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A POSSIBLE LINK BETWEEN CORAL DISEASES AND A CORALLIVOROUS SNAIL (*DRUPELLA CORNUS*) OUTBREAK IN THE RED SEA

BY

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A POSSIBLE LINK BETWEEN CORAL DISEASES AND A CORALLIVOROUS SNAIL (*Drupella cornus*) OUTBREAK IN THE RED SEA

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Arnfried Antonius[1] and Bernhard Riegl[1]

ABSTRACT

In April-May and in September 1996, a total of 25 reefs were studied between Taba and Ras Mohammed in the Gulf of Aqaba, Red Sea. In only four of these reefs *Drupella cornus* showed up in the transects in low numbers and coral diseases were found at a moderate level on most reefs. Only the reefs of Ras umm Sidd, near Sharm el Sheikh, exhibited *Drupella cornus* as well as coral diseases both at abundant or even epidemic levels. There definitely seems to be a correlation between abundance of snail and diseases, but the question of "what comes first" remains to be investigated : does massive coral die-off (mostly White Syndromes) attract or benefit *Drupella cornus* and thus promote a population explosion, or does a massive *D. cornus* invasion promote an epidemic of White Syndromes on corals ?

INTRODUCTION

In the course of a large scale ecological investigation of Gulf of Aqaba coral reefs, with special emphasis on coral health, the distribution of coral diseases and the impact of predators was investigated. We detected an abnormally high proportion of dead corals at Ras umm Sidd (fig.1) and found two major causes contributing to coral mortality:
1) an abundance of coral diseases, mainly White Syndromes (Antonius 1995a), and
2) a population explosion of the corallivorous gastropod *Drupella cornus* (plate).

The coral species most frequently affected was the branching species *Acropora hemprichi*, an important and dominant species on Red Sea reefs (Riegl & Velimirov 1994). Of all the reef sites studied throughout the Sinai-side of the Gulf of Aqaba (and in the past also Haql: Antonius 1988), Ras umm Sidd was found to be the only site showing this combination of high levels of *Drupella*-predation associated with high levels of coral diseases. This observation led us to the question whether the two phenomena were correlated. Intensive *Drupella* predation (without associated diseases), that caused the destruction of wide reef areas, has been reported by others from the northern and central Red Sea (Schuhmacher 1992; Schuhmacher et al. 1995), from Japan and the Philippines (Moyer et al. 1982), as well as from Western Australia (Turner 1992, 1994).

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Coral diseases (without associated *D. cornus*) degrading reef health have been reported from Caribbean (Antonius 1977, 1981), as well as Indo-Pacific locations (Antonius 1984, 1988).

The first stage of this study was carried out by both authors in April-May 1996; later work was conducted by Antonius in September of the same year.

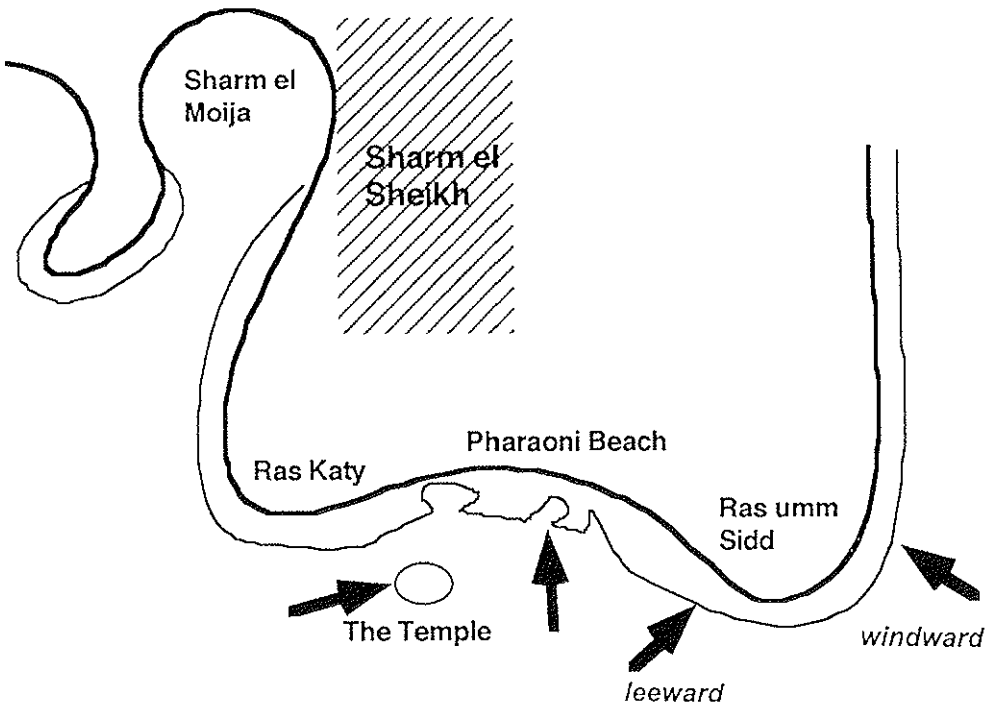

Figure 1 The four survey sites of the study: the fringing reefs of 1) Ras umm Sidd windward side, 2) Ras umm Sidd leeward side, 3) Pharaoni Beach, and the patch reefs of 4) The Temple.

MATERIALS and METHODS

Coral diseases and other coral destroying agents encountered during this survey were the following: Black Band Disease (BBD), Black Overgrowing Cyanophyta (BOC), White Band Disease (WBD, Tissue Bleaching (TBL), and Shut-Down-Reaction (SDR); all listed and described in Antonius (1995a), as well as a newly discovered Skeleton Eroding Band (SEB) which is presently under investigation. WBD, TBL, and SDR are jointly referred to as White Syndromes (WS). Also recorded was the coral-eating snail *Drupella cornus* (DRU).

The semi-quantitative Belt Method (Antonius 1995b) was used to assess these syndromes. It is a time-count technique using one half-hour of observation time, which is considered a SCAN. During every scan, the diver swims fairly close to the reef surface and notes down all pathologic syndromes on corals that are encountered. The numbers of syndromes counted during one scan are arranged in categories: 1-3 cases = condition 1, rare, 4-12 cases = condition 2, moderate; 13-25 cases = condition 3, frequent; 26-50 cases = condition 4, abundant; 51-100 cases = condition 5, epidemic, and any number in excess of 100 = condition 6, catastrophic. Four sites were surveyed this way: Ras umm Sidd windward, Ras umm Sidd leeward, Pharaoni Beach, and The Temple (figure 1 and table 1).

A similar semi-quantitative method was used to assess the impact of *Drupella cornus* predation on the local populations of *A. hemprichi*.. We sampled the same sites except Pharaoni Beach (fig. 2). During a 30 minute dive, which followed a depth gradient to 25 m depth, *D. cornus* populations were assessed in the same way described above (Belt-Method). In addition to that, all *A. hemprichi* colonies were recorded and grouped into four categories:

- alive, meaning no signs of recent partial mortality (no white areas)
- dead, meaning recently dead (whole colony white)
- partly dead, with some recently denuded branches (white skeleton)
- discolored, some colonies did not display the typical blue or green color, but were of a faded yellow and had filamentous algae settling on the tissues, which indicated poor health. This category was used in order to check for sources of mortality other than *Drupella*.

RESULTS

Of 25 reefs studied between Taba and Ras Mohammed in April-May 1996 (Antonius 1996, Riegl 1996), *Drupella cornus* was found on most of the surveyed reefs, but in densities so low that they did not always show up in a scan (few branches on digitate colonies stripped of tissues, no freshly dead entire colonies). At the level of condition 1 (rare), *Drupella cornus* was found on four reefs (Marsa el Muqabila, Nabq, Turtle reef, Kashaba beach: some stripped branches, also few completely stripped colonies, but less than 10% of digitate colonies affected).

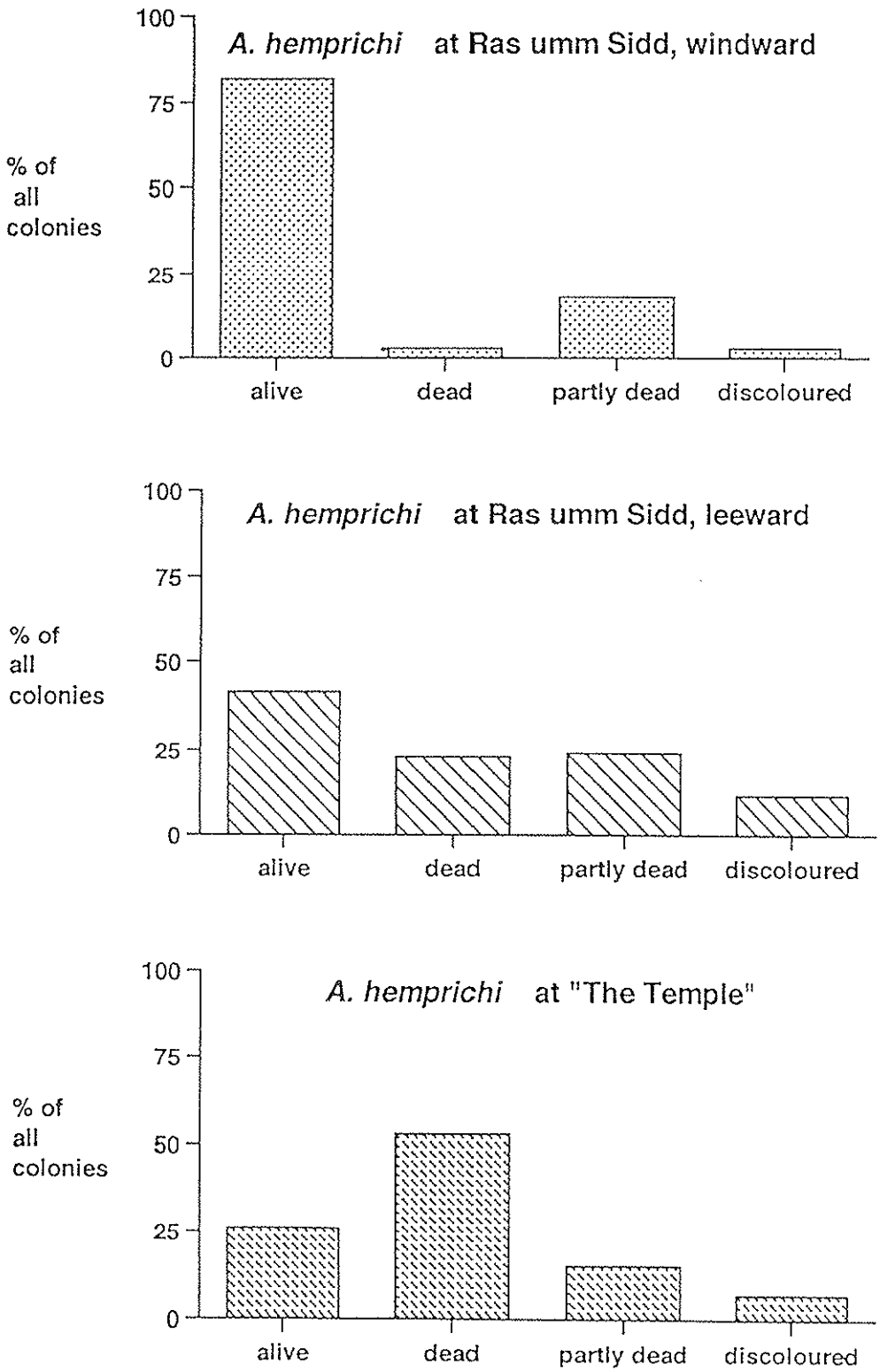

Figure 2 The state of health of *Acropora hemprichi* populations at three sample sites of the study area.

Plate Underwater photograph showing *Drupella cornus* feeding on a branch of *Acropora hemprichi* at the exact borderline of an active White Band Disease.

In very high densities, up to condition 5, *D. cornus* was only found at Ras umm Sidd (frequent completely stripped colonies, most colonies with stripped branches, over 20%, and up to 60%, of all colonies affected). These are elevated levels even when compared to values of high *Drupella* frequency obtained by Schuhmacher et al (1995) from Aqaba (1% coral death on average for the whole shallow reef, up to 30% tissue depletion).

The reefs with low and medium *Drupella* abundance also had a normal incidence of coral diseases as diagnosed according to Antonius (1995a). Ras umm Sidd and the adjacent Pharaoni Beach toward Ras Katy (fig. 1), however, showed high levels of coral diseases. They increased in frequency from the windward side of Ras umm Sidd to its leeward side and increased even further towards Pharaoni Beach and The Temple. Coral diseases were censused on the reef flat, on the reef edge and slope, and on the patch reefs immediately in front of the fringing reef (The Temple). The general health status of the reef therefore decreased markedly towards the center of the bay (table 1).

Table 1

Occurrence of coral diseases and *Drupella cornus* damage, as well as their frequency (= condition-numbers) at the four sample sites :

WBD (White Band Disease))
TBL (Tissue Bleaching)) = WS (White Syndromes)
SDR (Shut-Down-Reaction))
BOC (Black Overgrowing Cyanophyta),
SEB (Skeleton Eroding Band),
DRU (*Drupella cornus*)

Condition
1 = rare (1-3 cases per scan)
2 = moderate (4-12 cases per scan)
3 = frequent (13-25 cases per scan)
4 = abundant (26-50 cases per scan)
5 = epidemic (51-100 cases per scan)
6 = catastrophic (above 100 cases per scan)

Ras umm Sidd
Windward

	BOC	WBD	TBL
flat + slope	3	2	2

Ras umm Sidd
Leeward

	BOC	WBD	TBL	SDR	DRU	SEB
flat	4	4	3	2		1
slope	4	4	3	2	3	1

Pharaoni Beach

BOC	WBD	TBL	SDR	DRU	SEB
5	4	4	4	4	2

The Temple

BOC	WBD	TBL	SDR	DRU	SEB
5	5	4	4	5	2

Similar to the distribution of coral diseases, the frequency of *Drupella cornus* also increased from the windward side of Ras umm Sidd toward the bay (table 1). At the windward side of Ras umm Sidd, the shallow (0.5 m) reef-flat as well as the (steep) fore-reef-slope were practically free of *Drupella* (DRU). On the leeward side, the frequency of pathologic syndromes increased, but only on the slope was it accompanied by *Drupella* (table 1). At both sites, Pharaoni Beach and The Temple, incidences of coral diseases and *Drupella* frequency increased even further (table 1), with *Drupella* occurring below 1-1.5 m at Pharaoni Beach and below 3m at The Temple.

Although observation time was too short to obtain absolute certainty, we were able to distinguish three phases of WS-DRU interaction:

Phase 1: *Drupella cornus* snails, when occurring in low numbers, are usually feeding on the exact interface of a WBD (fig. 3); with such an open wound available, they do not attack healthy coral tissue.

Phase 2: Larger concentrations of *D. cornus* are feeding on healthy coral tissue at a speed far exceeding that of a WBD; this is the situation most frequently encountered at Ras umm Sidd.

Phase 3: The impact of excessive feeding by *Drupella* triggers a SDR, destroying more coral tissue than is occupied by snails; large numbers of *D. cornus,* now stranded on a coral branch without tissue, move on to new feeding grounds.

During a re-survey in September 96 it was noted that the categories of conditions, established in April-May, were changing. For example, when a condition 4 (abundant) in April-May covered roughly 30 cases, in September the number of cases had increased to between 40 and 50.

DISCUSSION

This correlation of declining reef health and increasing frequency of *Drupella* led us to the question how these two independent phenomena, i.e. WS diseases and *D. cornus* predation, could become connected through such a "circulus vitiosus" at Ras umm Sidd ?

Ras umm Sidd is one of the most frequented diving sites in the northern Red Sea (Hawkins & Roberts, 1992). Two hotels have private beaches inside the bay between Ras umm Sidd and Ras Katy (one of them the sample site Pharaoni Beach). Furthermore, it is close to the town of Sharm el Sheikh and its busy port at Sharm el Moija.

Reasons for the decline in reef health could be related to the leaching of toxic substances from the antifouling of ship bottoms, the disposal of sewage and septic tanks from the dive boats, and also to considerable impact by divers and swimmers. Tourists coming in by boat are usually told by their dive-guides what to avoid under water. But not everybody heeds the advice, and many divers come from land. The result is that corals are constantly being touched and stepped upon, thus remaining in a state of chronic irritation.

Whatever the reasons for the bad health particularly in the center of the bay, only this already weakened reef showed signs of a *Drupella* outbreak, while other reefs in the area showed normal health and low frequency of *Drupella*. At Ras umm Sidd, the frequency of coral diseases increased towards the bay both on the reef flat, where no *Drupella* were encountered, and the reef slope, where *Drupella* were frequent (table 1). Therefore, on the reef flat, there is little room for misidentifying White Syndromes as *Drupella* damage (table 1, leeward, flat). On the reef slope this situation was not so clear, as *Drupella* damage and White Syndromes are both frequent in this zone (table 1, leeward, slope) and not always easy to distinguish.

However, there is evidence that *Drupella* and WS occurrence may be linked in some way. For example: when a large WBD stretches across a corallum and a scant few specimens of *Drupella* are feeding on the exact interface of the disease (= phase 1), they were apparently attracted by the disintegrating coral tissue. The same phenomenon was observed involving the "fireworm" *Hermodice caruncullata* in the Caribbean Sea (Antonius 1975). A situation comparable to phase 2 (as defined in "Results") has been observed in the behavior of the crown-of-thorns starfish *Acanthaster planci* in the past (Antonius 1971). And a phase 3 phenomenon. i.e. a SDR outrunning the predator, was originally also documented for *Hermodice caruncullata* (Antonius 1977).

Thus, this particular sequence of events seems to be reasonably clear. However, since we do not know whether *every* local *D. cornus* invasion originated at the site of a WBD, the basic question still remains: does massive coral die-off (mostly WS) benefit *Drupella cornus* and thus promote a population explosion, or does a massive *Drupella* invasion promote epidemic White Syndromes on corals ?

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