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Spatial variability in productivity and biomass of seagrasses in the Andaman group of Islands, India

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ABSTRACT

Productivity and biomass of seagrasses (*E.acoroides, T.hemprichii, H.ovalis, H.ovata, C.rotundata, C.serrulata, H.uninervis, H. pinifolia,* and *S.isoetifolium*) in the Andaman group of Islands were evaluated during November - December 2007. Higher productivity was recorded in *E. acoroides* (14.7 (±1.28) $gCm^{-2}d^{-1}$) at Henry Lawrence Island whereas lower productivity was noted in *H. ovata* (0.23 (±0.01) $gCm^{-2}d^{-1}$) at Red Skin Island and Kalipur coast. The lower productivity of seagrasses in the Andaman Islands directly reflects biomass in all sampling sites. The minimum biomass value was recorded in *H. ovata* (79 (±1.52) $gfr.wt.m^{-2}$) at Havelok Island and the maximum value was recorded in *E. acoroides* (2800 (±247.19) $gfr.wt.m^{-2}$) at Henry Lawrence Island. The productivity and biomass of seagrasses showed apparent spatial and interspecies variations within the same location. The present study proved that the local ecology plays a vital role in determining productivity and biomass of seagrasses in the Andaman group of Islands.

Key words : *Seagrass, Productivity, Biomass, Spatial variability, Andaman Island*

Introduction

Seagrasses are submerged aquatic angiosperms that are vital components of coastal and estuarine ecosystems, which represent a dominant biological community along with the shallow coastal areas of the world. These plants create, as well as occupy essential niches in shallow coastal waters and provide habitat, food, substrate and protection for a variety of organisms (Zieman, 1987). Significantly, seagrasses represent high biomass productivity in seashore ecosystem rather than the biomass production of the terrestrial ecosystem. This high rate of primary productivity is directly reflected in the entire tropical ecosystem through secondary consumers, including herbivores, detritivores, and microorganisms (Touchette, 2007). However, seagrasses are subjected to various stresses such as mechanical abrasions by algal fronds, trampling and physical removal of shoots by farmers (de la Torre-Castro and Ronnback, 2004). Besides, the excretion of hydrogen peroxide and halogenated compounds by seaweeds (Mtolera *et al.*, 1995) as well as natural and human activities (Thangaradjou *et al.*, 2010a) leads to accelerated seagrass loss and it was evidenced at global scales.

There are 14 species of seagrasses recorded along the East and West Coasts of India (Thangaradjou *et* *al*., 2010a). Recent, reports from Chilika Lake (Priyadarsini *et al.,* 2014) and Andaman Islands (D'Souza *et al.,* 2015) points out the occurrence of 16 species are belonging to 7 genera (*Ruppia, Enhalus, Halophila, Thalassia, Syringodium, Cymodocea* and *Halodule*). The Gulf of Mannar, Palk Bay, Andaman and Nicobar Islands (Thangaradjou *et al*., 2010a) and Lakshadweep Islands (Nobi *et al*., 2011) are well known for seagrass resources. The Andaman and Nicobar Islands have eleven seagrass species, including the recent addition of *H. beccarii* (Savurirajan *et al.,* 2015) and *H. decipiens* (Immanuel *et al*., 2016).

The most persistent seagrass meadows in the Andaman group of Islands are found from the lower intertidal section to a depth of ~10-15 m along the open shores and in the lagoons around the Islands (Jagtap, 1991). Seagrass meadows of the Andaman group of islands were restricted to the reports of Jagtap (1991); Das (1996) and Thangaradjou *et al.,* (2010b). Around 830 ha of seagrass cover was reported from Andaman and Nicobar Islands, and a large portion confined to the fringes of the Islands (Jagtap 1992; Das 1996). The sea cow and green turtles in the Islands of India are dependent on seagrass for their food. However, an alarming decline of the dugong population has been reported from all locations where it occurs, leading to the existence of only 200 individuals in the country (Sivakumar, 2013), which was declared as critically endangered species and the sea cow are threatened by loss or degradation of seagrasses due to coastal development or industrial activities that cause water pollution.

On the other hand, an increase in the population of green turtle poses a threat to the existence of a seagrass ecosystem in the Lakshadweep Islands (Thangaradjou and Bhatt, 2018). However, Nobi *et al.* (2013) reported that seagrasses are distributed around 1323.97 ha in Andaman and Nicobar Islands through multi-spectral satellite data. In general, the seagrass meadows of the Andaman Islands and Gulf of Mannar are found to be more productive when compared to other seagrass sites of India (Thangaradjou *et al.,* 2010c and Thangaradjou *et al.,* 2015). Change in coastal geomorphology due to the 2004 Tsunami in the Indian Ocean resulted in dramatic changes in the initial density and distribution of seagrasses of this part of the sea. There are no reports of seagrass biomass and productivity of Andaman group of Islands after 2004 Tsunami. Considering all these aspects a survey on biomass and productivity of seagrass of the Andaman group of islands were carried out during November-December 2007 at selected sites recommended for prioritizing biodiversity conservation (Singh *et al*., 2000).

Materials and Methods

Study area

Andaman and Nicobar Archipelago (latitude: $6^0 45^0$-$13^0 41^0$N and longitude: $92^0 12^0$-$93^0 57^0$E) with over 572 Islands lie 1200 km away from South East Coast of the Bay of Bengal. Fringing and barrier reefs are dominated in the Andaman Islands (Ramesh *et al.,* 2006). Coral reefs form the dominant ecosystem with the combination of seagrasses and mangroves habitat in the lagoons and creeks, which protected by the reef (Nobi *et al*., 2010). The climate is typical of tropical Islands, the temperature ranges are 23–31 ^{o}C with irregular rainfall (3000 mm), usually dry during October to March and high humidity (70-80%). A field survey was carried out in 7 marine locations which fall in the South, Middle and North Andaman Islands (Fig. 1) based on the available literature and interactions with the local fishermen. Nine seagrasses (*Enhalus acoroides, Thalassia hemprichii, Halophila ovalis, H.ovata, Cymodoacea rotundata, C. serrulata, Halodule uninervis, H. pinifolia* and *Syringodium isoetifolium*) were collected to assess the productivity, canopy height, percentage cover, and biomass and geographical locations of the sampling locations given in Table 1.

Table 1. Geographical location of the sampling locations

S. No	Station name	Geographical location
1	Little Andaman	10^0 34′ 45.5"N; 92^0 35′ 36.8"E
2	Chidiyatapu	11^0 29′ 28.4"N; 92^0 42′ 32.4"E
3	Redskin island	11^0 33′ 50.7"N; 92^0 35′ 14.6"E
4	Neil	11^0 50′ 28.8"N; 930 02′ 43.6"E
5	Havelok	12^0 00′ 34.3"N; 92^0 50′ 49.0"E
6	Henry Lawrence	12^0 07′ 50.7"N; 93^0 05′ 43.9"E
7	Kalipur	13^0 13′ 35.8"N; 93^0 03′ 06.2"E

Seagrass Productivity

Several researchers recommended the measurement of changes in dissolved oxygen concentration in the ambient water of the aquatic plant community as products of photosynthesis. Dissolved O_2 was mea-

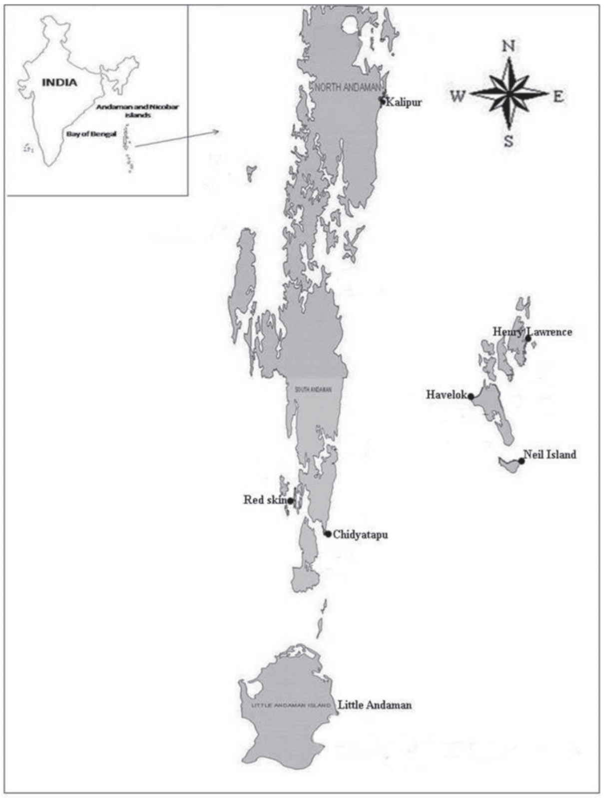

Fig. 1. The map showing sampling sites of the study area.

sured by the light and dark bottle method of Strickland and Parsons (1972), and productivity of seagrasses was estimated by incubating the leaf samples of seagrass species for 3hrs in light and dark bottle method as described by Qasim *et al.* (1971) and modified by Kannan and Thangaradjou (2006).

Seagrass canopy height

Collected samples of seagrass were identified with following the field guide of Kannan and Thangaradjou (2006) and confirmed by the report of Den Hartog (1970). Canopy height of seagrass leaf length was measured in the field using a 300 mm scale for each species in all the quadrat (0.25 m^2). After avoiding tallest 20% of leaves in each quadrat, the leaves from sediment to leaf tip were measured three matured leaf blades of each species in the quadrat (Kannan and Thangaradjou, 2006).

Seagrass percentage cover and biomass

Systematic line transects (5) of 100 m length perpendicular to the Coast was plotted at each location at 10 m interval for unbiased estimation. The survey was conducted during low tides by skin diving method. Percentage cover was estimated using 1m^2 wire netted quadrat frames subdivided into 100cells at 10 m interval. Quadrat of 0.25 m^2 was used for seagrass biomass estimation by random sampling. Seagrass plants with underground parts were uprooted within the frame. Collected samples were washed thoroughly in the field itself using ambient seawater to remove the sediments and debris. Moisture from the samples was extracted using blotting papers and weighed to get the total biomass. Mean value of fresh weight expressed in gram fresh weight per square meter (g.fr.wt.m^{-2}).

Statistical analysis

Relationships between seagrass productivity, biomass and canopy height were analysed by a 3D scattered plot with 95% confidence level. Additionally, stepwise multiple regression was used to describe the relationship between productivity and biomass, and physico-chemical parameters (Atmospheric temperature, water temperature, salinity, pH, DO, nitrite, nitrate, silicate, Inorganic phosphate, POC, EC, nitrogen, phosphorous, sand, silt, clay) obtained from our previous studies (Dilipan *et al.*, 2017). All statistical analysis was conducted using statistical package SPSS. Version. 11.5.

Results

In the present study, nine species of seagrasses (*E.acoroides, T.hemprichii, H.ovalis, H.ovata, C.rotundata, C.serrulata, H.uninervis, H.pinifolia,* and *S.isoetifolium*) were recorded in the Archipelago of Andaman Islands. Out of nine species, eight species were recorded from Henry Lawrence Island, except *C. serrulata,* which was recorded only in Little Andaman Island. Distribution of eight species in Henry Lawrence Island, depicts that offers shelter and protection to the luxuriant growth of seagrasses. In Andaman Islands, distribution of seagrasses was observed among dead and live coral reef areas. Distribution of massive, hard, and dead coral substratum along with the fringes of islands prevents the proliferation of seagrasses through vegetative reproduction. In contrast, some places like Neil Island and Havelock Island, seagrasses were observed in the mangrove areas also.

The productivity, canopy height and biomass values showed evident interspecies variation and variation within species at different locations (Fig.

2a). Productivity values showed comprehensible variation within inter and intra species at different locations and the productivity of *H.ovalis* varied among 0.391 and 0.950gC/m^2/day in all the stations with the minimum productivity (0.391gC/m^2/day) at Niel and the maximum productivity (0.950gC/m^2/day) at Havelok Island. Whereas, the productivity of *H.ovata* ranged between 0.115 and 0.420gC/m^2/day, registered minimum at Havelok and maximum at Red Skin Island. Besides, the productivity of *T.hemprichii* was showed 0.638 and 3.837gC/m^2/day, which recorded minimum at Havelok and maximum at Henry Lawrence Island.

The productivity of *C. rotundata* was ranged between 0.657 and 1.638gC/m^2/day, with minimum productivity (0.657gC/m^2/day) at Niel and maximum (1.638gC/m^2/day) at Henry Lawrence. Whereas, the productivity of *C.serrulata* was recorded 0.785 and 0.920gC/m^2/day at Buttler Bay and Naval area respectively at Little Andaman Island. In case of *H.uninervis,* productivity values were registered 0.401 to 0.940 mgC/m^2/day recording minimum at Red skin and maximum at Havelok, whereas the productivity of *H.pinifolia* ranged among 0.212 to 0.597gC/m^2/day, with the minimum (0.212mgC/m^2/day) at Red Skin and maximum (0.597gC/m^2/day) at Havelok Island.

Canopy heights of seagrass species at different locations varied widely (Fig.2b). Canopy height of *E. acoroides* and *S. isoetifolium* were recorded as 65.13 (±0.15) cm and 8.49 (±0.05) cm respectively at Henry Lawrence Island. Canopy height of *H.ovalis* varied from 1.21 (±0.01) cm to 1.5 (±0.02) cm, it was recorded minimum at Red Skin and maximum at Chidayatapu and it ranged between 0.59 (±0.05) cm to 0.79 (±0.05) cm for *H.ovata* with minimum at Red

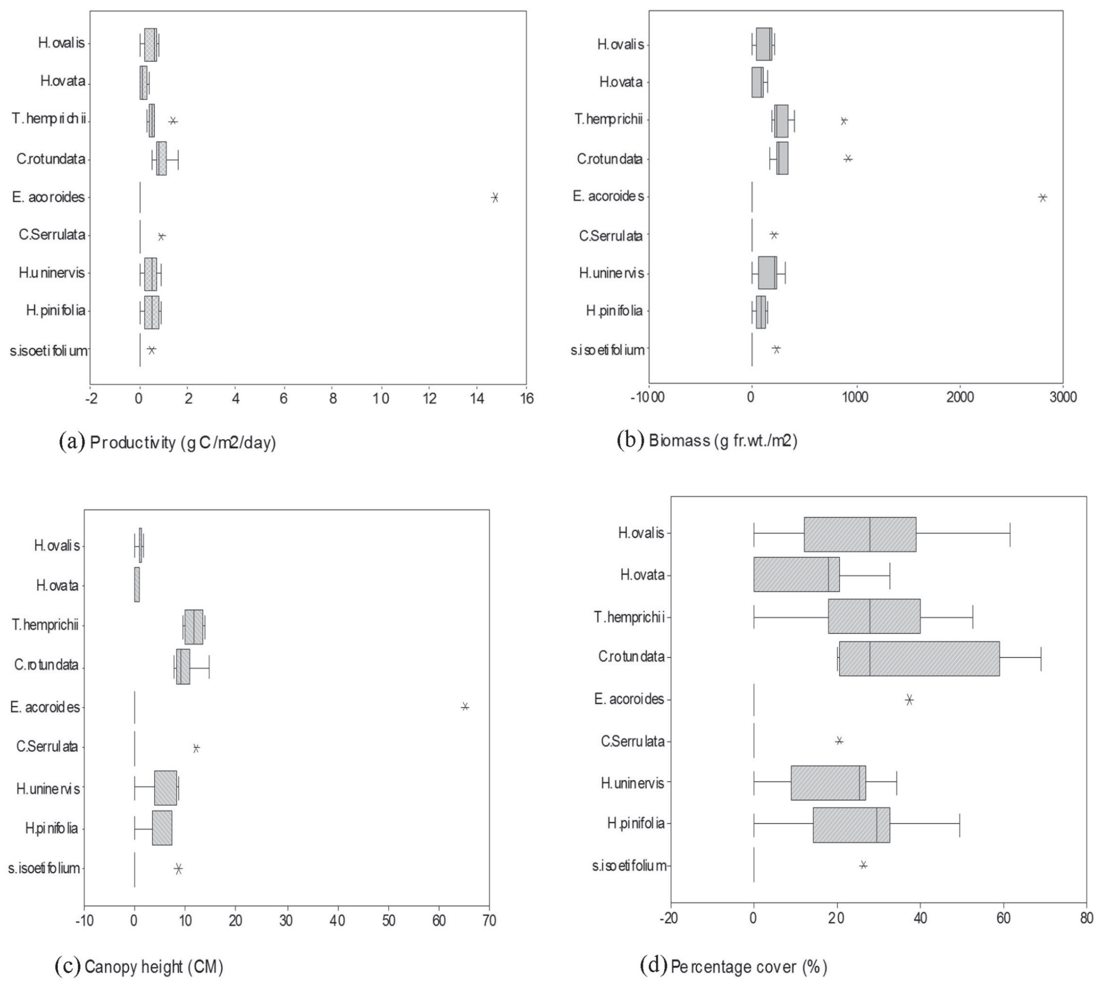

Fig. 2. Variability of (a) productivity, (b) canopy height, (c) percentage cover and (d) biomass of different seagrasses recorded at Andaman group of islands.

Skin Island and maximum at Henry Lawrence. Canopy height of *T. hemprichii* ranged among 9.55 (±0.05) and 13.6 (±0.61) cm, and *C. rotundata* height varied from 7.9 (±0.05) to 14.7 (±4.1) cm, it was minimum at Chidayatapu and maximum at Havelok Island. *Cymodocea serrulata* was found to be 12.2 (±5. 6) only at Little Andaman Island, and the canopy height of *H. uninervis* ranged from 7.79 (±0.01) to 8.46 (±0.5) cm, and *H. pinifolia* ranged from 6.6 (±0.5) to 7.4 (±0.05) cm at different Islands.

The percentage cover of seagrass species are given in figure 2c. *E. acoroides* and *S. isoetifolium* recorded only in Henry Lawrence with a percentage cover of 37.6 (±7.5) % and 26.6 (±5.5) % respectively. Percentage cover of *H.ovalis* varied widely among stations from 24.6 (±7.2) to 61 (±9.6) % with the minimum coverage at Red Skin Island and maximum at Henry Lawrence island. Percentage cover of *H.ovata* varied among 18 (±4.3) and 32.6 (±2.51) %, was recorded minimum at Red Skin Island and maximum at Havelok. *T. hemprichii* coverage varied among 17.6 (±7.3) and 52.6 (±8.3) % with minimum at Chidiyatapu and maximum at Henry Lawrence Island.

Percentage cover of *C. rotundata* ranges from 20 (±2) to 69% (±12.8) at different locations. It was recorded minimum at Little Andaman and Kalipur while maximum at Havelok Island. *Cymodocea serrulata* was recorded at 20.6% (±8.14) in the Little Andaman Island. Percentage coverage of *H.uninervis* was varied from 18 (±3) to 34.3% (±37.7) with minimum at Chidyatapu and maximum coverage at Havelok. *Halodule pinifolia* coverage was low at Havelok (29.3 (±1.5)) and was more (49.6 (±5.6)) at Red Skin Island. Percentage cover of *Syringodium isoetifolium* at Henry Lawrence was 26.6% (±5.5). Stepwise multiple regressions identified that the physico-chemical parameters were influencing

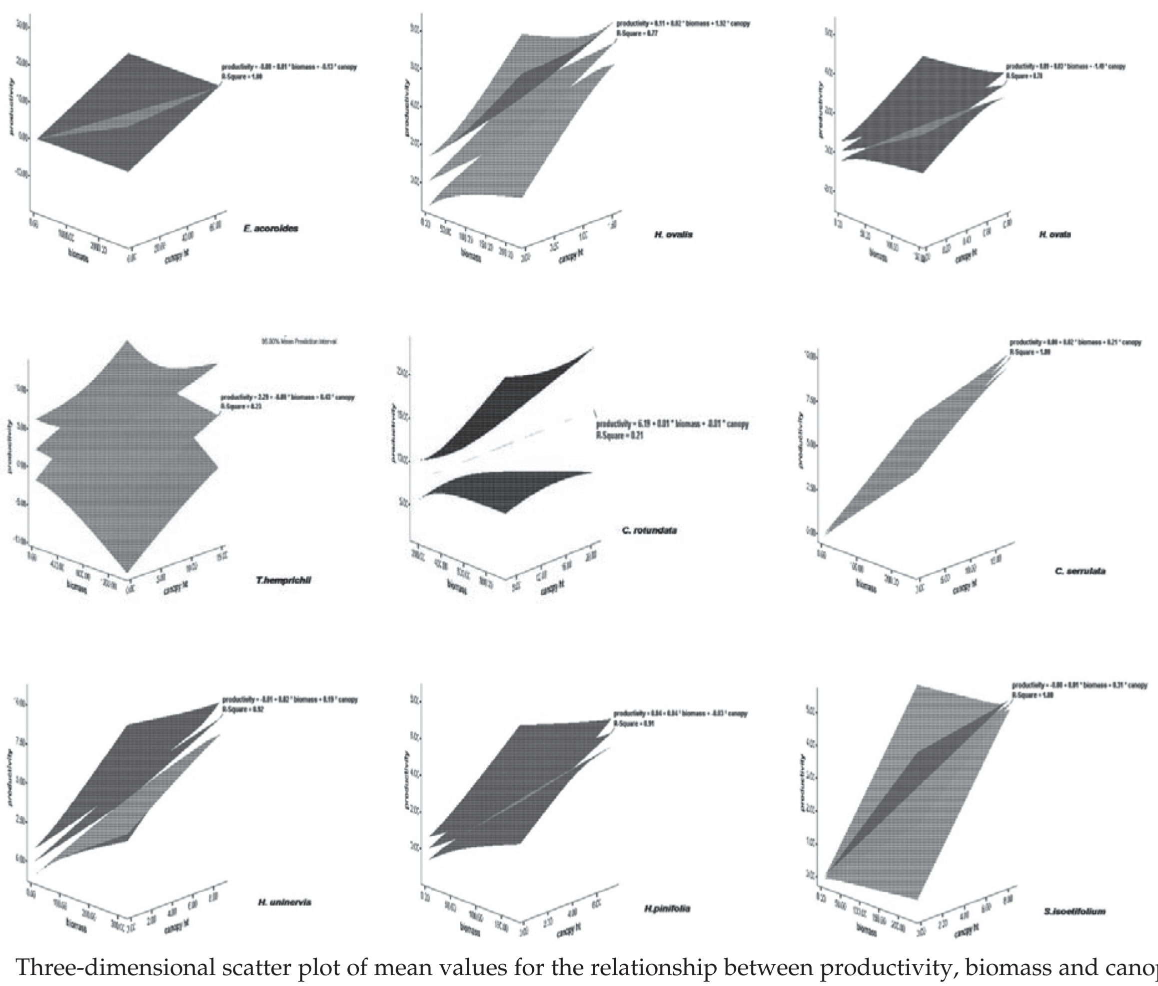

Fig. 3. Three-dimensional scatter plot of mean values for the relationship between productivity, biomass and canopy height at linear regression with 95% individual prediction.

seagrass productivity and biomass (Table 2). The biomass values were varied highly with respect to the species in different locations. *E. acoroides* at Henry Lawrence recorded biomass of 2800 (±247.19) gfr.wt.m^{-2} whereas biomass values of *H.ovalis* varied between 91.33 (±4.5) and 211.33 (±3.5) gfr.wt.m^{-2} with minimum at Chidiyatapu and maximum at Red Skin Islands. *H.ovata* biomass varied among 79 (±1.52) and 147.66 (±3.51) gfr.wt.m^{-2} while, *T.hemprichii* varied from 193.66 (±1.52) to 887 (±2) gfr.wt.m^{-2}.

The biomass of *C. rotundata* was recorded minimum (173.66 (±4.72) gfr.wt.m^{-2}) at Little Andaman Island, and maximum value (931.66 (±6.02) gfr.wt.m^{-2}) at Henry Lawrence, whereas the biomass of *C. serrulata* was 219 (±2.64) gfr.wt.m^{-2} at Little Andaman Island. In case of *H. uninervis*, biomass values ranged among 127.66 (±2.5) and 317 (±4.35) gfr.wt.m^{-2} with minimum at Red skin and maximum at Havelok Islands, while in case of *H. pinifolia*, it was ranged among 80 (±1) and 156.33 (±5.5) gfr.wt.m^{-2} with minimum at Red Skin and Neil Islands and maximum at Henry Lawrence. Biomass of *S. isoetifolium* was recorded as 237 (±12.5) gfr.wt.m^{-2} at Henry Lawrence Island (Fig. 2d).

Table 2. Cumulative R2 values for each variable (and the sign of its regression coefficient) entering the stepwise multiple regression models employing productivity (gCm^{-2}d^{-1}) and biomass (gfr.wt.m^{-2}) as the dependent variable.

S. No	Species	R2 (Productivity & Biomass)	Parameters for multiple regression (Productivity, Atm temp., water temp., salinity,pH DO, nitrite, nitrate, silicate, In phosphate, POC, EC, nitrogen, phosphorous, sand, silt, clay)	Parameters for multiple regression (Biomass, Atm temp., water temp., salinity,pH DO, nitrite, nitrate, silicate, In phosphate, POC, EC, nitrogen, phosphorous, sand, silt, clay)
1	*E.acoroides*	0.998 & 0.999	-40.81 +0.354 + 0.104 +0.124 +0.209 +0.323 +0.452 +0.405 -0.423 -0.070 -0.134 + 0.421 -0.001 -0.261 + 0.287 +0.019 except POC	-1404.157 +0.355 +0.104 +0.124 +0.209 +0.323 +0.452 +0.405 -0.423 -0.07 -0.134 +0.421 -0.001 -0.261 +0.287 +0.019 except POC
2	*T.hemprichii*	0.987 & 0.388	-133.286 +0.274 -0.127 +0.581 + 0.316 + 0.013 -0.125 +0.27 -0.167 -0.521 + 0.088 +0.482 +0.154 +0.449 -0.087 +0.085 -0.071 except phosphorous	-2442.886 +0.049 +0.063 -0.109 -0.139 +0.208 +0.309 -0.03 -0.311 +0.153 +0.292 -0.094 +0.357 +0.035 +0.025 -0.012 -0.103
3	*H.ovalis*	0.984 & 0.952	-38.305 +0.38 + 0.458 +0.32 +0.1 +0.038 -0.182 +0.266 +0.054 +0.306 +0.347 +0.143 -0.337 -0.26 +0.192 +0.74 except phosphorous	-409.116 +0.05 +0.079 +0.222 +0.313 -0.099 -0.289 +0.231 +0.2 -0.248 -0.242 +0.099 -0.332 -0.202 +0.166 +0.437 except phosphorous
4	*H.ovata*	0.971 & 0.494	-67.388 -0.57 -0.114 +0.197 -0.271 -0.174 -0.233 +0.223 -0.219 +0.096 +0.029 -0.243 +0.34 +0.308 -0.335 -0.105 except pH	-231.5 -0.086 +0.435 +0.313 +0.131 +0.095 -0.189 +0.331 -0.165 -0.29 -0.017 +0.041 +0.003 -0.182 +0.141 +0.458 except phosphorous
5	*C.rotundata*	0.902 & 0.408	-115.377 -0.092 -0.603 +0.56 +0.401 -0.925 +0.061 -0.217 -0.516 +0.304 +0.446 +0.284 + 0.495 -0.512 -0.382 except silicate	84.955 +0.007 -0.011 +0.208 +0.023 -0.03 -0.231 +0.06 -0.045 -0.208 +0.21 +0.06 -0.053 +0.015 -0.02 +0.017 except POC
6	*C.serrulata*	0.992 & 0.994	77.256 +0.315 +0.485 -0.455 -0.395 +0.477 +0.322 +0.184 -0.378 +0.462 +0.274 -0.286 -0.384 +0.39 +0.292 except EC	1012.521 +0.315 +0.486 -0.456 -0.395 +0.228 +0.477 +0.323 +0.184 -0.378 +0.462 +0.274 +0.229 -0.286 -0.384 +0.391 +0.292 except EC
7	*H.uninervis*	0.981 & 0.982	-594.606 +0.387 +0.173 +0.373 +0.569 +0.23 -0.006 +0.431 -0.059 -0.298 +0.032 -0.257 +0.301 -0.367 +0.367 +0.294 except EC	-783.546 +0.244 +0.059 +0.245 +0.577 +0.104 -0.03 +0.31 +0.125 -0.217 -0.01 -0.418 +0.336 -0.288 +0.288 +0.243 except EC
8	*H.pinifolia*	0.986 & 0.935	-602.714 +0.25 +0.272 +0.352 +0.464 +0.298 +0.028 +0.442 -0.151 -0.264 +0.109 -0.183 +0.26 -0.377 +0.375 +0.331 except EC	-446.831 +0.246 +0.141 +0.309 +0.531 +0.262 +0.093 +0.347 -0.112 -0.22 +0.188 -0.186 +0.381 -0.278 +0.284 +0.203 except EC
9	*S.isoetifolium*	0.996 & 0.906	-14.962 +0.354 +0.104 +0.124 +0.209 +0.322 +0.451 +0.404 -0.422 -0.069 -0.134 +0.42 -0.001 -0.26 +0.287 +0.018 except POC	-116.067 +0.354 +0.104 +0.124 +0.209 +0.322 +0.451 +0.404 -0.422 -0.069 -0.134 +0.42 -0.001 -0.26 +0.287 +0.018 except POC

Discussion

Productivity and biomass of seagrass populations confirm the perception that seagrass tends to form major, productive ecosystems, but data indicated that they unevenly distributed both in space, time, and across the species. *E. acoroides* showed a linear relationship (R^2=1) among productivity, biomass and canopy height (Fig. 3). Though the canopy height of *E. acoroides* was 65.33 (±0.15) cm, being distributed in less than 3m depths, accretion of epiphytes on the leaves decreased the productivity of the species by reducing light availability. The present result also indicates that there has been a high level of competition among the seagrass species existing in multi-species seagrass beds for nutrients and light. Moreover, species capable of producing deep and robust rhizome system compete to establish extensive meadows due to dead coral platforms, whereas morphologically small species like *Halophila* and *Halodule* with slender rhizomes are adapting themselves well to the geomorphological conditions of the Andaman Islands. Despite these facts, the results were comparable to other studies of the Indian Coast, especially productivity of *E. acoroides* equalling the richness of the Gulf of Mannar (Thangaradjou *et al.,* 1998).

Net productivity and biomass of *H. ovalis* and *H. ovata* have not exhibited a significant variation among the stations and mostly growing as monospecific in similar habitats (Fig. 3). Though these species have comparatively flat and broad leaves, they always register lower productivity. Kaladharan *et al.* (1998) inferred this low productivity with low content of chlorophyll per unit area of leaves when compared to other species. At locations where *Halophila* being found associated with *Halodule* spp. face difficulty in receiving light, due to a comparatively higher canopy height of *Halodule* which tend to reduce the light availability to the former. Present result confirmed with stepwise multiple regression, which excluded only total phosphorous content among all the variables and, the rich sediment, nutrient pool and the relatively small biomass of *Halophila* species presumably ensured nutrient availability to the species, however, light might be limiting factor for biomass and productivity. There was a significant linear relationship observed among productivity and biomass of *T. hemprichii* (Fig. 3). Mean values of productivity and biomass showed a discrepancy among the stations concerning canopy height. Productivity is significant because of the variability in the substratum and the depth at which it is growing. This fluctuation is mainly due to their thin leaves which lacks sufficient intercellular air spaces in the mesophyll layers which otherwise can retain the oxygen produced during active photosynthesis and re-utilize during the non-photosynthesis period (den Hartog, 1979; Brouns, 1985).

Linear relationship between the productivity, canopy height and biomass of *C. rotundata* (R^2=0.21) and *C. serrulata* (R^2=1) showed a difference among species (Fig. 3). Even though the canopy height of *Cymodocea* sp. was high in the sampling sites but they were not well adapted to poor ambient light of greater depths (>3m) (Jagtap *et al.,* 2003) and hence it showed less productivity. In this study, *Cymodocea* species were found to be distributed in bispecific with *T. hemprichii* or mixed meadows throughout the Andaman Island.

H.uninervis (R^2=1) and *H. pinifolia* (R^2=0.92) showed strong linear relationship among productivity, canopy height, and biomass (Fig. 3). In the present investigation statistical results confirm that the other environmental variable does not alter the relevant parameters, unlike *Cymodocea* sp. The patchy, isolated occurrences of *Halodule* sp. indicates that the seagrass meadow was severely constrained exceptionally by the substratum variation, particularly dominance of sand with hard Coral rubbles on Coral platforms reduces the possibility of meadow expansion. Present results could be confirmed by the negative correlation obtained among these species and sand.

S. isoetifolium was found distributed mixed in Henry Lawrence Island compared to other species in this Island, with a strong significant relationships between productivity, canopy height, and biomass (Fig. 3), although, mean values of productivity and biomass of *S.isoetifolium* was not comparable to the mainland.

The present results showed that the environmental parameters such as water temperature, pH, salinity, dissolved oxygen, nitrate, nitrite, silicate, inorganic phosphate recorded significant positive relationships with productivity of the tested seagrasses. The results suggest that the Andaman sea has neither significantly changed nor polluted over the period (Pai, 2007), though, 2004 tsunami resulted a significant destruction in the Andaman Islands leading great loss of seagrass biomass comparing to the mainland (Thangaradjou *et al.,* 2010a). On the other hand, high wave and current action, prevailing in this region cause damage to seagrass standing crop at all time. Based on the results, it is evident that more than the environmental variable, substratum and physical conditions prevail in the region limits seagrass distribution.

Although there were some differences in growth characteristics among sites and seagrass meadows, it was not systematic. Productivity rate of *T. hemprichii* was found to be lower at Chidayatapu but not in other stations, while the productivity rate of *C. rotundata* was high in this location. Thus, the study could not arrive at any trends in growth characteristics of seagrass in the Andaman Islands. Reduced productivity and biomass of *Halophila* and *Halodule* species, indirectly resemble lesser extent of canopy height of these two species when compared to other species. On the other hand, conditions of light reaching the seagrass canopy were highly variable, even over a short period, as they depend on season and cloudiness as well as water transparency.

Similarly, Plus *et al.* (2001) reported that increase in available light led to immediate influx of oxygen. Grazing losses reduce biomass, but they have also been reported to stimulate production (Cebrian *et al*., 1997). Large-scale grazing was not reported in this part of the sea. Anthropogenic disturbance reduces cover of seagrasses which limit both productivity and biomass to a more considerable extent by triggering entropic conditions in the ambient water column. Lesser productivity of seagrasses of Andaman Islands directly correlates with biomass in all the Islands.

To conclude, the assessment of productivity and biomass of seagrass populations confirms that seagrasses of Andaman often form rich, productive ecosystems at isolated patches. However, the coasts of Chidayatapu, Red Skin and Kalipur observed sparse distribution of seagrasses. Present survey depicts that understanding of seagrass production and biomass points warrants furthermore significant efforts in poorly studied areas and species, to achieve an improved inventory on seagrass resources around the Andaman Islands. Logistical issues in reaching the sites and conducting the field survey in the remote areas forced to limit sampling, particularly at the dense and shallow populations. Despite, the present estimates of average seagrass production and biomass provide a synoptic view on the seagrass cover of the regions.

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