Variation in vertical distribution of bioluminescnce intensity at a fixed location of the south coast of Sri Lanka during south-west and north-east monsoon

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Bioluminescence is the emission of visible light by living organisms and this phenomenon is common in both terrestrial and marine animals. Bioluminescent organisms produce light as a result of a chemical reaction. This study was carried out to understand the variation in vertical distribution of bioluminescence intensity at a fixed location (6° 6' 43.68"N, 79° 45' 27.18"E) of the south coast of Sri Lanka during north-east (NE) and south-west (SW) monsoon periods in January and May 2016, respectively. On each sampling day, bioluminescence intensity was measured using a recoverable bathyphotometer at two hours interval from 7.00 pm to 5.00 am. The vertical hauls of zooplankton samples were also collected from surface to 10 m depth using WP-2 net with 180 µm mesh size and samples were immediately preserved in 5% buffered formalin. Bioluminescence intensity ranged from 6 to 98 intensity counts during the NE monsoon and the highest bioluminescence intensity was recorded at around midnight (98 counts) and the lowest was around 5.00 am (6 counts). During the SW monsoon period, the highest bioluminescence intensity was recorded at around 9.00 pm (22 counts) and the lowest was around 5.00 am (12 counts). It was observed that bioluminescence intensity increased from dusk to midnight and gradually decreased in dawn. This indicates that bioluminescence intensity varies with the time of the day. However, bioluminescence intensity was comparatively high in SW monsoon than NE monsoon. There is a significant correlation between bioluminescence intensity and the depth (Pearson Correlation = 0.007, $P<0.05$). The highest bioluminescence intensity was found within the mixed layer depth (40-60 m) and it decreases with increasing depth. This study recorded seventeen bioluminescence zooplankton species belong to four phyla in the upper 10 m of the ocean. *Oncaea conifer* was the most abundant (124 ind./m^3) species during the NE monsoon while *Okiopleura dioica* was most abundant (104 ind./m^3) during the SW monsoon. This is the first observation of vertical migration in bioluminescent organisms in

Sri Lankan waters. Further studies will be done to identify bioluminescent species around Sri Lankan waters with their distribution.

Key words: bioluminescence, thermocline, bathyphotometer, zooplankton

Extended abstract

Introduction

Bioluminescence is the production and emission of visible light by living organisms. Bioluminescent organisms are rare on land, but extremely common in the oceans. It has been documented that approximately 1–3% of the biomass in the surface ocean belongs to bioluminescent taxa (Morin, 1983). Reasons for these luminous displays appear to be varied from organisms to organisms but these can be due to some basic reasons such as predator avoidance, prey attraction, physiological maintenance and intra-species communication (Abrahams and Townsend, 1993; Morin, 1983; Morin and Cohen, 2010).

Bioluminescent marine organisms include a range of small single cell bacteria to large vertebrates representing over 700 genera belonging to 16 phyla (Herring, 1987). The major groups of bioluminescent marine organisms include dinoflagellates, ostracods, copepods, euphausiids, radiolarians, cnidarians, ctenophores, cephalopods, decapod shrimps, chaetognaths and fish. Among these, zooplankton are considered as major bioluminescent organisms in the marine environment (Moline *et al*, 2007).

This study aims to investigate the variation in vertical distribution of bioluminescence intensity at a fixed location of the south coast of Sri Lanka during south-west monsoon north-east monsoon period.

Methodology

Bioluminescence intensity was measured at a fixed-location (6° 6' 43.68"N, 79° 45' 27.18"E) off the south coast of Sri Lanka on 21st 22nd January (north-east monsoon) 2016 and 3rd – 4th May (south-west monsoon) 2016 using a recoverable bathyphotometer (RBPM) adapting (free falling at a speed of about 1-1.5 m/s) from the research vessel R/V Samuddrika. Bioluminescence intensity was measured up to 100 m water depth in two hours interval from 7.00 pm to 5.00 am. Conductivity, Temperature and Depth (CTD) profiler was used to collect oceanographic parameters and the instrument was deployed to a maximum depth of 250 m.

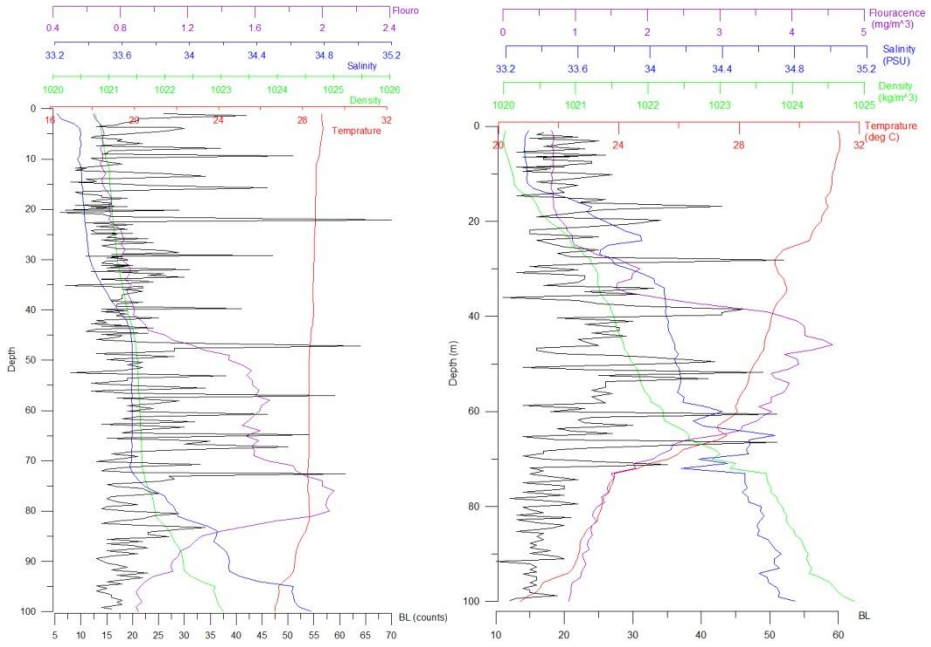
Surface zooplankton samples were collected vertically (from surface up to 10 m depth), using a plankton net with a mesh size of 180 μm at the same time when bioluminescence intensity measurements were taken. The zooplankton samples were preserved in 5% buffered formalin and identified the bioluminescent zooplankton species and estimated their abundance (ind./m^3). Bioluminescence intensity during south-west monsoon and north-east monsoon periods was compared statistically and relationship between bioluminescence intensity and depth was evaluated.

Results and discussion

Bioluminescence intensity profiles indicate strong stratification with numerous flashes of intensities ranging from 6 to 98 intensity counts during NE monsoon period and 4 to 60 intensity counts in SW monsoon period. Results indicate that bioluminescence is maximum in the surface layer up to around 60 m and highest bioluminescence intensity was found within the mix layer depth (40-60 m). At these depths flashes were numerous and of great intensity (up to 51 counts). From 60 m to 100m, few bioluminescence flashes with low intensity were recorded. The highest average bioluminescence intensity during NE monsoon was recorded around midnight (98 counts) and the lowest was at 5.00 am (6 counts). During SW monsoon, the highest bioluminescence intensity was recorded at around 9.00 pm (60 counts) and the lowest was at 5.00 am (4 counts). There is a significant correlation between bioluminescence intensity and the depth (Pearson Correlation = 0.007, $P<0.05$).

Bioluminescence peaks were mostly observed above the thermocline and figure 1 summarizes occurrence of bioluminescence peaks in two seasons.

Seventeen (17) bioluminescent zooplankton species belonging to four phyla (Annelida, Arthropoda, Chordata and Cnidaria) were identified (Table 01) in this study. Results revealed that *Okiopleura Dioica* is the most abundant species during SW monsoon period (22 ind./m^3) and *Oncaea conifer* was the highest abundant (60 ind./m^3) species during 1st inter-monsoon period (Table 1). This shows that monsoonal variation has effect of the density of surface bioluminescent species.



(a) (b)

Fig.1. Vertical distribution of Bioluminescence (BL), temperature, salinity, density and fluorescence (a) NE Monsoon (b) SW Monsoon

Table 01: Bioluminescence species abundance in the South coast of Sri Lanka

	Phylum	Family	Species	Average Abundance (ind/m^3)	
				Monsoon	Non monsoon
1	Arthropoda	Calanidae	*Undinula vulgaris*	34	4
2	Arthropoda	Clausocalanidae	*Clausocalanus arcuicornis*	44	0
3	Arthropoda	Corycaeidae	*Corycaeus speciosus*	3	8
4	Arthropoda	Centropagidae	*Centropages furcatus*	10	0
5	Arthropoda	Metridinidae	*Pleuromamma gracilis*	0	4
6	Arthropoda	Miracidae	*Macrosetella gracilis*	8	16
7	Arthropoda	Oncaeidae	*Oncaea conifer*	8	124
8	Arthropoda	Paracalanidae	*Acrocalanus longicornis*	76	52
9	Arthropoda	Paracalanidae	*Paracalanus indicus*	60	20

10	Arthropoda	Pontellidae	*Pontella fera*	4	0
11	Arthropoda	Pontellidae	*Pontellina sp*	4	0
12	Arthropoda	Pontellidae	*Potellina plumata*	28	12
13	Arthropoda	Scolecitrichidae	*Scolecithricella minor*	67	0
14	Arthropoda	Temoridae	*Temora stylifera*	4	20
15	Annelida	Tomopteridae	*Tomopteris helgoladica*	4	4
16	Cnidaria	Diphyidae	*Diphyes dispar*	4	8
17	Chordata	Oikopleuridae	*Oikopleura dioica*	104	64
Abundance				462	336

Conclusion

This study revealed that bioluminescence intensity varies with the time of the day and the intensity increased from dusk to mid night and gradually decreased until dawn. Though bioluminescence intensity was higher in SW monsoon period than the NE monsoon period, there is no any significant impact of monsoon pattern on temporal variation in bioluminescence intensity during the night time period.

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