Caribbean Journal of Science, Vol. 46, No. 2-3, 313-321, 2012

Notes on the marine algae of the International Biosphere Reserve *Seaflower*, Caribbean Colombia II: diversity of drift algae in San Andres island, Caribbean Colombia

Juan Felipe Ortiz[1] and Brigitte Gavio[1,2,*]

[1]*Departamento de Biología, Universidad Nacional de Colombia, Sede Bogotá, Ciudad Universitaria, Bogotá, Colombia*
[2]*Universidad Nacional de Colombia, Sede Caribe, San Luis Free Town #52-44, San Andres Isla, Colombia*
**Corresponding author: bgavio@unal.edu.co*

Abstract.—Drifting and wrack seaweeds were collected from four beaches off San Andres island, Caribbean Colombia, between February and November 2009 for a taxonomic survey of the floating flora in the area. We found 1 species of Cyanophyta, 28 species of Rhodophyta, 26 species of Phaeophyceae, and 26 species of Chlorophyta, for a total of 80 taxa. Of these, 24 species (30% of the species encountered) were new records, 18 for the archipelago and 6 for Colombia. These new records increase by 11.9% the number of species in the region recorded to date. The Phaeophyceae constituted the largest biomass, and most Rhodophyta species found were small epiphytes on *Padina*, *Dictyota* and *Dictyopteris*.

Keywords.—Caribbean, drift algae, new records, taxonomic composition

Introduction

Drift algae are detached macroalgae subject to drift by oceanic currents. These algae may float, moving with superficial oceanic currents, due to their morphology (i.e. buoyed by the presence of gas vesicles as in *Sargassum, Turbinaria* and*, Fucus*), or being small epiphytes on basiphytes (e.g. *Ceramium, Polysiphonia, Centroceras*). Other drift algae are simply dragged by currents along the substrata, where they may contribute to nutrient-enrichment of the substrata when the decomposing mat sinks (Zimmermann and Mongomery, 1984) and provide habitat for invertebrates in otherwise "bare" environments (Gore et al., 1981; Carlton and Geller, 1993; Holmquist, 1994, 1997; Ingólfsson, 1998; Macía, 2000; Biber et al., 2004 and Nordström and Booth, 2007). Drift algae are also used by macrofauna as "rafts" to enhance dispersal (e.g. Kingsford and Choat, 1985; Kingsford, 1992, 1995; Renaud et al., 1999; Norkko et al., 2000; Salovius et al., 2005; Lauringson and Kotta, 2006; Vandendriessche, 2006; Vandendriessche et al., 2006, 2007). When drift algae strand and accumulate on beaches they are known as beach wrack and become host to a diversity of insects and other invertebrates (Pennings et al., 2000; Jaramillo et al., 2006; and Behnke, 2009), mineralize the beach providing nutrients, and stabilize windblown sand (Behnke, 2009). This beach wrack is harvested in many countries as feed, fertilizer, and raw material for industrial use (Thakur et al., 2008). Drift algae may also be used as bioindicators of eutrophication (Lauringson and Kotta, 2006; Phillips, 2006; Lapointe and Bedford, 2007; Radberg and Kautsky, 2007; and Berezina and Golubkov, 2008) and have negative effects on benthic communities by reducing available light, limiting photosynthesis, competing for nutrients and inhibiting oxygen exchange (Valiela et al., 1997; Norkko et al., 2000; Berglund et al., 2003; and Lauringson and Kotta, 2006).

The objective of the project was to study the taxonomic composition of drift algae stranding on the beaches of San Andres Island, Caribbean Colombia.

Materials and Methods

Study site

San Andres is an oceanic island in the Southwestern Caribbean that lies between

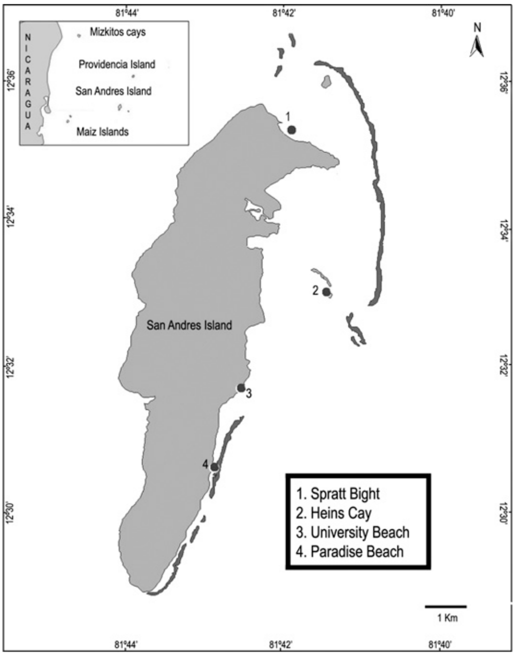


FIG. 1. Map of San Andres island, showing study sites.

12°28′58″ and 12°35′55″ N and 81°40′49″ and 81°43′23″ W (IGAC, 1986), approximately 290 Km off the coast of Nicaragua (Fig. 1). It is part of an Archipelago formed by 3 main islands (San Andres, Old Providence, and Santa Catalina) and several cays, banks, and atolls. The island is volcanic in origin. The subsidence of the volcanic base, and its simultaneous cover with calcareous deposits, biogenic in origin, during the Tertiary and Quaternary, gave rise to the present island (Diaz et al., 1995, 1996).

The island is influenced by the Caribbean current which causes temporal convergent gyres (Garay et al., 1988). Along the northeast coast of the island the currents are slow, with a maximum speed of 10m/min close to the reef. In protected areas the current velocity does not exceed 4-5 m/min, with the same wind conditions (Garay and Castro, 1993). The north-east trade winds which blow in a NE-SW direction almost permanently, generate currents and waves with considerable energy, a great part of which is absorbed by the reefs. Tropical depressions, with winds from W and NW reaching speeds of 20m/s, are common in the second half of the year (Diaz et al., 2000).

On the west side of the island, the platform is divided in three terraces, two of which are submerged and the third is elevated 2-3m above sea level (Diaz et al., 2000). In contrast, the marine platform on the eastern side is shallow, and there is a lagoon between the platform and shore (Geister, 1975). The reef on the northeastern side of the island is about 18 Km long, with a maximum width of 10 Km (Diaz et al., 1996). On the eastern side of the island, between the reef and the coast, there is a wide lagoon, where wave energy may vary considerably (Diaz et al., 2000). The sediments of the lagoon are coral gravel close to the reef and change to coralline fine sand close to the coast.

For the present study, four beaches were chosen on the northeastern side of the island, where drift algae have been observed to accumulate (Fig. 1).

University beach (UN) is a narrow beach (less than 3 m wide) where rocks are abundant. The beach is relatively exposed to waves and substantial amounts of drift algae accumulate on it and the street behind it.

Paradise Beach (PA) is a wide beach, mainly sandy, in front of which there are patches of *Thalassia* seagrass beds.

Heins Cay beach (HC) is a narrow beach on a small cay off San Andres island.

Spratt Bight beach (SB) is perhaps the widest beach of the island.

Sampling was carried out between February and November of 2009. The algae were collected in the water (drift) or stranded on the beach (wrack). The specimens in the water were collected with a net or by hand and the wrack algae were collected by hand. The algae were immediately fixed in 4% formalin: seawater solution and brought to the lab for identification. The algae were observed with a Leica stereoscope and observed with an Olympus BX51optic microscope, connected to a Moticam 2300 digital camera. Cross sections were made by hand with a razor blade. The digital photos were edited with Adobe Photoshop CS2 version 9.0.

TABLE 1. Species list. UN: University beach; PA: Paradise beach; HC: Heins Cay; SB: Spratt Bight. T: tetrasporophpytic stage; F: female gametophyte fertile. *denotes new record for the Archipelago of San Andres, Old Providence and Santa Catalina; **denotes new record for Colombia.

	UN	PA	HC	SB	Notes	Reproductive stage
CYANOPHYTA						
Oscillatoriaceae						
Lyngbya confervoides C. Agardh		x	x			
RHODOPHYTA						
Corallinaceae						T
Amphiroa fragillisima (L.) J.V. Lamouroux	x		x			
Jania adherens J.V. Lamouroux				x		
Liagoraceae						
Ganonema farinosum (J.V. Lamouroux) K.C. Fan & Yung C. Wang*		x				F
Hypneaceae						
Hypnea cervicornis J. Agardh**				x		T
Hypnea musciformis (Wulfen in Jacquin) J.V. Lamouroux		x	x			
Hypnea spinella (C. Agardh) Kützing		x				T
Gracilariaceae						
Gracilaria damaecornis J. Agardh*		x				
Gracilaria domingensis (Kützing) Sonder*				x		
Champiaceae						
Champia salicornioides Harvey*		x		x	Epiphytic on *Hypnea musciformis* and *Thalassia testudinum*	T, C
Wrangeliaceae						
Anotrichium tenue (C. Agardh) Nägeli			x		Epiphytic on *Padina pavonica*	
Ceramiaceae						
Centroceras gasparrini (Meneghini) Kützing**				x	Epiphytic on *Dictyota caribea*	
Centroceras micracanthum Kützing**			x	x	Epiphytic on *Udotea flabellum*	T
Ceramium nitens (C. Agardh) J. Agardh			x		Epiphytic on *Udotea flabellum*	
Gaylliella flaccida (Kützing) T.O. Cho & L. McIvor	x	x			Growing with *Polysiphonia* sp.	
Spyridiaceae						
Spyridia hypnoides (Bory) Papenfuss		x				T
Dasyaceae						
Dasya collinsiana M. Howe*		x				T
Rhodomelaceae						
Chondria cnicophylla (Melvill) De Toni**			x		Epiphytic on *Udotea flabellum*	T
Chondria dasyphylla (Woodward) C. Agardh*			x			
Chondria leptacremon (Melvill) De Toni**			x			
Chondrophycus gemmifera (Harvey) Garbary & Harper*				x		T
Chondrophycus poiteaui (J.V. Lamouroux) Nam*			x			
Laurencia sp.			x		Sterile	
Laurencia filiformis (C. Agardh) Montagne*				x		
Laurencia intricata J.V. Lamouroux			x			
Neosiphonia sphaerocarpa (Børgesen) M.S. Kim and I.K. Lee			x			T

(Continued)

Table 1. Continued.

	UN	PA	HC	SB	Notes	Reproductive stage
Polysiphonia sp.		x				
Polysiphonia flaccidisima Hollenberg*			x		Epiphytic on Dictyota cervicornis	T
Polysiphonia howei Hollenberg in W.R. Taylor*				x		
HETEROKONTOPHYTA						
Ectocarpaceae						
Hincksia mitchelliae (Harvey) P.C. Silva		x				T
Dictyotaceae						
Dictyopteris delicatula J.V. Lamoroux	x	x	x	x	very abundant	
Dictyota bartayresiana J.V. Lamoroux	x	x				T
Dictyota caribea Hörnig & Schnetter	x	x	x	x		
Dictyota cervicornis Kützing	x	x		x		T
Dictyota ciliolate Kützing		x				
Dictyota crispata J.V. Lamoroux	x	x	x	x	Epiphytic on Syringodium. filiforme.	
Dictyota mertensii (Martius) Kützing	x					T
Dictyota menstrualis (Hoyt) Schnetter, Hörnig & Weber-Peukert	x		x			
Dictyota pinnatifida Kützing		x		x		
Dictyota pulchella Hörnig & Schnetter	x	x	x	x	Epiphytic on Padina gymnospora	
Lobophora variegata (J.V. Lamouroux) Womersley ex E.C. Oliveira				x		
Padina boergensii Allender & Kraft	x					
Padina gymnospora (Kützing) Sonder	x	x		x		T
Padina pavonica (L.) Thivy in W.R. Taylor*		x	x			T
Padina sancte-crucis Børgesen		x	x			
Spatoglossum schroederi (C. Agardh) Kützing	x	x				
Stypopodium zonale (J.V. Lamouroux) Papenfuss	x		x	x		
Sargassaceae						
Sargassum fluitans (Børgesen) Børgesen		x		x		
Sargassum hystrix var. *buxifolium***				x	With holdfast	
Sargassum natans (L.) Gaillon	x					
Sargassum polyceratum Montagne	x					
Sargassum polyceratum var. *ovatum* (Collins) W.R. Taylor		x				
Sargassum vulgare C. Agardh			x			
Turbinaria tricostata E.S. Barton	x	x	x		Highly epiphytized	T
CHLOROPHYTA						
Ulvaceae						
Ulva lactuca L.				x		
Cladophoraceae						
Chaetomorpha clavata Kützing*		x			On a piece of sock	
Chaetomorpha linum (O.F. Müller) Kützing*	x		x			
Cladophora catenata (L.) Kützing*	x		x			

(Continued)

TABLE 1. Continued.

	UN	PA	HC	SB	Notes	Reproductive stage
Cladophora laetevirens (Dillwyn) Kützing*						
Cladophora vagabunda (L.) Hoek			x			
Cladophoropsis macromeres W.R. Taylor*		x				
Cladophoropsis membranaceae (Hofman Bang ex C. Agardh) Børgesen				x		
Siphonocladaceae			x	x		
Dictyosphaeria cavernosa (Forsskål) Børgesen	x	x		x		
Dictyosphaeria ocellata (M. Howe) Olsen-Stojkovich			x			
Valoniaceae						
Ernodesmis verticillata (Kützing) Børgesen	x	x		x		
Valonia ventricosa C. Agardh	x	x	x			
Bryopsidaceae						
Bryopsis pennata J.V. Lamouroux	x	x		x		
Bryopsis plumosa (Hudson) C. Agardh		x				
Derbesia sp	x					
Codiaceae						
Codium isthmocladum Vickers		x				
Caulerpaceae						
Caulerpa cupressoides (Vahl) C. Agardh				x		
Caulerpa racemosa (Forsskål) J. Agardh		x		x		
Caulerpa sertularioides (S. Gmelin) M. Howe	x					
Udoteaceae						
Halimeda incrassata (J. Ellis) J.V. Lamouroux			x			
Halimeda monile (J. Ellis & Solander) J.V. Lamouroux			x	x		
Halimeda opuntia (L.) J.V. Lamouroux	x			x		
Halimeda simulans M. Howe				x		
Penicillus capitatus Lamarck				x		
Penicillus lamourouxii Decaisne	x		x			
Udotea flabellum (J. Ellis & Solander) M. Howe			x	x	Highly epiphytized	

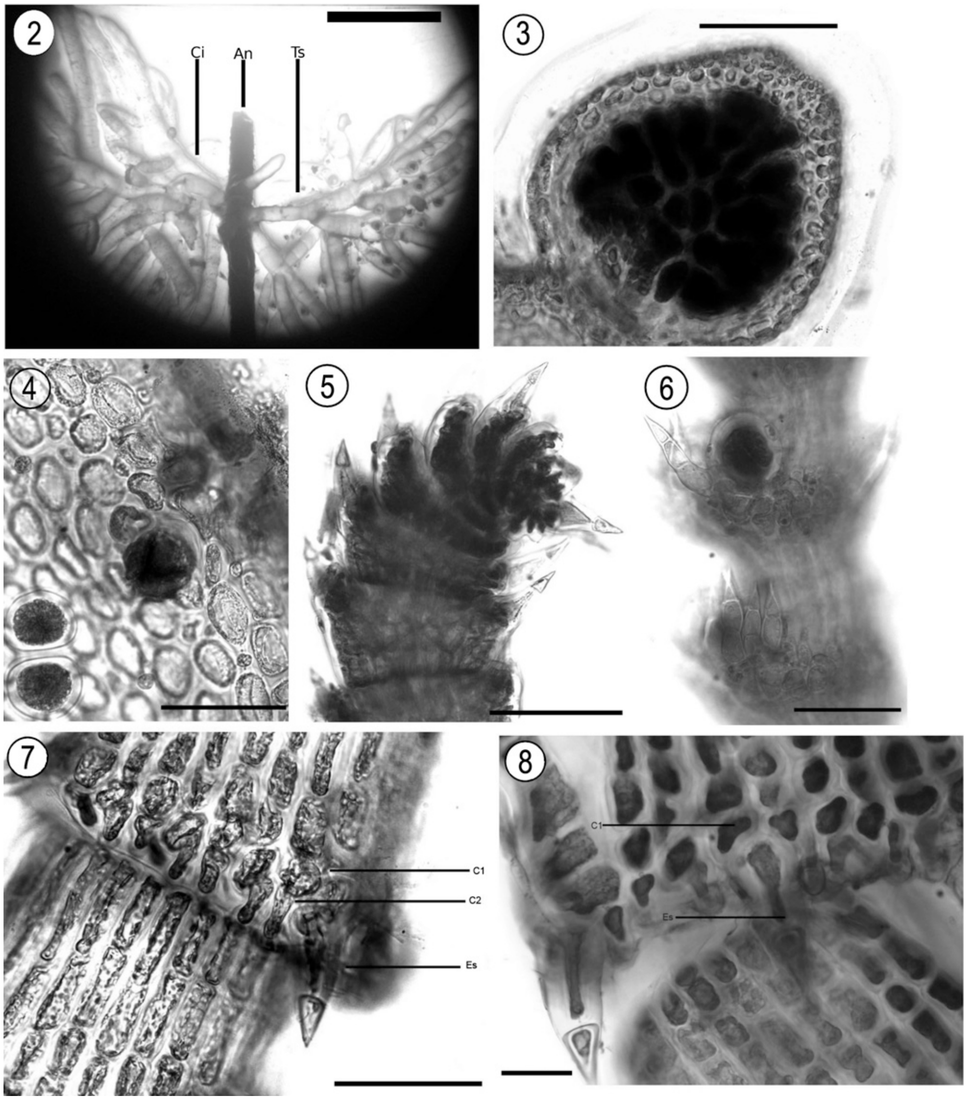
RESULTS

One species of Cyanophyta, 28 species of Rhodophyta, 25 species of Phaeophyceae, and 26 species of Chlorophyta were identified, for a total of 80 taxa (Table 1). This corresponds to 39.8% of the total number of species known for the entire Archipelago.

Six of the species are new records for Colombia (1 Pheaophyceae: *Sargassum hystrix* var. *buxifolium* Chauvin in J. Agardh; and 4 Rhodophyta: *Hypnea cervicornis* J. Agardh, *Centroceras gasparrini* (Meneghini) Kützing, *C. micracanthum* Kützing, *Chondria cnicophylla* (Melvill) De Toni and *C. leptacremon* (Melvill) De Toni). Large amounts of the seagrasses *Syringodium filiforme* Kützing in Hohenacker and *Thalassia testudinum* Banks ex König were found at all locations, and represented the majority of biomass stranded on the beaches.

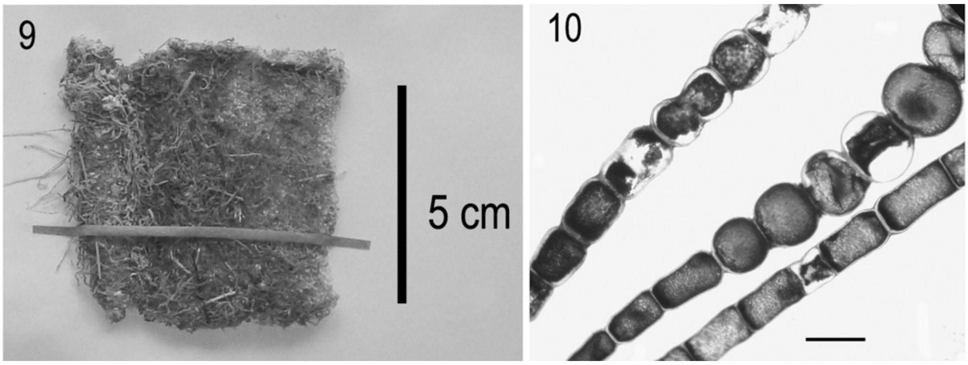
TABLE 2. Distribution of algal species distributed in major taxonomic groups among sites. UN: University beach, PA: Paradise beach, HC: Haynes Cay beach, SB: Spratt Bight beach.

	UN	PA	HC	SB
Cyanophyta	0	1	1	0
Rhodophyta	2	9	13	9
Phaeophycae	15	16	10	11
Chlorophyta	10	10	9	13
Total	**27**	**35**	**34**	**33**



FIGS. 2-8. Figs 2-4 *Champia salicornioides*. Spratt Bight. Fig. 2. Habit of two individuals epiphytic on the same fragment of *Syringodium filiforme*. Ci: Cystocarpic phase. An: *Syringodium*. Ts: Tetrasporophytic phase. Scale bar: 500 μm. Fig. 3. Cystocarp surface view. Scale bar: 200 μm. Fig. 4. Tetrasporangia surface view. Scale bar: 200 μm. Figs 5-7. *Centroceras micracanthum*. Heynes Cay. Fig. 5. Apical surface view. Scale bar: 100 μm. Fig. 6. Tetrasporangium. Scale bar: 100 μm. Fig. 7. Surface view. C1: First cortical cell, C2: Secondary elongated cortical cell, Es: Spine. Scale bar: 50 μm. Fig. 8. *Centroceras gasparrini*. Spratt Bight. Superficial view. C1: First cortical cell, Es. Spine. Scale bar: 50 μm.

Among the sites, PA, HC and SB had a similar number of species, ranging from 33 to 36 in total (Table 2). UN had a slightly lower number of species, 27 in total. Particularly, UN showed a low diversity in red algae, with only two species of Rhodophyta. Only four species, all Dictyotaceae, were found at all 4 sites: *Dictyopteris delicatula* Lamouroux, which was always very abundant, *Dictyota caribea* Hörnig & Schnetter ex Hörnig, *D. crispata* Lamouroux and *D. pulchella* Hörnig & Schnetter. Forty eight



Figs. 9-10. *Chaetomorpha clavata*, collection # DASI 021, Sound Bay 19/3/09. Fig. 9. Habit of wrack specimen on a piece of sock (herbarium specimen). Scale bar: 5 cm. Fig. 10. Habit of the alga under microscope magnification. Scale bar: 500 μm.

taxa, on the other hand, were found exclusively at one site.

The red algae were mostly small epiphytes on larger taxa, such as *Dictyota*, *Udotea*, *Padina* and *Dictyopteris* (Table 1). Many of the epiphytes, as well as the larger taxa, were fertile (tetrasporophytic). Only *Champia salicornioides* Harvey was found to be gametophytic as well as tetrasporophytic at Spratt Bight (Figs 2-4).

Among the 18 new records for the Archipelago, there were representatives of 5 Rhodophyta families, 1 Phaeophyceae family and 1 Chlorophyta family (Table 1). Among the latter, *Derbesia* was not identifiable to species due to the poor condition of the sample. Among the 6 new records for Colombia, there are representatives of three Rhodophyta families and 1 family of Phaeophyceae (Table 1).

Discussion

The number of species encountered as drift indicates that this floating ecosystem is species rich. Drift algae were found during the entire period examined, although in greater biomass between February and March and between August and November (data not shown).

Of the 80 species reported herein, 24 are new records (30% of the species encountered). However, the origin of these algae is not known although some of these new records have also been found as attached algae near the island (Gavio, personal obs.). Won et al. (2009) reported three taxa of the genus *Centroceras* in the Caribbean: *C. gasparrinii*, *C. hyalacanthum* and *C. micracanthum*. Two of the three species are present in the drift flora we examined (Figs 5-8).

As mentioned earlier, most of the new records have been found in a recent unpublished survey in the near-shore waters of the island. One exception is *Chaetomorpha clavata* Kützing, which to date we have not found around the island and in the drift, was found only once, growing on a piece of sock (Figs 9-10). Although it is probable that in future field surveys we will find the alga as a component of the island flora, it is also possible that it came from another region, transported by currents.

It is of interest that many of the red algal species collected were tetrasporophytic. Increased spore dispersal may result from the various species of algae being in the drift. Stewart (2006) demonstrated that ontogenic changes during the life cycle of *Turbinaria ornata* (Turner) J. Agardh affect its chance of detachment and thus its dispersal capacities. Vermeij et al. (2009) also showed that *Hypnea musciformis* (Wulfen) Lamouroux, an invasive alga in Hawaii, successfully disperses (asexually) along island reefs by drifting. Two of the three species of *Hypnea* we found in the drift community, were tetrasporophytic.

Further studies on drift algae should address temporal change in biomass and species composition, faunal association, growth rate of detached algae and spore release.

Acknowledgments.—We wish to thank Erica Sánchez and Maria Alejandra Díaz of the Colegio Luis Amigó, for their help during field sampling. Dr. David Ballantine greatly improved the manuscript, for which we are grateful. We acknowledge the Department of Biology, Universidad Nacional de Colombia, for their flexibility with the curricular activities of JFO. The project was funded by the Universidad Nacional of Colombia, Sede Caribe, project # 20101003140.

REFERENCES

Behnke, P. 2009. That bunch of seaweed on the beach . . . *Skimmer* 35(6):1-3.

Berezina, N. and S. Golubkov. 2008. Effect of drifting macroalgae *Cladophora glomerata* on benthic community dynamics in the easternmost Baltic Sea. *J. Marine Syst.* 74:S80-S85.

Berglund, J., J. Mattila, O. Rönnberg, J. Hekkilä, and E. Bonsdroff. 2003. Seasonal and inter-annual variation in occurrence and biomass of rooted macrophytes and drift algae in shallow bays. *Estuar. Coast. Shelf S.* 56:1167-1175.

Biber, P., M. Harwell and W. Cropper. 2004. Modeling the dynamics of three functional groups of macroalgae in tropical seagrass habitats. *Ecol. Model.* 175:25-54.

Carlton, J. T. and J. B. Geller. 1993. Ecological Roulette: The Global Transport of Nonindigenous Marine Organisms. *Sci. New Series* 261(5117):78-82.

Diaz, G. and M. Diaz. 2003. Diversity of benthic marine algae of the colombian Atlantic. *Biota Colombiana* 4(2):203-246.

Diaz, J., J. Garzón-Ferreira and S. Zea. 1995. *Los Arrecifes coralinos de la isla de San Andres, Colombia: Estado actual y perspectivas para su conservación.* Academia Colombiana de Ciencias exactas, físicas y naturales, *Colección Jorge Alvarez Lleras* No. 7.

Diaz J., G. Diaz-Pulido, J. Garzón-Ferreira, J. Geister, J. A. Sanchez, and S. Zea. 1996. Atlas de los arrecifes coralinos del Caribe Colombiano. Serie Publicaciones Especiales No. 2. Santa Marta: INVEMAR.

Diaz, J. M., L. M. Barrios, M. H. Cendales, J. Garzón-Ferreira, J. Geister, M. Lopez-Victoria, G. H. Ospina, F. Parra-Velandia, J. Pinzón, B. Vargas-Angel, F. A. Zapata and S. Zea. 2000. Areas coralinas de Colombia. Serie Publicaciones Especiales No. 5. Santa Marta: INVEMAR.

Garay J., F. Castillo, C. Andrade, J. Aguilera, L. Niño, M. De La Pava, W. López, and G. Márquez. 1988. Estudio oceanográfico del área insular y oceánica del Caribe colombiano – archipiélago de San Andres y Providencia y cayos vecinos. *Bol. Cient. CIOH* 9:3-73.

Garay J, and L. Castro. 1993. Niveles de hidrocarburos del petróleo en la isla de San Andres Caribe colombiano 1992. *Bol. Cient. CIOH* 13:85-101.

Geister Von J. 1975. Riffbau und geologische Entwicklungsgeschichte der Insel San Andres (westliches Karibisches Meer, Kolumbien). *Stuttgarter Beitr. Naturk. Ser. B. Nr.* 15.

Gore, R. H., E. E. Gallaher, L. E. Scotto and K. A. Wilson. 1981. Studies on decapod crustacea from the Indian River Region of Florida. *Estuar. Coast. Shelf S.* 12:485-508.

Holmquist, J. G. 1994. Benthic macroalgae as a dispersal mechanism for fauna: influence of a marine tumbleweed. *J. Exp. Mar. Biol. Ecol*. 180:235-251.

Holmquist, J. G. 1997. Disturbance and gap formation in a marine benthic mosaic: influence of shifting macroalgal patches on seagrass structure and mobile invertebrates. *Mar. Ecol. Prog. Ser*. 158:121-130.

IGAC. 1986. San Andres y Providencia: Aspectos geográficos. Bogotá: Instituto Geográfico Agustín Codazzi.

Ingólfsson, A. 1998. Dynamics of macrofaunal communities of floating seaweed clumps off western Iceland: a study of patches on the surface of the sea. *J. Exp. Mar. Biol. Ecol.* 231:119-137.

Jaramillo E., R. de la Huz, C. Duarte and H. Contreras. 2006. Algal wrack deposits and macroinfaunal arthropods on sandy beaches of the Chilean coast. *Rev. Chil. Hist. Nat.* 79:337-351.

Kingsford, M. J. 1992. Drift algae and small fish in coastal waters of northeastern New Zealand. *Mar. Ecol. Prog. Ser.* 80:41-55.

Kingsford, M. J. 1995. Drift algae: a contribution to near-shore habitat complexity in the pelagic environment and an attractant for fish. *Mar. Ecol. Prog. Ser*. 116:297-301.

Kingsford M. J. and J. H. Choat. 1985. The fauna associated with drift algae captured with a plankton-mesh purse seine net. *Limnol. Oceanogr*. 30(3):618-630.

Lapointe, B. and B. Bedford. 2007. Drift rhodophyte blooms emerge in Lee County, Florida, USA: Evidence of escalating coastal eutrophication. *Harmful Algae* 6:421-437.

Lauringson, V. and J. Kotta. 2006. Influence of the thin drift algal mats on the distribution of macrozoobenthos in Kõiguste Bay, NE Baltic Sea. *Hydrobiologia* 554:97-105.

Maciá, S. 2000. The effects of sea urchin grazing and drift algal blooms on a subtropical seagrass bed community. *J. Exp. Mar. Biol. Ecol.* 246:53-67.

Nordström, M., and D. Booth. 2007. Drift algae reduce foraging efficiency of juvenile flatfish. *J. Sea Res.* 58:335-341.

Norkko, J., A. Norkko, and E. Bonsdorff. 2000. Drifting algal mats as an alternative habitat for benthic invertebrates: species specific responses to a transient resource. *J. Exp. Mar. Biol. Ecol.* 248:79-104.

Pennings S. C., T. H. Carefoot, M. Zimmer, J. P. Danko and A. Ziegler. 2000. Feeding preferences of supralittoral isopods and amphipods. *Can. J. Zool.* 78:1918-1929.

Phillips, J. A. 2006. Drifting blooms of the endemic filamentous brown alga *Hincksia sordida* at Noosa on the subtropical east Australian coast. *Mar. Poll. Bull.* 52:962-968.

Ragberg, S. and L. Kautsky. 2007. A comparative biodiversity study of the associated fauna of perennial fucoids and filamentous algae. *Estuar. Coast. Shelf S.* 73:249-258.

Renaud, P. E., D. A. Syster and W. G. Ambrose Jr., 1999. Recruitment patterns of continental shelf benthos off North Carolina, USA: effects of sediment enrichment and impact on community structure. *J. Exp. Mar. Biol. Ecol.* 237:89-106.

Salovius, S., M. Nyqvist and E. Bonsdorff. 2005. Life in the fast lane: macrobenthos use temporary drifting algal habitats. *J. Sea Res.* 53:169-180.

Schnetter, R. 1978. *Marine Algen der karibischen Küsten von Kolumbien. II Chlorophyceae.* Vaduz: Bibliotheca Phycologica.

Stewart, H. L. 2006. Ontogenetic changes in buoyancy, breaking strength, extensibility, and reproductive investment in a drifting macroalga *Turbinaria ornata* (Phaeophyta). *J. Phycol.* 42:43-50.

Taylor, W. R. 1960. Marine algae of the eastern tropical and subtropical coasts of the Americas. Ann Arbor: Univ. Michigan Press.

Thakur, M. C., C. Reddy, and B. Jha. 2008. Seasonal variation in biomass and species composition of seaweeds stranded along Port Okha, northwest coast of India. *J. Earth Syst. Sci.* 117(3):211-218.

Valiela, I., J. McClelland, J. Hauxwell, P. Behr, D. Hersh, and K. Foreman. 1997. Macroalgal blooms in shallow estuaries: controls and ecophysiological and ecosystem consequences. *Limnol. Oceanogr.* 42:1105-1118.

Vandendriessche, S. 2006. Food and habitat choice in floating seaweed clumps: the obligate opportunistic nature of the associated macrofauna. *Mar. Biol.* 149:1499-1507.

Vandendriessche, S., M. Vincx, and S. Degraer. 2006. Floating seaweed in the neustonic environment: A case study from Belgian coastal waters. *J. Sea Res.* 55:103-112.

Vandendriessche, S., M. Messiaen, S. O'Flynn, M. Vincx and S. Degraer. 2007. Hiding and feeding in floating seaweed: Floating seaweed clumps as possible refuges or feeding grounds for fishes. *Estuar. Coast. Shelf S.* 71:691-703.

Vermeij, M. J. A., M. L. Dailer and C. M. Smith. 2009. Nutrient enrichment promotes survival and dispersal of drifting fragments in an invasive tropical macroalga. *Coral Reefs* 28:429-435.

Won, B. Y., T. O. Cho, and S. Fredericq. 2009. Morphological and molecular characterization of species of the genus *Centroceras* (Ceramiaceae, Ceramiales), including two new species. *J. Phycol.* 45(1):227-250.

Zimmermann, C. F. and J. R. Montgomery. 1984. Effects of a decomposing drift algal mat on sediment pore water nutrient concentrations in a Florida seagrass bed. *Mar. Ecol. Prog. Ser.* 19:299-302.