

## Type II White-Band Disease

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**Abstract:** Epizootics of type II white-band disease (WBD II) can be confused with type I white-band disease (WBD I) and with bleaching. The only well documented cases of WBD II have been on *Acropora cervicornis* from the Bahamas, but descriptive reports indicate that it may be widespread. WBD II begins as a bleaching margin which precedes a necrotic margin. The bleaching margin usually progresses at a faster rate than the necrotic margin and can arrest, allowing the necrotic margin to catch up. In this case, the disease has the appearance of WBD I. Living polyps are found in the bleached zone although recovery has not been observed. *A. bacterium*, similar to *Vibrio charcharia* is always isolated from the surface mucopolysaccharide layers (SML) of the bleached zone, but not from the SML of unbleached areas.

**Key words:** Coral disease, *Acropora cervicornis*, white-band disease, coral bacteria.

During the past decade there has been a great deal of concern over the worldwide degradation of coral reef ecosystems (Williams *et al.* 1987). Coral 'bleaching' (loss or reduction of endosymbiotic algae or their photosynthetic pigments) has been correlated with increased sea surface temperatures (Goreau and Hayes 1994) and linked to global warming (Glynn 1993). One result of the increased awareness of this phenomenon has been the establishment of a number of monitoring programs ranging from the Caribbean Coastal Marine Productivity Program (CARICOMP, a network of marine scientists from 25 laboratories in 16 countries, established in 1993) to localized programs run out of various dive shops. Although the reporting of bleaching events has improved, and a number of reports have described biochemical and histological changes during bleaching events (Glynn *et al.* 1985, Black *et al.* 1995, Brown *et al.* 1995) an understanding of the process at the

cellular/molecular level has not been fully described. This may be due to the fact that many studies have been based on the specific bleaching signs which may indicate an environmental response of the coral animal to unusual conditions, a normal cyclic event (Buddemeier and Fautin 1993), or a response to an infectious agent (Kushmaro *et al.* 1996).

Until recently, bleaching was not thought to be associated with infectious disease. The only well-documented bacterial infection in hard corals is black-band disease, caused by a consortium of cyanobacteria (Rützler and Santavy 1983), sulfur reducers (Garrett and Ducklow 1975, Carlton and Richardson 1995) and other bacteria affecting mainly boulder and encrusting corals. The primary sign of black-band disease is an advancing black mat of fine filaments behind which only bare skeletal calcium carbonate is left. Since no living coral polyps are left behind the advancing black mat, this disease is seldom confused with bleaching

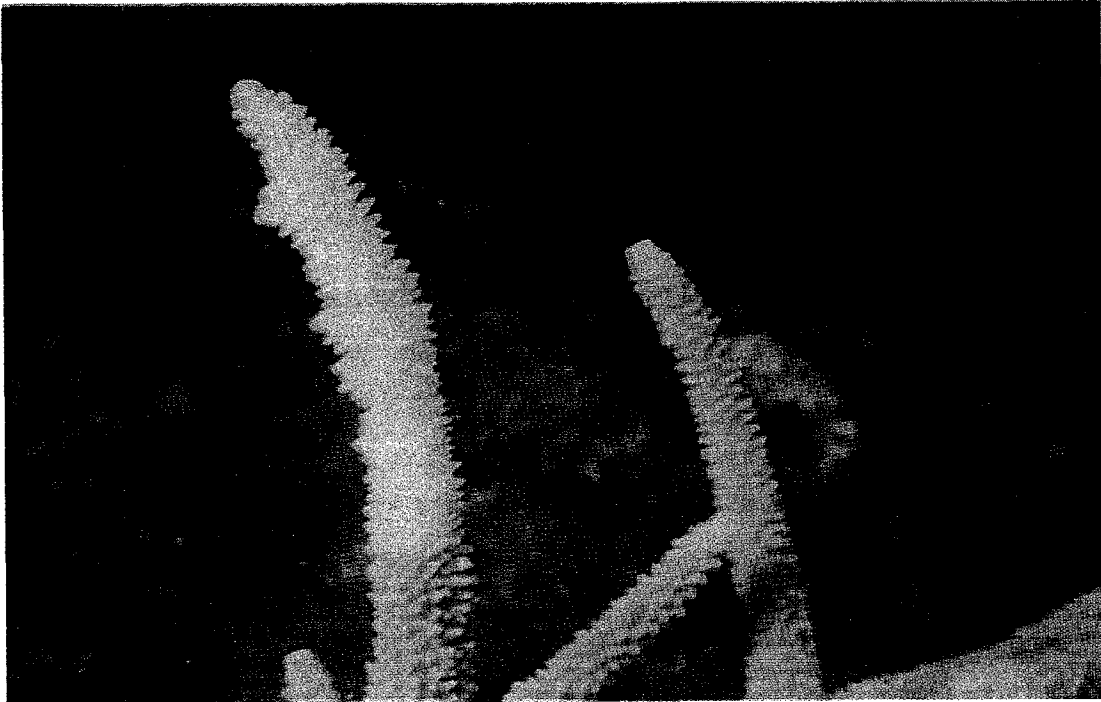


Fig. 1. Type II white band disease. Bleaching can occur from the base up or from the tip down.

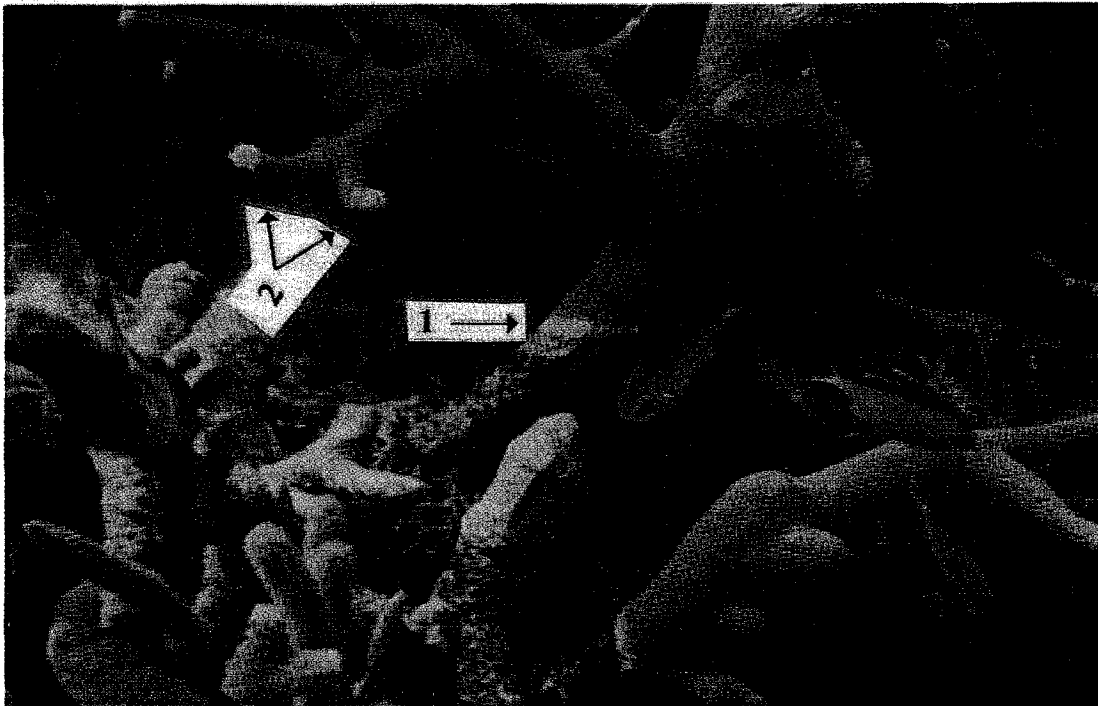


Fig. 2. Arrested type II WBD in staghorn coral. The necrotic margin of sloughing tissue has caught up with the band of bleached living tissue at the normally pigmented tissue, making these corals appear to have type I WBD (arrow 1). Tip down WBD II results in dissolution of skeletal material (arrow 2). (photo by Eric Cole). Branch width above is about 2 cm; fish length (lower) is 4 cm long.

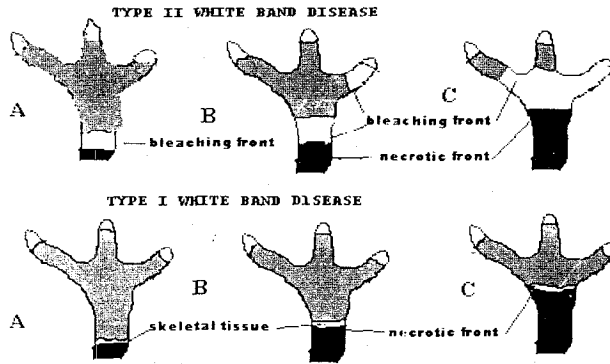


Fig. 3. Comparison of the progression of WBD I and II. (A) Type II shows a bleaching area of tissue around the branch while Type I exhibits a white band of skeleton adjacent to normally pigmented tissue. (B) The receding margin progresses in both types, Type II bleaching margin progresses at a faster rate and can be bottom-to-top or top-to-bottom. (C) The bleaching margin may arrest in Type II while the receding margin proceeds. (D) The receding margin may or may not arrest. In this case Types I and II are indistinguishable.

(which does not kill polyps unless the symbiotic algae do not become reestablished). Similarly, white-band disease (WBD, type I) which occurs more frequently on branching corals (particularly the acroporids), exhibits characteristic signs which make it easily distinguishable from bleaching. This disease progresses usually from the base of a branch outward, leaving a white band of calcium carbonate skeleton (Gladfelter 1982). Affected tissue often shows the presence of bacterial aggregates (Peters 1993).

More recently, another apparently infectious disease (type II WBD) has been documented from the Bahamas. In 1993, large stands of staghorn coral (*Acropora cervicornis*)

TABLE 1

Bleaching margin measurements of *A. cervicornis* affected with WBD II in San Salvador, Bahamas. Each row represents one branch

Day 0 (cm)	Day 3 (cm)	Progression of bleaching relative to degrading margin after three days
9.0	9.5	0.5
9.0	10.0	1.0
3.5	4.0	0.5
2.0	0.0	-2.0a
2.5	4.0	0.5
7.0	7.5	0.5
2.0	2.25	0.25
2.25	3.0	0.75
2.0	4.0	2.0
5.0	7.0	2.0
4.0	4.0	0.0b
3.25	3.5	0.25
3.5	4.0	0.5
5.0	5.0	0.0b
6.0	8.0	2.0
4.0	4.5	0.5
8.5	9.0	0.5
5.0	33.0	28.0

a Bleaching arrested.

b Progression of degenerating tissue the same as bleaching margin.

were observed to show signs of both bleaching and type I WBD. This disease progresses much like type I WBD with advancing loss of tissue followed by a white band of skeleton, but the tissue loss is preceded by a 2-20 cm band of living bleached tissue between the normally pigmented tissue and skeleton (Fig.1). Recovery of bleached tissue has never been observed, although the bleaching area can, in some cases,

TABLE 2

Location of isolates metabolically similar to the genus *Vibrio* from *A. cervicornis*

Species	Water Mass	Apparently Healthy Tissue	WBD II Bleached Tissue
<i>V. harveyi</i>	+	+	+
<i>V. metschnikovii</i>	+	+	+
<i>V. parahaemolyticus</i>	+	+	+
<i>V. anguillarum</i>	+	+	+
<i>V. fischeri</i>	+	+	-
<i>V. cholerae</i>	-	+	+
<i>V. pelagius</i>	-	+	+
<i>V. natriegens</i>	-	+	-
<i>V. mediterranei</i>	-	-	+
<i>V. charcharia</i>	-	-	+

arrest, allowing the peeling margin to catch up to the pigmented tissue (Fig. 2, arrow 1). In this case, the disease resembles type I WBD. This disease has been reported in the literature simply as white-band disease (Ritchie and Smith 1995a) not distinguishing it from type I, which does not display the bleaching component. Figure 3 compares the progression of type I and II WBD. In addition, type I begins near the base of the colony and progresses upward and outward. Type II does this also, but can also begin at the tip and progress downward resulting in the degradation of both living tissue and skeletal material (Fig. 2, arrow 2). Recently (Feb., 1997), a stand of *A. cervicornis* showing signs of active WBD II was observed in San Salvador, Bahamas. Ten branches were marked and the bleaching margin was measured from 18 secondary branches. After three days these were remeasured (Table 1). The bleaching margin advanced 0.8 cm (median = 0.17, standard deviation = 2.21, range 0 - 9.33 cm d<sup>-1</sup>) faster than the degenerating edge (0.5 cm d<sup>-1</sup>). The bleaching tissue margin arrested on one branch (# 4), allowing the necrotic edge to catch up.

Bleached corals show increased population levels of the bacterial genus *Vibrio* (Ritchie and Smith 1995b) and it has been suggested that, at least in one case (Kushmaro *et al.* 1996), bleaching was caused by a *Vibrio* strain. Bleached *A. cervicornis* tissue caused by WBD II shows increased population levels of a bacterium morphologically and metabolically similar to *Vibrio charcharia* in their surface mucopolysaccharide layers that could not be isolated from apparently healthy areas from the same colony or unaffected colonies (Table 2). *V. charcharia* was approximately 18 percent of the total heterotrophic bacterial community associated with WBD II while *V. mediterranei* was less than half of this.

In summary, WBD II appears to be a progressive infectious disease which may be widespread. From personal descriptions (A. Curran, Smith College and D. Gerace, Bahamian Field Station), WBD II is likely to have eliminated *A. cervicornis* from 'Cervicornis Reef' in San Salvador Island during the 1980s. Although the

*V. charcharia* - like bacterium can be consistently isolated from WBD II bleached tissue, to date, it has not been convincingly shown whether or not the association between coral bleaching (including WBD II) and *Vibrio* is a pathogenic relationship or a shift in the normal microbiota due to physiological or metabolic changes in the coral host.

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#### RESUMEN

Los epizoitos de la enfermedad de banda blanca tipo II (WBD II) puede ser confundida con la enfermedad de banda blanca tipo I (WBD I) y con el blanqueamiento. Los únicos casos bien documentados de WBD I han sido encontrados en *Acropora cervicornis* de las Bahamas, sin embargo los informes descriptivos indican que esta enfermedad puede que esté más extendida. La WBD II empieza como una banda blanca que precede a una banda necrótica. El margen blanco usualmente progresa a una tasa mayor que el margen necrótico y puede detenerse permitiendo que el margen necrótico lo alcance. En este caso, la enfermedad adquiere la apariencia de una WBD I. En la zona blanqueada se encuentran pólipos vivos, sin embargo no se ha observado recuperación. Una bacteria, similar a *Vibrio charcharia* siempre es aislada de las capas superficiales de mucopolisacáridos (SML) de la zona blanqueada, pero no de las SML de las áreas sanas.

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