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DISPERSED OIL EFFECTS ON MANGROVES, SEAGRASSES, AND CORALS IN THE WIDER CARIBBEAN

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ABSTRACT

Most oil spill clean-up plans in the wider Caribbean indicate that dispersants should not be used. This is in error for coastal and estuarine spills. There have been a series of studies, which will be reviewed, both for field and laboratory on toxicity effects of dispersants on critical habitat matrix organisms in the Caribbean basins. Red mangroves and several coral species were seen to not have toxic effects from Corexit 9527 within the 1-50 ppm range. The Rhizophora mangle experiments by Teas indicated better survival when Corexit was used, than oil alone. Laboratory results for seagrasses on seven dispersants showed lows, medium, and high toxicities not dependent on oil type. These results indicated an "acceptable" list of dispersants as the British have is necessary for the wider Caribbean matrix-species preservation during spills where dispersants will be used. Three major wider Caribbean seagrasses have differing toxicity responses, dependent on the dispersant, but in the same ranking: Thalassia more tolerant than Halodule, more tolerant than Syringodium. Coral results in Bermuda and Panama by Knap et al. (1985) for Diploria strigosa and Porites porites with Agaricia sp. indicate that the dispersant Corexit 9527 is not toxic (1-50 ppm). Ongoing studies in Jamaica are discussed for coral and seagrasses.

INTRODUCTION

Most of the shorelines containing mangroves and corals are in the developing world. Oil spill clean-up in these countries has been adopted from measures from temperate climates where less sensitive habitat species occur on shorelines.

After dispersants were used with a negative result in the Torry Canyon Spill, dispersants were banned from use by most nations. Two developments occurred: 1) many manufacturers made a far less toxic dispersant; 2) many spills were not able to be controlled by mechanical means because these were too large, too fast in arriving at the shore, or too difficult to contain in booms (high seas, high winds, fast tides), or a different spatial configuration for boom development. Recent work on mangroves (in field and laboratory) shows that mangroves are statistically more able to survive oiling if dispersant is added prior to the time the oil approaches the mangroves (Teas et al., 1987).

The work done to date on corals included intensive studies of the effects of the dispersant Corexit 9527 and a BP product on the coral Diploria strigosa in Bermuda (the northern-most site of Atlantic corals) by Knap and associates. Their conclusion was to recommend use of dispersants to the government of Bermuda. Le Gore et al. (1983) studied Corexit 9527 on several Arabian Gulf corals and found no toxicity. In Panama, field tests showed no toxicity of Corexit 9527 on Porites porites, Avicennia niger and Thalassia testudium (Getter et al., 1987, Knap et al., 1985), although a real life oil spill showed large areas of decimation (Cubit et al., 1987).

Mangroves have been shown to be decimated in a series of oil spills in all continents. Seagrasses have been less well documented, but definite damage as an effect of oil spills have been shown (review by Thorhaug, in prep).

METHODS

The specimens were selected to represent major critical habitat organisms in the front seaward edge of community, in mid-depth range and in near-shore or estuarine areas. The specimens were chosen with help from U.W.I. and NRCD experts.

Seven individual specimens for each variable testing set were taken from outer Kingston Harbor for seagrasses and from the middle north coast or the proximity of Discovery Bay for seagrasses. Only very healthy specimens were used.

After collection and acclimation, specimens were exposed to the test substance in 100,000 mL fresh seawater in 50 gallon glass tanks. Static conditions with vigorous bubbling occurred for the incubation period. Specimens had test substance plus incubation water removed replaced with fresh running seawater. The oil was aged 24 hours prior to administration. The dispersant was poured into the oiled seawater and vigorously mixed by a paddle for one minute. Measurement of incubation exposure and growth were made prior to administration of test substance, after and at 2 to 3 d intervals thereafter (10 d seagrass and 14 d corals). 125 ml oil with 12.5 ml dispersant or 75 ml oil with 7.5 ml dispersant were used. Measurements were made from May to September. Health of corals was described on a graduated scale previously discussed by Thorhaug and Marcus (1982) with 100% alive and colorful as 10 and 1 equals to dead, bleached. Five to 50% bleached, discolored or spotted. 10 = 100% alive and colorful, 5 = 50% bleached, discolored or spotted and 1 = 100% dead, bleached.

Seagrass gradation of health and blade growth included a scale previously outlined in Thorhaug and Marcus (1982). The growth measurements were made on a 2-4 cm young blade, one on each of seven shoots. Counts of mortality made on all 700 blades per tank. The statistics were Student-Newman-Keuls analysis of variances. The preliminary results of our first sets of experiments are recorded in results. Ongoing results are still being analyzed.

RESULTS

The results to date are preliminary. Final results will be forthcoming in one year. The results of the laboratory testing can be separated into two sets of data, although general results have begun to emerge which can be synthesized. The general result, not ever recorded until now, shows that the toxicity of various dispersant products was very similar in order of ranking between species of both corals and seagrass: three levels of toxicities were apparent at high concentrations: high toxicity (80 to 100% mortality); medium toxicity (45 to 75% mortality) and low toxicity (0 to 30% mortality). The same dispersant products fall into the same rank-order for all species tested and for corals and seagrasses.

Coral Data

Table 1 shows two high concentrations of dispersed oil for 10 hour exposure (which time period is relevant to about the time a tidal cycle would have the dispersed oil exposure to corals).

Corals show a definite order of increasing tolerance to the dispersant products. Conco K (K), OFC D609, Corexit 9527, Kemarine, ADP 7 (Petrogreen) and Janosolv are among those most toxic to all three species. Corexit 9550 falls into an intermediate range. The lesser toxicity includes Elastosol, Cold Clean, Finasol. These latter mortalities were 25% and less. We are continuing to test dispersant products in Jamaica.

Seagrass

The preliminary laboratory toxicity testing seen in Table 2 shows that Jamaican seagrasses were very sensitive to the following dispersants: Conco K(K), ADP 7 and OFC D609 and Corexit 9527.

The seagrass tolerated Elastosol, Cold Clean and Finasol far better. With ADP 7 and Corexit 9550 being intermediate toxicity. Bunker crude oil was more toxic than was Venezuelan middle light crude.

DISCUSSION

Management Principles for Use of Dispersant on Tropical Habitats

For the first time a series of major dispersants marketed around the world were laboratory tested and compared in toxicity on dominant corals and seagrasses in the Greater Caribbean. These tests showed some products of low toxicity, which even 2 orders of magnitude above recommended use were not toxic to corals or seagrasses. On the other hand, some products were quite toxic to both seagrass and corals and should not be used near these resources. The order of ranking of toxicity of products was approximately the same between corals and seagrasses.

It is now apparent that some dispersants at concentrations recommended by the manufacturer can be used under various sets of emergency conditions for oil spills which frequently occur in the world's tropics: a) estuarine spills where or when mechanical means are inadequate to control oil from impacting one or more type of habitat, especially mangroves, b) nearshore coastal spills where environmental conditions are rapidly transporting spill toward one or more critical habitat, c) weather conditions when mechanical clean-up is ineffective and there is a danger of impacting corals, mangroves or seagrasses. (It should be noted that our present information from literature shows mangroves appear to be affected "physically" by oil. When oil remains in the sediment, it appears to smother the mangroves by cutting off oxygen to the lenticels in the subsediment. If only the above ground portion is oiled, no mortality occurs. If the oil is dispersed prior to arriving into the mangroves, the mangroves do not experience massive mortality [Teas et al., 1987]).

Thus, it is important to find low toxicity products as dispersants for coral and seagrass.

All parties must stop using the generic term "dispersants" within the oil spill clean-up plans. Specific tested and non-toxic dispersants must be named for spills on each habitat type with their upper concentration limits for use described.

Further laboratory tests must be done by nations in tropical areas to test their commonly used and stockpiled dispersants for toxicity effects on their critical habitat organism such as various species of corals, mangroves, seagrasses and marshes. It is unrealistic to imagine small third world nations will find this a priority. Regional multinational and industrial funds should undertake this.

A network of rapid information dissemination to industry, environmental management, government spill clean-up managers should be organized so that whatever information is derived can be disseminated.

Resource maps which must include the exact species of mangrove, seagrass or corals should be included in oil spill contingency plans. Since the toxicity effects differ by more than order of magnitude between species, present "lumping" resource maps (ie. "seagrasses) are inadequate. By integrating the resource maps into planning oil spill clean-up in a manner as Venezuela has, updated information can easily be incorporated into plans on a yearly basis.

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Table 1. Percentage mortality of selected Jamaican major habitat corals vs. Dispersant type of dispersed Venezuelan light oil.

Dispersant Type	*Porites porites* 125 mL. 10 Hrs.	*Porites porites* 75 mL. 10 Hrs.	*Montastrea annularis* 125 mL. 10 Hrs.	*Montastrea annularis* 75 mL. 10 Hrs.	*Acropora palmata* 125 mL. 10 Hrs.	*Acropora palmata* 75 mL. 10 Hrs.
Conco	100	100	100	100	100	
OFC D609	100	88	100	ND	100	
Corexit 9527	72	88	100	76	100	
Kemarine	100	100	100	88	100	
ADP 7	100	ND	100	ND	100	
Corexit 9550	43	0	0	12	100	
Jansolv	87	72	72	52	ND	
Elastosol	0	0	0	0	0	
Cold Clean	0	ND	17	ND	ND	
Finasol	0	0	0	0	20	
Oil only	52	12	52	0	90	
Control	0	0	0	0	0	

Table 2. Percentage mortality of selected Jamaican major habitat seagrasses vs. Dispersant type of dispersed Venezuelan light oil.

Dispersant Type	*Thalassia* 125 mL. 6 Hrs.	*Thalassia* 75 mL. 10 Hrs.	*Halodule* 125 mL. 6 Hrs.	*Halodule* 75 mL. 10 Hrs.
Conco	100	57	82	90
OFC D609	70	35	63	82
Corexit 9527	89	32	93	72
Kemarine	63	48	68	68
ADP 7	50	22	46	90
Corexit 9550	40	20	46	31
Jansolv	0	0	0	3
Elastosol	15	11	46	13
Cold Clean	0	0	0	0
Finasol	0	0	0	4
Oil only	30	11	28	13
Control	11	10	9	11