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NOTA:

JUVENILE SCLERACTINIAN CORAL MORTALITY AT NUESTRA SEÑORA DEL ROSARIO ARCHIPELAGO, COLOMBIAN CARIBBEAN*

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RESUMEN

Mortalidad de corales escleractínios juveniles en el archipiélago Nuestra Señora del Rosario, Caribe colombiano. En la estación de monitoreo de arrecifes coralinos del SIMAC en isla Tesoro, archipiélago Nuestra Señora del Rosario, se evaluó la mortalidad y se identificaron algunos signos de deterioro en corales escleractínios juveniles (colonias < 2-4 cm). Se marcaron y evaluaron 41 colonias por un período de seis meses (abril-octubre de 2006), de las cuales 31 pertenecieron a especies incubadoras de plánulas (con dominancia de *Porites astreoides* y *Agaricia* spp.) y 10 a especies liberadoras de gametos (con mayor abundancia de *Montastraea cavernosa*). La tasa de mortalidad encontrada (0.1) fue baja comparada con otras registradas, condición posiblemente relacionada con una presión moderada de los tensores presentes en el área durante la época del estudio. La abundancia de corales juveniles en los diferentes taxones y los signos de deterioro registrados son reflejo de las estrategias de vida, en las que especies incubadoras de plánulas son usualmente más abundantes y vulnerables.

PALABRAS CLAVE: Corales juveniles, Tasas de mortalidad, Incubadores de plánulas, Liberadores de gametos, Caribe colombiano.

Early mortality of scleractinian corals, soon after successful processes of reproduction and recruitment, is an important factor in the composition of coral communities (Bak and Engel, 1979). Post-settlement survival of juvenile corals is controlled by species-specific characteristics (e.g. growth rates and size of the colonies: Babcock, 1985; Vermeij, 2006), interaction with other reef organisms (e.g. competition and predation: Box and Mumby, 2007; Venera-Ponton *et al*., 2011) and environmental conditions (e.g. seawater temperature, sedimentation rates and pollution: Wittemberg

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and Hunte, 1992; Richmond, 1997; Edmunds, 2004). Life-history strategies of species also play a fundamental role in the abundance and survival of juvenile corals (Bak and Engel, 1979; Van Moorsel, 1983; Hughes, 1985; Vermeij, 2006). In this research, an approach to the rates of mortality and some damage conditions of juvenile scleractinian corals was done in the Nuestra Señora del Rosario Archipelago (NSRA), an area in the Colombian Caribbean affected by natural and anthropogenic disturbances that have led to a continuous reef degradation (Alvarado *et al*., 1986; Solano *et al*., 1993; Gil-Agudelo *et al*., 2006; Pineda *et al*., 2006).

Two surveys within a six months interval (April-October 2006) were carried out in SIMAC's (National Monitoring System for the Coral Reefs of Colombia) monitoring site of Tesoro Island, northern zone of NSRA (10°14'3.1''N - 75°44'47.2''W). Juvenile scleractinian corals were located on each survey in six band transects (10 x 2 m), at 5-12 m depth. Similar to Vidal *et al.* (2005), the juvenile corals were defined as the sexual produced colonies with a maximum diameter of 2 cm for small-fast growing species (e.g. *Agaricia* spp. and *Porites astreoides*) and 4 cm for massive-slow growing species (e.g. *Montastraea* spp. and *Colphophyllia natans*).

In the initial survey, a total of 41 juvenile corals of eight taxa were tagged, 31 of which were brooder species and 10 were spawners (Table 1). Most of these colonies were identified as *Agaricia* spp. (n= 14) and *Porites astreoides* (n= 16). On the last survey, 34 of the colonies initially tagged were found healthy, three with damage conditions (one partially smothered by algae, one broken and one partially bleached on a pattern resembling a white plague disease), and four colonies were found dead (Figure 1, Table 1).

Table 1. Taxa and number of colonies found in permanent transects during the study period (n_0: beginning and n_f: end) in Tesoro Island. Damage conditions: (a) partially smothered by algae, (b) partially bleached, (c) broken.

TAXA	n_0	n_f		
		Healthy	Deteriorated	Death
Agaricia spp.*	14	9	1(a), 1(b), 1(c)	2
*Eusmilia fastigiata**	1	1	0	0
*Porites astreoides**	16	15	0	1
*Diploria strigosa***	1	1	0	0
*Montastraea cavernosa***	5	4	0	1
*Siderastrea siderea***	3	3	0	0
*Colphophyllia natans***	1	1	0	0
Total brooders(*)	**31**	**25**	**3**	**3**
Total spawners (**)	**10**	**9**	**0**	**1**
Total n	**41**	**34**	**3**	**4**

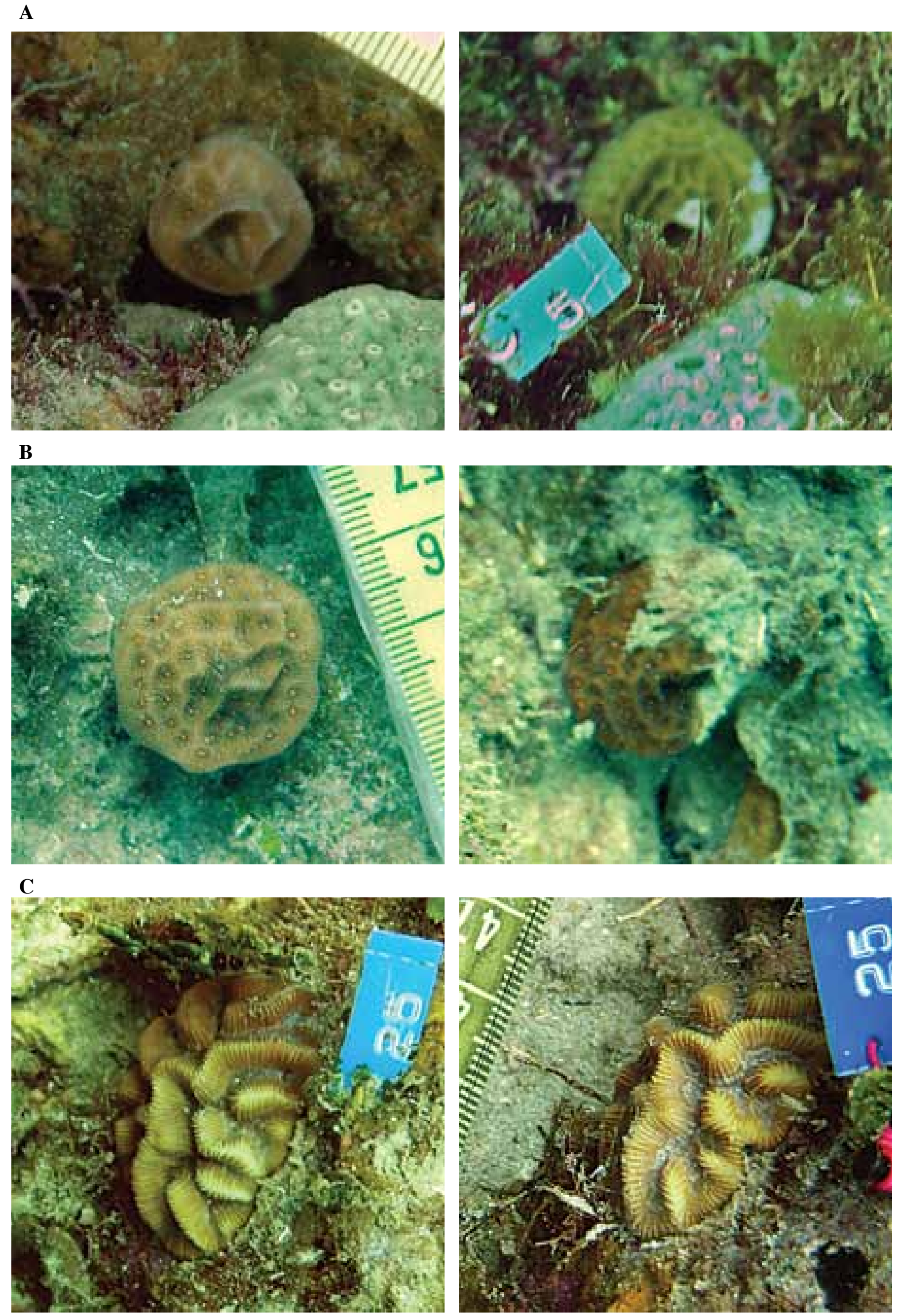

Figure 1. Initial (left) and final condition (right) of some of the juvenile corals surveyed in Tesoro Island. (A) *Agaricia agaricites* found partially bleached, (B) *A. agaricites* found partially smothered by algae, and (C) *Diploria strigosa* found healthy.

Mortality rate of juvenile corals (M_r) was calculated following the mathematical expression [$M_r = (n_0 - n_f) / n_0$], with n_0 as the total number of colonies initially tagged, and n_f as the total number of colonies found alive at the end of the study period (including those with damage conditions). Thus, the mortality rate of juvenile corals for this study was 0.10.

It is difficult to compare the mortality rate found here, with other reports due to methodological differences in the species and period assessed. However, a discreet review suggested that the value obtained in this study (0.10) was considerably lower than reports from other studies in the Caribbean (≈ 0.33: Bak and Engel, 1979; ≈ 0.72: Hughes, 1985; ≈ 0.20: Smith, 1997; ≈0.47: Vermeij, 2006; ≈ 0.45: Irizarry-Soto and Weil, 2009). In the NSRA, there is a high influence of natural and anthropogenic disturbances that have lead to coral reefs degradation, such as: high sedimentation rates and pollution (Alvarado *et al.*, 1986; Pineda *et al*., 2006), and sporadic anomalies in sea surface temperature (Solano *et al*., 1993; Gil-Agudelo *et al*., 2006). Despite the special susceptibility of juvenile corals to some of these stressors (Wittemberg and Hunte, 1991; Edmunds, 2004), the low mortality rate found in this study could be a sign of a moderate pressure during the study period. Furthermore, the special degree of protection of Tesoro Island as "*área intangible*" (equivalent degree to a No-entry area) (Pineda *et al*., 2006), could be a management strategy promoting the survival of juvenile corals.

Life history strategies influence the abundance and survival of corals during their life cycles. For example, most massive species are spawners with low recruitment (low abundance as juveniles) and high survival rates; whereas small sized species are usually brooders with high recruitment (high abundance as juveniles) but low survival (Back and Engel, 1979; Hughes, 1985; Knowlton, 2001). These life history traits are partially reflected in this analysis, even when this study was not intended to determine the abundance and composition of juvenile corals in the area. Most of the juvenile corals surveyed were identified as brooder species (≈ 75 %), while massive spawners corals were sparse (Table 1). Furthermore, the special vulnerability of brooder juvenile corals was also noticed, as just the taxon *Agaricia* spp. was found with damage conditions (Table 1, Figure 1).

The evidence of several studies suggests that a phase shift process may be taking place in Caribbean coral reefs, in which brooding species, like *Agaricia* spp. and *P. astreoides*, have become dominant over major reef building species following disturbances of the last decades (Done, 1999; Aronson and Pretch, 2001; Knowlton, 2001; Aronson *et al*., 2004). Further studies, including a wider range of species and periods of time, are necessary to a better understanding of the survivorship of juvenile corals and its role in the coral community structure. In response to current and oncoming environmental changes, it is important to focus these studies on the mortality of key species to elucidate if a phase shift process is taking place.

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LITERATURE CITED

Alvarado, E. M., F. Duque, L. Flórez and R. Ramírez. 1986. Evaluación cualitativa de los arrecifes coralinos de las islas del Rosario (Cartagena-Colombia). Bol. Ecotrópica: Ecosistemas Tropicales, 15: 1-30.

Aronson, R. B. and W. F. Pretch. 2001. White-band disease and the changing face of Caribbean coral reefs. Hydrobiologia, 460: 25-38.

Aronson, R. B., I .G. Macintyre, C. M. Wapnich and M. W. O'Neill. 2004. Phase shifts, alternative states, and the unprecedented convergence of two reef systems. Ecology, 85 (7): 1876-1981.

Babcock, R. C. 1985. Growth and mortality in juvenile corals (*Goniastrea, Platygyra* and *Acropora*): the first year. Proc. 5th Int. Coral Reef Symp. (4): 355-360.

Back, R. P. M. and M. S. Engel. 1979. Distribution, abundance and survival of juvenile hermatipic corals (scleractinia) and the importance of life history strategies in the parent coral community. Mar. Biol., 54: 341-352.

Box, S. J. and P. Mumby. 2007. Effect of macroalgal competition on growth and survival of juvenile Caribbean corals. Mar. Ecol. Prog. Ser., 342: 139-149

Done, T. J. 1999. Coral community adaptability to environmental change at the scales of regions, reefs and reef zones. Amer. Zool., 39: 66-79.

Edmunds, P. J. 2004. Juvenile coral populations dynamics track rising seawater temperature on a Caribbean reef. Mar. Ecol. Prog. Ser., 269: 111-119.

Gil-Agudelo, D. L., J. Garzón-Ferreira, A. Rodríguez-Ramírez, M. C. Reyes-Nivia, R. Navas-Camacho, D. E. Venera-Pontón, G. Díaz-Pulido and J. A. Sánchez. 2006. Blanqueamiento coralino en Colombia durante el año 2005. 83-87. In: INVEMAR (Ed.). Informe del estado de los ambientes marinos y costeros en Colombia: Año 2005. Serie de publicaciones periódicas No. 8, Santa Marta. 360 p.

Hughes, T. P. 1985. Life histories and population dynamics of early successional corals. Proc. 5th Int. Coral Reef Symp., 4: 101-106.

Irizarry-Soto, E. and E. Weil. 2009. Spatial and temporal variability in juvenile coral densities, survivorship and recruitment in La Parguera, southwestern Puerto Rico. Car. J. Sci., 45 (2-3): 269-281.

Knowlton, N. 2001. The future of coral reefs. PNAS, 98: 5419-5425.

Pineda, I. J., L. A. Martínez, D. M. Bedoya, P. Caparroso and J. A. Rojas. 2006. Plan de manejo del Parque Nacional Natural Corales del Rosario y San Bernardo. UAESPNN, Territorial Costa Caribe, Cartagena. 379 p.

Richmond, R. H. 1997. Reproduction and recruitment in corals: critical links in the persistence of coral reefs. 175-197. In: Birkeland, C. (Ed). Life and death of coral reefs. Chapman and Hall, Nueva York. 536 p.

Smith, S. R. 1997. Patterns of coral settlement, recruitment and juvenile mortality with depth at Conch Reef, Florida. Proc. 8th Int. Coral Reef Symp., 2: 1197-1202.

Solano, O. D., G. Navas and S. K. Moreno-Forero. 1993. Blanqueamiento coralino de 1990 en el Parque Nacional Natural Corales del Rosario (Caribe colombiano). An. Inst. Invest. Mar. Punta Betín, 22: 97-111.

Van Moorsel, G. W. N. M. 1983. Reproductive strategies in two closely related stony corals *(Agaricia,* Scleractinia). Mar. Ecol. Prog. Ser., 13: 273-283.

Venera-Ponton, D. E., G. Diaz-Pulido, L. J. McCook and A. Rangel-Campo. 2011. Macroalgae reduce growth of juvenile corals but protect them from parrotfish damage. Mar. Ecol. Prog. Ser., 421: 109-115.

Vermeij, M. J. A. 2006. Early life/history dynamics of Caribbean coral species on artificial substratum: the importance of competition, growth and variation in life/history strategy. Coral Reefs, 25: 59-71.

Vidal, A. M., C. M. Villamil and A. Acosta. 2005. Composición y densidad de corales juveniles en dos arrecifes profundos de San Andrés isla, Caribe colombiano. Bol. Invest. Mar. Cost., 34: 211-225.

Wittemberg, M. and W. Hunte. 1992. Effects of eutrophication and sedimentation on juvenile corals. Mar. Biol., 112: 131-138.

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