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EFFECTS OF TROPICAL STORM BRET ON CURAÇAO REEFS

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It is obvious that hurricanes can have a destructive effect on reefs situated on the leeward sites of islands (Glynn et al., 1964). However, also minor storms passing at relatively great distance can cause severe damage. Here we report on damage caused by tropical storm Bret, passing south of the island of Curaçao at a distance of 110-145 km in August 1993. Curaçao is situated off the coast of Venezuela and outside the "hurricane belt" (Rogers, 1993).

The closest approach to Curaçao of Bret was on 8 August 1993, from 06.00-08.00. Maximum wind velocity measured at the Curaçao Meteorological Service was about 42 kn, mean value: 25—30 kn. The estimated wave height near the location Seaquarium was approximately 1.5 m above normal. The storm was not accompanied by heavy precipitation. Bret was the 21st tropical cyclone passing Curaçao within 100 nm since 1900, the former cyclone was Joan in 1988.

Damage on marine life was surveyed 2 weeks after the storm at five localities along the leeward coast of the island (Fig. 1; for detailed information on the study sites see Van Duyl, 1985). In selection of the sites we were guided by Van Duyl's (1985) reef atlas. Severe damage was recorded for the scleractinian corals *Acropora palmata* (Lamarck) and *Millepora complanata* (Lamarck). *Dendrogyra cylindrus* (Ehrenberg) was incidentally damaged in shallow water, <5 m.

Acropora palmata damage was surveyed by counting the number of broken branches (branch length > 20 cm) of haphazardly chosen colonies. In *A. palmata* 43% to 89% of colonies were damaged in four localities, no damage was observed at Playa Kalki. In these colonies 25% to 50% of the branches were broken off. Damage on *A. palmata* was found at 4 localities up to depths over 8 m (Table 1). There was a clear decrease in living coral of *A. palmata* colonies at these sites. Most fragmented branches that were detached were bleached and likely to die. This is in contrast to Bak and Criens (1981), who found virtually no mortality after experimentally breaking up colonies. Post-breakage mortality after the storm is probably a result of such storm associated factors as continued high wave energy, scouring (Knowlton et al., 1981) and sedimentation. An abrupt decrease of water temperature from 27°C to 23.6°C registered about 40 h after the storm can be considered as one of the major delayed effects (Fig. 2). This sudden temperature change is larger than the average annual fluctuation and was registered on a Ryan Instruments thermograph situated at a depth of 30 m near CAR-MABI Buoy 1 (see Van Veghel, 1994). Temperature was normal 3 d after the decrease. The storm must have effected the process of sexual reproduction since the *A. palmata* colonies were carrying gonads (Van Veghel, pers. obs.). This simply was a consequence of the die off of living tissue or regeneration processes (Van Veghel and Bak, 1993).

Millepora complanata was surveyed from 2 to 6 m at 1-m intervals. Colonies

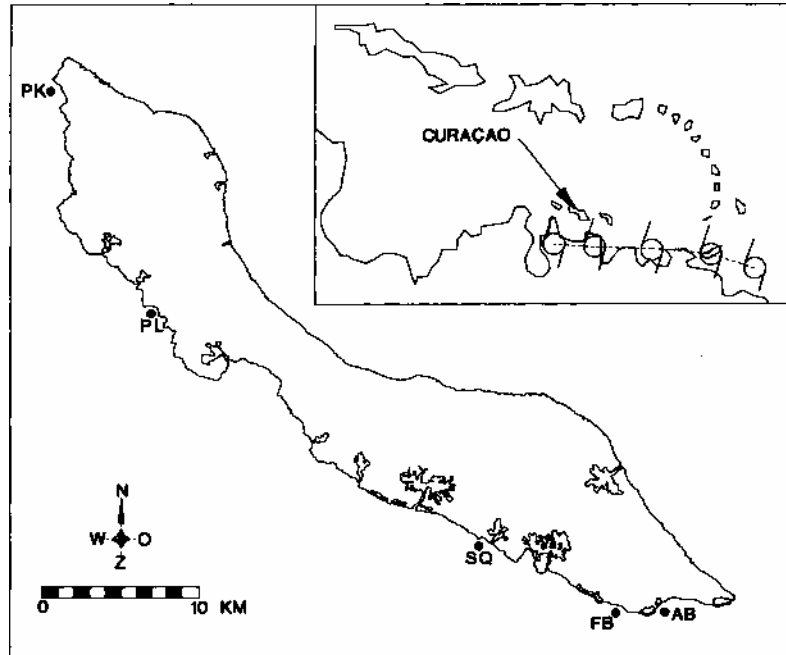


Figure 1. Location of surveyed localities on Curacao, Netherlands Antilles, and the route of tropical storm Bret. Location: AB = Awa Blancu, FB = Fuikbaai, SQ = Seaquarium, PL = Playa Largu, PK = Playa Kalki.

were considered damaged when one or more plates were broken. Damage had occurred at all localities and ranged from 7% to 94% of the colonies. A decrease in damage with increasing depth is demonstrated in Table 2.

It is obvious that the two localities most distant from the storm's eye, Playa

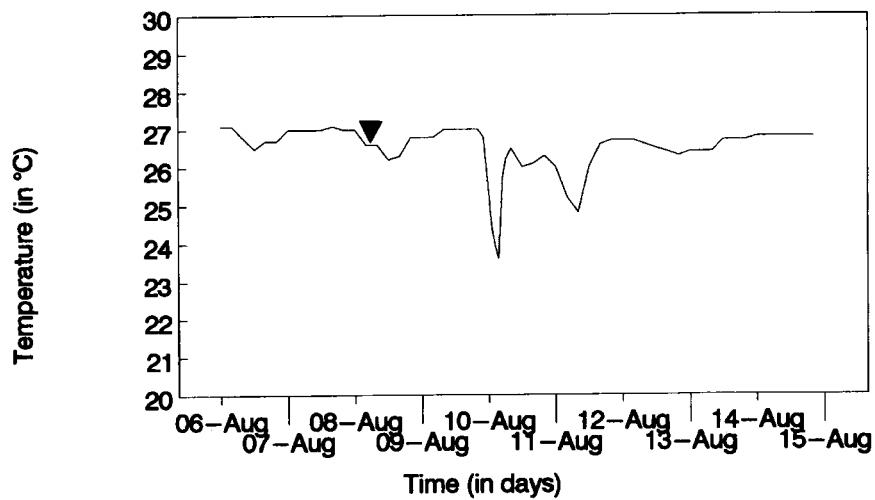


Figure 2. Temperature fluctuations before and after the tropical storm Bret passed Curaçao. Time of closest passage is indicated by the triangle.

Table 1. *Acropora palmata*. Recorded damage on Curacao reefs after tropical storm Bret. The number (No.) of colonies and branches surveyed and the % damage is given as well as the max depth damage occurred.

Locality	Colonies (No.)	Damaged	Branches (No.)	Damaged	Depth (m)
Awa Blancu	46	78	391	36	8.2
Fuikbaai	49	57	426	25	4.8
Seaquarium	65	89	542	50	4.8
Playa Largu	63	43	530	25	4.4
Playa Kalki	32	0	390	0	—

Table 2. *Millepora complanata*. Percentage colonies damaged along a depth gradient on Curacao reefs after tropical storm Bret (number of colonies); — = colonies absent.

Locality	Depth (m)				
	2	3	4	5	6
Awa Blancu		94 (107)	73(116)	44(101)	19 (62)
Fuikbaai		75 (93)	57 (97)	35 (100)	
Seaquarium Playa		82 (122)	65 (160)	52(105)	35(113)
Largu Playa Kalki	35(115) 7 (107)	22 (103) 0 (100)	8 (120)		

Largu and Playa Kalki, had the least damage. The effect of the tropical storm could be barely recognized on Playa Kalki. The data presented show that a disturbance can damage a coral reef up to a distance of 145 km from its center.

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