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Diversity and Abundance of Shallow-water Sea Cucumbers in Samar and Leyte, Philippines

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ABSTRACT

Combined inventory of commercially collected sea cucumbers in buying stations and fishery-independent surveys of fishing grounds and marine protected areas (MPA) in Samar and Leyte conducted from January – December 2012 revealed 60 species of shallow-water holothurids distributed under Orders

Apodida, Aspidochirotida, Dendrochirotida and Molpadiida. Three of the 15 unidentified species, *Paracaudina* spp. and *Holothuria* sp. are possible new species report in the Philippines.Species' diversity of Samar and Leyte is high but the density of each species is very low ranging from 0.03 – 60.64 ind/ha with all commercially exploited species having densities <1 ind/ha.Catch per unit of effort (CPUE) calculated from results of timed gathering in fished areas of Guiuan, Eastern Samar and Maasin City is likewise low at 4.2 ind/gatherer/hr and 5.8 ind/gatherer/hr respectively. The CPUE in Palompon, Leyte is high at 235.6 ind/gatherer/hr but *Holothuria albiventer,* a species of no commercial value in the global market composes 87.5% of the catch. The MPAs also show relatively high CPUE values at 50 ind/gatherer/hrand 90 ind/gatherer/hr for Bagonbanua Marine Reserve and Fish Sanctuary in Guiuan, Eastern Samar and Tabuk Marine Park Fish and Bird Sanctuary in Palompon, Leyte respectively albeit also composed of low commercial value species.

Keywords - holothurids, species diversity, abundance, Leyte-Samar Philippines, new species record

INTRODUCTION

Sea cucumbers are among the most adapted and diverse marine invertebrates found in almost all types of marine habitats and in varying depth. Estimates of the number of sea cucumber species worldwide varies. Pawson (1982) and Smiley (1994) gave a total of 1,460 species belonging to 6 orders, 25 families and 199 genera. Conand (2004) and Toral-Granda (2006) placed the number of sea cucumber species at 1,500 with new species still being described each year.

Sea cucumbers are traded mostly as dried beche-de-mer or trepang (99%) and to a lesser extent as frozen or salted (Kalaeb et al. 2008; Kinch et al. 2008a). There is a developing market for ornamental/aquarium specimens, live, chilled or soaked in brine. Dried sea cucumbers, however, make up 99% of those globally traded (Choo 2008a; Brown et al. 2010). In addition, new uses of dried sea cucumbers are also being developed such as in pharmaceuticals and cosmetics (Kerr 2000; Bruckner 2006; Choo 2008a). The increasing demand for trepang, mostly by foreign markets has caused over exploitation of the resource. What used to be unexploited low value species are now also targeted. The number of commercially exploited species worldwide rose from 50 (Brown et al. 2010) to 66 (Purcell 2010; Purcell et al. 2011). Bruckner (2006) and Conand (2004) listed and categorized 43 main commercial species exploited globally as high, medium, and low commercial values. In Asia, 52 of the reported 125 species (Choo 2008a) are commercially exploited.

The Philippines is among the top exporters of dried sea cucumbers second to Indonesia (Conand 2004; Akamine 2005; Toral-Granda 2006). The number of species traded rose from fivewhen the trade begun in the 1990s to the current 33 species (Trinidad-Roa 1987; Schoppe 2000; Akamine 2002; Choo 2008b). Dried sea cucumbers are exported to China Hong Kong Special Administrative Region (SAR), Singapore, Republic of Korea, Taiwan province of China, and Japan (Gamboa et al. 2004; Choo 2008b). Clearly, sea cucumbers provide livelihoods to municipal fishers, local processors and traders (Conand 2004; Gamboa et al. 2004; Kinch 2008a). Maintaining the diversity and population of sea cucumber species is not just necessary to sustain livelihoods. It likewise sustains ecosystem services (Coleman and Williams 2002; Conand 2004; Toral-Granda 2006; Wolkenhauer et al. 2010).

OBJECTIVES OF THE STUDY

This study thus aimed to determine the species composition and abundance of shallow-water holothurids in the Samar-Leyte area. Clark and Rowe (1971) identified 97 species of shallow-water sea cucumbers in the Philippines. Similar studies conducted in specific parts of the country (Reyes-Leonardo 1984; Schoppe 2000b; Kerr et al. 2006; Olavides et al. 2010) brought the pooled number of identified species to 125. Eastern Visayas has a long standing trepang fishery but only Schoppe (2000b) has documented the holothurids of Cuatro Islas, Inopacan, Leyte.

MATERIALS AND METHODS

Inventory

Seven municipalities and cities in Samar and Leyte with known sea cucumber fishery indicated by the presence of dried sea cucumber traders were selected for the species inventory. These are San Antonio in Northern Samar, Catbalogan City in Samar, Guiuan and Lawaan in Eastern Samar, Palompon and Leyte in Leyte, and Maasin City in Southern Leyte (Figure 1). Available sea cucumbers from traders (also known as buyers), and wet markets in each area were identified and photographed. Specimens/samples of unfamiliar species were bought for tissue extraction, preserved in 95% ethyl alcohol and brought to the laboratory for ossicles analysis.

Since the available species in the buying stations are the commercially important species only, local gatherers were contracted to collect up to three individuals of whatever species of sea cucumbers (*i.e.* edible or not and/or with or without commercial value) they can find in their fishing ground. Whenever three individuals of a species were available, one is preserved in 95% ethyl alcohol as whole specimen. The other two specimens were relaxed in 10% $MgCl_2$ sea-watersolution before these were measured and weighed. Tissue samples for ossicle examination were then taken from the dorsal and ventral section and the tentacles placed in vials with 95% ethanol and brought to the laboratory for ossicles examination. In some cases animals were dissected for internal anatomy examinations. Cursory field surveys were also conducted in Eastern Samar (Guiuan, Salcedo, and Lawaan), Samar (Zumarraga), Leyte (Palompon), and Southern Leyte (Macrohon and Maasin City).

Specimens were identified using published field identification guides and other references (Clark and Rowe 1971; Rowe and Doty 1977; Reyes-Leonardo 1984; Conand 1998; Schoppe 2000b; Kerr et al. 2006; Samyn et al. 2006; Samyn et al. 2010; O'Loughlin 2011; Purcell et al. 2012). For less common species, photographs of the specimens and the ossicles were sent to the Invertebrate Laboratory of Dr. Marie Antonette Junio-Meñez at The Marine Science Institute, University of the Philippines, who verified/facilitated identification.

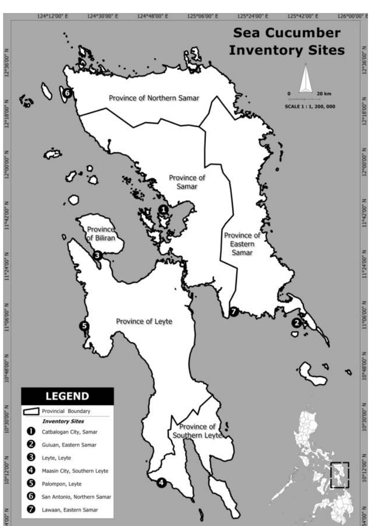


Figure 1. Municipalities and cities where rapid species inventory of shallow-water sea cucumbers was conducted

Abundance

Fishers were hired to gather shallow-water holothurids in selected areas of Samar and Leyte. The sites selected were Bagonbanua Marine Reserve and Fish Sanctuary (Bagonbanua) and five fishing sites in Guiuan, Eastern Samar (Fig. 2); six fishing sites in Maasin City (Fig. 3); Tabuk Marine Park Fish and Bird Sanctuary (Tabuk) and five fishing sites in Palompon, Leyte (Fig. 4). The type of habitat/substratum on each fishing ground was noted. Gathering was done during low tide in the evening or after midnight as practiced by the sea cucumber gatherers. The length of time spent gathering and the estimated area covered were recorded. In some cases, the fishers were instructed to gather for one hour only. The catch of each fisher was sorted, identified, photographed, counted and measured (length, body width and weight). Animals that were not needed for ossicles analysis were returned to the MPAs.

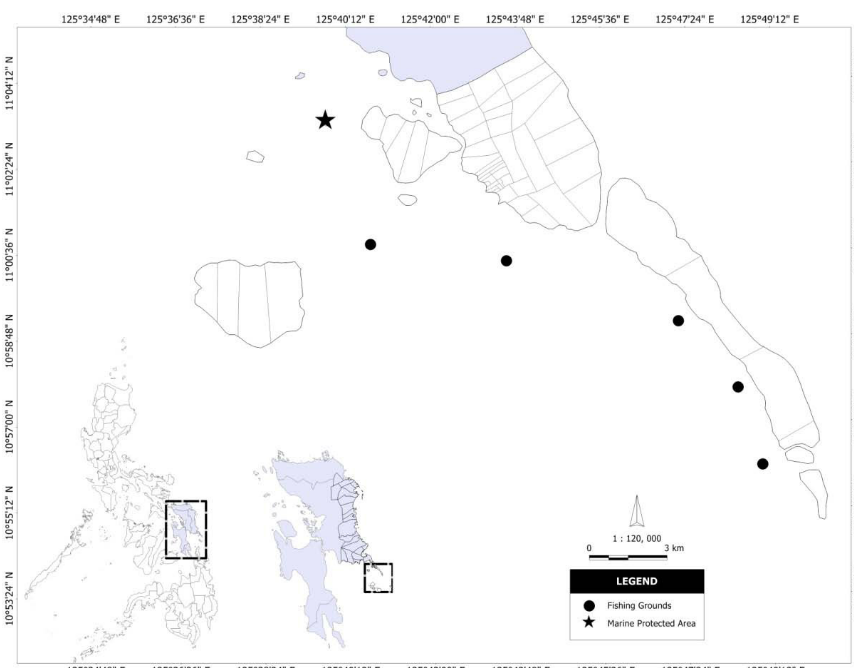


Figure 2. Sites of fishery-independent survey – Guiuan, Eastern Samar

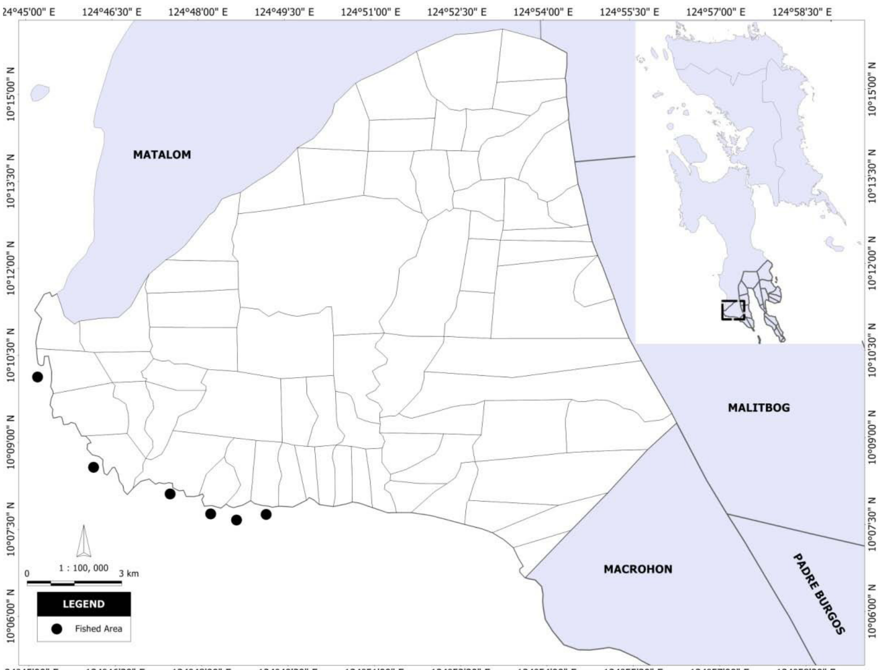


Figure 3. Sites of fishery-independent survey – Maasin City, Southern Leyte

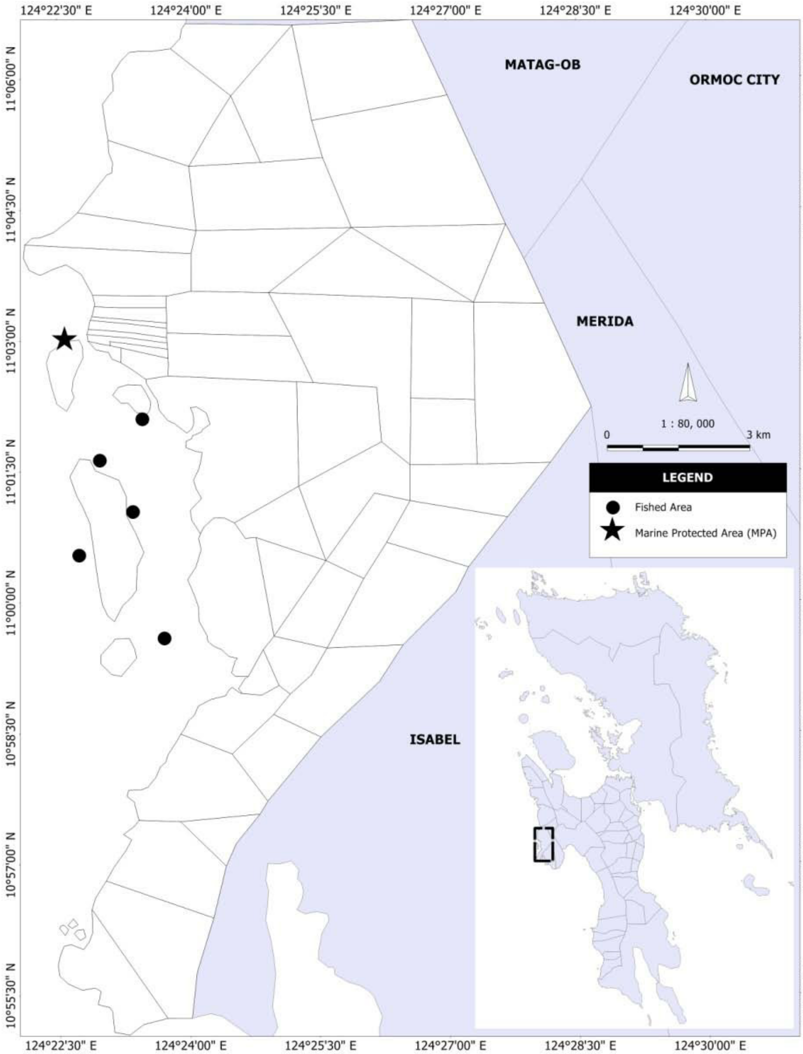


Figure 4. Sites of fishery-independent survey – Palompon, Leyte

Data Analysis

The sea cucumber density (number of individuals per hectare), species population density (number of individuals per species per hectare) and catch per unit of effort (number of individuals per gatherer per hour) were calculated from the data obtained. Species diversity was determined using the Shannon Index of General Diversity (H). A comparison of the species composition between sites was also determined by computing the Index of Similarity (S).

RESULTS AND DISCUSSION

Species Composition

The sites surveyed for sea cucumbers are sandy-rocky areas (mostly with dead corals and coral rubbles) interspersed with seagrasses except for Leyte, Leyte and Southern Leyte where a muddy bottom was also surveyed in each site.

Samar and Leyte has at least 60 species of shallow-water sea cucumbers belonging to Orders Apodida, Aspidochirotida, Dendrochirotida and Molpadiida (Table 1). This includes those identified from the buying stations. Of these, 45 were identified to the species level and 15 still need further examination for proper identification (Appendix 1). The unidentified species are specimens collected from the field surveys.

Eastern Samar has the most number of species with 29 identified and four unidentified species. Maasin City has 24 identified and two unidentified species while Leyte has 21 identified and nine unidentified species. Northern Samar and Samar has 15 and 11 identified species respectively. Twelve species are common in at least four sites. These are *Actinopyga echinites, Bohadschia bivittata, B. marmorata, B. vitiensis, Holothuria arenicola, H. coluber, H. impatiens, H. leucospilota, H. scabra, Pearsonothuria graeffeii, Stichopus horrens, and Synapta maculata.*

Three unidentified species found during the cursory field survey in Leyte, Leyte (Plates No. 1-3) are definitely different from the identified as well as the unidentified species from all areas. Two of these (Plates No. 1 & 2) are locally known as "Kamote" or sweet potato in reference to the colour and shape of the animal. These were classified as belonging to Order Molpadiida and tentatively identified as *Molpadia* sp.1 and *Molpadia* sp. 2but were later identified by experts (Junio-Meñez, pers. comm.) as *Paracaudina* spp. According to the locals the "Kamote" are edible but are not really sought after as regular food. In the north-west coast of Peninsular Malaysia Zaidnuddin (2002 cited in Choo, 2008a) reported the presence of *Paracaudina sp.* in muddy areas and that these are consumed raw by the locals.

Another unidentified species, *Holothuria sp.* 1 (Plate No. 3) is called "Mani-mani" by the locals. "Mani-mani" is also found in Leyte, Leyte in the same habitat as the 'Kamote" buried in the mud. The "Mani-mani" is however not edible according to the locals. Interestingly, the muddy area surveyed in Southern Leyte does not have both the "Kamote" and "Mani-mani." These were not also among those found in Catbalogan City considering that the main fishing ground, the Maqueda Bay, is also with a muddy bottom. There is no report on all three species in the Philippines and thus are potential new species records in the country.

Table 1. Shallow-water sea cucumbers in Samar and Leyte

Identified Species	Eastern Samar		N. Samar	Samar	Leyte		S. Leyte	Occurrence
	Guiuan-Salcedo	Lawaan	San Antonio	Catbalogan-Zumarraga	Palompon	Leyte	Maasin-Macrohon	
Order ASPIDOCHIROTIDA								
1. *Actinopyga capillata* Rowe and Massin	X						X	2
2. *Actinopyga echinites* (Jaeger)	X	X	X		X	X	X	6
3. *Actinopyga lecanora* (Jaeger)	X		X					2
4. *Bohadschia argus* Jaeger	X		X					2
5. *Bohadschia bivittata* (Mitsukuri)	X			X	X		X	4
6. *Bohadschia marmorata* Jaeger	X	X			X		X	4
7. *Bohadschia vitiensis* (Semper)	X		X	X	X		X	5
8. *Holothuria albiventer* Semper					X			1
9. *Holothuria arenicola* Semper	X	X			X		X	4
10. *Holothuria atra* Jaeger	X		X		X			3
11. *Holothuria coluber* Semper	X	X	X		X			4
12. *Holothuria edulis* Lesson	X		X					2
13. *Holothuria flavomaculata* Semper	X							1
14. *Holothuria fuscocinerea* Jaeger	X				X		X	3
15. *Holothuria fuscogilva* Cherbonnier	X		X				X	3
16. *Holothuria fuscopunctata* Jaeger	X		X					2
17. *Holothuria hilla* Lesson	X	X			X			3
18. *Holothuria impatiens* (Forsskal)	X	X			X		X	4
19. *Holothuria immobilis* Selenka	X							1
20. *Holothuria inhabilis* Selenka					X		X	2
21. *Holothuria leucospilota* Brandt	X	X	X		X	X	X	6
22. *Holothuria mactanensis*						X		1
23. *Holothuria nobilis* (Selenka)							X	1

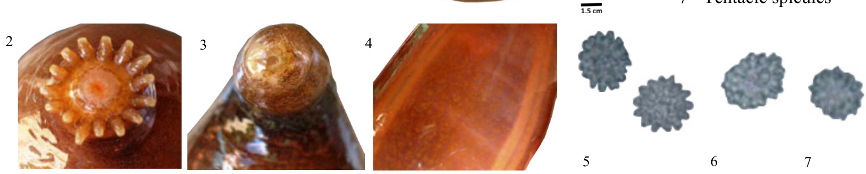
24. *Holothuria notabilis* Ludwig					X		X	2
25. *Holothuria pardalis* Selenka		X						1
26. *Holothuria pervicax* Selenka							X	1
27. *Holothuria rigida* Selenka		X			X		X	3
28. *Holothuria scabra* Jaeger	X	X			X	X	X	5
29. *Holothuria spinifera* Theel				X				1
30. *Pearsonothuria graeffeii* (Semper)			X		X	X	X	4
31. *Stichopus chloronotus* Brandt			X					1
32. *Stichopus horrens* Selenka	X	X	X	X	X	X	X	7
33. *Stichopus noctivagus* Cherbonnier	X							1
34. *Stichopus naso* Semper				X				1
35. *Stichopus ocellatus* Massin,Zulfigar, Tan Shau Hwai and Rizal Boss					X		X	2
36. *Stichopus quadrifiasciata* Massin				X			X	2
37. *Stichopus aff. rubermaculosus*				X			X	2
38. *Stichopus rubermaculosus* Massin, Zulfigar, Tan Shau Hwai and Rizal Boss				X			X	2
39. *Stichopus variegatus* Semper							X	1
40. *Thelenota ananas* (Jaeger)	X		X					2
Order APODIDA								
41. *Eupta godeffroyi* Semper	X							1
42. *Opheodesoma glabra* Semper	X							1
43. *Opheodesoma grisea* Semper	X							1
44. *Synapta maculata* Chamisso and Eysenhardt	X	X	X	X	X		X	6
Order DENDROCHIROTIDA								
45. *Neocucumis proteus* Bell				X				1
TOTAL IDENTIFIED SPECIES	**27**	**12**	**15**	**10**	**20**	**6**	**24**	

Species' similarity (S) between sites

Table 2 shows the species' similarity between sites surveyed. Leyte and Southern Leyte hasthe highest S value of 0.571 while Eastern Samar and Samar has the lowest S value of 0.186.

Plate 1. *Paracaudina sp.*1

1- Whole Specimen
2- Tentacles
3- Anus
4- Body wall
5- Dorsal tissue spicules
6- Ventral tissue spicules
7- Tentacle spicules



Remarks: Relaxed specimen; body wall very transparent, outline of lateral muscles very clear and visible from the outside; cylindrical body shape and elongating to the posterior side; clear pink in colour; respiratory trees present; gonads reddish orange in colour; intestine filled with mud; no cuverian tubules. Body spicules are ball-like with protrusions; spicules from tentacles are ball-like with protrusions and ball like with depression (hole/s) at the center.

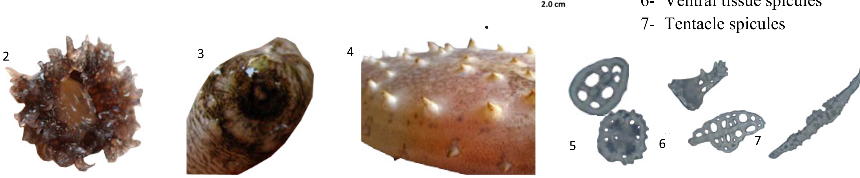
Plate 2. *Paracaudina sp. 2*

1- Whole Specimen
2- Tentacles
3- Anus
4- Body wall
5- Dorsal tissue spicules
6- Ventral tissue spicules
7- Tentacle spicules

Remarks: Body shape cylindrical with no distinct dorsal and ventral side; clear old rose colour with reddish-orange pigmentation pattern; body wall not as transparent as *Paracaudina sp. 1* and lateral muscles not visible from outside; anal portion with prominent "folds"; creamy white gonads; respiratory trees present; calcareous ring not hardened; spicules are uniquely different from *Paracuadina sp.* 1. Lateral muscles coloured bright orange.

Plate 3. *Holothuria sp. 1*

1- Whole Specimen
2- Tentacles
3- Anus
4- Body wall
5- Dorsal tissue spicules
6- Ventral tissue spicules
7- Tentacle spicules



Remarks: Relaxed live specimen; body shape cylindrical and elongating posteriorly and anteriorly; dorsal side is darker (greenish brown) while the ventral side is whitish; papillae yellowish with very prominent base and with pointed tips giving a rough sharp feel; gonads deep yellow; sac-like intestinefilled with mud; no cuverian tubule; spicules composed of buttons, tables and rods.

Table 2. Index of Similarity(S) between sites surveyed

Sites Compared	Number of Species per Site		Number of Common Species	S Value
	A	B		
1. Eastern Samar and Northern Samar	32	15	13	**0.553**
2. Eastern Samar and Samar	32	11	4	**0.186**
3. Eastern Samar and Leyte	32	30	15	**0.484**
4. Eastern Samar and Southern Leyte	32	26	14	**0.483**
5. Northern Samar and Samar	15	11	3	**0.231**
6. Northern Samar and Leyte	15	30	8	**0.356**
7. Northern Samar and Southern Leyte	15	36	7	**0.341**
8. Samar and Leyte	11	30	5	**0.244**
9. Samar and Southern Leyte	11	26	8	**0.432**
10. Leyte and Southern Leyte	30	26	16	**0.571**

This study added five species namely; *Actinopyga capillata, Stichopus rubermaculosus, S. quadrifasciata, S. ocellatus and Neocucumis proteus* (Appendix 2) to the pooled list of species from Clark and Rowe (1971), Reyes-Leonardo (1984), Schoppe (2000b), Labe (2004), Kerr et al. (2006), and Olavides et al. (2010). This brings the total number of identified species in the Philippines to 132 (Appendix 3). According to Choo (2008a) there are 125 species in Asia (pooled from various sources) and 52 of these are exploited commercially. From the list of the 52 commercially exploited species, 38 species are found in the Philippines although Choo (2008b) reported only 33 species as commercially exploited in the country.

The Bolinao-Anda reef shares 33 common species with Samar-Leyte (includes species from Schoppe (2000b) while Central Visayas and Samar-Leyte shares only 29 common species. Olavides et al. (2010) has six unidentified species from Bolinao-Anda while Kerr et al. (2006) has four unidentified species from the

Central Visayas. This study recorded 15 unidentified species. It is possible that the unidentified species from the different sites are the same or perhaps different thus its non-inclusion in the calculation of the index of species' similarity between sites in the Philippines. Interestingly, the index of similarity is highest between Bolinao-Anda and Samar-Leyte (0.72) and relatively high also (0.61) between Central Visayas and Samar-Leyte, likewise, between Bolinao-Anda and Central Visayas. The similarity in habitats surveyed as well as the wide distribution of the sea cucumbers could account for the high species' similarity.

Fishery independent survey

Results of the fishery-independent survey, shows a high species' diversity (H) in Maasin City (H=1.161) compared to Guiuan, Eastern Samar and Palompon, Leyte with general species diversity index of 0.887 and 0.525 respectively (Appendix 4). The species' diversity index is affected by the number of species and the number of individuals per species in the area. Not only does Maasin City have the highest number of species (21), but it also has more or less an evenly distributed number of individuals per species(Table 3). In Palompon, Leyte, with 15 species, *Holothuria atra* is the most abundant species in the MPA and *H. albiventer* in the fishing grounds. Guiuan, Eastern Samar has 16 species and *H. atra* is also the most abundant in the MPA. *Holothuria atra* is low-value species while *H. albiventer* is not among the 43 listed commercially important species traded globally (Conand 2004; Bruckner 2006). Interestingly, *H. atra* is not consumed locally while residents of Palompon and nearby municipalities consume *H. albiventer* as "pickled" or salad. The market demand is however limited and, so the price is also very low at Php20.00 per half liter can of chopped *H. albiventer*.

Maasin City with 21 species has the lowest estimate of population density at 5.9 ind/ha and estimates of population densities per species ranged from 0.03 – 0.84 ind/ha. Bagonbanua has the highest species density estimates at 0.3 – 46.5 ind/ha, while that of Tabuk ranged from 0.06 – 13.33 ind/ha. The fished areas in Guiuan have a population density per species ranging from 0.22 – 8.26 ind/ha while that of Palompon fished areas ranged from 0.24 – 121.29 ind/ha. Except for *H. albiventer,* the population densities in all the sites fall very much below the estimated minimum species population density of 100 ind/ha (Purcell et al. 2009) for a viable species population. Sea cucumbers are broadcast spawners and thus are density-dependent for reproductive success. Low densities are also observed in other countries like Eritrea, Fiji, Papua New Guinea, Western

Australia, Saudi Arabia (Shiell 2004; Kinch et al. 2008b; Kalaeb et al. 2008; Hasan 2009; Friedman et al. 2010) particularly for high and medium value commercial species as a result of over exploitation. On the other hand, high densities even of commercially exploited species are observed in British Columbia, the United States and also in Eritrea ranging from 100 – 2,500 ind/ha (Bruckner 2004; Kalaeb et al. 2008).

Market demand and relatively high price for the product drive the gatherers to collect whatever they can find. Some fishers expand their fishing grounds and explore new species and methods of gathering. For example, *Neocucumis proteus* (Bola-bola)is a practically unknown species before the demand came from the Korean market around 2010. Gatherers from as far as Masbate (in Luzon) and Davao (in Mindanao) flocked to Guiuan to "rake" the sea bottom for "Bola-bola." They use air compressors (hookah) and an indigenously designed rake-like device to collect the "Bola-bola" buried in soft bottom. Fortunately, the municipality of Guiuan has a municipal ordinance banning the use of air compressor in fishing thus the excursions of these transient fishers were not very much successful. A local buyer then encouraged local gatherers to continue what the transient fishers did but for some reasons, this too failed. The "Bola-bola" gatherers in Catbalogan City claim that the "Bola-bola" is already scarce after only about two years of extensive gathering. Currently, "Bola-bola" is the most expensive species in Samar and Leyte at Php100.00-150.00 per piece (fresh/live) regardless of size. A gatherer would be lucky if he gets 1-2 pieces diving for 2 hours or so.

Table 3. Distribution and abundance of shallow-water sea cucumbers in Samar and Leyte (fishery-independent surveys)

Scientific Name	Number of Individual per Species (% relative abundance)				
	Guiuan		Palompon		Maasin
	Marine Sanctuary	Fishing Ground	Marine Sanctuary	Fishing Ground	Fishing Ground
Aspirochirotida					
1. *Actinopyga capillata*		2(1.5)			13 (6.9)
2. *Actinopyga echinites*		1(0.8)	8(1.5)		5(2.6)
3. *Actinopyga lecanora*	42(13.9)	13(9.8)			
4. *Bohadschia argus*		1(0.8)			
5. *Bohadschia bivittata*			4(0.7)		2(1.1)
6. *Bohadschia marmorata*	32(10.6)	11(8.3)	42(7.8)	25(2.1)	20(10.5)

7. *Bohadschia sp.*				2(0.2)	
8. *Bohadschia vitiensis*		11(8.3)	8(1.5)		
9. *Holothuria albiventer*				1031(87.5)	
10. *Holothuria arenicola*				8(0.7)	13(6.8)
11. *Holothuria atra*	149(49.3)	2(1.5)	448(83)		
12. *Holothuria coluber*		3(2.3)			
13. *Holothuria fuscocinerea*	37(12.3)	16(12.0)		78(6.6)	5(2.6)
14. *Holothuria fuscogilva*					1(0.5)
15. *Holothuria hilla*		16(12.0)	2(0.4)		
16. *Holothuria immobilis*		2(1.5)			
17. *Holothuria impatiens*	1 (0.3)	38(28.6)	12(2.2)	14(1.2)	2(1.1)
18. *Holothuria inhabilis*					8(4.2)
19. *Holothuria leucospilota*		7(5.3)	2(0.4)	7(0.6)	14(7.4)
20. *Holothuria notabilis*					11(5.8)
21. *Holothuria pervicax*					5(2.6)
22. *Holothuria rigida*					16(8.4)
23. *Holothuria scabra*	1 (0.3)	1(0.8)	11(2.0)	7(0.6)	27(14.2)
24. *Holothuria sp.13*					20 (10.6)
25. *Pearsonothuria graeffei*					16(8.4)
26. *Stichopus horrens*	40(13.3)	2(1.5)	3(0.6)	3(0.3)	7(3.7)
27. *Stichopus noctivagus*		7(5.3)			
28. *Stichopus ocellatus*				3(0.3)	
29. *Stichopus quadrifasciata*					1(0.5)
30. *Stichopus rubermaculosus*					2(1.1)
31. *Stichopus aff. rubermaculosus*					1(0.5)
32. *Stichopus variegatus*					1(0.5)
TOTAL	302 (100)	133 (100)	540 (100)	1178 (100)	190 (100)
Area Surveyed (hectares)	3.2	4.6	33.6	8.5	32
Total Manhours	3	31.4	6	5	33
Density (number of individuals/ hectare)	94.4	29.2	16.1	138.5	5.9
CPUE(# of individual per gatherer per hour)	50.3	4.2	90	235.6	5.8

The same is true for other commercially exploited species in Samar and Leyte. Computed CPUE from the timed fishing surveys is also low. In Bagonbanua and Tabuk, the CPUE is50 ind/hr and 90 ind/hr respectively. The CPUE in fished areas in Guiuan and Maasin is4.2 ind/hr and 5.8 ind/hr respectively. The high CPUE in Palompon (235.6 ind/hr) is not a cause for joy economically speaking because *H. albiventer,* a species of no or very little commercial value, compose 87.5% of the catch. In fact, local trepang traders/buyers do not buy this species. All the other species comprising the catch in the different sites are of low value based on the commercial value category by Bruckner (2006). It is only in Maasin where *H. scabra* comprised 14% of the total catch. Sadly, the CPUE figures are not promising to fishers depending on the sea cucumber resources for livelihood.

This grim picture of over exploitation of the sea cucumber resource is not only true to the Philippines, this is also happening in other countries particularly in developing countries. The sea cucumbers in Milne Bay in Papau New Guinea are also heavily exploited causing localized disappearance of *H. scabra* from the area (Kinch et al. 2008b). Population density of 16 commercially exploited species in the bay ranged from <0.1 - 9.8 ind/ha(Skewes et al.2002 cited in Kinch et al. 2008b). Only *H. atra, H. edulis*, and *H. chloronatus* had densities >1 ind/ha. In South Sulawesi, Indonesia large commercially important sea cucumbers as well as non-commercially important species almost disappeared from the reefs after 10 years of hookah fishing in the area (Kinch et al. 2008a). According to Tuwo (2004 cited in Choo 2008a), a decade ago a small trawl can catch 10-20 sea cucumbers per night but overfishing reduced this catch to 1-2 specimens per night, definitely not a profitable endeavor. The sea cucumber fishery in Malaysia is no different. Forbes and Ilias (1999 cited in Choo 2008a) reported that high value species such as *H. scabra* are already rare in Sabah, East Malaysia and fishing pressure on the medium and low value species is increasing.

Not only are the numbers decreasing; the sizes of the sea cucumbers gathered from Samar and Leyte are likewise declining (Table 4). Average length of the few individuals of *H. scabra,* the only high value species in the list was 14 cm very much below the Galapagos sea cucumber fishery size regulation of 20 cm for fresh animals which is being implemented in Australia, Papua New Guinea, Fiji, and Tonga (Toral-Granda 2006). Only *Pearsonothuria graeffei* a low value species passed the minimum size regulation. The sea cucumber fishery of Samar and Leyte can thus be categorized as highly diverse, low-value fishery.

Table 4. Average length and weight of some commercially important species in Samar and Leyte

Species	N	Ave. Length (cm)	Ave. Weight (g)	Value*
1. *Actinopyga echinites*	18	13.8	90.18	2
2. *Actinopyga lecanora*	15	3.41	16.6	2
3. *Bohadschia argus*	1	5.33	88.33	3
4. *Bohadschia marmorata*	64	14.03	108.41	3
5. *Bohadschia vitiensis*	5	13.61	226.67	3
6. *Holothuria arenicola*	25	13.03	21.35	3
7. *Holothuria atra*	48	15.17	69.36	3
8. *Holothuria coluber*	4	5.08	13.42	3
9. *Holothuria impatiens*	74	11.72	37.88	3
10. *Holothuria leucospilota*	33	17.95	114.74	3
11. *Holothuria scabra*	47	12.75	105.44	1
12. *Pearsonothuria graeffei*	18	20.06	214.27	3
13. *Stichopus horrens*	22	13.13	67.93	3
*1-High Value; 2-Medium Value;3- Low Value				

CONCLUSIONS

The Samar-Leyte area has undoubtedly high species diversity with almost 35% of the sea cucumber species in the Philippines. It would not in fact be wrong to say that many species are still waiting to be discovered in the area as this study did not cover many habitat types. But, what good is diversity if the survival of the species is threatened? In fact, over exploitation of sea cucumbers, considered “allogenic” engineers of the marine ecosystems can negatively impact both biological diversity and ecosystem functions (Coleman and Williams 2002).

The populations of many high value species such as *Holothuria scabra* and *H. nobilis* have collapsed (Toral-Granda 2006) in many parts of the globe primarily due to overfishing. The same could happen in Samar and Leyte. In fact, it may already be happening given the very low population densities as found in this study. Being mainly broadcast spawners, proximity of individuals and density of spawners are important factors (Purcell 2010). In the Philippines, shallow-water sea cucumbers are commercially exploited by about 930,000 gatherers or an average of 37.4 gatherers per square kilometer of reef area (Purcell et al.2011). Clearly, a lot of people are depending on a depleted resource. But even the fast growing *H. scabra* takes about two years to attain acceptable market size (Purcell and Simitoga 2008 cited in Purcell 2010). Unabated exploitation therefore, will only hasten the collapse of the sea cucumber population. Already, the result of this study show low CPUE, small sizes and low body weight. Purcell (2011) reports an "alarmingly high incidence of over exploitation and depletion of sea cucumber stocks, particularly in the Indo-Pacific." Samar and Leyte are no exception. If the current exploitation rate continues, then sea cucumber species could disappear, and the productivity of the coastal ecosystems could be adversely affected (Wolkenhauer et al. 2010).

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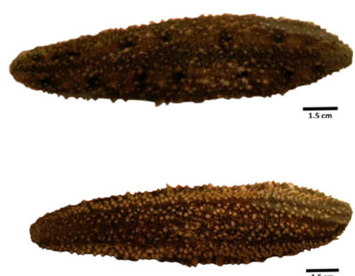
Plate 4. Unidentified Shallow-water Sea Cucumbers in Samar and Leyte

Bohadschia sp. 3

Holothuria sp. 2

Holothuria sp. 3



Holothuria sp. 7

Holothuria sp. 8

Plate 5. Unidentified Shallow-water Sea Cucumbers in Samar and Leyte

30

Dorsal

Ventral

Holothuria sp. 9

Dorsal

Ventra

Holothuria sp. 13

Dorsal

Ventral

Synapta sp.

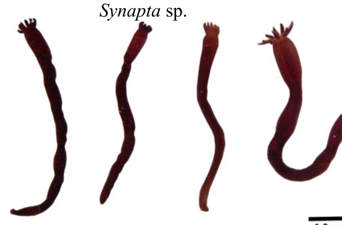


Photo: RD

Synaptula sp.

Plate 6. Identified species added to the pooled list of Shallow-water Sea Cucumbers in the Philippines

Dorsal

Ventral

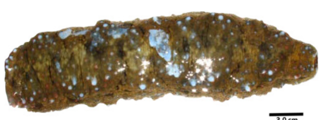
Actinopyga capillata Rowe & Massin *Dorsal*

Dorsal

Ventral

Stichopus aff.rubermaculosus
Massin, Zulfigar, Tan Shau Hwai & Rizal Boss

Dorsal



Ventral

Stichopus rubermaculosus
Massin, Zulfigar, Tan Shau Hwai & Rizal Boss

Dorsal

Ventral

Stichopus quadrifasciata Massin

Dorsal

Ventral

Stichopus ocellatus
Massin, Zulfigar, Tan Shau Hwai & Rizal Boss

Neocucumis proteus Bele

Table 4. Shallow-water Sea Cucumbers Found in the Philippines

Scientific Name	Philippines[1]	Calatagan, Batangas[2]	Bolinao-Anda[3]	Central Visayas[4]	Leyte[5]	Samar-Leyte[6]
Order Aspirochirotida						
Family Holothuriidae						
1. *Actinopyga caerulea*	X			X		
2. *Actinopyga capillata*						X
3. *Actinopyga caroniliana*				X		
4. *Actinopyga echinites*	X	X	X	X	X	X
5. *Actinopyga lecanora*	X		X	X		X
6. *Actiopyga mauritiana*	X					
7. *Actinopyga miliaris*	X	X	X	X		
8. *Actinopyga obesa*	X					
9. *Actinopyga palauensis*				X		
10. *Actinopyga serratidens*	X					
11. *Bohadschia argus*	X	X	X	X	X	X
12. *Bohadschia bivittata*	X			X		X
13. *Bohadschia graeffei*	X	X				
14. *Bohadschia koellikeri*			X	X		
15. *Bohadschia marmorata*	X	X	X	X	X	X
16. *Bohadschia aff. marmorata*				X		
17. *Bohadschia paradoxa*	X					
18. *Bohadschia similis*	X		X			X
19. *Bohadschia tenuissima*	X					
20. *Bohadschia vitiensis*	X		X	X		X
21. *Labidodemas rugosum*	X					
22. *Labidodemas semperianum*	X					
23. *Holothuria coluber*	X	X	X	X	X	X
24. *Holothuria rigida*	X	X		X	X	X
25. *Holothuria edulis*	X	X	X	X	X	X
26. *Holothuria aff. edulis*				X		
27. *Holothuria pulla*	X	X	X		X	
28. *Holothuria insignis*	X					X
29. *Holothuria pardalis*	X	X	X			
30. *Holothuria verrucosa*	X		X			X
31. *Holothuria fuscocinerea*	X	X	X	X		X
32. *Holothuria leucospilota*	X		X	X		X
33. *Holothuria pervicax*	X	X	X	X		X
34. *Holothuria aff. pervicax*				X		
35. *Holothuria albiventer*	X	X	X			X
36. *Holothuria aculeata*	X					

37. *Holothuria martensi*	X					
38. *Holothuria scabra*	X	X	X		X	X
39. *Holothuria nobilis*	X	X	X		X	X
40. *Holothuria notabilis*		X				X
41. *Holothuria difficilis*	X		X			
42. *Holothuria erinaceus*	X		X			X
43. *Holothuria moebii*	X					
44. *Holothuria flavomaculata*	X					X
45. *Holothuria saccularis*	X					
46. *Holothuria spinifera*	X					X
47. *Holothuria squamifera*	X					
48. *Holothuria arenicola*	X		X	X		X
Scientific Name	Philippines[1]	Calatagan, Batangas[2]	Bolinao-Anda[3]	Central Visayas[4]	Leyte[5]	Samar-Leyte[6]
49. *Holothuria hilla*	X	X	X	X	X	X
50. *Holothuria aff. hilla*			X	X		
51. *Holothuria impatiens*	X	X	X	X		X
52. *Holothuria gracilis*	X					
53. *Holothuria atra*		X	X	X	X	X
54. *Holothuria aff. atra*				X		
55. *Holothuria fuscogilva*			X	X		X
56. *Holothuria fuscopunctata*				X	X	X
57. *Holothuria whitmae*					X	
58. *Holothuria inhabilis*			X	X	X	X
59. *Holothuria klunzingeri*		X				
60. *Holothuria cinerascens*	X					
61. *Holothuria canaliculata*				X		
62. *Holothuria excellens*				X		
63. *Holothuria turriscelsa*				X		
64. *Pearsonothuria graeffei*			X	X	X	X
Family Stichopodidae						
Stichopus chloronotus	X	X	X	X		X
65. *Stichopus hermanni*			X	X	X	X
66. *Stichopus horrens*	X		X	X	X	X
67. *Stichopus naso*	X	X				X
68. *Stichopus rubermaculosus*						X
69. *Stichopus quadrifasciata*						X
70. *Stichopus ocellatus*						X
71. *Stichopus aff. noctivagus*				X		
72. *Stichopus noctivagus*				X		
73. *Stichopus variegatus*	X	X	X	X		X
74. *Thelenota ananas*			X		X	X
75. *Thelenota anax*			X	X	X	
76. *Thelenota rubralineata*				X	X	X
77. *Order Dendrochirotida*						

Family Psolidae						
78. *Psolus boholensis*	X					
79. *Psolus complanatus*	X					
Family Cucumariidae						
80. *Actinocucumis typicus*			X			
81. *Colochirus robustus*	*					
82. *Cucumaria miniata*	*					
83. *Haxelockia versicolor*	X					
84. *Neocucumis proteus*						X
85. *Ocnus capensis*	X					
86. *Pentacta anceps*	X					
87. *Pentacta cylindricus(Semper)*	X					
88. *Pentacta cutumis*	X					
89. *Pentacta quadrangularis*	X					
90. *Pentamera citrea(Semper)*	X					
91. *Pseudocolochirus violaceus*	X					
92. *Stolus buccalis*	X					
93. *Stolus canescens*	X					
94. *Stolus conjugens*	X					
95. *Thorsonia adversaria*	X					
96. *Thyone villosa*	X					
97. *Trachythyone imbricata*	X					
98. *Trachythyone pygmaea*	X					
Scientific Name	Philippines[1]	Calatagan, Batangas[2]	Bolinao-Anda[3]	Central Visayas[4]	Leyte[5]	Samar-Leyte[6]
Family Phyllophoridae						
99. *Cladolabes acicula*	X					
100. *Cladolabes perspicillum*	X					
101. *Cladolabes roxasi*	X					
102. *Cladolabes schmeltzi*	X		X			
103. *Neothyonidium magnum*	X					
104. *Phyllophorus cebuensis*	X					
105. *Phyllophorus brocki*	X					
Order Molpadiida						
Family Caudinidae						
106. *Acaudina molpadioides*	X					
Order Apodida						
Family Synaptidae						
107. *Anapta gracilis*	X					
108. *Euapta godeffroyi*	X			X	X	X
109. *Labidoplax dubia*	X					
110. *Opheodesoma clarki*	X					
111. *Opheodesoma glabra*	X	X	X			X
112. *Opheodesoma grisea*	X	X	X	X	X	X
113. *Opheodesoma sp.1 aff. grisea*				X		

114. *Opheodesoma sp.2 aff. grisea*				X		
115. *Opheodesoma spectabilis*	X					
116. *Pendekaplectana nigra*	X	X	X			
117. *Plolyplectana kefersteini*	X		X			
118. *Ployplectana zamboangae*	X					
119. *Protankyra pseudodigitata*	X					
120. *Protankyra similis*	X					
121. *Protankyra verrilli*	X					
122. *Rynkatorpa bisperforata*	X					
123. *Synapta maculata*						
124. *Synatula indivisa*	X					
125. *Synaptula media*			X			
126. *Synaptula maculata*						
127. *Synaptula madreporica*	X					
128. *Synaptula recta*	X					
129. *Synaptula reticulata*	X					
130. *Synapta tualensis*	X					
Family Chiridotidae						
131. *Chiridola rigida(Semper)*	X					
132. *Polycheira rufescens(Brandt)*	X					
TOTAL	97	27	43	46	23	46

Table 5. General Diversity Index(H) of Different Sites Surveyed (Fishery-independent)

SPECIES	Importance Value (# individual/ha) ni	ni/N	log ni/N	(ni/N log ni/N)
GUIUAN				
1. *Actinopyga capillata*	0.26	0.005	-2.301	0.012
2. *Actinopyga echinites*	0.13	0.002	-2.699	0.005
3. *Actinopyga lecanora*	7.05	0.126	-0.9	0.113
4. *Bohadschia argus*	0.13	0.002	-2.699	0.005
5. *Bohadschia marmorata*	5.51	0.099	-1.004	0.099
6. *Bohadschia vitiensis*	1.41	0.025	-1.602	0.040
7. *Holothuria atra*	19.36	0.347	-0.46	0.160
8. *Holothuria coluber*	0.38	0.007	-2.155	0.015
9. *Holothuria fuscocinerea*	6.79	0.122	-0.914	0.112
10. *Holothuria hilla*	2.05	0.037	-1.432	0.053
11. *Holothuria immobilis*	0.26	0.005	-2.301	0.012
12. *Holothuria impatiens*	5	0.090	-1.046	0.094
13. *Holothuria leucospilota*	0.9	0.016	-1.796	0.029
14. *Holothuria scabra*	0.26	0.005	-2.301	0.012
15. *Stichopus horrens*	5.38	0.096	-1.018	0.098

16. *Stichopus noctivagus*	0.9	0.016	-1.796	0.029
TOTAL	**55.77**	**1.000**	**-26.424**	**H= 0.887**
PALOMPON				
1. *Actinopyga echinites*	0.19	0.005	-2.301	0.012
2. *Bohadschia bivittata*	0.1	0.002	-2.699	0.005
3. *Bohadschia marmorata*	1.59	0.039	-1.409	0.055
4. *Bohadschia* sp	0.05	0.001	-3.000	0.003
5. *Bohadschia vitiensis*	0.19	0.005	-2.301	0.012
6. *Holothuria albiventer*	24.09	0.596	-0.225	0.134
7. *Holothuria arenicola*	0.19	0.005	-2.301	0.012
8. *Holothuria atra*	10.64	0.263	-0.580	0.153
9. *Holothuria fuscocinerea*	1.85	0.046	-1.337	0.062
10. *Holothuria hilla*	0.05	0.001	-3.000	0.003
11. *Holothuria impatiens*	0.62	0.015	-1.824	0.027
12. *Holothuria leucospilota*	0.21	0.005	-2.301	0.012
13. *Holothuria scabra*	0.43	0.011	-1.959	0.022
14. *Stichopus horrens*	0.14	0.003	-2.523	0.008
15. *Stichopus ocellatus*	0.07	0.002	-2.699	0.005
TOTAL	**40.41**	**1.000**	**-30.459**	**H= 0.525**
MAASIN				
1. *Actinopyga capillata*	0.4	0.068	-1.167	0.079
2. *Actinopyga echinites*	0.16	0.027	-1.569	0.042
3. *Bohadschia marmorata*	0.62	0.105	-0.979	0.103
4. *Bohadschia bivittata*	0.06	0.010	-2.000	0.020
5. *Holothuria arenicola*	0.41	0.069	-1.161	0.080
6. *Holothuria fuscocinerea*	0.16	0.027	-1.569	0.042
7. *Holothuria fuscogilva*	0.03	0.005	-2.301	0.012
8. *Holothuria impatiens*	0.06	0.010	-2.000	0.020
9. *Holothuria inhabilis*	0.25	0.042	-1.377	0.058
10. *Holothuria leucospilota*	0.44	0.074	-1.131	0.084
11. *Holothuria notabilis*	0.34	0.057	-1.244	0.071
12. *Holothuria pervicax*	0.16	0.027	-1.328	0.036
13. *Holothuria rigida*	0.5	0.084	-1.076	0.091
14. *Holothuria scabra*	0.84	0.142	-0.846	0.120
15. *Holothuria* sp 13	0.62	0.105	-0.979	0.103
16. *Pearsonothuria graeffei*	0.5	0.084	-1.076	0.091
17. *Stichopus horrens*	0.22	0.037	-1.432	0.053
18. *Stichopus quadrifasciata*	0.03	0.005	-2.301	0.012
19. *Stichopus rubermaculosus*	0.06	0.010	-2.000	0.020
20. *Stichopus aff. rubermaculosus*	0.03	0.005	-2.301	0.012
21*Stichopus variegatus*	0.03	0.005	-2.301	0.012
TOTAL	**5.92**	**1.000**	**-32.138**	**H= 1.161**