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CHECKLIST

The seaweed flora of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Western Philippines

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Background and aims – Studies on the diversity of the seaweed flora of the Philippines have waned in the past decades, and detailed data on the distribution of these economically important resources is missing. We attempt to bridge this gap by providing information on the diversity, distribution, and some aspects of the ecology of the seaweed flora of a marine biodiversity corridor in the western Philippines, the Balabac Marine Biodiversity Conservation Corridor (BMBCC).
Methods – In seventeen stations of the BMBCC, seaweed floras were assessed. All seaweeds encountered were identified *in situ*, down to species level, when possible. All unidentified specimens were collected and identified in the laboratory. Cluster analysis based on Jaccard index was used to infer similarities among the seaweed floristic components of each station. A comprehensive checklist was made using data from this study and other available literature.
Key results – There were 176 seaweed species in the area (Chlorophyceae: 70 spp., Rhodophyceae: 75 spp., and Phaeophyceae: 31 spp.). Cluster analysis showed a separation between the seaweed flora of areas within the Sulu Sea and those of the West Philippine Sea. Similarities among the floristic components of these areas may be attributed to the resemblances in the prevailing ecological conditions (i.e. substrate, wave exposure, and water movement, among others).
Conclusions – BMBCC harbours a relatively diverse seaweed flora, considering its small area. In addition, habitat characteristics, particularly the substrate type, appear to influence floristic compositions and similarities among the different surveyed areas. This report is the first to consolidate floristic information in a marine biodiversity conservation corridor in the country.

Key words – Balabac, checklist, diversity, floristics, macroalgae, Palawan, Philippines, seaweeds.

INTRODUCTION

Palawan and the adjacent island groups are among the most diverse in terms of both terrestrial and marine flora and fauna; much of these areas were identified as either of very high or extremely high priority for biodiversity conservation. With respect to marine conservation priorities, Honda Bay, Taytay-Dumaran Bay, Cuyo Islands, and Balabac Island are of very high priority, while El Nido to Ulugan Bay, Calamianes, and Tubbataha reefs are of extreme priority. Two marine biodiversity corridors (defined as 'areas with high flux exchange of biodiversity mediating propagules') were also identified in Palawan, namely, the Mindoro-Calavite Tablas Triangle, which traverses between Mindoro and Calamianes, and the Balabac Strait Corridor (Ong et al. 2002).

Although these priority conservation areas were identified based on the available information on the very diverse marine flora and fauna in the locality, little is known on the seaweed flora of Palawan in general. Studies were limited to mainland Palawan, especially along the vicinity of Puerto Princesa City: Sariego (Western Philippines University, unpubl. res.) reported 72 species from Pandan Island in Honda Bay; Roleda et al. (2001) reported 116 species in Honda Bay; Sariego & Montaño (Western Philippines University, unpubl. res.) reported 46 species also in Honda Bay; and Liao (1987) reported 159 species (including Cyanophyta) from Cuyo Island, a portion of which was published recently (Liao et al. 2013). Published reports on the seaweed flora of Palawan only include the latter, as well as those of Trono & Ang (1982) in Bugsuk Island and neighbouring islets, and Umezaki (1989). Indeed, studies on the diversity and distri-

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bution of the seaweed flora in Palawan, and the Philippines in general, are scanty and patchy. Diversity studies were limited in areas of Luzon (e.g. Manila Bay; Bolinao, Pangasinan; and Puerto Galera, Mindoro), Central Visayas (e.g. Negros Oriental, Cebu, Leyte, and Panay) and the Sulu archipelago (see Ganzon-Fortes 2012 for a more comprehensive review), among others. However, despite the recent advances on seaweed research and its application, we advocate that more work should be conducted on the basic aspects of the diversity and distribution of the seaweed resources of the country. We argue that the marked decrease in taxonomic or floristic studies on the seaweed flora of the Philippines in the past two decades is counterproductive because knowledge on the diversity and distribution of these resources provides a basis for the sustainable use, among others. Ong et al. (2002) also emphasized the need to continue efforts on the inventory and updating the information on the country's biodiversity.

Hence, in an effort to address the need and to fill the gap in the information on the diversity and distribution of the seaweed flora in the vast coastal areas of the Philippine archipelago, we report herein the diversity, distribution, and some aspects of the ecology of the seaweed resources of Balabac, Southern Palawan. Balabac, together with the nearby islands, constitutes the Balabac Marine Biodiversity Conservation Corridor (BMBCC). The accumulation of a database on the diversity, distribution, and ecology of the seaweed flora is indispensable for the development, management and conservation of the seaweed resources, as well as monitoring of the potential ecological changes in the BMBCC and of Palawan in general.

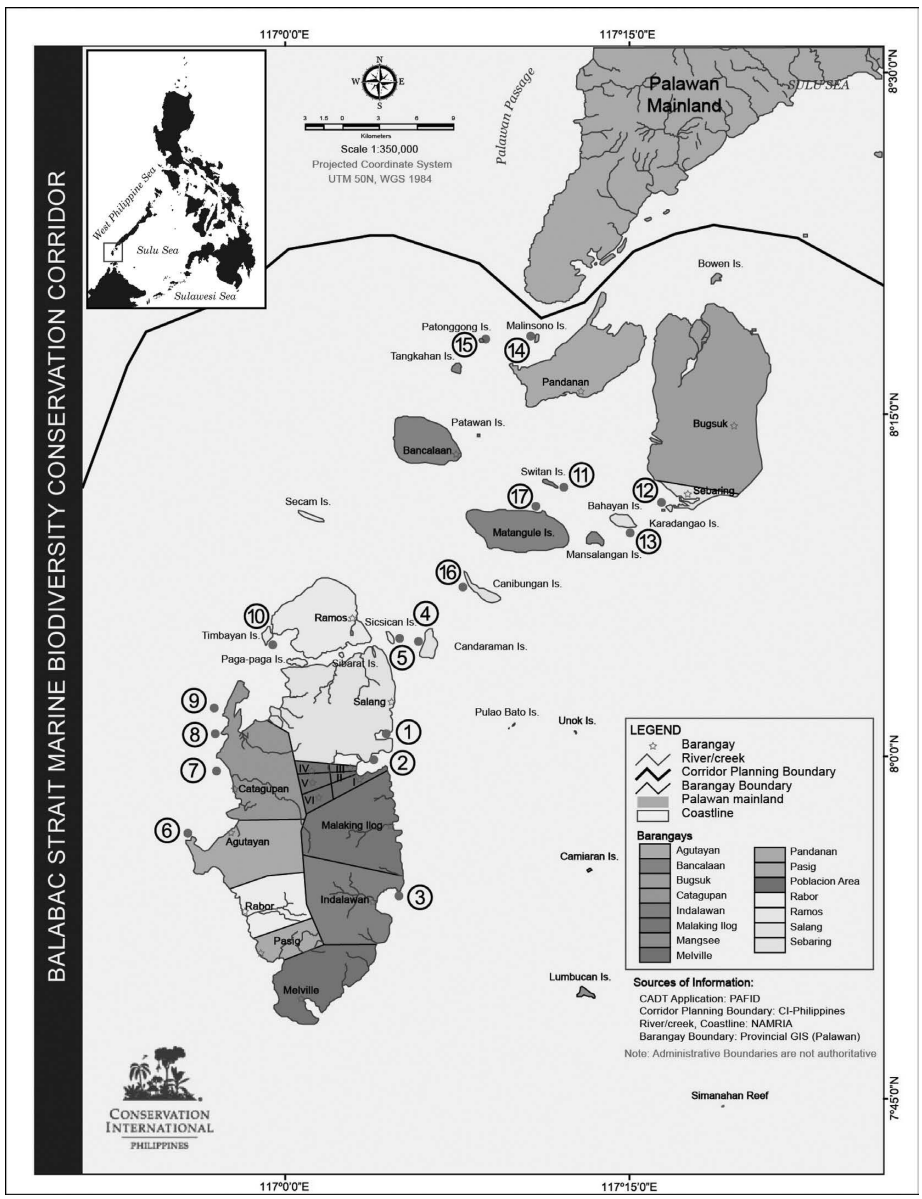

Figure 1 – The Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan showing study sites. Map redrawn from the BMBCC map provided by the Conservation International – Philippines. Sites were numbered accordingly and their respective descriptions were outlined in table 1.

Table 1 – Sampling sites in the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines. Sites were briefly described based on some physical characteristics (e.g. substrate and wave exposure) and distinct ecological features. The numbering corresponds to fig. 1.

Site No.	Locality	Description
Mainland stations		
1	Cabuang Bay	Shoreward portion characterized by extensive growth of secondary mangrove forest; a wave-exposed reef flat characterized by sandy-corally to rocky substratum dominated by *Sargassum*
2	Calandorang Bay	Located within Tambon cove and protected from influence of strong waves and currents; sandy substratum with dense seagrass meadow.
3	Indalawan Bay	Reef flat located on the eastern portion of the bay, completely exposed during low tide; seaward portion a developed coral community while landward portion inhabited by few mangrove stands; reef extending to about 300 m from the shoreline and with sandy to sandy rocky substratum
4	Candaraman Island	In a narrow fringing reef with fine to coarse white sandy substratum, on the northwest side of the island
5	Sicsican Island	A reef flat located in the southwestern portion of the island with substrates characterized by fine white sand, coral rubbles and very little vegetation; also wave-exposed and dominated by brown seaweed species; colonies of the sea urchin *Diadema* also inhabiting the area
6	Ligas Point	A very broad reef flat characterized by fine to coarse sandy bottom with coral heads on the seaward portions; an extensive bed of *Caulerpa* extending up to 2 km offshore; giant clams also present in the deeper and drop-off portions of the reef
7	Sigumay Point	About 3 to 6 m deep during high tide with dark fine sandy substratum; protected from waves by a long stretch of sand bar located 1 km offshore; sparse old mangrove stand along the shore
8	Lalangoyan Reef	A small offshore reef located about 500 m from the shore, protected by a sand bar, and fully exposed during extreme low tide; possibly influenced by freshwater due to its proximity to the mouth of Catagupan River; substratum coarse sand and coral rubbles
9	Punaguis Reef	A wide wave-exposed offshore reef extending southward from Punaguis Point to about 2 km from the shore, partly uncovered during low tide; substratum coarse sand and coral rubbles
10	Timbayan (Paz) Island	At least 2 m deep, with fine sandy substrate; shores with primary growth of mangroves
Island stations		
11	Switan Island	At the eastern side of a limestone islet; coarse sandy and rocky substrates that are exposed during low tide; area dominated by several phaeophytan species
12	Caradangao Island	Characterized by soft, fine sand and silt co-dominated by seagrasses and various species *of Caulerpa*; blades of seagrasses covered with epiphytes, indicative of poor water movement; sparse stand of old mangrove trees present along the shore
13	Bahayan Island	Site on the western side of the island characterized by coral rubble and rocky substratum colonized by various species of sponges and seagrasses; regenerating corals found throughout the sampling site.
14	Malinsuno Island	Site located on the northern portion of the island facing the southernmost tip of mainland Palawan; substratum fine sand to coarse corally near shore and becoming corally to rocky seaward; reef flat extending more than 1 km off shore fully exposed during low tide
15	Patonggong Island	Reef flat with coarse sand to hard coralline substratum extending 300 m seawards; coral heads present at seaward portion of the reef; extensive bed of *Thalassodendron ciliatum* in the middle portion of the reef exposed to waves and wind
16	Canibungan Island	Narrow fringing reef with substratum of coarse white sand dominated by small to medium-sized seagrass species and exposed to strong water current and wind; seaward portion presently used for seaweed farming
17	Matangule Island	Located in Sitio Marabon; hard, coarse sandy substratum dominated by fine to medium-sized seagrass species; extensive growth of *Ulva lactuca* along the shore, indicating domestic pollution

MATERIALS AND METHODS

Site selection

Desktop assessment of the area was conducted using Coast and Geodetic Survey Maps to determine the potential sampling sites. A total of seventeen sampling sites were identified in mainland Balabac and its adjacent islands (fig. 1). Ten stations were established in mainland Balabac, where five stations were sited at the eastern side and five at western side of the island. Seven stations were established on adjacent islands and islets. Timbayan (Paz), Sicsican and Candaraman islands on the south-western side of North Balabac Strait were considered as part of mainland Balabac. Those located at the north-eastern side of the North Balabac Strait, namely Switan, Caradangao, Bahayan, Malinsuno, Patonggong, Canibungan, and Matangule islands, were designated as the

island sampling stations. Brief descriptions of the study sites are outlined in table 1. These studies were conducted in 2007 to 2008 in conjunction with other component projects on the assessment and evaluation of several sites as potential areas for the farming of seaweeds.

Floristic composition

Most seaweed species were identified *in situ*. Representative specimens of the different species found in the vicinity were collected. The collected materials were placed in labelled plastic bags, washed with seawater to remove adhering sand and silt, and sorted. Six samples of each species were soaked in 70% isopropyl alcohol and mounted on herbarium sheets. Undetermined specimens were identified at the Marine Science Institute, University of the Philippines (UP-MSI), Diliman, Quezon City. Seaweed exsiccatae were deposited at the herbarium of the Western Philippines University, Sta. Monica, Puerto Princesa, Palawan. Some duplicate materials were also sent to UP-MSI and deposited at the GT Velasquez Herbarium.

To provide a more inclusive list of the flora of the BMBCC, we included data by Trono & Ang (1982), who reported on the diversity of seaweeds from Bugsuk Island and its vicinity. Bugsuk Island lies at the north-eastern portion of the BMBCC but was not included in the present study (i.e. the present seaweed biodiversity survey in the BMBCC focused on the larger mainland Balabac and adjacent islands) (fig. 1).

Seaweed species that were encountered only in a specific site were designated as 'rare' species. That is, we defined a species as 'rare' relative to the locations that were surveyed within the BMBCC in the present study. Meanwhile, we assigned species as 'common' when they were encountered in at least twelve out of the seventeen study sites.

After all seaweed species were listed, taxonomic authority, synonymy and validity were verified against data by Silva et al. (1987) and Silva et al. (1996), as well as AlgaeBase (Guiry & Guiry 2013). The taxonomic classification used in this report followed that of Silva et al. (1987).

Statistical analyses

To infer similarities between stations with respect to their seaweed flora, hierarchical unweighted pair-groups method using arithmetic averages (UPGMA) cluster analysis based on Jaccard index was run in R (using VEGAN, Oksanen et al. 2013).

RESULTS AND DISCUSSION

Diversity and distribution of the seaweed flora in the Balabac Marine Biodiversity Conservation Corridor

Based on the data from the present study and those from Trono & Ang (1982), a total of 176 seaweed taxa were recorded in the BMBCC (table 2). The total seaweed taxa of the BMBCC (including Bugsuk) represents 18% of the 966 reported seaweed taxa from the country (Ang et al. 2013). However, our checklist does not include small and epiphytic species, except some members of the *Polysiphonia*–*Neosiphonia* complex (e.g. *Neosiphonia ferulacea* (Suhr ex J.Agardh) S.M.Guimarães & M.T.Fujii (= *Polysiphonia ferulacea* Suhr ex J.Agardh) and two unidentified species of *Polysiphonia*). A more detailed study on these minute yet highly diverse constituent of the seaweed flora will significantly increase the number of this list. In addition, our checklist also included some interesting species such as *Caulerpa lentillifera* var. *compacta* Trono & Ang, which was first described in the area in 1982. Some representatives of species that were previously described by Trono (2004) but were not assigned with specific epithets were also observed: the green seaweeds *Avrainvillea* sp. (Trono 2004), *Codium* sp. (Trono 2004), *Halimeda* sp. (Trono 2004), and the red seaweed *Laurencia* sp. 2 (Trono 2004). These species were first reported from Sorsogon, Eastern Philippines. Our checklist thus extends the distribution of these species to the Sulu Sea and West Philippine Sea area.

In the present survey, a total of 147 seaweed species were observed, comprising 65 chlorophytes (44%), 28 phaeophytes (19%), and 54 rhodophytes (37%) (table 2). Mainland Balabac and its island territories had 116 species in common (52 chlorophytes, thirteen rhodophytes, and 51 phaeophytes). Thirty-one 'rare' species were observed, most of which were also found in mainland Balabac (tables 3 & 4). The most species-rich area was Indalawan Bay (59 spp.; mainland), followed by Malinsuno Is. (58 spp.; island) and Bahayan Is. (52 spp.; island). Lowest species richness was found in Caradangao Is. with only 27 species (table 2). The high diversity in Indalawan Bay and Malinsuno may be primarily attributed to the extensive rocky and corally substrate and good water movement. Conversely, low diversity in Caradangao Is. may be attributed to the loose sandy and silty substratum and low water movement. Loose substrates often limit growth by the unavailability of stable surfaces that permit settlement and can smother benthic algae during periods of disturbance, causing negative physiological consequences such as reduced photosynthetic rates. Generally, mainland Balabac was more species-rich (including a number of 'rare' species) than the island territories (table 3). The relatively higher number of taxa recorded in mainland Balabac may be related to the higher number of sampling sites and the highly diverse physical attributes/characteristics of these sampling areas. However, the attribution of 'rarity' to a species may be due to low sampling or result from differences in substrate. We note that most of the 'rare' species were found in areas that have sandy (Timbayan (Paz) Is.) or sandy to corally and rocky (Cabuang and Indalawan Bay) substrates. All common and 'rare' seaweed species found within the BMBCC during the recent study were listed in table 4.

Similarities of the seaweed flora in the BMBCC

Cluster analysis showed that areas that were geographically adjacent and/or with the same range of environmental conditions, especially substrate and wave and current exposure, had similar flora (fig. 2). Areas influenced by the Sulu Sea had seaweed floristic components that were distinct to those found in the West Philippine Sea. Considering that the BMBCC lies within the area where water masses from the Sulu Sea and West Philippine Sea exchange, the flora is expected

Table 2 – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.
Species are listed chronologically under the three major seaweed groups. Sites were abbreviated as follows: Cab = Cabuang Bay, Cal = Calandorang Bay, Ind = Indalawan Bay, Lig = Ligas Pt., Sig = Sigumay Pt., Pun = Punaguis Pt., Lal = Lalanguyan, Cand = Candaraman Is., Sic = Sicsican Is., Paz = Timbayan (Paz) Is., Bah = Bahayan Is., Mat = Matangule Is., Pat = Patonggong Is., Car = Caradangao Is., Cani = Canibungan Is., Swit = Switan Is., and Mal = Malinsuno Is. Seaweeds reported from Bugsuk Island (Trono & Ang 1982) were also included to provide a comprehensive list of species found within the BMBCC.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac												Island Territories					
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Chlorophyceae (70)																		
Acetabularia dentata Solms				x				x										
Acetabularia major G.Martens				x				x	x									
Anadyomene eseptata W.J.Gilbert	x																	
Anadyomene plicata C.Agardh	x	x	x	x				x	x	x	x		x				x	
Avrainvillea erecta (Berk.) A.Gepp & E.S.Gepp	x	x		x			x		x				x	x	x			
Avrainvillea lacerata Harv. ex J.Agardh																		x
Avrainvillea sp. (Trono 2004)										x								
Boergesenia forbesii (Harv.) Feldmann		x	x			x	x				x		x		x			
Boodlea composita (Harv.) F.Brand	x		x	x		x		x	x		x		x	x		x	x	x
Bornetella oligospora Solms			x	x						x								
Bornetella sphaerica (Zanardini) Solms					x											x		
Bryopsis sp.			x															
Caulerpa brachypus Harv.				x	x	x			x							x		x
Caulerpa cupressoides (Vahl) C.Agardh			x	x													x	x
Caulerpa cupressoides var. *lycopodium* Weber Bosse					x										x		x	
Caulerpa cupressoides var. *urvilleana* (Mont.) L.J.Hodgson, Pham Huu Tri, Lewmanomont & McDermid (= *Caulerpa urvilleana* Mont.)					x						x	x		x	x		x	x
Caulerpa lentillifera J.Agardh				x	x				x		x			x	x	x		
Caulerpa lentillifera var. *compacta* Trono & Ang																		x
Caulerpa mexicana Sond. ex Kütz.																		x
Caulerpa microphysa (Weber Bosse) Feldmann				x	x		x		x			x		x			x	

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac										Island Territories							
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Chlorophyceae (70)																		
Caulerpa peltata J.V.Lamour. (= *Caulerpa racemosa* var. *laetevirens* (Mont.) Weber Bosse)				x	x	x	x		x	x						x	x	
Caulerpa racemosa (Forssk.) J.Agardh	x	x	x	x	x		x	x			x	x	x	x	x	x	x	x
Caulerpa racemosa var. *turbinata* (J.Agardh) Eubank				x														
Caulerpa serrulata (Forssk.) J.Agardh			x	x			x			x		x		x	x	x	x	
Caulerpa sertularioides (S.G.Gmel.) M.Howe		x	x	x				x	x	x	x	x	x	x	x	x	x	x
Caulerpa sertularioides f. *farlowii* (Weber Bosse) Børgesen																		x
Caulerpa taxifolia (Vahl) C.Agardh			x	x			x		x		x				x	x	x	
Caulerpa webbiana var. *pickeringii* (Harv. & Bailey) Eubank					x								x		x			
Chaetomorpha crassa (C.Agardh) Kütz.			x									x			x			
Chlorodesmis fastigiata (C.Agardh) Ducker (= *Chlorodesmis comosa* Harv. & Bailey)	x		x	x														x
Chlorodesmis hildenbrandtii A.Gepp & E.S.Gepp	x	x	x		x			x							x	x		
Cladophora oakii Yamada	x	x			x	x	x	x										
Cladophora sp.											x			x	x		x	
Cladophora vagabunda (L.) C.Hoek (= *Cladophora inserta* Dickie)																		x
Cladophoropsis fasciculata (Kjellm.) Wille (= *Cladophoropsis sundanensis* Reinbold)												x						
Cladophoropsis vaucheriiformis (Aresch.) Papenf. (= *Cladophoropsis dichotoma* (Zanardini) Papenf.)											x		x	x	x		x	

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac												Island Territories					
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Chlorophyceae (70)																		
Codium arabicum Kütz.			x										x		x			
Codium edule P.C.Silva			x															
Codium sp. (Trono 2004)	x										x	x	x					
Dictyosphaeria cavernosa (Forssk.) Børgesen	x	x	x	x				x	x		x	x	x		x	x	x	x
Dictyosphaeria verluysii Weber Bosse			x	x		x		x	x						x		x	
Halicoryne wrightii Harv.					x													
Halimeda cylindracea Decne.					x			x	x	x	x	x			x	x	x	x
Halimeda discoidea Decne.		x			x		x			x			x					
Halimeda discoidea f. *subdigitata* W.J.Gilbert				x						x			x					
Halimeda incrassata (J.Ellis) J.V.Lamour.		x	x	x			x	x	x	x	x	x			x	x	x	
Halimeda macroloba Decne.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Halimeda macrophysa Askenasy			x		x		x		x				x		x			
Halimeda opuntia (L.) J.V.Lamour.	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Halimeda simulans M.Howe			x	x							x					x		x
Halimeda sp. (Trono 2004)									x	x			x					
Halimeda sp. 1													x			x		
Halimeda taenicola W.R.Taylor										x								
Halimeda tuna (J.Ellis & Sol.) J.V.Lamour.			x		x	x	x	x		x								
Microdictyon okamurae Setch.		x									x	x		x	x	x	x	
Neomeris annulata Dickie			x	x					x									
Neomeris vanbosseae Howe	x	x	x	x			x	x	x		x		x			x		
Tydemania expeditionis Weber Bosse										x								
Udotea argentea Zanardini							x		x				x	x		x	x	x
Udotea geppiorum Yamada	x	x		x	x	x			x	x			x	x		x	x	x
Udotea orientalis A.Gepp & E.S.Gepp	x	x	x	x	x		x		x	x						x	x	x
Udotea sp.	x																	

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac											Island Territories						
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Chlorophyceae (70)																		
Ulva clathrata (Roth) C.Agardh (= *Enteromorpha clathrata* (Roth) Grev.)															x			
Ulva flexuosa Wulfen (= *Enteromorpha tubulosa* (Kütz.) Kütz.)						x												x
Ulva intestinalis L. (= *Enteromorpha intestinalis* (L.) Nees)	x		x		x												x	
Ulva lactuca L.											x	x			x	x		
Ulva reticulata Forssk.	x											x						
Valonia aegagrophila C.Agardh	x		x			x					x	x		x		x	x	
Valonia fastigiata Harv. ex J.Agardh								x										
Valonia ventricosa J.Agardh						x		x		x	x		x		x	x		
Rhodophyceae (75)																		
Acanthophora muscoides (L.) Bory	x	x	x						x	x			x	x	x		x	
Acanthophora spicifera (Vahl) Børgesen		x			x	x		x					x					
Actinotrichia fragilis (Forssk.) Børgesen	x	x	x			x	x				x	x			x	x		
Amphiroa foliacea J.V.Lamour.			x				x			x								
Amphiroa fragilissima (L.) J.V.Lamour.	x	x	x		x	x					x		x		x	x	x	
Amphiroa sp.									x		x							
Betaphycus gelatinus (Esper) Doty ex P.C.Silva (= *Eucheuma gelatinae* (Esper) J.Agardh)											x							
Bostrychia tenella (J.V.Lamour.) J.Agardh (= *Bostrychia binderi* Harv.)											x							
Ceramium sp.																		x

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac									Island Territories								
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Rhodophyceae (75)																		
Ceratodictyon intricatum (C.Agardh) Norris (= *Gelidiopsis intricata* (C.Agardh) Vickers)										x			x			x	x	
Ceratodictyon spongiosum Zanardini				x	x		x		x	x	x		x		x		x	x
Chondria armata (Kütz.) Okamura				x					x									
Chondria sp. 1								x			x						x	
Chondria sp. 2								x										
Chondrophycus cartilagineus (Yamada) Garbary & J.T.Harper (= *Laurencia cartilaginea* Yamada)														x				
Chondrophycus tronoi (Ganz.-Fort.) K.W.Nam (= *Laurencia tronoi* Ganz.-Fort.)	x									x	x	x	x				x	
Dasya antillarum (M.Howe) A.Millar (= *Dasyopsis antillarum* M.Howe)																		x
Digenia simplex (Wulfen) C.Agardh		x																
Eucheuma arnoldii Weber Bosse																		x
Eucheuma denticulatum (Burm.f.) Collins & Herv. (= *Eucheuma muricatum* (S.G.Gmel.) Weber Bosse)				x			x		x	x			x		x		x	x
Eucheuma serra (J.Agardh) J.Agardh																		x
Galaxaura divaricata (L.) Huisman & R.A.Towns. (= *Galaxaura fasciculata* Kjellm.)	x		x						x				x					
Galaxaura oblongata (J.Ellis & Sol.) J.V.Lamour.			x							x							x	
Gelidiella acerosa (Forssk.) Feldmann & Hamel	x	x	x								x						x	
Gracilaria arcuata Zanardini										x					x	x	x	
Gracilaria coronopifolia J.Agardh	x			x			x						x	x	x		x	x
Gracilaria fastigiata J.Agardh	x		x		x	x		x					x	x				
Gracilaria gigas Harv.				x			x											
Gracilaria salicornia (C.Agardh) E.Y.Dawson			x	x		x			x			x		x				
Gracilaria sp.				x														

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac												Island Territories					
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Rhodophyceae (75)																		
Gracilaria sp. 1 (= *Gracilaria* sp. Trono & Ang 1982)																		x
Halymenia floresii (Clemente) C.Agardh										x								
Halymenia maculata J.Agardh																		x
Halymenia sp.				x														
Hydropuntia edulis (S.G.Gmel.) Gurgel & Fredericq (= *Gracilaria edulis* (S.G.Gmel.) P.C.Silva)				x	x			x	x	x								
Hydropuntia eucheumatoides (Harv.) Gurgel & Fredericq (= *Gracilaria eucheumatoides* Harv.)	x			x							x						x	x
Hypnea cornuta (Kütz.) J.Agardh																		x
Hypnea esperi Bory																		x
Hypnea musciformis (Wulfen) J.V.Lamour.									x		x							
Hypnea pannosa J.Agardh									x			x						
Hypnea sp.	x										x		x				x	
Hypnea spinella (C.Agardh) Kütz. (= *Hypnea cervicornis* J.Agardh)			x		x	x		x	x			x	x	x	x	x	x	x
Hypnea valentiae (Turner) Mont.	x			x	x	x		x			x	x	x		x	x	x	x
Jania sp.			x							x					x			
Kappaphycus alvarezii (Doty) Doty ex P.C.Silva (= *Eucheuma cottonii* Weber Bosse)							x			x			x	x	x			x
Kappaphycus cottonii (Weber Bosse) Doty ex P.C.Silva	x																	
Kappaphycus striatus (Schmitz) Doty ex P.C.Silva (=*Eucheuma striatum* Schmitz)																		x
Laurencia intricata J.V.Lamour.																		x
Laurencia flexilis Setch.			x														x	
Laurencia nidifica J.Agardh				x			x		x				x		x		x	
Laurencia obtusa (Huds.) J.V.Lamour.																		x

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac									Island Territories								
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Rhodophyceae (75)																		
Laurencia okamurae Yamada (= *Laurencia japonica* Yamada)																		x
Laurencia sp. 2 (Trono 2004)	x									x	x	x	x				x	
Laurencia sp.																		x
Leveillea jungermannioides (K.Hering & G.Martens) Harv.																		x
Liagora ceranoides J.V.Lamour.			x															
Liagora farinosa J.V.Lamour.			x															
Liagoropsis schrammii (P.L.Crouan & H.M.Crouan) Doty & I.A.Abbott	x																	
Lithothamnion sp.			x								x						x	
Mastophora rosea (C.Agardh) Setch.			x														x	
Melanamansia glomerata (C.Agardh) R.E.Norris (= *Amansia glomerata* C.Agardh)	x	x						x										
Neosiphonia ferulacea (Suhr ex J.Agardh) S.M.Guimarães & M.T.Fujii (= *Polysiphonia ferulacea* Suhr ex J.Agardh)																		x
Palisada perforata (Bory) K.W.Nam (=*Laurencia papillosa* (C.Agardh) Grev.)	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Palisada thuyoides (Kütz.) Cassano, Sentíes, Gil-Rodríguez & M.T.Fujii (= *Laurencia paniculata* (C.Agardh) J.Agardh)																		x
Peysonnelia rubra (Grev.) J.Agardh											x		x					
Peyssonelia sp.										x								
Polysiphonia sp. 1			x			x		x										
Polysiphonia sp. 2								x										
Portiera hornemannii (Lyngb.) P.C.Silva													x					
Spyridia filamentosa (Wulfen) Harv.																		x
Tolypiocladia glomerulata (C.Agardh) F.Schmitz																		x

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac											Island Territories						
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Rhodophyceae (75)																		
Tolypiocladia calodictyon (Harv. ex Kütz.) P.C.Silva								x		x	x			x		x	x	x
Tolypiocladia condensata (Weber Bosse) P.C.Silva																		x
Wrangelia bicuspidata Børgesen																		x
Wrangelia penicillata (C.Agardh) C.Agardh																		x
Phaeophyceae (31)																		
Dictyota bartayresiana J.V.Lamour. (= *Dictyota patens* J.Agardh)					x	x										x	x	
Dictyota cervicornis Kütz.			x		x			x			x					x		
Dictyota dentata J.V.Lamour.							x			x						x		
Dictyota dichotoma (Huds.) J.V.Lamour.	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x	
Dictyota friabilis Setch.											x	x						
Dictyota implexa (Desf.) J.V.Lamour. (= *Dictyota divaricata* J.V.Lamour.)			x			x		x				x	x		x			x
Dictyota mertensii (Mart.) Kütz.	x		x								x				x		x	
Dictyota sp. 1					x	x		x		x	x		x		x	x		
Dictyota sp. 2			x			x					x						x	
Hormophysa cuneiformis (J.F.Gmel.) P.C.Silva		x	x	x	x		x		x	x	x		x			x		x
Hydroclathrus clathratus (C.Agardh) M.Howe	x	x	x	x		x			x	x		x			x		x	x
Hydroclathrus tenuis C.K.Tseng & B.Ren Lu															x			
Padina australis Hauck	x	x	x	x	x	x		x			x	x	x			x	x	x
Padina japonica Yamada	x	x	x	x			x	x	x		x	x		x	x		x	
Padina minor Yamada	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	
Sargassum crassifolium J.Agardh				x					x			x	x		x	x	x	
Sargassum cristaefolium C.Agardh	x	x	x													x		x
Sargassum gracillimum Reinbold							x											
Sargassum kushimotense Yendo	x																	

Table 2 (continued) – Checklist of the marine benthic algae of the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, Philippines.

Species	Balabac Island and adjacent island territories (this study)																	Bugsuk Island
	Mainland Balabac												Island Territories					
	Cab	Cal	Ind	Lig	Cand	Sic	Sig	Pun	Lal	Paz	Bah	Mat	Pat	Car	Cani	Swit	Mal	
Phaeophyceae (31)																		
Sargassum oligocystum Mont. (= *Sargassum binderi* Sond. ex J.Agardh)	x			x		x	x	x		x			x			x		
Sargassum polycystum C.Agardh	x	x	x	x		x			x	x	x	x				x	x	x
Sargassum siliquosum J.Agardh							x									x		
Sargassum sp.				x									x					
Sargassum sp. 2																		x
Sargassum sp. 3																		x
Sirophysalis trinodis (Forssk.) Kütz. (= *Sargassum sp.* 1 (Trono & Ang 1982); *Cystoseira trinodis* (Forssk.) C.Agardh)																		x
Turbinaria conoides (J.Agardh) Kütz.	x	x			x										x	x		
Turbinaria decurrens Bory	x	x								x			x		x			
Turbinaria luzonensis W.R.Taylor			x		x													
Turbinaria ornata (Turner) J.Agardh	x		x				x		x	x			x		x			
Turbinaria sp.											x				x		x	
Total No. of Species: 176	**48**	**34**	**59**	**51**	**38**	**32**	**35**	**38**	**43**	**45**	**52**	**34**	**50**	**27**	**51**	**47**	**58**	**59**

Table 3 – Floristic composition of the marine benthic algal groups in the Balabac Marine Biodiversity Conservation Corridor (BMBCC) in this study.
Species richness (numbers of species) among the different seaweed groups with total number of 'rare' species (enclosed in parenthesis). Values exclude that of the species found in the study on Bugsuk Island and vicinity by Trono & Ang (1982).

	Mainland	Island	Total
Chlorophyceae	59 (11)	47 (2)	65 (13)
Phaeophyceae	25 (11)	25 (4)	28 (15)
Rhodophyceae	49 (2)	37 (1)	54 (3)
Total	133 (24)	109 (7)	147 (31)

to be generally uniform and the result of this study seemed peculiar. Together with differences in current patterns within these seas, the greater mainland Balabac may have acted as a physical barrier against the efficient exchange of propagules in the area, resulting to the observed clustering. Nonetheless, this biogeographic difference between the Sulu Sea and Western Philippine Sea with respect to their seaweed flora is concordant with the hypothesized marine biogeographic regions in the Philippines (Aliño & Gomez 1993).

Moreover, all island territories, except Caradangao Is., were found to have flora more similar to each other than to those found in the mainland. These island territories are primarily characterized by coarse sand to hard rocky to corally substratum. The separation of Caradangao Is. from other stations may be primarily attributed to the soft, sandy and silty substrate and relatively poor water movement in the area. Meanwhile, the mainland stations had distinct similarities. The floristic components of areas found in embayments within the Sulu Sea (Indalawan Bay, Cabuang Bay, and Calandorang Bay) were more similar to each other, whereas those found in the West Philippine Sea area were similar. The similarities of the seaweed flora of Candaraman Is., Sicsican Is., and Punaguis Pt. may also be attributed to the similarity of their substrates (i.e. fine sand and rubbles).

CONCLUSION

Our study provides a comprehensive list totalling 176 seaweed species for an area with a relatively undocumented seaweed flora. Representing 18% of the known Philippine seaweed taxa, the BMBCC has a relatively high diversity, considering its small area. Distinct separation between seaweed floristic composition of areas within the Sulu Sea and those within the West Philippine Sea may be attributed to geophysical barriers (i.e. differences in current patterns and presence of a large island), and similarities among the floristic components may be attributed to the similarities of the prevailing ecological conditions, primarily substratum types.

Our checklist is among the recent efforts to address the recommendations reiterated by Ong et al. (2002) and is the first to consolidate floristic information on the seaweed resources in a marine biodiversity conservation corridor since the said call for continued biodiversity work. This list is therefore not only useful in the scientific community (e.g. in augmenting biogeographic studies) but also provides very useful information for resource managers. Our report provides a considerable contribution which can and should be replicated in other parts of the country.

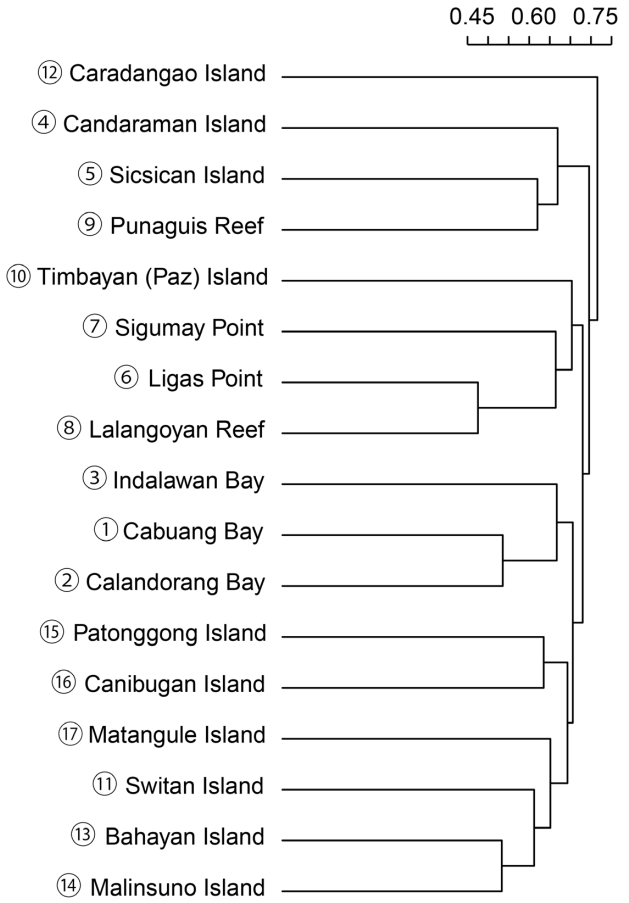

Figure 2 – Dendrogram from hierarchical UPGMA cluster analysis of all seaweed sampling stations in the Balabac Marine Biodiversity Conservation Corridor (BMBCC), Southern Palawan, based on Jaccard index. The numbering of sampling stations corresponds to the map.

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Table 4 – List of 'rare' (A) and 'common' seaweed species (B) observed in the Balabac Marine Biodiversity Conservation Corridor (excluding Bugsuk Island), Southern Palawan, Philippines.
Specific localities of species that were designated as 'rare' are listed. The total number of species per seaweed group was enclosed in parenthesis.

A. 'Rare' species (31)	
Species	**Locality**
Chlorophyceae (13)	
Anadyomene eseptata W.J.Gilbert	Cabuang Bay
Avrainvillea sp. (Trono 2004)	Timbayan (Paz) Is.
Bryopsis sp.	Indalawan Bay
Caulerpa racemosa var. *turbinata* (J.Agardh) Eubank	Ligas Pt.
Cladophoropsis fasciculata (Kjellm.) Wille	Matangule Is.
Codium edule P.C.Silva	Indalawan Bay
Halicoryne wrightii Harv.	Candaraman Bay
Halimeda taenicola W.R.Taylor	Timbayan (Paz) Is.
Tydemania expeditionis Weber Bosse	Timbayan (Paz) Is.
Udotea sp.	Cabuang Bay
Ulva clathrata (Roth) C.Agardh	Canibungan Is.
Ulva flexuosa Wulfen	Malinsuno Is.
Valonia fastigiata Harv. ex J.Agardh	Punaguis Pt.
Rhodophyceae (15)	
Betaphycus gelatinus (Esper) Doty ex P.C.Silva	Bahayan Is.
Bostrychia tenella (J.V.Lamour.) J.Agardh	Bahayan Is.
Chondria sp. 2	
Chondrophycus cartilagineus (Yamada) Garbary & J.T.Harper	Caradangao Is.
Digenia simplex (Wulfen) C.Agardh	Calandorang Bay
Gracilaria sp.	Ligas Pt.
Halymenia floresii (Clemente) C.Agardh	Timbayan (Paz) Is.
Halymenia sp.	Ligas Pt.
Kappaphycus cottonii (Weber Bosse) Doty ex P.C.Silva	Cabuang Bay
Liagora ceranoides J.V.Lamour.	Indalawan Bay
Liagora farinosa J.V.Lamour.	Indalawan Bay
Liagoropsis schrammii (P.L.Crouan & H.M.Crouan) Doty & I.A.Abbott	Cabuang Bay
Peyssoniella sp.	Timbayan (Paz) Is.
Polysiphonia sp. 2	Punaguis Pt.
Portiera hornemannii (Lyngb.) P.C.Silva	Patonggong Is.
Phaeophyceae (3)	
Hydroclathrus tenuis C.K.Tseng & B.Ren Lu	Canibungan Is.
Sargassum gracillimum Reinbold	Sigumay Pt
Sargassum kushimotense Yendo	Cabuang Bay

B. Common species (11)	
Chlorophyceae (6)	**Phaeophyceae (4)**
Caulerpa racemosa (Forssk.) J.Agardh	*Dictyota dichotoma* (Huds.) J.V.Lamour.
Caulerpa sertularioides (S.G.Gmel.) M.Howe	*Padina minor* Yamada
Dictyosphaeria cavernosa (Forssk.) Børgesen	*Padina australis* Hauck
Halimeda macroloba Decne.	*Padina japonica* Yamada
Halimeda opuntia (L.) J.V.Lamour.	**Rhodophyceae (1)**
Halimeda incrassata (J.Ellis) J.V.Lamour.	*Palisada perforata* (Bory) K.W.Nam

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