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Coral diseases and bleaching on Colombian Caribbean coral reefs

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Abstract: Since 1998 the National Monitoring System for the Coral Reefs of Colombia (SIMAC) has monitored the occurrence of coral bleaching and diseases in some Colombian coral reefs (permanent stations at San Andres Island, Rosario Islands, Tayrona, San Bernardo Islands and Urabá). The main purpose is to evaluate their health status and to understand the factors that have been contributing to their decline. To estimate these occurrences, annual surveys in 126 permanent belt transects (10x2m) with different depth intervals (3-6 meters, 9-12 meters and 15-18 meters) are performed at all reef sites. Data from the 1998-2004 period, revealed that San Andrés Island had many colonies with diseases (38.9 colonies/m^2), and Urabá had high numbers with bleaching (54.4 colonies/m^2). Of the seven reported coral diseases studied, Dark Spots Disease (DSD), and White Plague Disease (WPD) were noteworthy because they occurred in all Caribbean monitored sites, and because of their high interannual infection incidence. Thirty five species of scleractinian corals were affected by at least one disease and a high incidence of coral diseases on the main reef builders is documented. Bleaching was present in 34 species. During the whole monitoring period, *Agaricia agaricites* and *Siderastrea siderea* were the species most severely affected by DSD and bleaching, respectively. Diseases on species such as *Agaricia fragilis, A.grahamae, A. humilis*, *Diploria clivosa*, *Eusmilia fastigiata*, *Millepora complanata,* and *Mycetophyllia aliciae* are recorded for first time in Colombia. We present bleaching and disease incidences, kinds of diseases, coral species affected, reef localities studied, depth intervals of surveys, and temporal (years) variation for each geographic area. This variation makes difficult to clearly determine defined patterns or general trends for monitored reefs. This is the first long-term study of coral diseases and bleaching in the Southwestern Caribbean, and one of the few long term monitoring studies on coral diseases worldwide. Rev. Biol. Trop. 58 (Suppl. 1): 95-106. Epub 2010 May 01.

Key words: Monitoring, SIMAC, coral diseases, bleaching, coral reefs, Colombian Caribbean.

During the last three decades coral reefs have suffered extensive loss of living tissue mainly due to coral bleaching (Glynn 1993, Wilkinson 2000, Richard & Precht 2001, Aronson *et al*. 2002, Rosenberg & Ben-Haim 2002) and coral diseases (Peters 1997, Santavy & Peters 1997, Goreau *et al*. 1998, Green & Bruckner 2000, Sutherland *et al*. 2004). Disease is defined as "An interruption, cessation, or disorder of body function, system, or organ" (Stedman 2000). Since 1973 when the first coral disease was documented by Antonious, the numbers of illnesses that affect corals have increased rapidly, affecting reefs and reducing living tissue in these ecosystems throughout the world (Green & Bruckner 2000, Rosenberg & Ben-Haim 2002, Sutherland *et al.* 2004). Usually, these affections cause the death of coral tissue, but their etiology is poorly understood, and the pathogenic agent responsible for most diseases are still unknown (Green & Bruckner 2000, Rosenberg & Ben-Haim 2002, Sutherland *et al*. 2004). Some of the most commonly observed diseases that affect Caribbean

stony corals are Black Band Disease (BBD), White Band Disease (WBD), White Plague (WPD), Dark Spots Disease (DSD), Yellow Band Disease (YBD), and White Pox (WPx) (Richardson *et al*. 1997, 1998b, Gil-Agudelo & Garzón-Ferreira 2001, Patterson *et al*. 2002, Gil-Agudelo *et al*. 2004, Borger 2005).

Coral bleaching is defined as the loss of symbiotic algae and/or their photosynthetic pigments by coral polyps and has been frequently associated with drastic changes in the physicochemical conditions of the water (temperature, salinity, transparency, among others), extreme low tides and diseases (Brown 1997, Banin *et al*. 2000, Rosenberg & Ben-Haim 2002, Sutherland *et al*. 2004). In most cases, if after several weeks or months the process responsible for bleaching is not reversed, the coral will die mainly because part of the nutrients used by corals are derived from their symbiotic relation with zooxanthellae (Glynn 1993, Rosenberg & Ben-Haim 2002, Sutherland *et al*. 2004). In cases where bleaching has not caused coral mortality, a decrease in the reproductive capability of corals, and disruption of the normal coral development has been observed (Rosenberg & Ben-Haim 2002). Extensive damage to reefs due to bleaching events has been documented in places such as in Indonesia (1983), Thailand (1991 and 1995), French Polynesia (1991 and 1994), and the Great Caribbean (1998) (Brown 1997, Aronson *et al*. 2002). In Colombia, massive corals deaths due to bleaching were documented by Prahl in Gorgona Island (1983 and 1985) and Vargas-Angel *et al*. (2001).

Although the importance of coral diseases and bleaching for Colombian Caribbean reefs are well recognized, studies have been restricted to only document their occurrence. Bleaching events have been reported for Santa Marta (Zea & Duque-Tobón 1989, CARICOMP 1997, Pinzón *et al*. 1998, Rodríguez-Ramírez & Garzón Ferreira 2003), Portete Bay (Solano 1994), and Rosario Islands (Navas-Suarez & Moreno-Forero 1993, Solano *et al*. 1993, Garzón-Ferreira & Kielman 1994). Other coral diseases reported for Colombian reefs include the disease occurrence documentation, host species determination, and their distribution (Garzón-Ferreira *et al*. 1996, Barrios 2000, Garzón-Ferreira *et al*. 2001, Weil *et al*. 2002). Only for the DSD case there are some detailed occurrence studies, development, and identification of the pathogen been carried out (Garcés 2000, Gil-Agudelo & Garzón-Ferreira 2001, Gil-Agudelo *et al*. 2004).

The development of the "Sistema Nacional de Monitoreo de Arrecifes Coralinos en Colombia-National Monitoring System for the Coral Reefs of Colombia" (SIMAC) has allowed the on coral bleaching and diseases information collection since 1998. This have been done in a systematic and standardized manner in seven reef areas in the Colombian Caribbean (San Andrés Island, Rosario Archipelago, Tayrona, San Bernardo Archipelago and Urabá Gulf) (Prahl & Erhardt 1985, Díaz *et al*. 1995, 1996, 2000). The present work synthesizes the results of coral bleaching and disease monitoring obtained by SIMAC between 1998 and 2004. This is the first study that analyzes spatial (monitoring areas and depth levels) and temporal (years) variation on the occurrence of coral diseases and bleaching in Colombia.

MATERIALS AND METHODS

Study sites: Permanent stations were evaluated from San Andres Island, Rosario Islands, Tayrona, San Bernardo Islands and Urabá (see Fig. 1. in Garzón-Ferreira & Rodríguez-Ramírez 2010). More detailed information on study sites may be found in Garzón-Ferreira *et al*. (2002) and Garzón-Ferreira & Rodríguez-Ramírez (2010).

Surveys and data collection: Annual reef monitoring was performed between 1998 and 2004 following the protocols described by Garzón-Ferreira & Rodríguez-Ramírez (2010). For each of the seven areas monitored two or three depth levels were assessed: shallow (3-6m), mid-depth (9-12m) and deep (15-18m)- and, two or three reefs (or plots) by depth level were established permanently (see Garzón-Ferreira & Rodríguez-Ramírez 2010).

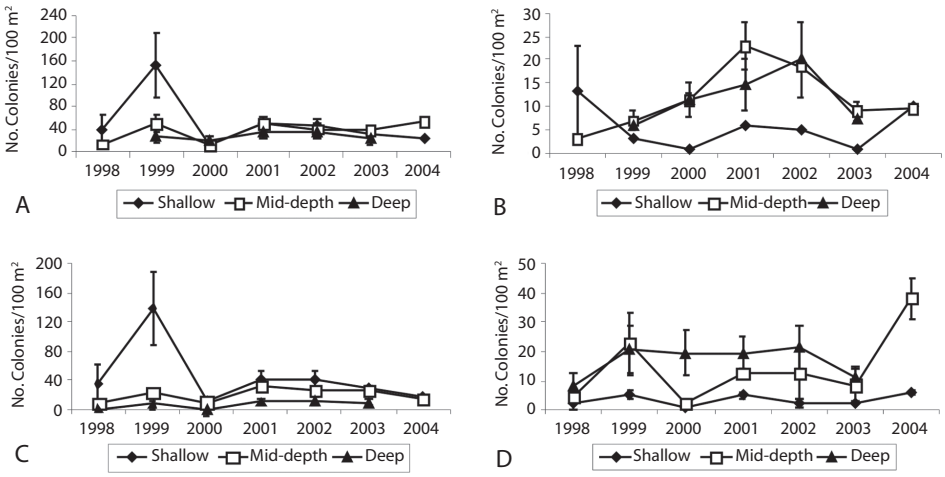

Fig. 1. Number of coral colonies (± 1 SE) affected by A) total diseases, B) bleaching, C) Dark Spots Disease and D) White Plague Disease per 100m^2 in San Andrés reef sites between 1998 and 2004. No data were collected for the deep sites in 1998 or 2004.

Due to logistic problems, the monitoring protocol was not carried out in Islas del Rosario in 2000, the deeper sites in San Andrés in 1998, and the deeper sites in San Andrés, Chengue, and Islas del Rosario in 2004. The sampling unit was a 10x2 meter belt transect, in which the central axis was the line extended between two stainless steel rods that delimited the permanent transect. The width of the transect was estimated by extending one meter PVC pipe on each side of the central line. All stony coral colonies larger than five centimeters on each side of the central line within the transect were recorded and examined for diseases and coral bleaching. The presence of coral diseases or bleaching was recorded over three to five permanent belt transects per reef site (see Garzón-Ferreira & Rodríguez-Ramírez 2010). More details on this methodology and description of diseases recorded can be found in Garzón-Ferreira *et al*. (2002) and Garzón-Ferreira & Rodríguez-Ramírez (2010).

The total number of reported colonies with disease or bleaching signs was obtained by adding the transect data in each plot. The mean of diseased and bleached colonies by depth level and area were obtained for each year of the study. Since some of the reef sites (San Andrés, Rosario, and Tayrona) had 5 transects (=100m^2) and others (San Bernardo and Urabá) had only 3 (=60m^2), all results were standardized to 100m^2. Graphic analyses of the occurrence of DSD and WPD were done for the surveyed areas, while the other diseases showed such low occurrence that in depth analyses were not performed. Due to inconstancies in the number of coral genets recorded every year, we decided not to express our results in percentages (prevalence). We present our data as occurrence (total number of colonies observed to be affected by the evaluated condition).

RESULTS

General observations: The presence of coral diseases was observed in all surveyed areas between 1998 and 2004 (Table 1). San Andres and Tayrona showed the presence of the highest number of different diseases during this period. *Agaricia agaricites* was the species with the highest number of diseased colonies,

TABLE 1

Distribution of diseases and bleaching on SIMAC reef sites surveyed. An X indicates the presence of at least one diseased or bleached colony. WPD (White Plague Disease), DSD (Dark Spots Disease), BBD (Black Band Disease), YBD (YellowBand Disease), WBD (White Band Disease), SDR (Shut Down Reaction), SAC (Serratiosis of Acroporids) and BLA (Bleaching)

REEF AREAS	WPD	DSD	YBD	BBD	WBD	SAC	SDR	BLA
San Andrés	X	X	X	X	X		X	X
Rosario	X	X	X	X	X			X
Tayrona	X	X	X	X	X	X		X
San Bernardo	X	X	X		X			X
Urabá	X	X	X					X

followed by *Siderastrea siderea*. In contrast, *Agaricia undata*, *Isophyllia sinuosa*, *Madracis formosa*, *Madracis pharensis*, *Manicina areolata, Mussa angulosa, Mycetophyllia danaana, Porites colonensis, Solenastrea buornoni* and *Tubastrea coccinea* did not show signs of coral diseases during the study period.

A total of 45 coral species were observed and recorded during SIMAC monitoring. A total of 35 of these (77.8%) showed signs of at least one disease, including some of the most important reef forming corals (Table 2). The diseases that affected most coral species were WPD (33) followed by DSD (32) (Table 2); these diseases were also found in all evaluated areas (Table 1). *Montastraea annularis* and *Montastraea franksi* were found as the corals species susceptible to the most number of coral diseases (WPD, DSD, BBD, YBD, and shut-down reaction). From all coral species recorded with signs of diseases, only *Siderastrea radians* did not show signs of WPD (Table 2).

Coral bleaching was observed in all SIMAC sites (Table 1). Bleaching signs were detected in 33 out of the 45 coral species recorded (73.3%) (Table 2). The highest numbers of affected species (23) were found in the Tayrona site (Table 2). *Siderastrea siderea* had the highest number of colonies showing signs of bleaching. No bleaching signs were observed in *Acropora cervicornis, Agaricia humilis, A. undata, Diploria clivosa, Isophyllia sinuosa, Madrasis formosa, M. pharensis, Manicina areolata, Mussa angulosa, Mycetophyllia aliciae, M. danaana, Porites colonensis y Solenastrea buornoni* during the seven years of monitoring.

Temporal variation of diseases and bleaching: In San Andrés, disease occurrence averaged between 15.2 and 76.5 colonies per 100m^2 and a general multiannual average of 38.9 colonies/100m^2 for the seven years of monitoring. In this area a notable increase on the incidence of coral diseases happened during 1999, especially in the shallower sites, where occurrence rose to 151.0 colonies/100m^2 (Fig. 1a).

Coral bleaching exhibited an average range of 5.3 to 14.5 colonies/100m^2 and a general multiannual average of 9.5 colonies/100m^2. It showed a notorious peak in 2001 of 23.0 colonies/100m^2 (Fig. 1b). The two analyzed diseases (DSD and WPD) behaved in a different way, with DSD increasing in shallow areas in 1999 (139.5 colonies/100m^2) (Fig. 1c) and WPD in intermediate depths in 2004 (38.0 colonies/100m^2) (Fig. 1d). These values influenced the general occurrence of all diseases studied. DSD exhibited an average range between 7.7 to 57.7 colonies/100m^2 and a general multiannual average of 26.2 colonies/100m^2. WPD showed a multiannual average of 12.0 and an average ranging from 4.8 to 16.3 colonies/100m^2.

In Rosario Islands, the multiannual diseases occurrence averaged 13.4 colonies/100m^2, ranging from 6.7 to 21.5 colonies/100m^2.

TABLE 2
Coral diseases and bleaching found in reefs sites of SIMAC between 1998 and 2004, and coral species affected by at least one disease or bleaching during this time

CORAL SPECIES	WPD	DSD	BBD	YBD	WBD	SDR	SAC	BLA
Acropora cervicornis					X			X
Acropora palmata	X		X		X		X	X
Agaricia agaricites	X	X	X			X		X
Agaricia fragilis	X							X
Agaricia grahamae	X							X
Agaricia humilis	X							
Agaricia lamarcki	X							X
Agaricia tenuifolia	X							X
Colpophyllia natans	X	X	X	X				X
Dichocoenia stokesi	X	X						X
Diploria clivosa	X	X						
Diploria labyrinthiformis	X	X						X
Diploria strigosa	X	X	X	X				X
Eusmilia fastigiata	X	X						X
Favia fragum	X	X						X
Helioseris cucullata	X	X						X
Isophyllastrea rigida	X	X						X
Madracis decactis	X	X						X
Madracis mirabilis	X							X
Meandrina meandrites	X	X		X				X
Millepora alcicornis	X							X
Millepora complanata	X							X
Montastraea annularis	X	X	X	X		X		X
Montastraea cavernosa	X	X	X					X
Montastraea faveolata	X	X	X	X				X
Montastraea franksi	X	X	X	X		X		X
Mycetophyllia aliciae	X							
Mycetophyllia ferox	X							X
Mycetophyllia lamarckiana	X	X	X					X
Porites astreoides	X	X		X				X
Porites porites	X	X						X
Scolymia sp								X
Siderastrea radians		X						X
Siderastrea siderea	X	X	X					X
Stephanocoenia intersepta	X	X	X					X
Stephanocoenia michelini	X	X						X

Rosario Islands also showed a disease occurrence peak in 1998 with 36.0 colonies/100m^2 for the intermediate depths (Fig 2a). Bleaching fluctuated at all depths with a common peak in 2003 reaching up to 34.5 colonies/100m^2 (Fig. 2b). Bleaching exhibited an average between 11.0 and 31.8 colonies/100m^2 and a multiannual average of 18.5 colonies/100m^2. DSD exhibited a range between 0.3 and 2.5 colonies/100m^2 and a multiannual average of 1.1 colonies/100m^2. The increase in DSD occurrence in 1999 (3.5 colonies/100m^2) did not affect the general occurrence of diseases in the area (Fig. 2c). On the contrary, in 1998,

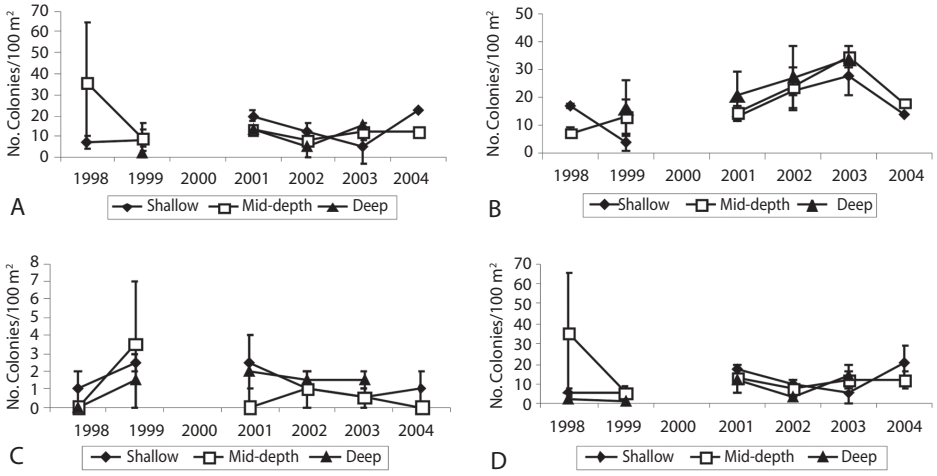

Fig. 2. Number of coral colonies (± 1 SE) affected by A) total diseases, B) bleaching, C) Dark Spots Disease and D) White Plague disease per 100m^2 in Rosario reefs sites between 1998 and 2004. No data were collected in 2000 and for the deep site in 1998 or 2004.

WPD showed a peak in the area for the intermediate depths that influenced the general mean (35.0 colonies/100m^2) (Fig. 2d). WPD exhibited a multiannual average of 11 colonies and a yearly average between 3.8 and 16.5 colonies/100m^2.

In Tayrona, general diseases occurrence between 1998 and 2004 was 10.1 colonies/100m^2, with averages fluctuating between 2.7 and 18.5 colonies/100m^2. Higher values (22 colonies/100m^2) were observed during 2001 and 2003 at different depths (Fig. 3a). Coral bleaching exhibited its highest values during 1998 and 1999 (Fig. 3b), decreasing in later years. The general multiannual average observed was 16.8 colonies/100m^2 with an average between 5.2 and 29.2 colonies/100m^2. In the area, DSD showed peaks in 1999 (8.0 colonies/100m^2) and 2001 (9.0 colonies/100m^2) (Fig. 3c), which were similar to the peaks observed in the general diseases average. The multiannual average of DSD was 2.8 colonies/100m^2 and annual average ranging between 1.0 and 6.2 colonies/100m^2. Finally, WPD exhibited an annual average oscillating between 0.8 and 12.5 colonies/100m^2 and a multiannual average of 6.4 colonies/100m^2. WPD contributed substantially to the general diseases occurrence in 2001 and 2003, mainly for the intermediate depths in 2003 (Fig. 3d).

Monitoring efforts in San Bernardo Islands started in 2002 with sampling sites at two different depth intervals, shallow and intermediate. During these years, general disease occurrence decreased since the beginning of the observations, from a maximum average of 25.8 to 8.3 colonies/100m^2 with a multiannual average of 17.6 colonies/100m^2. Disease occurrence was highest during 2002 at intermediate depths (Fig. 4a). Bleaching showed a multinannual average of 6.0 and an average range between 2.5 and 8.6 colonies/100m^2, with no distinguishable patterns between the two depth levels (Fig. 4b). Regarding DSD and WPD, these diseases showed contrasting patterns during the monitoring. DSD was high in 2002 when monitoring efforts started, diminishing thereafter (Fig 4c). The multiannual average in these three years of monitoring for DSD was 10.2 colonies/100m^2 with a range between 6.4

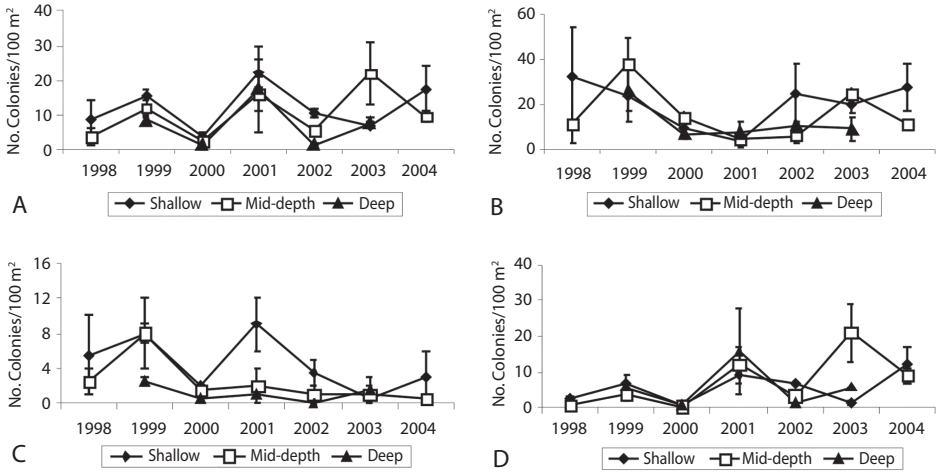

Fig. 3. Number of coral colonies (± 1 SE) affected by A) total diseases, B) bleaching, C) Dark Spots Disease and D) White Plague disease per 100m^2 in Tayrona reef sites between 1998 and 2004. No data were collected for the deep site in 1998 or 2004.

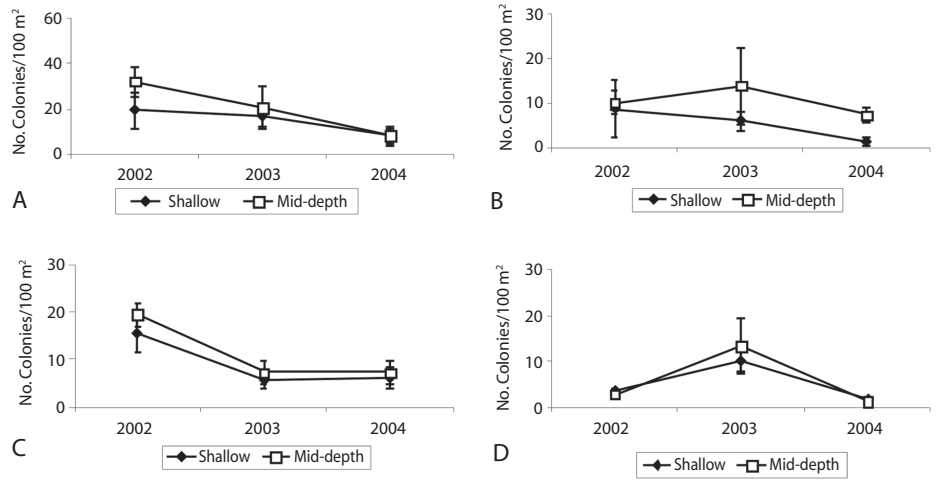

Fig. 4. Number of coral colonies (± 1 SE) affected by A) total diseases, B) bleaching, C) Dark Spots Disease and D) White Plague disease per 100m^2 in San Bernardo reef sites between 2002 and 2004.

and 17.5 colonies/100m^2. Meanwhile, WPD showed an increase in occurrence in 2003 (Fig. 4d), and an average range oscillating between 1.4 and 11.7 colonies/100m^2 and an average of 5.4 colonies/100m^2.

The station in Urabá, with two depth levels, shallow and intermediate, was also installed in 2002. The general diseases occurrence showed a decrease throughout the years, especially in shallow sites (Fig. 5a), with a general

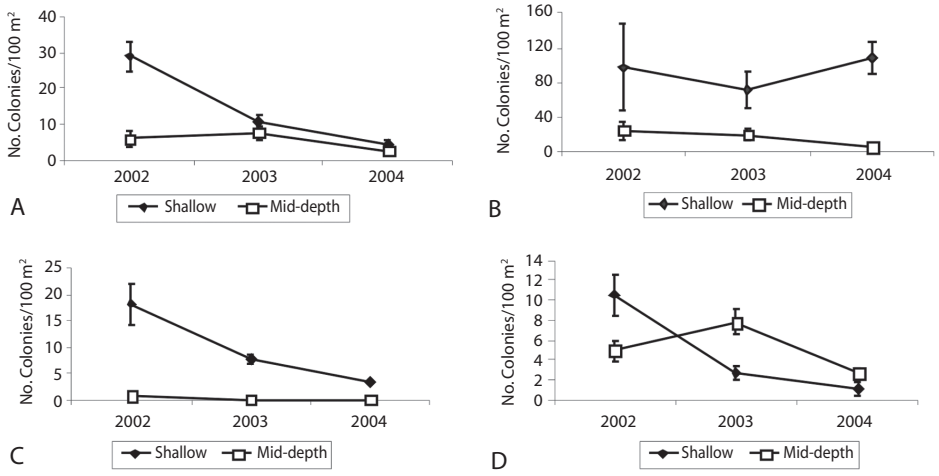

Fig. 5. Number of coral colonies (± 1 SE) affected by A) total diseases, B) bleaching, C) Dark Spots Disease and D) White Plague disease per 100m^2 in Urabá reef sites between 2002 and 2004.

occurrence of 10.1 and an average range of 3.6 to 17.5 colonies/100m^2. The multiannual average of bleaching was 54.4 with an annual average ranging from 45.8 to 60.8 colonies/100m^2 (Fig. 5b). DSD and WPD showed a behavior similar to all diseases, decreasing after 2002, especially in shallower sites (Figs. 5c and 5d). DSD occurrence averaged between 1.7 and 9.5 colonies/100m^2 with a multiannual average of 5.0 colonies/100m^2. WPD also showed a multiannual average of 5.0 colonies/100m^2 with an average ranging between 1.9 and 7.7 colonies/100m^2.

DISCUSSION

No temporal patterns were evident for diseases occurrence or bleaching throughout the seven years of monitoring, but all coral diseases reported for the Caribbean were found during this study affecting a large number of coral species. DSD and WPD were the coral diseases that contributed the most to the occurrence of diseases in the monitored coralline areas. Either or both diseases were the main contributors to the increase in the occurrence of coral diseases in areas such as Rosario Islands in 1998, San Andrés in 1999, San Bernardo in 2002, and Tayrona in 2001 and 2003. This shows that variation in the occurrence of diseases was not caused by regional or large scale processes, but seemed to be the result of local processes.

The number of coral species affected by diseases increased throughout the study. In 1998, 16 coral species were found to be affected by at least one disease, while in 2004 this number increased to 35. This agrees with the observed increase of coral diseases and bleaching, and their direct link to the reduction of coral cover in the Caribbean (Bruckner & Bruckner 1997, Santavy & Peters 1997, Hayes & Goreau 1998, Garzón-Ferreira *et al.* 2001, Weil *et al*. 2002, Sutherland *et al*. 2004). Massive corals such as *Montastraea* spp.*, Diploria* spp.*, Stephanocoenia michelini*, *Colpophyllia natans and Siderastrea siderea*, the foliaceus coral *Agaricia agaricites* and the branching coral *Acropora palmata* were the most affected by diseases. Some of these species constitute the framework of Caribbean reefs, and their condition might influence the whole ecosystem.

Similar results have been found by Garzón-Ferreira *et al* (2001) and Weil *et al* (2002). Our documentation of diseases in the corals species of *Agaricia fragilis, A.grahamae, A. humilis*, *Diploria clivosa*, *Eusmilia fastigiata*, *Millepora complanata, Mycetophyllia aliciae* and *Siderastrea radians* increases the number of corals known to be affected by diseases in Colombia (Garzón-Ferreira *et al.* 2001, Weil *et al.* 2002).

No clear tendencies were found in the occurrence of coral bleaching throughout the present study. Also, no relationship between the occurrence of coral diseases and coral bleaching was evident. A total of 34 coral species were found with signs of bleaching during the seven years of monitoring. The most important Caribbean corals were affected by bleaching, and although a decrease in living tissue due to bleaching was not found during the monitoring of coral cover (Rodríguez-Ramírez *et al.* 2010), these events potentially caused alteration of coral growth, reproduction, and other functions (Jokiel 2004) that contributed to the deterioration of Colombian reefs. Bleaching events on Colombian reefs have mainly been related to local and regional increases in seawater temperature. This is the case for the increased bleaching observed in 1999 in Tayrona, when the monthly average temperature was 1°C higher than the multiannual mean (CARICOMP 1997) for several months. Nonetheless, less than 5% mortality was documented (CARICOMP 1997).

DSD affected the largest number of coral colonies in SIMAC study sites. Similarly, Weil *et al*. (2002) established DSD as the most prevalent coral disease in the Caribbean affecting 1.3% of colonies (ranging from 0.2 to 7.6%), including a prevalence of 2.7% (±5.4%) for Colombian reefs. High occurrence of DSD in places like San Andrés and San Bernardo may be explained by the abundance of corals susceptible to this disease. We found a clumped distribution, which is an indication of a contagious nature. Although there were low numbers of infected corals, Urabá had a high percentage of colonies infected that were not reflected in the results shown in this report, mainly due to the high dominance of large *S. siderea* colonies (>2m in diameter). DSD prevalence changes with variations in water temperature (Gil-Agudelo & Garzón-Ferreira 2001, Borger 2005), which might help in controlling its expansion. This characteristic might have special importance in places like Tayrona, where climatological and oceanographical conditions create changes in water temperature of more than 8ºC throughout the year (Rodríguez-Ramírez & Garzón-Ferreira 2003), limiting DSD occurrence to only a few colonies per $100m^2$.

In San Andrés, after a noticeable peak of coral diseases in 1999, few fluctuations were observed. This peak was the result of a sudden increase in the number of corals with DSD in shallow stations. Weil *et al*. (2002) established that San Andrés was one of the places with the highest percentage of corals affected by this disease (1.3%) in the Caribbean. Similarly, Gil-Agudelo & Garzón-Ferreira (2001) found that most corals affected by DSD are found in shallow waters, but there is no explanation for the sudden outbreak of this disease this year.

In SIMAC areas, the number of species affected by WPD was considerably higher than the other recorded diseases, which is in agreement with the results of other studies (Green & Bruckner 2000, Garzón *et al*. 2001, Weil *et al*. 2002, Sutherland *et al*. 2004). Weil *et al*. (2002) found for WPD in the Caribbean, with a prevalence of 0.8% (ranging from 0.1 to 3.2%) and in Colombia ranging from 1.2 to 1.8%. This disease affects a wide range of coral species, and seems to be less susceptible to environmental variations than other diseases (Santavy & Peters 1997, Goreau *et al*. 1998), but causes a high rate of tissue loss (Richardson *et al*. 1998a). WPD has been widely documented and studied in the Caribbean, and is responsible of high levels of coral mortality (Rutzler & Santavy 1983, Edmunds 1991, Kuta & Richardson 1996, 1997, Richardson *et al.* 1997). Between 2003 and 2004 a noticeable increase in WPD was found in San Andrés Islands. This outbreak concurs with an outbreak of this disease

observed in the central Caribbean (Sánchez *et al*. 2010).

It is important to continue coral bleaching and disease monitoring efforts in order to understand the processes involved in disease occurrence and distribution in Colombian reefs. It is also important to extend the number of monitored areas in order to assess areas that have not been evaluated. We recommend, also adoption of new methodologies such as video and photographic recording, marking and following individual colonies, and use of biomarkers, among others.

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RESUMEN

Desde 1998 el "Sistema Nacional de Monitoreo de Arrecifes Coralinos de Colombia" SIMAC, ha observado la ocurrencia de enfermedades coralinas y blanqueamiento en arrecifes colombianos (estaciones fijas en la Isla de San Andrés, Tayrona, Islas del Rosario, Islas de San Bernardo y Urabá Chocoano). Para estimar la ocurrencia se ha examinado anualmente un total de 126 bandas permanentes (10x2m), dispuestas en diferentes rangos de profundidad en las áreas arrecifales objeto de estudio. El análisis de la información obtenida entre 1998 y el 2004 revela que San Andrés presenta altos promedios de colonias enfermas (38.9 colonias/100m^2) y que Urabá exhibe ésta condición para el blanqueamiento (54.4 colonias/100m^2). Del total de siete enfermedades detectadas, se destacan por su presencia en todas las áreas y la ocurrencia interanual, los Lunares Oscuros (DSD) y la Plaga Blanca (WPD). Un total de 35 especies de corales pétreos fueron registradas con al menos una enfermedad y se encontró una alta ocurrencia de enfermedades en las principales especies formadoras de arrecifes. El blanqueamiento se halló presente en 34 especies. Mientras WPD se halló en más especies (33), la DSD se registró un mayor número de veces. *Agaricia agaricites* fue la especie con mayor número de registros de DSD; por otra parte *Siderastrea siderea* fue vista un mayor número de veces con signos de blanqueamiento. Especies como *Agaricia fragilis, A.grahamae, A. humilis*, *Diploria clivosa*, *Eusmilia fastigiata*, *Millepora complanata, Mycetophyllia aliciae* y *Siderastrea radians* son registradas por primera vez con presencia de enfermedades en Colombia. Cada área geográfica presentó variaciones espaciales (localidades, rangos de profundidad) y temporales (años) en cuanto a las prevalencias, tipos de enfermedades y especies de corales afectadas, que dificultan determinar patrones claramente definidos o tendencias generales para los arrecifes evaluados.

Palabras clave: Monitoreo, SIMAC, enfermedades coralinas, blanqueamiento, arrecifes coralinos, Caribe colombiano.

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