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**MARINE ALGAE FROM OCEANIC ATOLLS IN THE SOUTHWESTERN
CARIBBEAN (ALBUQUERQUE CAYS, COURTOWN CAYS, SERRANA BANK,
AND RONCADOR BANK)**

BY

GUILLERMO DIAZ-PULIDO AND GERMAN BULA-MEYER

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ABSTRACT

A total of 171 taxa of benthic marine algae are recorded from four oceanic atolls in the southwestern Caribbean Sea (Albuquerque Cays, Courtown Cays, Roncador Bank and Serrana Bank). The algae were collected in the different geomorphological zones and bottom habitats occurring in these reef-complexes, and within a depth range from intertidal to 40 m. Of the total taxa found, 6 are Cyanobacteria, 61 Chlorophyta, 22 Phaeophyta and 82 Rhodophyta. Twenty seven taxa are new records for the Colombian Caribbean. The marine flora of these atolls is closely related with that of the northern Caribbean phytogeographical region.

INTRODUCTION

Albuquerque and Courtown Cays and Serrana and Roncador Banks are four small atolls part of the Colombian Archipelago of San Andrés and Providencia in the southwestern Caribbean Sea (Fig. 1a and 1b). Several phycological surveys have been carried out in these remote reefal areas, including studies on algal distribution (Hay, 1984; Díaz-Pulido and Díaz, in press) and records of some species from this area (Littler and Littler, 1992; Bula-Meyer and Díaz-Pulido, 1995). However, to date, no intensive floristic accounts have been published from these atolls, contrasting with the numerous checklists of benthic marine algae available from other southwestern Caribbean localities [i. e., San Andrés and Providencia islands (Kapraun, 1972; Schnetter, 1976, 1978; Márquez, 1992), Belize (Norris and Bucher, 1982; Littler et al., 1995), Glovers Atoll (Tsuda and Dawes, 1974), Swan Islands (Taylor, 1975), and Miskito Bank (Phillips et al., 1982)]. The checklist presented here contains additional information about the different environments where algae were collected. This list may be useful for future biogeographical studies, and represents a further step in marine biodiversity studies of this little known Caribbean area.

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STUDY AREA AND METHODS

A full description of the study area and characteristics of the marine habitats, as well as notes on geologic origin, and climatic and oceanographic conditions can be found in Milliman (1969), Geister (1992) and Díaz et al. (1995; 1996). All four atolls exhibit in general the same basic geomorphological features and marine habitats, presenting each a windward and leeward fore-reef terrace, continuous peripheral reefs ("barrier reef"), a lagoonal terrace and discontinuous peripheral reefs on the leeward side, resulting in rather open lagoons (Fig. 1a and 1b). The algae were collected by the first author during two cruises aboard the R/V Ancón (INVEMAR, Santa Marta, Colombia) conducted in May-June 1994 to Courtown (12° 24' N, 81° 28' W) and Albuquerque (12° 10' N, 81° 51' W), and to Serrana (14° 16' N, 80° 20' W) and Roncador (13° 34' N, 80° 04' W) one year later. A total of 111 collecting sites were visited (28 at Courtown, 28 at Albuquerque, 29 at Serrana and 26 at Roncador), comprising the various geomorphological zones and marine habitats down to a depth of 40 m (Table 1). Collected material were fixed in 4 % formalin and mounted on herbarium sheets. Wet specimens were later transferred to 70 % alcohol and deposited in the algal collection of INVEMAR; dry specimens were deposited in the herbarium of the first author (DP). The taxonomic arrangements proposed by Wynne (1986) were mainly followed. Some groups were identified with specialized literature: Cyanobacteria (Humm and Wicks, 1980; Golubic and Focke, 1978; Drouet, 1981), *Udotea* (Littler and Littler, 1990), *Avrainvillea* (Littler and Littler, 1992) and *Dictyota* (Hörnig et al., 1992). Each taxa is followed by codes indicating the geomorphological zone, marine habitat and depth range where they were collected in each atoll. Taxa reported for the first time for Colombia are preceded by asterisks (*).

RESULTS AND DISCUSSION

A total of 171 algal taxa (162 species, 1 subspecies, and 8 forma) were recorded from the coral reef complexes of Albuquerque (111 taxa), Courtown (107 taxa), Roncador (88 taxa) and Serrana (98 taxa); they included 6 Cyanobacteria, 61 Chlorophyta, 22 Phaeophyta and 82 Rhodophyta (Table 2). The families with the highest species numbers were Udoteaceae (25), Corallinaceae (23), Ceramiaceae (22), and Dictyotaceae (15), whereas species-rich genera were *Dictyota* (10), *Halimeda* (8), *Caulerpa* (7), and *Avrainvillea*, *Udotea* and *Peyssonnelia* (6 species each). An analysis by functional-form groups of macroalgae (Littler et al., 1983 a, b) showed that groups with less complex morphologies, such as the Filamentous-, Coarsely Branched- and Sheet-Groups, exhibited the highest number of taxa (39, 37 and 29 respectively), comprising the 64 % of the total recorded (excluding Cyanobacteria). On the other hand, functional-form groups comprising tougher macrophytes yielded lower numbers of taxa (e.g. Thick Leathery with 19, Jointed Calcareous with 17 and Crustose with 24). However, a great number of taxa of calcareous algae (which have examples in different functional-form groups) was recorded from these reefal areas (59), supporting the argument that they represent a highly diverse group in environments exposed to great grazing pressures (Littler and Littler, 1984).

The most common species was *Dictyota cervicornis*, occurring in almost all explored habitats. Other fairly common species were *Halimeda opuntia*, *Lobophora variegata*, *D. paffii* and *Amphiroa fragilissima*, all of them widely distributed in almost every environment. Certain algae occurred almost exclusively in specific habitats. Such is the case of *Hydroclathrus clathratus*, *Acanthophora spicifera*, *Padina jamaicensis*, *Avrainvillea rawsonii*, *A. digitata*, *Enteromorpha lingulata*, *Chaetomorpha gracilis*, *Cladophora dalmatica*, which were preferentially encountered on shallow flat bottoms of the lagoonal terrace. Likewise, *Rhipocephalus phoenix*, *Halimeda incrassata*, *H. simulans*, *H. monile* and most species of *Udotea*, *Avrainvillea* and *Penicillus* are mainly dwellers of sand-plain bottoms of the lagoonal basin.

Twenty-seven taxa are new records for the Colombian Caribbean flora: *Oscillatoria lutea* C. Agardh, *O. submembranacea* Ardissonne et Strafforella, *Phormidium hendersonii* Howe, *Schizothrix mexicana* Gomont, *Calothrix crustacea* Schousboe et Thuret, *Struvea ramosa* Dickie, *Derbesia* cf. *marina* (Lyngbye) Kjellman, *D. vaucheriaeformis* (Harvey) J. Agardh, *Avrainvillea asarifolia* f. *olivaceae* Littler et Littler, *A. digitata* Littler et Littler, *A. levis* f. *translucens* Littler et Littler, *A. silvana* Littler et Littler, *Udotea cyathiformis* v. *cyathiformis* f. *infundibulum* (J. Agardh) Littler et Littler, *U. dixonii* Littler et Littler, *U. looensis* Littler et Littler, *U. luna* Littler and Littler, *Neomeris mucosa* Howe, *Sargassum histrix* J. Agardh, *Liagora norrisiae* Abbott, *Titanoderma bermudense* (Foslie et Howe) Woelkerling, Chamberlain et Silva, *T. prototypum* (Foslie) Woelkerling, Chamberlain et Silva, *Botryocladia pyriformis* (Børgesen) Kylin, *Balliella pseudocorticata* (Dawson) D. Young, *Ceramium rubrum* (Hudson) C. Agardh, *Griffithsia heteromorpha* Kützing, *Lejolisia* cf. *mediterranea* Bornet, and *Hypoglossum caloglosoides* Wynne et Kraft. Although these are widely distributed species in the Caribbean, their distribution in the atolls is restricted to a few habitats (Table 2).

Habitats in which greater number of stations were established, yielded the higher number of species [i.e. lagoonal patch reefs of *Montastraea* spp. (97 species), windward fore-reef terraces (92 species), and Leeward terraces (81 species)]. Therefore, it does not appear relevant to make comparisons of species richness between habitats differing in collecting intensity. Although similar number of stations were visited in the four atolls, a lesser number of taxa were recorded in Roncador and Serrana than in Albuquerque and Courtown. This difference may reflect a more intensive collecting effort in the latter atolls, rather than differences in species richness among them. However, in general terms it may be stated that the algal flora is quite similar in the four atolls.

The marine algal flora of the atolls studied is relatively rich in species when compared with other well studied Caribbean reef-complexes: Belize (284 taxa, Norris and Bucher, 1982; Littler et al., 1995), Swan Islands, Honduras (51 species, Taylor, 1975), Glovers Atoll, Belize (100 species, Tsuda and Dawes, 1974), Miskito Bank, Nicaragua (99 species, Phillips et al., 1982), San Andrés Island, Colombia (96 species, Kapraun, 1972; Schnetter, 1976; 1978; 1980), Providencia Island, Colombia (50 species, Márquez,

1992), Rosario Islands, Colombia (145 species, Bula-Meyer et al., 1993), Curaçao (142 species, Van den Hoek et al., 1975). Our results agree well with Taylor (1975), that the phylogeographic relationship of the archipelago of San Andrés and Providencia (including the atolls studied) to the flora of the northern Caribbean is rather clear.

The list presented here should be regarded as preliminary, since floristic accounts and collecting were more intensively conducted on hard substrata and areas with luxuriant coral reef development than in back reef flats and sand and rubble plains, which take up a significant area in all four atolls. Further collecting is needed to more comprehensively inventory the marine algal flora of southwestern Caribbean Atolls.

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Table 1. Codes employed to indicate the depth range, marine habitats and geomorphological zones of each algal taxa in Table 2.

CODE	DEPTH RANGE (m)	MARINE HABITAT	GEOMORPHOLOGICAL ZONES
A1	8-12	Gorgonaceans and frondose macroalgae on hard bottom	Windward fore-reef terrace
A2	12.1-16	"	"
A3	16.1-20.5	"	"
B	1-3.5	<i>Millepora</i> , <i>Palythoa</i> , crustose corallines, algal turfs, and <i>Gorgonia</i>	Continuous peripheral reef ("Barrier reef")
C	1-2	<i>Acropora palmata</i> -reefs	Lagoonal terrace
D	5.5	<i>A. cervicornis</i> -reefs	"
E1	0.5-2	Frondose macroalgae on coarse sand and rubble bottoms (back reef)	"
E2	2.1-4	"	"
F	0.1-0.5	Beachrock	"
G1	0.5-4	<i>Montastraea</i> spp.-reefs	Lagoonal basin
G2	4.1-8	"	"
G3	8.1-12	"	"
H	0.4-2	<i>A. palmata</i> -reefs	"
I	3.5	<i>A. cervicornis</i> -reefs	"
J1	4-8	Psammophytic algae on bioturbated sand-plains	"
J2	8.1-12	"	"
J3	12.1-16	"	"
K	0.5-2.5	Coralline algal ridges, <i>Millepora</i> , Gorgonaceans and <i>A. palmata</i> -reefs	Discontinuous peripheral reefs
L1	6-10	Mixed and scattered corals with some sand grooves	Leeward fore-reef terrace
L2	10.1-14	"	"
L3	14.1-18.5	"	"
M1	30-35	"	Outer slope
M2	35.1-40	"	"

Table 2. Benthic algae occurring in Albuquerque Cays (ALB), Courtown Cays (COU), Roncador Bank (RON), and Serrana Bank (SER). See Table 1 for explanation of codes. Species preceded by asterisks are new records for the Colombian flora. ∞

SPECIES	ALB	COU	RON	SER
CYANOBACTERIA (=CYANOPHYTA)				
Hormogonales: Oscillatoriaceae				
<i>Microcoleus lyngbyaceus</i> (Kützing) Crouan	A3,G2,L3	G1-2,L2	G2	G2
* <i>Oscillatoria lutea</i> C. Agardh	A3,B,F,G2-3,H,L3,M1	A3,B,E,G1-3,I,K,L2-3		
* <i>O. submembranacea</i> Ardissonne et Strafforella	C	G2		
* <i>Phormidium hendersonii</i> Howe	G2,H	G2		
* <i>Schizothrix mexicana</i> Gomont	A3,G2,H,L3	G2-3, L2-3		
Nostocaceae				
* <i>Calothrix crustacea</i> Schousboe et Thuret	F,H	A3,G2,I,L2-3	A3,G1-3,K,L3	A2,G2-3,L3
CHLOROPHYTA				
Ulotrichales: Ulvellaceae				
<i>Ulvella lens</i> P. et H. Crouan		L3		A2
Ulvales: Ulvaceae				
<i>Enteromorpha lingulata</i> J. Agardh		E		
Cladophorales: Anadyomenaceae				
<i>Anadyomene saldanhae</i> Joly et Oliveira Filho	A3,H,L3	A3,D,G2-3,L3	E,L1	A3,G2,H
<i>A. stellata</i> (Wulfen in Jacquin) C. Agardh		L3	A3	G1-2,L3
Cladophoraceae				
<i>Chaetomorpha gracilis</i> (Kützing) Kützing		E		
<i>Cladophora dalmatica</i> Kützing		E		
<i>C. sp.</i>	G2	A3,D,G2,	A3,G1-3,K	G3
Siphonocladaceae				
<i>Cladophoropsis membranacea</i> (C. Agardh) Børgesen	F	D,G2		A2

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
* <i>Struvea ramosa</i> Dickie			A3	
<i>Ventricaria ventricosa</i> (J. Agardh) Olsen et J. West	A3,B,G2,H,L3	B,G1-2,L3	A3,G1-3,K,L3	A3,G1-3,H
Valoniaceae				
<i>Dictyosphaeria cavernosa</i> (Forsskål) Børgesen	B,G2,H,L3	G1-2	A3,G1-2,K	G1-3,H
<i>Valonia macrophysa</i> Kützing	A3,G2,L3	A3,G1	G1-2,K,L3	A3,G3,H
<i>V. ocellata</i> Howe	F,K	G2	G1-2,K	A3,L3
<i>V. sp.</i>		A3		
Bryopsidales: Bryopsidaceae				
<i>Bryopsis pennata</i> Lamouroux	B,C	B	A3,G2	
* <i>Derbesia cf. marina</i> (Lyngbye) Kjellman	G2			
* <i>D. vaucheriaeformis</i> (Harvey) J. Agardh	G2			
<i>Ostreobium quekettii</i> Bornet et Flahault		L3		G3
Caulerpaceae				
<i>Caulerpa cupressoides</i> (West in Vahl) C. Agardh			G2,H,L3	A3,G2,L3
<i>C. mexicana</i> (Sonder ex Kützing) J. Agardh				A2
<i>C. microphysa</i> (Weber-van Bosse) Feldman	M1			A2,L3
<i>C. peltata</i> Lamouroux	G2,L3	B,D,G2,K	G1-3,H,K	G1,H
<i>C. serrulata</i> (Forsskål) J. Agardh emend. Børgesen	G2	G3	G2,L3	G1,G3
<i>C. verticillata</i> J. Agardh	A3,B,G2-3, L3	D,G2,H	A3,G1-3,K,M2	G2-3,H
<i>C. webbiana</i> Montagne		A3		
<i>Caulerpella ambigua</i> (Okamura) Prud'homme van Reine et Lokhorst		A3,B		
Codiaceae				
<i>Codium intertextum</i> Collins et Hervey	G2			
<i>C. isthmocladum</i> subsp. <i>clavatum</i> (Collins et Hervey) Silva			E	
<i>C. repens</i> P. et H. Crouan ex Vickers	G2		G1-2,L3	G2-3

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
Udoteaceae				
<i>Avrainvillea asarifolia</i> f. <i>asarifolia</i> Børgesen	J2			G3,J1
* <i>A. asarifolia</i> f. <i>olivaceae</i> Littler et Littler	G2			
* <i>A. digitata</i> Littler et Littler			E	H
* <i>A. levis</i> f. <i>translucens</i> Littler et Littler				A3,G3,J1
<i>A. longicaulis</i> f. <i>longicaulis</i> (Kützinger) Murray et Boodle	G3,J1			J1
<i>A. rawsonii</i> (Dickie) Howe			E	
* <i>A. silvana</i> Littler et Littler				J2
<i>Halimeda copiosa</i> Goreau et Graham	A3, B,G2-3,H, L3,M1	A3,G2,L3,M2	G3,M2	A2-3,G2-3, L3
<i>H. discoidea</i> Decaisne				L3
<i>H. goreauii</i> W. Taylor	A3,B,C,G2-3, H,K,L3,M1	A3,D,G2-3,H,K, L3,M2	A3,G1-3,H,K, L3,M2	A1,A3,G1- 3,H, L3
<i>H. incrassata</i> (Ellis) Lamouroux	B,C,G2-3	G3,J1		A2,E
<i>H. monile</i> (Ellis et Solander) Lamouroux		E,I		G3,J1,L3
<i>H. opuntia</i> (Linnaeus) Lamouroux	A3,B,C,F,G1-3, H,K,L3, M1	A3,B,C,D,G1- 3,H,I,K,L2-3	A3,B,G1-3,H, K,L3,M2	A1,A3,B,G1- 3, H,L3
<i>H. simulans</i> Howe			G1-2,J1,L3	J1
<i>H. tuna</i> f. <i>tuna</i> (Ellis et Solander) Lamouroux	B,G2-3,H,K,L3	G1-3	G1-3,H,L3,M2	A1-3,B,G1- 3,H, L3
<i>Penicillus capitatus</i> Lamarck	G2-3,J1-2	E,G1-2,I,J1-2	G1-2,J1-2	G3,H,J1-2
<i>P. dumetosus</i> (Lamouroux) Blainville	C,G2-3	G3	G1-3,J1-2,L3	A2,G2-3,H, J1-2,L3
<i>P. pyriformis</i> A. et E. S. Gepp	G2-3,J1-2		G1-3,J1-2,L3	G3,H,J1-2
<i>Rhipiliopsis stri</i> (Earle et Young) Farghaly et Denizot		A3		
<i>Rhipocephalus phoenix</i> f. <i>brevifolius</i> A. et E. S. Gepp	J2	D,J1		
<i>R. phoenix</i> f. <i>longifolius</i> A. et E. S. Gepp	H	A3,J1,H		

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
<i>Rhipocephalus phoenix</i> f. <i>phoenix</i> (Ellis et Solander) Kützing	A3,G2-3,J1-2	A3,G2,J1-2,L3	A3,G1-3,J1-2, L3	A2-3,G3,J1- 2,L3
<i>Udotea caribaea</i> Littler et Littler				L3
<i>U. cyathiformis</i> v. <i>cyathiformis</i> f. <i>cyathiformis</i> Decaisne	J2		J1,L3	G3,J2-3,L3
* <i>U. cyathiformis</i> v. <i>cyathiformis</i> f. <i>infundibulum</i> (J. Agardh) Littler et Littler				L3
* <i>U. dixonii</i> Littler et Littler	K			A1-2,G3,H, J3, L3
<i>U. flabellum</i> (Ellis et Solander) Howe				J1,J3
* <i>U. looensis</i> Littler et Littler	G2-3	L3,M2	G2-3,J1-3,L1, L3,M2	A1-2,G3,J3, L3
* <i>U. luna</i> Littler and Littler			J2-3	G3,J2,L3
Dasycladales: Dasycladaceae				
<i>Neomeris annulata</i> Dickie				A2,G3
* <i>N. mucosa</i> Howe	A3	A3,G1		A2,B,L3
Polyphysaceae				
<i>Polyphysa polyphysoides</i> (P. et H. Crouan in Mazé et Schramm) Schnetter	F			A2,G1,G3
PHAEOPHYTA				
Scytosiphonales: Scytosiphonaceae				
<i>Hydroclathrus clathratus</i> (C. Agardh) Howe		E	E	E
Dictyotales: Dictyotaceae				
<i>Dictyopteris delicatula</i> Lamouroux	C,F	A3,B,C, K		
<i>Dictyota alternans</i> (J. Agardh) Hörnig, Schnetter et Prud' homme van Reine	A3,B,C,G2-3, H,K,L3	A3,B,E,G1,I,L3	A3,H,L1,L3	A1,B
<i>D. caribaea</i> Hörnig et Schnetter		D,E		

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
<i>Dictyota cervicornis</i> Kützing	A3,B,C,G2-3, H,K,L3,M1	A3,C,D,E,G1-3, H,I,K,L2-3 E	A3,E,G1-3,H, K,L1,L3,M2	A1-3,B,E2, G1-3,H,L3
<i>D. guineensis</i> (Kützing) Crouan ex Mazé et Schramm				
<i>D. hamifera</i> Setchell	A3,K,L3	B,K		A1,A3,G2
<i>D. jamaicensis</i> W. Taylor	K		L3	
<i>D. mertensii</i> (Martius) Kützing	E,K	E		
<i>D. neglecta</i> Hörnig et Schnetter	M1			
<i>D. pfaffii</i> Schnetter	A3,B,C,G2-3, H,K,L3,M1	A3,B,C,D,G1- 3,H,I,K,L2-3	A3,G1-3,H,K, L1,L3,M2	A1-3,B,G1- 3,H, L3
<i>D. pulchella</i> Hörnig et Schnetter		A3,B,D		
<i>Lobophora variegata</i> (Lamouroux) Womersley [shelf form, Littler et al., 1989]	A3,G2-3, L3, M1-2	A3,B,G1-3,I,L2 -3,M2	A3,G1-3,K,L1, L3,M1-2 G2	A2-3,G2-3, H,L3 E2,G1-3,J1
<i>L. variegata</i> (Lamouroux) Womersley [ruffled form, Littler et al., 1989]				
<i>L. variegata</i> (Lamouroux) Womersley [crust form of Littler et al., 1989]	A3,B,C,G2,H,L 3	G1	A3,G1-3,H,K	B,G1,H
<i>Padina gymnospora</i> (Kützing) Sonder	G2			A2
<i>P. jamaicensis</i> (Collins) Papenfuss	C	E	E,H	
<i>Styopodium zonale</i> (Lamouroux) Papenfuss	A3,B,C,G1,H, K,L3	A3,B,C,H,I,L3	A3,G1,H,L1,L3	A2-3,B,H
Fucales: Sargassaceae				
<i>Sargassum polyceratum</i> Montagne	A3,F,G2-3,H, L3	A3,G2-3,L3	A3,G2-3,H,K, L3	G1-3,H,L3
* <i>S. hystrix</i> J. Agardh	A3,G2,H,L3,M 1	A3,L3	A3,L1,L3	A3, B,G3, L3
<i>Turbinaria tricostata</i> Barton	C	D,E,G2	G1,L1	B,G1,H
<i>T. turbinata</i> (Linnaeus) Kuntze	C,F,G2,K			B,H

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
RHODOPHYTA				
Nemaliales: Helminthocladiaceae				
<i>*Liagora norrisiae</i> Abbott				B
<i>L. sp.</i>		E1-2		
Galaxauraceae				
<i>Galaxaura lapidescens</i> (Ellis et Solander) Lamouroux	G2-3	L2-3	A1,G2-3,L3	A2,G3,L3
<i>G. obtusata</i> (Ellis et Solander) Lamouroux	L3			
Rhodogorgonales: Rhodogorgonaceae				
<i>Rhodogorgon ramosissima</i> J. Norris et Bucher	H		E1,G1	
Gelidiales: Gelidiaceae				
<i>Gelidium pusillum</i> (Stackhouse) Le Jolis	G1-3	B,G1-3	G1-3,L3	G1-3
<i>G. sp.</i>		A3,B,G2-3		
Corallinales: Corallinaceae				
Articulated				
<i>Amphiroa fragilissima</i> (Linnaeus) Lamouroux	A3,B,C,G2-3,H,K,L3	A3,B,C,D,G1-3,I,L3	A3,G1-3,H,L1,L3	A1-3,B,G1-3,H,L3
<i>A. hancockii</i> W. Taylor	A3,L3	A3,B,L3	A3,L1,M1	A1
<i>A. rigida</i> Lamouroux		B,L3		
<i>A. tribulus</i> (Ellis et Solander) Lamouroux	A3,B,C,G2-3,H,L3	A3,C,D,G1-2,I,K	A3,B,G2-3,H,L1,L3	A2,B,L3
<i>Haliptilon subulatum</i> (Ellis et Solander) Johansen		C		
<i>Jania adhaerens</i> Lamouroux	F,G2	A3,B,E,G1-2		
<i>J. sp.</i>	A3,B,G2-3,H	A3,B,E,G1-3,L2-3	A3,G2-3,K,L1,L3	A1,G3,L3
Nonarticulated				
<i>Hydrolithon boergesenii</i> (Foslie) Foslie	A3,B,C,G2-3,K,L3	A3,G2-3,L2-3	A3,G1-3,H,K,L1,L3	A2-3,B,G1-3,H,L3

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
<i>H. farinosum</i> (Lamouroux) Penrose et Chamberlain	F,G2	B,E,G2,H	K	L3
<i>Lithophyllum congestum</i> (Foslie) Foslie	K			
<i>Neogoniolithon</i> sp1		E		
<i>N.</i> sp2.	A3			
<i>Porolithon pachydermum</i> (Foslie) Foslie	B,C,G2,H,K	B,C,D,H,K	A3,B,G1-2,H,K	A1,B,G1,H
* <i>Titanoderma bermudense</i> (Foslie et Howe) Woelkerling, Chamberlain et Silva	B,C,H,K	B,H,K	B,G1,H	A1,A3,E1, H
* <i>Titanoderma prototypum</i> (Foslie) Woelkerling, Chamberlain et Silva	A3,B,C,H,K		A3,G1-3,H,K, L3	A2-3,B,G1- 2,H
Corallinaceae sp.1	L3			
Corallinaceae sp.2	A3,G2,L3	A3,L3	A3,G2-3,L1,L3, M1	A1-3,G2-3, L3
Corallinaceae sp.3	L3			
Corallinaceae sp.4		G3		
Corallinaceae sp.5	G2			
Corallinaceae sp.6	L3			
Corallinaceae sp.7	M1			
Corallinaceae sp.8			A3	
Gigartinales: Hypneaceae				
<i>Hypnea cervicornis</i> J. Agardh			K	
<i>H. musciformis</i> (Wulfen in Jacquin) Lamouroux	F			
<i>H. spinella</i> (C. Agardh) Kützing		B		A1
Solieriaceae				
<i>Meristiella echinocarpa</i> (Areschoug) Cheney et Gabrielson		A3	L3	
Peyssonneliaceae				
<i>Peyssonnelia</i> sp.1	A3,L3,M1	A3,G3,L2-3	A3,G1-3,L3,M1	A1-3,G3,L3
<i>P.</i> sp.2	A3,L3,M1	A3,B,L2,L3	A3,G3,L1-3,M1	A2,A3,G3

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
<i>Peyssonnelia</i> sp.3	G2	B,L3		G1,G3
<i>P.</i> sp.4	A3,G3,L3,M1	A3,G2,G3	A3,G2-3,L1,L3	A1,G3
<i>P.</i> sp.5	B,C,K	B	G1,G3,H	B,G1,H
<i>P.</i> sp.6	A3,B,G2,L3,M	B,K	G1-2,H,K,L1	H
	1			
Halymeniaceae				
<i>Cryptonemia crenulata</i> (J. Agardh) J. Agardh	A3,L3	A3,G3	A3,L3	
Rhodymeniales: Champiaceae				
<i>Champia vieillardii</i> Kützing	L3	B,G2,L2-3	A3,L1	G2,L3
<i>Coelothrix irregularis</i> (Harvey) Børgesen	B,G2-3	D,G2-3,L3	G1-3,H,K,L1, L3	A1,B,G2- 3,H
Rhodymeniaceae				
* <i>Botryocladia pyriformis</i> (Børgesen) Kylin	L3		A3,L1	
Ceramiales: Ceramiaceae				
<i>Acrothamnion butleriae</i> (Collins) Kylin			A3	
<i>Anotrichium tenue</i> (C. Agardh) Nägeli	G2		A3	A3
<i>Antithamnion antillanum</i> Børgesen	L3	A3,B,G3		A3
<i>A. ogdeniae</i> Abbott		A3		
<i>A. percurrans</i> Dawson		A3		
<i>Antithamnionella breviramosa</i> (Dawson) Wollaston			A3	
* <i>Balliella pseudocorticata</i> (Dawson) D. Young		M2		
<i>Centroceras clavulatum</i> (C. Agardh) Montagne	F,G2	B,G2		D
<i>Ceramium nitens</i> (C. Agardh) J. Agardh	A3	B		
* <i>C. rubrum</i> (Hudson) C. Agardh	K			
<i>C.</i> sp.	G2,L3	A3,B,E1,H,K	A3	A3
<i>Crouania attenuata</i> (C. Agardh) J. Agardh		A3,E1		E2
* <i>Griffithsia heteromorpha</i> Kützing				G3

Table 2. Continued.

SPECIES	ALB	COU	RON	SER
<i>Griffithsia schousboei</i> Montagne		G2		
<i>Gymnothamnion elegans</i> (Schousboe in C. Agardh) J. Agardh	K			
<i>Haloplegma duperreyi</i> Montagne	K,L3		L1,L3	A2,L3
* <i>Lejolisia</i> cf. <i>mediterranea</i> Bornet				A2
<i>Pleonosporium caribaeum</i> (Børgesen) R. Norris	K			
<i>Spyridia filamentosa</i> (Wulfen) Harvey in Hooker		D,E1	K	
<i>Wrangelia argus</i> (Montagne) Montagne	K,L3	B	A3,L3	
<i>W. penicillata</i> (C. Agardh) C. Agardh	A3,B,G2,L3	A3,B,G3	L3	A3
Ceramiaceae sp.	G2			
Delesseriaceae				
* <i>Hypoglossum caloglosoides</i> Wynne et Kraft	G2,L3		L3	
<i>H. simulans</i> Wynne, Price et Ballantine			A3	
<i>H. subsimplex</i> Wynne				G3
<i>H. tenuifolium</i> (Harvey) J. Agardh		M2		
<i>H. sp.</i>	A2	A3	L1,L3	
<i>Martensia pavonia</i> (J. Agardh) J. Agardh	A3,B	A3	A3	G2
<i>Nytophyllum</i> sp.		K	A3,L3	
Dasyaceae				
<i>Dasya mollis</i> Harvey			L3	
<i>Heterosiphonia crispella</i> (C. Agardh) Wynne	K,L3	A3,D,G2	E1	H
Rhodomelaceae				
<i>Acanthophora spicifera</i> (Vahl) Børgesen	F			E2
<i>Chondria platyramea</i> Joly et Ugadim				
<i>Laurencia intricata</i> Lamouroux	G2,L3,F	B,G2,L2	H,L1,L3	B
<i>L. obtusa</i> (Hudson) Lamouroux		H	G1,H	
<i>L. sp.1</i>		A3		G3
<i>L. sp.2</i>	A3			
<i>Polysiphonia</i> sp.	G2,F	B,G2,L3,D	A3,E1	A3

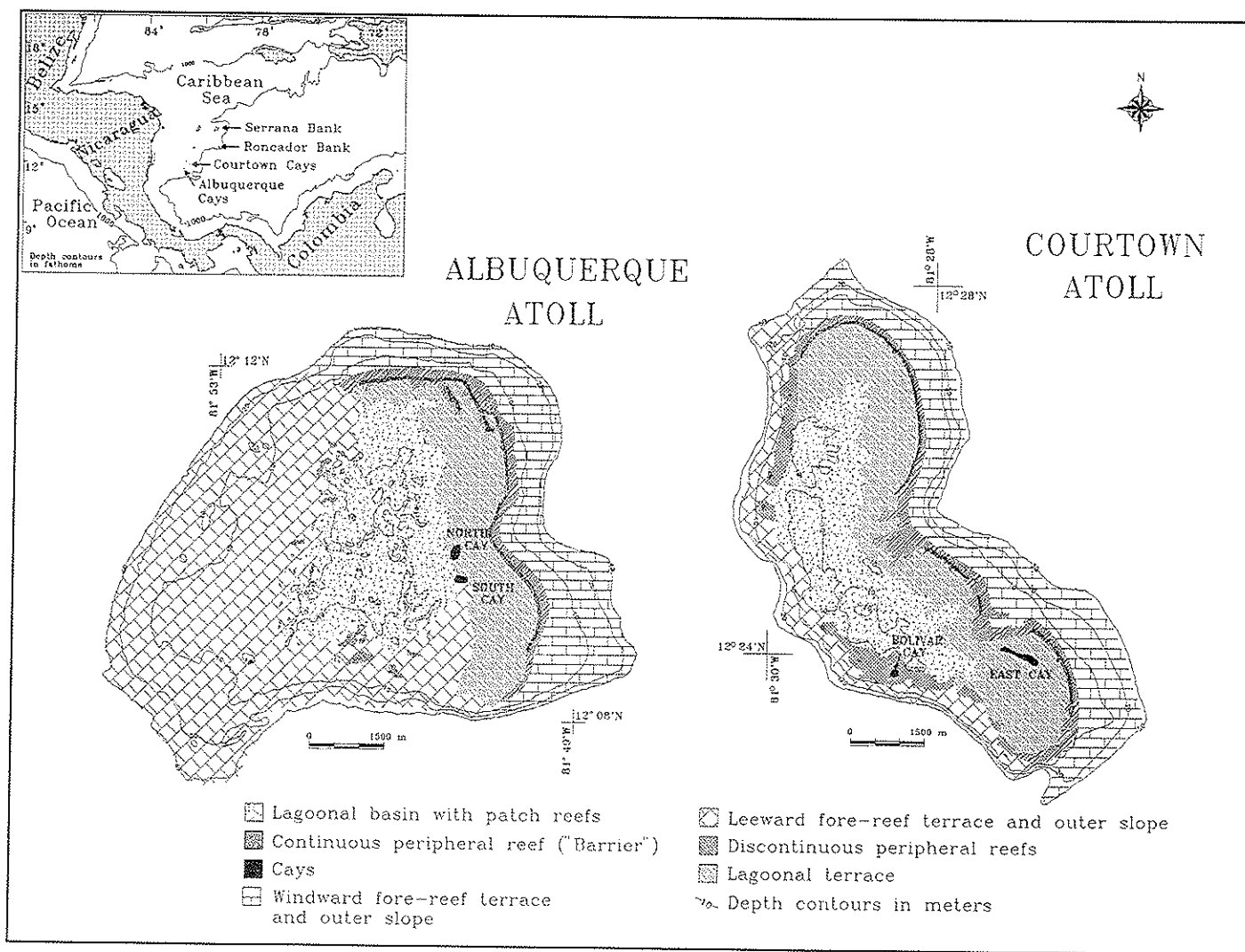


Figure 1a. Location of the study area in the Caribbean. Albuquerque and Courtown atolls showing geomorphological features.

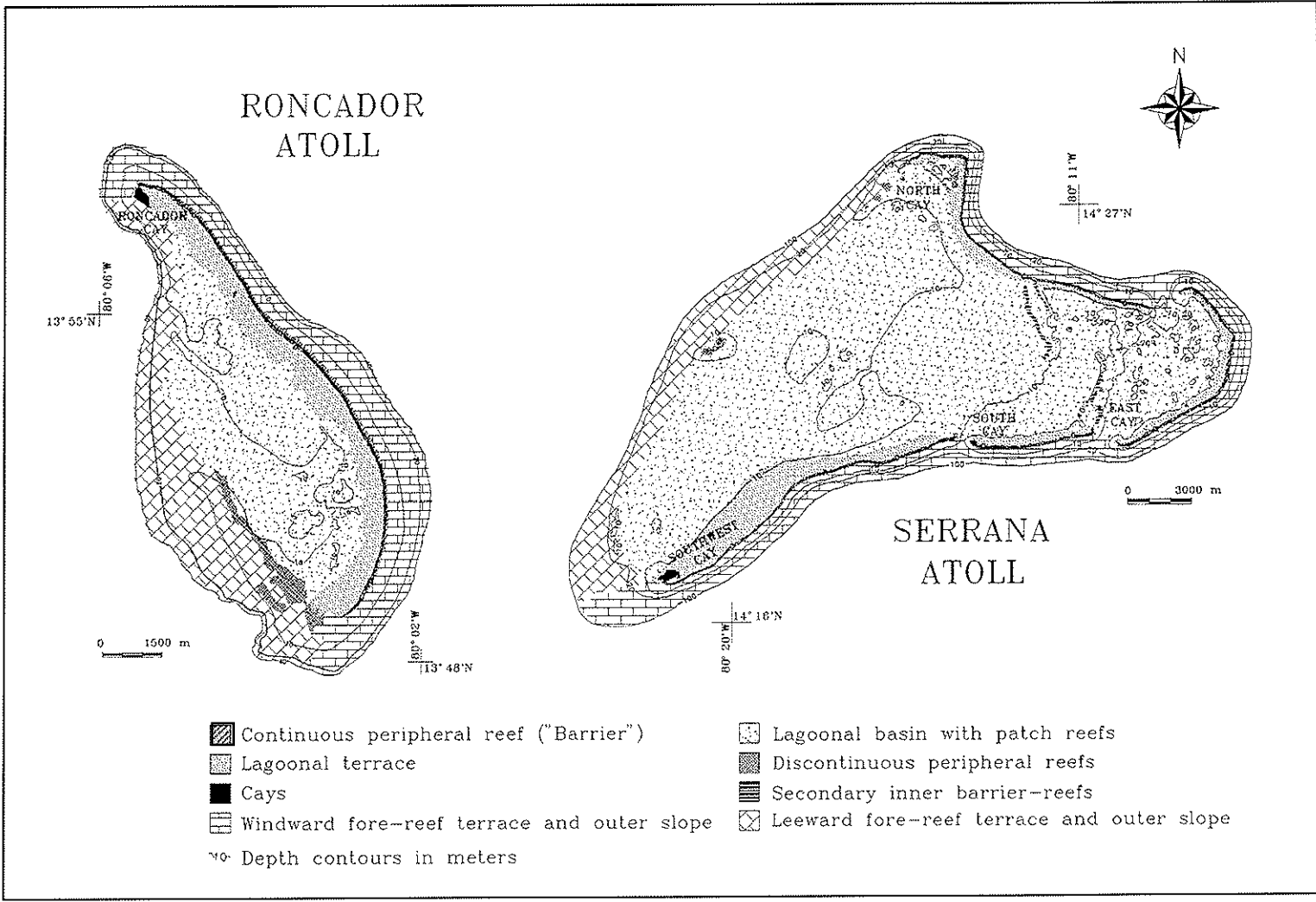


Figure 1b. Roncador and Serrana atolls showing geomorphological features.