

Bioluminescent marine zooplankton along the east coast of Sri Lanka: Identification and spatial distribution

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Abstract

Bioluminescence is the production and emission of visible light by living organisms. Many organisms, including single cell bacteria to large vertebrates representing over 700 genera are known to produce light. Among these, zooplanktons are considered as one of the major bioluminescent organisms in the marine environment. The present study was carried out to identify the bioluminescent zooplankton species and their spatial distribution patterns off the east coast of Sri Lanka. Zooplankton samples were collected at 6 different sites from off Trincomalee to Batticaloa area (81° 38'E and 82°02'E, 7°56'N and 8°00'N) in November 2015 on board R/V Samuddrika. Zooplankton samples were collected at night and preserved in 5% formalin for laboratory analysis and identified to the lowest possible taxon. Species richness and species abundance (ind.ml⁻¹) at each sampling site were calculated. Five bioluminescent zooplankton species; *Acrocalanus longicornis*, *Oncaea conifer*, *Corycaeus speciosus*, *Macrosetella gracilis* and *Oikopleura dioica* belonging to the two phyla were identified. *O. conifer* was the most abundant bioluminescent zooplankton species and it was reported at five sampling sites among six (average density of 4 ind.ml⁻¹). The highest density of *O. conifer* was reported at sampling sites 2 and 4 (6 ind.ml⁻¹) and the lowest at site 6 (2 ind.ml⁻¹) close to near shore station. *A. longicornis*, and *M. gracilis* species were reported only at one sampling site with a density of 2 ind.ml⁻¹. The highest species richness and Shannon-Winner diversity index were recorded at sampling site 2. Bioluminescence intensity (relative scale) of sampling sites ranged from 20.42±8.18 (site 3) to 35.17±38.78 (site 5). There were no significant differences in nutrients i.e. Nitrate, Phosphate and Silicate and sea surface temperature (P> 0.05, ANOVA) among sampling sites.

Keywords: Bioluminescence, zooplankton, species richness, diversity index

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Introduction

Bioluminescence is a rare phenomenon in terrestrial environment but it is ubiquitous in marine environment. It is a result of a chemical reaction which gives light as by product. It has been documented that approximately 1-3 % of biomass in the surface ocean belongs to bioluminescent taxa. These bioluminescent marine organisms range from 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, chetognaths and fish. Among these, zooplanktons are considered as one of the major bioluminescent organisms in the marine environment (Moline *et al.* 2007). Although a handful

studies have been carried out to identify light producing zooplankton species and their spatial and temporal distribution in the Indian Ocean (Lapota *et al.* 1988), no such studies have been conducted in the coastal waters around Sri Lanka. This the first time such a study was carried out to identify the bioluminescent zooplankton species inhabiting the marine waters off the east coast of Sri Lanka and study their spatial distribution patterns.

Materials and Methods

A set of bio-optical and hydrophysical observations were conducted off the east coast of Sri Lanka from 9th to 11th November 2015 on board R/V Samuddrika to examine bioluminescent zooplankton species. Six different sites from offshore to near shore were sampled at night in the region encompassing 81° 38'E and 82 °02'E, 07° 56'N and 08° 00'N. Zooplankton samples were collected using 150µm plankton net by vertical towing. The collected zooplankton samples were preserved in 5% buffered formalin for later identification and enumeration. At the laboratory bioluminescent zooplanktons were identified to the lowest possible taxon using available keys (Razouls *et al.* 2016; White *et al.* 2003). Bioluminescent zooplankton abundance (ind.ml-1) at each sampling site was estimated by taking three sub samples and counting the number of each species using a Sedgwick-Rafter cell. Shannon-Winner diversity index, species richness and species evenness were also calculated with respect to each sampling site.

Result and discussion

Five bioluminescent zooplankton species; *Acrocalanus longicornis*, *Oncaea conifer*, *Corycaeus speciosus*, *Macrosetella gracilis*, and *Oikopleura dioica* belonging to two phyla (Arthropoda and Chordata) were identified during this study (Table 1).

Table 1. Abundance (ind.ml-1) of bioluminescent zooplankton species at each sampling site

Phylum	Species name	Density (ind.ml ⁻¹)						Average density (ind.ml ⁻¹)
		1	2	3	4	5	6	
Arthropoda	<i>Acrocalanus longicornis</i>		2					2
	<i>Oncaea (Triconia) conifer</i>	3	6		6	3	2	4
	<i>Macrosetella gracilis</i>			2				2
	<i>Corycaeus speciosus</i>		1			2		1.5
Chordata	<i>Oikopleura dioica</i>		1	3			1	1.6

Table 2. Variation in species richness, diversity indices, species evenness and average bioluminescence intensity (\pm SD) of each sampling site

Location number	Species Richness	Shannon Winner Diversity Index	Simpson's Index of diversity	Species Evenness	Average Light intensity \pm SD
1	1	0	0	0	29.81 \pm 13.99
2	4	1.09	0.59	0.79	28.47 \pm 12.96
3	2	0.67	0.51	0.97	20.42 \pm 8.18
4	1	0	0	0	25.42 \pm 25.58
5	2	0.67	0.51	0.97	31.54 \pm 28.51
6	2	0.64	0.49	0.92	35.17 \pm 38.78

Abundance of bioluminescent zooplankton species was calculated (ind.ml⁻¹) and the *O. conifer* was found as the most abundant species. This species was recorded at five sampling sites out of the six sites with an average density of 4 ind.ml⁻¹. *A. longicornis* and *M. gracilis* was recorded only at sampling site 1 and 5, respectively. The density of both species at each landing site was reported 2 ind.ml⁻¹ (Table 1). Diversity indices (Shannon-Winner Diversity Index and Simpson's Index of diversity), species richness, species evenness and bioluminescence intensity of sampling sites are summarized in Table 2. The highest species richness was reported at sampling site 2 and the bioluminescence intensity ranged from 20.42 \pm 8.18 to 35.17 \pm 38.78 (Table 2).

Conclusion

Five bioluminescent zooplankton species are present off the east coast of Sri Lanka and their abundance found to vary spatially. However additional species are anticipated with further investigation with variation in bioluminescence intensity a possible indicator of organism spatial distribution and abundance. Further, research on intensity variation of bio-luminous organism would a good indicator to understand vertical distribution of the area.

References

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