BIOLOGÍA 6

Tecnociencia 2006, Vol. 8, N° 2.

# SEASONALITY AND SPECIES COMPOSITION IN THE BENTHIC ALGAE OF CACIQUE REEF FLAT, CARIBBEAN COAST OF PANAMA

**Carlos Seixas [1], Anaika Arcia y Fátima Navarro**

[1] Universidad de Panamá, Centro Regional Universitario de Veraguas, Facultad de Ciencias Naturales, Exactas y Tecnología
e-mail: carlosseix@yahoo.com

## ABSTRACT

A one year study (April 1998 to May 1999) was conducted on the Cacique reef flat in the Caribbean coast of Panama. Of 49 species of benthic macroalgae encountered, 17 (35%) were Chlorophyceae, 13 (26%) Phaeophyceae and 21 (43%) Rhodophyceae. Among the Chlorophyceae, Bryopsidales order comprise the largest number of species (14) and Udoteaceae was the most common family. 8 species of Phaeophyceae belonged to Dictyotales order and Dictyotaceae family and 5 species to the Fucales order, Sargassaceae family. 7 orders of Rhodophyceae were recorded, with the species belonging to Ceramiales, Rhodomelaceae family being dominant. Seasonality was evident on the Cacique reef flat. The number of benthic macrophytes species showed an increasing trend from windy season to the calm season.

## KEYWORDS

Marine algae, macrophytes, benthic algae, marine flora, macroalgae, seasonality.

## RESUMEN

Se efectuó un estudio de un año (abril de 1998 a mayo de 1999) con el propósito de evaluar los cambios estacionales en la flora de macroalgas bénticas de la plataforma de arrecifes de Cacique, provincia de Colón, República de Panamá. De las 49 especies encontradas, 17 (35%) fueron Chlorophyceae, 13 (26%) Phaeophyceae y 21 (43%) Rhodophyceae. Entre las Chlorophyceae, el orden Bryopsidales exhibió el mayor número de especies (14) mientras que Udoteaceae fue la familia más común.

8 especies de Phaeophyceae se clasificaron dentro del orden Dictyotales, familia Dictyotaceae y 5 especies en el orden Fucales, familia Sargassaceae. Se encontraron 7 órdenes de Rhodophyceae siendo la familia Rhodomelaceae del orden Ceramiales los más diversa. Se encontró evidencia de estacionalidad en la flora del arrecife. El número de especies de macrófitas bénticas se incrementó de verano a invierno.

**PALABRAS CLAVES**
Algas marinas, algas bénticas, flora marina, macroalgas, estacionalidad.

## INTRODUCTION

Seasonal variations of benthic marine macroalgae have been documented in both temperate and tropical ecosystems. Such seasonality has usually been associated to a variety of abiotic and biotic factors (River & Peckol 1995, Anderson et al., 1996, Lotze & Schramm 2000). In tropical waters were seawater temperatures are relatively stable and nutrient levels are generally low seasonality has been related with disturbance (Rogers 1997), grazing pressure (Díaz-Pulido & Díaz 1997), changes in water quality (Schaffelke et al., 2005), desiccation due to exposure to air, domestic and industrial pollution(Taouil & Yoneshigue-Valentin, 2002) and seasonal changes in the physical environment. Connor (1984) encountered highest cover of live plants and animals during windy season month in Galeta reef flat, Panama. Calm season was the period of greatest damage to live biota and this loss was correlated with total hours of exposure above sea level during daylight hours when extreme low tides coincide with calm weather. Although several studies demonstrate seasonality of the algal flora, it is not clear if predictable changes in the biota are caused by regular changes in the physical environment. The objective of this study was to examine the algal component of the reef flat in two periods of changes in the physical environment, the windy season and the calm season.

## MATERIALS AND METHODS

### Study area

The community studied is part of a fringing reef in Cacique, province of Colón in the Caribbean coast of Panamá (9º 6’ 50’’ N; 79º 36’ 54’’ W). The survey was done between April 1998 and May 1999. This coastline experiences considerable climatic seasonality, although the timing and duration of seasons can vary from year to year. The two major seasons at Cacique are the windy season, usually mid-December to April and the calm season, usually May through early December. In the windy season the reef is exposed to high wave energy as a result of strong northeast trade winds which constantly force water across the reef increasing turbulence and turbidity. The calm season is characterized by light variable winds, increasing precipitation and when calm clear weather coincides with low tides during daylight hours, algae on the reef flat are exposed to intense sunlight, desiccation and high temperatures.

### Field surveys

Fieldwork was carried at the end of the windy and calm season between April 1998 and May 1999. Collections were made primarily by wading, snorkeling and incidental dredging. Material was preserved in 3% formalin-seawater and herbarium sheets as vouchers.

## RESULTS

### Species composition

A total of 49 taxa were identified during the study (Table 1 and Fig. 1). The most diverse group was the Rhodophyceae (19 taxa), followed by Chlorophyceae (17 taxa) and then Phaeophyceae (13 taxa). The largest number of infrageneric taxa was recorded in the Rhodomelaceae family (Rhodophyceae, Ceramiales), followed Dictyotaceae (Phaeophyceae, Dictyotales) and finally Udoteaceae (Chlorophyceae, Bryopsidales) the most diverse genera being *Dictyota, Galaxaura, Halimeda, Caulerpa, Codium, Laurencia and Sargassum*.

### Seasonality

Diversity on the reef, during the calm season, was generally higher than the windy season, being Rhodophyceae the dominant taxon (Fig. 2 ). Between all benthic groups, the most predictable changes in occurrences were observed in Chlorophyceae and Rhodophyceae. Most of the Phaeophycean taxa identified in the study were present only during the calm season.

Table 1. A checklist of the benthic marine algae on the Cacique reef flat, Caribbean coast of Panama between April 1998 and May 1999.

**CHLOROPHYTA**
**CHLOROPHYCEAE**

**BRYOPSIDALES**

**CODIACEAE**

*Codium intertextum Collins & Hervey*
*Codium isthmocladum Vickers*
*Codium taylorii P. C. Silva*

**UDOTEACEAE**

*Halimeda discoidea Decne*
*Halimeda incrassata (J. Ellis) J. V. Lamour*
*Halimeda monile (J. Ellis & Sol.)J. V. Lamour*
*Halimeda opuntia (L.) J. V. Lamour*
*Halimeda tuna (J. Ellis & Sol.) J. V. Lamour*
*Penicillus capitatus Lam.*
*Udotea flavellum (J. Ellis & Sol.) J. V. Lamour*

**CAULERPACEAE**

*Caulerpa cupressoides (H. West) C. Agardh*
*Caulerpa racemosa (Forssk.) J. Agardh*
*Caulerpa sertularioides (S. G. Gmel.) M. Howe*

**BRYOPSIDACEAE**

*Derbesia lamourouxii (J. Agardh) Solier*

**CLADOPHORALES**
**SIPHONOCLADACEAE**

*Ventricaria ventricosa (J. Agardh) J. L. Olsen & J. A. West*
*(Valonia ventricosa)*
*Dictyosphaeria cavernosa (Forssk.)Børgesen*

**ANADYOMENACEAE**

*Anadyomene stellata (Wulfen) C. .Agardh*

**HETEROKONTOPHYTA**
**PHAEOPHYCEAE**

**DICTYOTALES**

**DICTYOTACEAE**

*Dictyota bartayresiana J. V. Lamour.*
*(Dictyota bartayresii)*
*Dictyotacervicornis Kütz*
*Dictyota ciliolata Sond. ex Kütz*
*Dictyota pulchella Hörnig & Schnetter*
*(Dictyota divaricada, D. indica)*
*Dictyota jamaicensis W. R. Taylor*
*Dictyopteris delicatula J. V. Lamour*
*Padina boergesenii Allender & Kraft*
*(Padina gymnospora)*
*Padina sanctae-crucis Børgesen*

**FUCALES**
**SARGASSACEAE**

*Sargasssum fluitans (Børgesen) Børgesen*
*Sargassum natans (L.) Gaillon*
*Sargassum polyceratium Mont.*
*Turbinaria tricostata E. S. Barton*
*Turbinaria turbinata (L.) Kuntze*

**RHODOPHYTA**
**RHODOPHYCEAE**
**FLORIDEOPHYCIDAE**

**CORALLINALES**

**CORALLINACEAE**

*Amphiroa fragilísima (L.) J. V. Lamour*
*Amphiroa Tríbulus (J. Ellis & Sol.) J. V. Lamour*

**GELIDIALES**

**GELIDIELLACEAE**

*Gelidiella acerosa (Forssk.) Feldmann & Hamel*

## CRYPTONEMIALES

### HALYMENIACEAE

*Halymenia duchassaingii (J. Agardh) Kylin*

## GIGARTINALES

### HYPNEACEAE

*Hypnea spinella (C. Agardh) Kützing*
*(Hypnea cervicornis)*

## CERAMIALES

### RHODOMELACEAE

*Acanthophora muscoides (L.) Bory*
*Acanthophora spicifera (Vahl) Børgesen*
*Bryothamnion triquetrum (S. G: Gmelin) M. Howe*
*Digenia simplex (Wulfen) C. Agardh*
*Bostrychia tenella (J. V. Lamouroux) J. Agardh*
*(Bostrychia binderi)*
*Laurencia corallopsis (Montagne) Howe*
*Laurencia obtuse (Huds.)J. V. Lamour*
*Laurencia papillosa (C. Agardh) Grev.*

## GRACILARIALES

### GRACILARIACEAE

*Gracilaria mammillaris (Mont.) M. Howe*
*Hydropuntia crassissima (P. Crouan & H. M. Crouan) M. J. Wynne*
*(Gracilaria crassissima)*

## NEMALIALES

### GALAXAURACEAE

*Galaxaura marginata (J. Ellis & Sol.) J. V. Lamour.*
*(G. frutescens)*
*G. subverticillata Kjellm.*
*G. rugosa(J. Ellis & Solander) J. V. Lamouroux*
*(G. lapidescens, G. squalida)*
*Tricleocarpa fragilis (L.) Huisman & R. A. Towns.*
*(Galaxaura oblongata)*

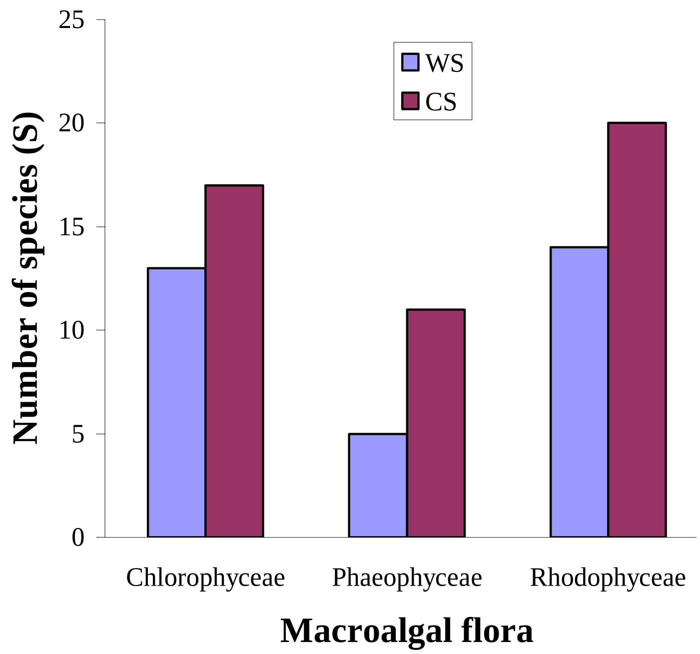


Fig. 1. Number of species of macrophytes on the Cacique reef flat at the end of the windy (WS) and calm (CS) season between April 1998 and May 1999**.**

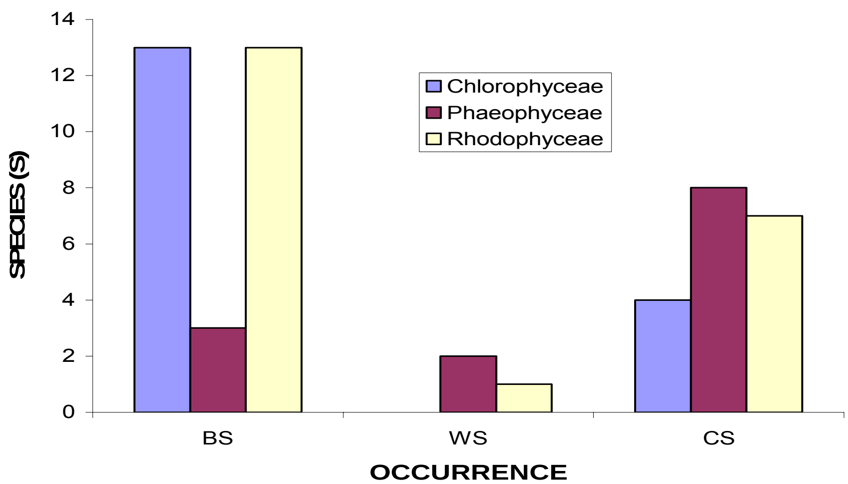


Fig.2. Number of species present in both windy and calm season (BS), windy season only (WS) and calm season only (CS) between April 1998 and May 1999.

## DISCUSSION

The diversity on the Cacique reef flat during calm season was higher. In the windy season the reef is exposed to relatively high wave energy as a result of its unprotected orientation toward the sea with increased turbulence, turbidity and wind-driven waves that constantly force water across the reef creating a directional flow toward shore (Connor 1984). Because the low tidal amplitude the reef flat is seldom either covered with deep water or exposed above the water for long periods. Reef holes and crevices rescaling turbulence because breaks low frequency oscillations in multiple high frequency oscillations or small eddies (Madsen et al., 2001). In this wave-dominated environments, water movement is a prime factor regulating the growth and distribution of submersed aquatic macrophytes. Butcher (1933) recognized that changes in water flow or velocity could alter the biomass and species composition of submersed aquatic macrophytes in streams and rivers. Water movement may to act on features such as leaf shape (Madsen 1991), growth form (Keddy 1982) or stem tensile strength (Brewer & Parker 1990) favouring certain species and altering community composition. *In situ* studies of freshwater macrophytes have generally shown that community biomass decreases with increasing current velocity. Showed that net photosynthesis of eight freshwater macrophyte species decreased as current velocity increased from 0.01 to 0.086 m $s^{-1}$. Water flow can affect macrophytes both directly, due to stretching, breaking and mechanical damage and indirectly, due to changes in gas exchange or light attenuation by the higher sediment resuspension.

It seems likely that generalizations about seasonality in tropical communities must be limited to a particular community with own peculiar array of biological, geological and physical attributes (Connors 1984).

## REFERENCES

Anderson, R. J., P. M. S. Monteiro & G. J. Levitt. 1996. The effect of localised eutrophication on competition between *Ulva lactuca* (Ulvaceae, Chlorophyta) and a commercial resource of *Gracilaria verrucosa* (Gracilariaceae, Rhodophyta). *Hydrobiol*. *326/327*: 291–296.

Brewer, C. A. & M. Parker. 1990. Adaptations of macrophytes to life in moving water: Upslope limits and mechanical properties of stems. *Hydrobiologia* 194: 133–142.

Butcher, R. W. 1933. Studies on the ecology of rivers. I. On the distribution of macrophytic vegetation in the rivers of Britain. J. Ecol. 21: 58–91.

Connor, J. 1984. Seasonal changes in an algal community of a tropical fringing reef in Panama. PhD Thesis. Univ. of Maryland. 95 pp.

Díaz-Pulido, G. & J. M. Díaz. 1997. Algal assemblages in lagonal reefs of Caribbean oceanic atolls. . Proc. 8th Int. Coral Reef Sym. 827-832.

Keddy, P. A. 1982. Quantifying a within-lake gradients of wave energy: interrelationships of wave energy, substrate particle size and shoreline plants in Axe Lake, Ontario. Aquat. Bot. 14: 41–58.

Lotze, H.K. & W. Schramm. 2000. Ecophysiological traits explain species dominance patterns in macroalgal blooms. *J. Phycol. 36*: 287–295.

Madsen, J. D. 1991. Resource allocation at the individual plant level. Aquat. Bot. 41: 67–86.

Madsen, J. D., P. A. Chambers, W. F. James, E.W. Koch & D. F. Westlake. 2001. The interaction between water movement, sediment dynamics and submersed macrophytes. *Hydrobiologia* 444: 71–84,

Rivers, J. S. & P. Peckol. 1995. Summer decline of *Ulva lactuca* (Chlorophyta) in a eutrophic embayment: interactive effects of temperature and nitrogen availability.
*J. Phycol. 31*: 223–228.

Rogers, C. 1997. A fishy story about hurricanes and herbivory: Seven years of research on a reef in St. John, U. S. Virgin Islands. Proc. 8th Int. Coral Reef Sym. 1:555-560.

Schaffelke, B., J. Mellors & N. Duke. 2005. Water quality in the Great Barrier Reef region: responses of mangrove, seagrass and macroalgal communities. Marine Pollution Bulletin 51: 279-296

Taouil A. & Y. Yoneshigue-Valentin. 2002. Alteraçoes na composiçao floristica das algas da praia de Boa Viagem (Niterói, RJ). Rev. Bras. Bot. Vol. 25 (4).

**ACKNOWLEDGEMENTS**

This study could not have been possible without the support of the University of Panamá in Veraguas. Thanks are due to the people of Cacique, Colón who aided this research but most especially to Mr. Porfirio Ardines and María Del Socorro de Ardines.