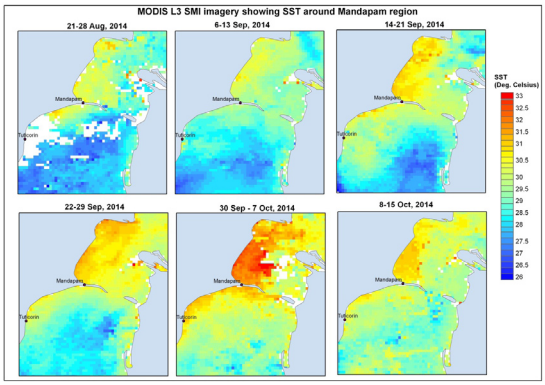

Figure 10. SST Map of Gulf of Mannar and Palk bay during August 2014 to October 2014

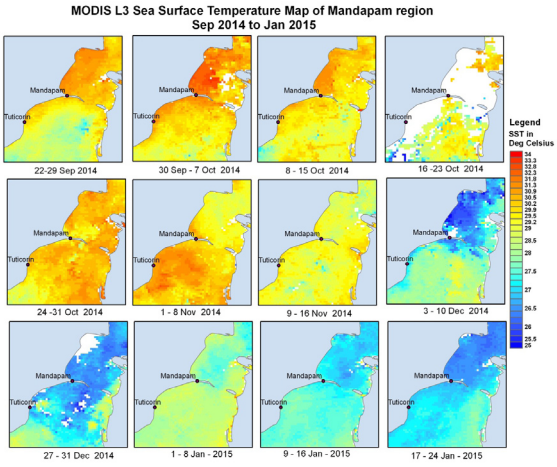

Figure 11. SST Map of Gulf of Mannar and Palk bay during September 2014 to January 2015

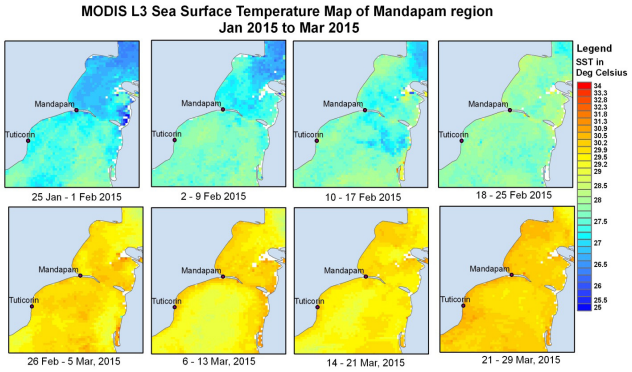

Figure 12. SST Map of Gulf of Mannar and Palk bay during January 2015 to March 2015

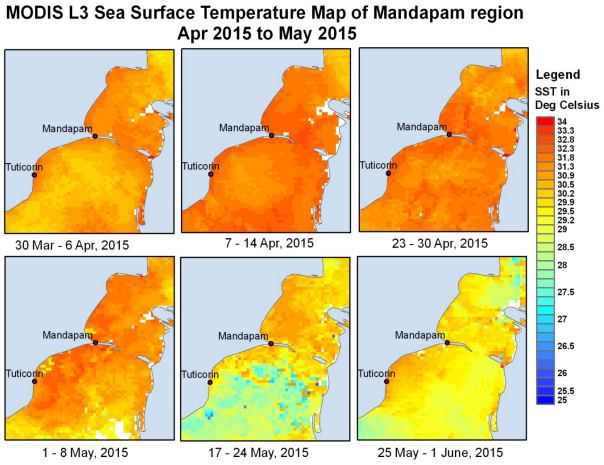

Figure 13. SST Map of Gulf of Mannar and Palk bay during March 2015 to May 2015

is not influenced by the abiotic factors SST and Photoperiod, but other nutritional factors may influence it.

5. Conclusion

The result of the present study on the influence of abiotic parameters SST and Photoperiod conclude that the gonadosomatic index of *S. virgulata* is not influenced by either SST and Photoperiod significantly during the study period in the Gulf of mannar. The seasonal variations in the GSI of *S. virgulata* may be due to the nutritional factors from the food material available to them from season to season.

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