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Comparative diversity analysis and species composition of seagrass and macroalgae along the intertidal zone of sarangani province, Philippines

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Abstract

The study was carried out as an intensive sampling survey in the intertidal zones of Sarangani Province (Glan and Maasim), relying on the low tide to determine the total species number, relative species abundances, frequency and spatial distribution of seagrass.Eight Species of seagrasses andnineteen species of macroalgaewere gathered. These have been the sampling sites of researchers, most especially students, for its reputation of having diverse distribution of such aquatic plants. A total of fifty sampling plots were laid using quadrats; ten quadrats were arranged alternately with a five-meter disparity between each plot, placed perpendicularly to the shore. The study identified species of seagrass belonging to the family *Potamogetonaceae* and *Hydrocharitaceae*. Nineteen species of macroalgae were identified from where either seagrass was present or absent and categorized under the family of *Dasycladaceae, Ulvaceae, Halimedaceae, Caulerpaceae, Dictyotaceae, Sargassaceae, Galaxauraceae, Wurdemanniaceae, Gelidiaceae, Gracilariaceae* and *Cryptonemiaceae*.Seagrass. Biodiversity indices such as dominance, Shannon's diversity, evenness, species richness and number of individuals were also determined using PAST software. Distribution analysis revealed the three highest number of species among the eightseagrass species were*Enhalusacoroides, Haloduleuninervis and Thalassiahemprichii-such were*common in both sites. The *Padina minor* from the nineteen identified macroalgaespeciesin the algal community has the most number of species. There are great indications of seagrass and macroalgae presence with its distribution when proper sampling procedure is done. Researchers strongly recommend that physicochemical such salinity and sedimentation and also correlation on distribution of species be studied further.

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Introduction

Seagrass are marine angiosperm that are adapted to live permanently in drenched seawater. Worldwide, there are about 58 known species (Bandeira, 1995; Richmond, 1997). Seagrass provide food and habitat to numerous marine species, stabilize the ocean bottom, maintain water quality, and help support local economies.(Jackson *Et al.* 2001, McManusand Polsenberg 2004, Orth *Et al.* 2006). Worldwide, seagrasses are subjected to stresses resulting from human activities, among the missewage disposal.

Tropical coastal marine ecosystems including seagrass beds and macroalgae communities are undergoing intense deprivation in response to natural and human disturbances *(*Jackson *Et al. 2001,* McManus and Polsenberg *2004,* Orth *Et al. 2006).* Sea basic ruling premise in plant communities is that nutrient addition shifts the competitive balance from slow-growing primary producers to faster-growing species. In seagrass beds, a gradual shift is expected to occur as nutrient loads are increased *(*Duarte *1995;* Valiela *Et al. 1997;* Hauxwell *Et al. 2001;* McGlathery *2001,* Fourqurean and Rutten *2003),* where macroalgae proliferations might overgrow and displace seagrasses. The intertidal zone is typified by a greater range of environmental conditions than any species can permanently withstand and still reproduce successfully (Trait and DeSanto, 1972).

Like in many tropical regions, the Sarangani Province coast has well developed seagrass and macroalgae communities. One of its beaches, Isla Jardin, Gumasa as well as in the opposite side of the coastal zone of Sarangani, Maasim these areas inhabits multiple numbers of species. Therefore the intertidal seagrasses of the area are prone to the effects of sewage because they lie closely. Another area,Linao, Maasim, located about 20 km north of Isla Jardin, Del Mar,receives no direct sewage discharge but rather a wide number of seagrass species therein.

The present study set out to investigate and compare the two sites upon the distribution of seagrass and macroalge. Sewage discharge on the composition and distribution of seagrass.To achieve this objective,Glan ad Maasim was selected as the study site .

Methods and materials

The Study Area

The study was carried out at Sarangani Province, located at southeastern Mindanao, which geographically lies between 5°55`25” - 125°61'32.93"N and 125°09’45”- 125°11`44”E. Two sites were selected at each location consisting offifty (50) quadrats. The sites represent the general area. The actual location of sites were determined through the use of Global Positioning System (GPS).

Fig.1. Map of the study sites Mindanao showing relative location of the Philippines (A) (googlearth.com), map of the Sarangani Province showing the relative location of the study areas; (B) Gumasa, Glan (C) Tinoto, Maasim, Sarangani Province.

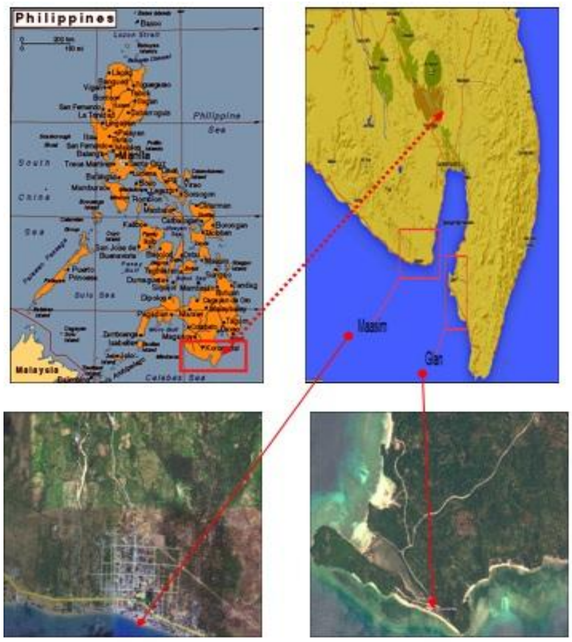

Fig. 1. Shows the geographical location of the two study sites marked with red dot from the map of the Philippines.

Inventory of seagrass and macroalgae

The study was carried out in the two sampling areas. The identified species of seagrasses and macroalgae were listed and included as part of species inventory. Species observed outside the transect were also included as part of the species composition. The seagrass and macroalgae were identified with the help of Dr. Hilconida Paalan Calumpong's book, Field Guide to the Common Mangroves, Seagrasses and Algae of the Philippines. The species observed in the study area, even outside of the sampling plots, were documented and considered as part of the species inventory. Sampling efforts focus on the intertidal areas.

Establishment of sampling stations

The two sites were surveyed along the intertidal areas with sufficient seagrasses and macroalgae. Five transects were established in each of the sampling station having a length of 100 meters. The distance between transects was about 50 meters. In each transect, 10 quadrats were laid with a dimension of 1m X 1m. Seagrasses and macroalgae were identified and counted and the data were used to analyse for biodiversity values and percent cover.

Biodiversity measurements.

The data on abundance was used to compute for biodiversity values. These include species richness, abundance, dominance evenness, and Shannon's diversity. The software PAST (Hummer *Et al.*, 2001) was used to compute for the values. Percent cover was also evaluated in seagrasses and macroalgae (McKenzie; L.J.; Campbell, S.J. & Roder, C.A). Reliable identification guides and manuals were used in the identification of seagrasses and macroalgae (Calumpong *Et al*, 2007)

Statistical analysis.

The statistical tool T Test with equal variances was used to compare the biodiversity values of the two sites. Microsoft Excel was used to compute the T Test and the data were projected in error bar chart.

Results and discussions

Species identification

Eight (8) seagrass species and nineteen (19) macroalgae species were identified in the two sampling sites of Sarangani Province. (seeTable I &II*)* For the seagrass, two (2) families of seven (7) species were present in Glan and two (2) families of seven (7) species were in Maasim, Sarangani Province. With the macroalgae, among the ten (10) families, there werefourteen (14) species present in Glan while there were seven (7) families of nine(9) species identified in Maasim, Sarangani Province. Shown in Table II, apparently, seagrass are much more dominant than macroalgae in both areas. The top three seagrass species that are found in both areas are *Thalassiahemprichii, Haloduleuninervis* and *Enhalusacoroides*. Species from genus *Enhalus* are dominant both in the coastal areas of Glan and Maasim, like the species of genus *Thalassia*. However, while there are also many samples of genus *Halodule* found in Glan, not much can be found in Maasim.Macroalgae are extensively much more largely present in the zones of Glan. Some species that are found in Glan are not even present in Maasim. The zones of Glan and Maasim, nonetheless, have four species in common. These are *Cladophoropsis-fasciculata, Liagoraceranoides, Caulerpaserrulata* and *Padina minor*, with the species from genus *Padina*in lead by drastic merit. Among the families of seagrass,the family *Hydrocharitaceae* dominate in the number of individual species such *Enhalus acoroides, Halophila minor, Halophila ovalis, and Thalassia hemprichii.* However, *Cymodocea rotundata* from the family of *Potamogetonaceae* shows significant numbers of species present in thetwo sampling sites Glan and Maasim. The least number of individual species is the *Halophila minor* in the family of *Hydrocharitaceae.* The most diverse in seagrass species is Maasim in contrast with Glan has the most number of macroalgae species.

In the macroalgae aspect, the species *Padina minor* from family *Dictyotaceae* dominate the most while *Caulerpa sp.* from family *Caulerpaceae* has the least number. In table III & Fig. 2, statistically and graphically shown given the diversity values of Species richness and Dominance Maasim is most diverse than Glan in the distribution of seagrasses.

Table IV and Fig. 3 exhibits its diversity values there is a little bit difference between the two sites. But still there is no significance difference in macroalgae distributions. In fig. 5 and 6, shows the coverage of the seagrass and macroalgae; and as result in seagrass cover Maasim has most diverse than Glan, in the other hand Glan has most diverse than Maasim in macroalgae.

Table I. Abundance and species composition of Seagrass in Glan and Maasim, SaranganiProvince.

Family	Species	Glan	Maasim	Total
I. Potamogetonaceae	1. *C. Rotundata*	155	368	523
	2. *H. Pinifolia*	119	201	320
	3. *H. Unninervis*	300	2,301	2,601
	4. *S.Isoetifolium*	89	7	96
II. Hydrocharitaceae	5. *Acoroides*	2,044	2,367	4,411
	6. *H. Minor*	0	114	114
	7. *H. Ovalis*	27	0	27
	8. *T. Hemprichii*	951	592	1,543
	Total # of species per site	**7**	**7**	**14**
	Total # of individuals	**3,685**	**5,950**	**9,635**

Table II. Abundance and Species composition of Macroalgae in Glan and Maasim, Sarangani Province.

Family	Species	Glan	Maasim	Total
I. Caulerpaceae	1. *Caulerpa sp.*	31	0	31
	2. *Caulerpa serrulata*	26	20	46
II. Dasycladaceae	3. *Bornetella Oligospora*	25	0	25
	4. *Lobopora Variegata*	23	0	23
III. Dictyotaceae	5. *Padina Minor*	415	26	441
IV. Galaxauraceae	6. *Galaxaura Oblongata*	46	0	46
	7. *Galaxaura Rugosa*	42	0	42
V. Gelidiaceae	8. *Gelidiella Acerosa*	40	0	40
VI. Gracilariaceae	9. *Gracilaria Salicornia*	0	28	28
	10. *Gracilaria Verrucosa*	35	0	35
VII. Halimedaceae	11. *Halimeda Discoidea*	0	34	34
	12. *Halimeda Incrassata*	37	26	63
	13. *Halimeda Macrolaba*	0	24	24
VIII. Helminthocladiaceae	14. *Liagora Ceranoides*	31	35	66
IX. Rhodomelaceae	15. *Amansia Glomerata*	31	0	31
X. Sargassaceae	16. *Turbinaria Ornata*	40	0	40
XI. Siphonocladaceae	17. *Cladophoropsis Fasciculata*	0	23	23
XII. Ulvaceae	18. *Ulva Reticulata*	0	14	14
XIII. Wurdemanniaceae	19. *Wurdemannia Miniata*	51	0	51
	Total # of species per site	**14**	**9**	**23**
	Total # of individuals	**873**	**230**	**1103**

Table III. Statistical analysis of Seagrass Dominance, Shannon, Evenness, Species Richness and Abundance on the two sites of Sarangani Province.

Diversity Values	Glan	Maasim	T-Test
Dominance	0.2799924	0.32569	0.1675559^{ns}
Shannon	1.725682	1.255528	2.67079E-07^{ns}
Evenness	0.69863	0.97583	4.7E-15^{ns}
Species Richness	8.7	3.94	1.85077E-22^{ns}
Abundance	17.58	4.64	7.29E-21^{ns}

Legend: ns= not significant; and Significant: **P*>0.1; ***P*>0.05; ****P*>0.01.

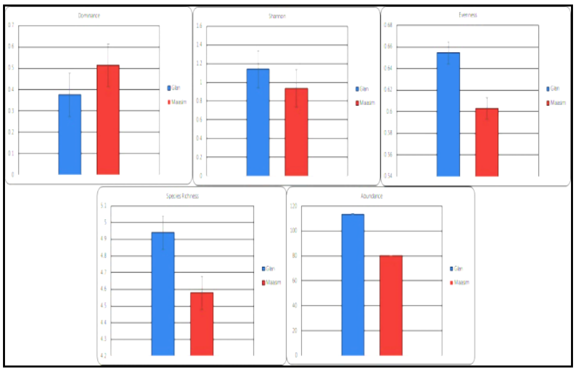

Fig. 2. Bar Chart of the Mean Values of Seagrass Biodiversity Attributes Across Area. (Dominance, Shannon, Evenness, Species Richness and Abundance.

Species composition and inventory

There were seven (7) species of seagrass among the eight (8) identified species found to have diverse amount in the two sites. The species that common dominating to both sites were *Enhalus acoroides*. While the least species common to both sites were *Syringodium isoetifolium*.Nevertheless there is one (1) species found not no common to the areas of study. These were *Halophila ovalis* for Glan and *Halphila minor* for Maasim. (see table I).Abundance of seagrass in Maasim reveals 5,950 individuals while Glan has 3,685 with a total of 9,365 species counted.

There were fourteen (14) macroalgae species found in Glan and nine (9) in Maasim. The *Padina minor* were dominant both in the two sites and there were five (5) species of macroalgae not found in Glan present in Maasim and ten (10) species found in Maasim which were absence in Glan. With its composition there were only three (3) revealed species common in both sites. (see Table II).Abundance of macroalgae in Maasim reveals 230 individuals while Glan has 873 with a total of 1,103 species counted.

Comparative analysis on Diversity of species

Seagrass species

Seagrass species in Glan and Maasim, Saragani Province. The Diversity values reveals the significant difference on the two sites. (See Table III & graph in Fig. 2) the Dominance in Glan has an equivalent of 0.375124 and Maasim reveals 0.513308, as a result driven by T-Test there is significant difference in the two sites. Shannon in Glan was 0.9363454 while in Maasim 1.141566 also there is significant difference between these areas of study. Evenness 0.654536 for Glan and 0.603136 for Maasim shows no significant difference. Species Richness has diversity values of 4.94 for Glan and for Maasim 4.58 for instance there is still no significant difference. With its Abundance statistically 113.72 in Glan and 80.3 in Maasim, in other words there is no significant difference in the two sites for the species diversity.

Macroalgae Species

The two sites showing relative diversity on the species as the detail shown in Table IV (see graph i Fig. 3). The Dominance, Shannon, Evenness, Species Richness and Abundance of these areas of study were showing no significant difference at all.

Table IV. Statistical analysis of Macroalgae Dominance, Shannon, Evenness, Species Richness and Abundance on the two sites of Sarangani Province.

Diversity Values	Glan	Maasim	T-Test
Dominance	0.375124	0.513308	0.000014587**
Shannon	0.9363454	1.141566	0.001290266**
Evenness	0.654536	0.603136	0.039007^{ns}
Species Richness	4.94	4.58	0.13113208^{ns}
Abundance	113.72	80.3	7.79581^{ns}

Legend: ns= not significant; and Significant: **P*>0.1;***P*>0.05; ****P*>001.

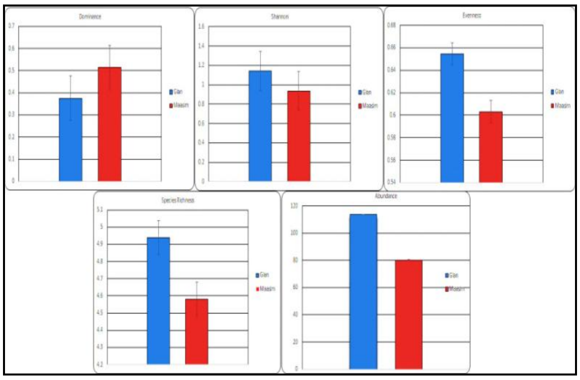

Fig. 3. Bar Chart of the Mean Values of Macroalgae Biodiversity Attributes Across Area. (Dominance, Shannon, Evenness, Species Richness and Abundance).

SEAGRASS SPECIES

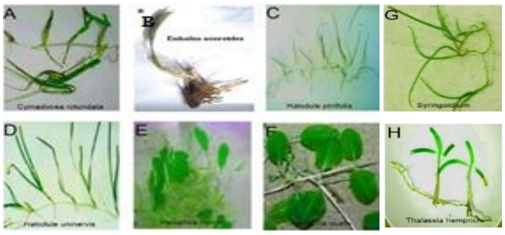

Fig. 4. *Seagrass Species (A) Cymodocea rotundata (B)Enhalus acoroides(C) Halodule pinifolia (D)Halodule uninervis(E) Halophila minor (F) Halodule ovalis (G) Syringodium isoetifolium (H) Thalassia hemprichii.*

The picture shows the photos of actual collected seagrass species.

Species percent coverage

Fig. 5 exhibits the coverage of seagrass and macroalgae in the twelve selected plots in the sampling site of Maasim, Sarangani Province. It suggestto which among the twelve plots for seagrass, only two (2) plots have the most diverse numbers of species covering 100% of seagrass species within it. The least percent cover in the fig. above has 45% for seagrass and 2% for macroalgae. In the other side shown, the short amount of macroalgae distribution in the presence wherein star fish, corals and other microorganisms present in the plot.

Table V. Represents the seagrass coverage in Glan and Maasim, Sarangani Province. As shown in the table, Maasim has a higher percentage with 73.14% average than Glan with 35.27% seagrass cover among the 50, 50 plots respectively.

MACROALGAE SPECIES

Fig. 5. *Macroalgae Species (A) Caulerpa sp.(B) Caulerpa serrulata (C) Bornetella olisgospora (D) Lobopora variegata (E) Padina minor (F) Galaxaura oblongata (G) Galaxaura rugosa (H) Gelidiella acerosa (I) Gracilaria salicornia (J) Gracilaria verrucosa (K) Halimeda discoidea (L) Halimeda incrassata (M) Halimeda macrolaba (N) Liagora ceranoides (O) Amansia glomerata (Q) Turbinaria ornata (R)Cladophoropsis (S) Ulva reticulata (T) Wurdemannia miniata.*

As shown in Fig. 4, the actual species of macroalgae collected were identified and classified.

Fig. 6 showed the coverage of seagrass and macroalgae in the twelve (12) selected plots in the sampling area; Glan, Sarangani Province. It is shown here among the twelve (12) plots for seagrass, only two (2) plots have the most diversed numbers of species with a cover of 100% (percent) of seagrass species within it. In the other side shown, the shorter amount of macroalgae distribution in the presence wherein star fish, corals and other microorganisms present in the plot.

Table V. Seagrass average percent cover in the two area of study. T= transect (consists 10 quadrats).

Area of study	T1	T2	T3	T4	T5	Average percent cover
Glan	34.55%	36.36%	27.27%	45.46%	32.73%	35.27%
Maasim	41.42%	78.57%	70.71%	97.14%	77.86%	73.14%

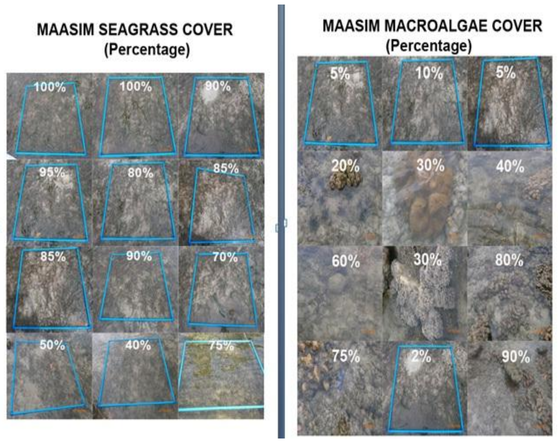

Fig. 6. Shows the percent cover of seagrass and macrolagae species in Maasim, Sarangani Province.

Fig. 7. Shows the percent cover of seagrass and macroalgae species in Glan, Sarangani Province.

Table VI. Macroalgaeaverage percent cover in the two area of study. T= transect (consists 10 quadrats).

Area of study	T1	T2	T3	T4	T5	Average percent cover
Glan	40%	75.86%	68.28%	93.79%	75.17%	70.62%
Maasim	27.14%	28.57%	21.43%	35.71%	25.71%	28%

The least percent covered in the Fig. 6 has 45% for seagrass and 10% for macroalgae. Table VI. Represents the macroalgae coverage of the two sites Glan and Maasim Sarangani Province. As shown in the table, Glan has a higher percentage of macroalgae diversity with 70.62% average than Maasim with 28% macroalgae cover among the 50, 50 plots respectively.

Conclusions and recommendations

As a result of the intensive sampling survey in the intertidal zones of Sarangani Province (Glan and Maasim), Macroalgae has much higher diversity attributes in Glan (see Fig. 7) compared to Maasim (see Fig. 6). Seagrass has much higher diversity attributes in Maasim compared to Glan. Graphically and statistically shown, seagrasses are much more dominant than macroalgae in both areas. Given the huge area and diversity, there must be some undistinguished and undiscovered species. Based on statistical analysis there is a significant relationship between the macroalgae distribution and the distribution of seagrasses in the two sites (see Fig. 2*)*. A bar graph represented there was significant difference in seagrass species among the two sites. In macroalgae aspect, there was no significant difference. The researchers suggest to which studies on physichochemical, microorganisms, minerals, water salinity and sedimentation has a correlation on the distribution of the species.

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