

Relative Toxicity of Oil Dispersants to *Mytilus viridis* & *Macrobrachium idella*

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There was a great variation in the relative toxicity of different oil dispersants. Dispersant IB 2/80 was most toxic and dispersant IB 11/80 was not lethal at the highest concentration tested. The ranking order of the emulsions (oil dispersant) was almost identical for both the species tested, although there was a significant shift in the range of LC_{50} values, indicating that one species is less sensitive than the other. Oil dispersant mixtures were less toxic than the dispersants alone.

Toxicity of oil dispersants to marine organisms has been evaluated using a standard static bioassay¹. In the present study effects of these dispersants and oil dispersant mixtures on *Mytilus viridis* and *Macrobrachium idella* have been studied.

Toxicity tests were carried out as described by APHA². The routine acute test consisted of exposing 10 test organisms per concentration. Different concentrations were prepared by serial dilutions of the stock solution of the commercial grade dispersant (supplied by M/s Castrol Ltd, Bombay). A control experiment was performed in parallel where the animals were kept in seawater. A second control, containing oil, (crude oil from Bombay High) was also run simultaneously, while studying the effect of oil/dispersant mixtures. All tests were conducted in seawater under controlled conditions (sal 34×10^{-3} ; pH 8; dissolved $O_2 > 5$ ppm; temp. $27^\circ \pm 1^\circ C$). The volume of crude oil used in the oil dispersant mixture was kept constant (approx. 1 mm thickness oil film). The relative toxicity was studied in replicate 96 h bioassay. Probit analysis of the data was made with the help of a computer.

The results (Table 1) indicated that the toxicities (expressed as LC_{50}) of the dispersants are not of the same order. LC_{50} values were inversely proportional to the time of exposure. A wide difference between the 24 h and 96 h LC_{50} values was observed. This may be due to the release or breakdown of certain components of the dispersants after prolonged mixing in seawater.

Relative toxicities of different dispersants varied greatly for both the species and the difference was about 9 to 66 fold for the dispersants and 1 to 2 fold for the oil/dispersant mixture. Dispersant IB 2/80 was most toxic for both the species tested. The 96 h LC_{50} values were 1.72 and 67.51 ppm for *M. idella* and *M. viridis* respectively. It was about 40 times more toxic to *M. idella* than to *M. viridis*. In general, *M. viridis* was less susceptible to the dispersant than *M. idella*. Oil dispersant mixtures were less toxic than the dispersant

alone, and many fold less toxic than the crude oil. When the dispersants were mixed with crude oil, the overall difference or range in the toxicity of the different dispersants to the test organisms was 4 - 60 fold for *M. viridis* and 100 - 400 fold for *M. idella*. It was found that for those dispersants which were toxic when used alone, except IB 2/80 and IB 11/80, the toxicity when mixed with oil was greatly reduced.

The toxicity data are rearranged to produce rank order with respect to the 2 species using the rank correlation coefficient r , where $r = \frac{1 - 6 \sum d^2}{n(n^2 - 1)}$, n = number of rank, d = difference between rank order for both the species tested. There existed a significant difference in the rank order of the dispersant, but the rank order for oil dispersant mixtures showed close agreement (Table 2). The rank orders were based on the 96 h LC_{50} values. It has been observed³, that the rank orders established at different times differ significantly. It is apparent from the present results that the toxicity response is not constant with time. Therefore, the dispersants are ranked in groups with respect to their 96 h LC_{50} values⁴, viz. 1-100 ppm, toxic; 100-1000 ppm, moderately toxic; and 1000-10000 ppm, slightly toxic.

According to this classification all the dispersants were toxic to *M. idella* when used alone, whereas for *M. viridis* their toxicity differed. It was found in a variety of marine animals that the combination of oil/dispersant was more toxic than either the crude oil/dispersant alone⁵. The present results show that after mixing the dispersant with oil, the toxicity of the dispersants decreases several folds. The exact cause of this modifying factor is not known, however, it may be due to the change in the molecular structure of the dispersants when combined with oil thereby inactivating the toxic components of the dispersants or as Tarzwell⁶ points out that it is the emulsification of the oil-itself and the spreading throughout the water which largely govern the toxicity of the mixture.

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Table 1—Acute Toxicity of Dispersant and Oil Dispersant Mixture to *M. viridis* and *M. idella*
(All values are given in ppm (v/v), a—LC₅₀ values; b—confidence limits; and c—slope function)

Dispersants	<i>M. viridis</i>			<i>M. idella</i>		
	Time interval		% Difference 24 h to 96 h	Time interval		% Difference 24 h to 96 h
	24 h	96 h		24 h	96 h	
IB 2/80	(a)	221.68	67.51	(a)	4.16	1.72
	(b)	276.7-177.6	90.4-50.4	(b)	4.8-3.6	2.3-1.3
	(c)	5.35	5.32	(c)	8.81	4.70
IB 1/80	(a)	591.72	77.52	(a)	19.85	8.42
	(b)	957.0-365.9	117.2-51.3	(b)	23.3-16.9	10.6-6.7
	(c)	2.81	3.77	(c)	8.15	5.81
IB 11/80	(a)	1916.46	885.45	(a)	40.46	23.79
	(b)	2057.9-1761.1	1091.1-718.5	(b)	42.9-38.2	26.5-21.3
	(c)	14.80	6.00	(c)	22.49	9.78
IB 12/80	(a)	1302.00	681.49	(a)	39.0	22.00
	(b)	1404.9-1206.6	711.9-601.7	(b)	42.2-37.5	25.0-19.3
	(c)	13.05	9.21	(c)	22.68	8.98
IB 13/80	(a)	3013.24	1319.77	(a)	34.10	19.88
	(b)	3281.3-2767.0	1573.5-1106.9	(b)	37.0-31.4	23.2-17.0
	(c)	15.62	6.43	(c)	13.24	8.28
Dispersant/oil mixture						
IB 2/80	(a)	1.500	600.05	(a)	0.001	0.001
	(b)	—	678.5-530.7	(b)	—	—
	(c)	—	11.11	(c)	—	—
IB 1/80	(a)	7,500	4602.04	(a)	0.05	0.05
	(b)	—	5045.4-4197.6	(b)	—	—
	(c)	—	13.08	(c)	—	—
IB 11/80	(a)	7,500	7,500	(a)	10,000	10,000
	(b)	—	—	(b)	—	—
	(c)	—	—	(c)	—	—
IB 12/80	(a)	7,500	5521.03	(a)	2969.31	2440.11
	(b)	—	5869.7-5193.0	(b)	3113.4-2831.9	2594.5-2294.0
	(c)	—	22.86	(c)	23.18	18.17
IB 13/80	(a)	7,500	5356.86	(a)	3848.88	3062.97
	(b)	—	5721.1-5015.8	(b)	4035.9-3670.5	3296.1-2846.3
	(c)	—	—	(c)	25.72	21.07

Table 2—Comparison of Rank Orders of Dispersants and Oil/Dispersant Mixture Based on 96 h LC₅₀ Values

Dispersant				Oil/dispersant mixture				Remarks
<i>M. viridis</i>	<i>M. idella</i>	d	d ²	<i>M. viridis</i>	<i>M. idella</i>	d	d ²	
IB 2/80	IB 2/80	0	0	IB 2/80	IB 2/80	0	0	Highly toxic
IB 1/80	IB 1/80	0	0	IB 1/80	IB 1/80	0	0	Toxic
IB 12/80	IB 13/80	1	1	IB 13/80	IB 12/80	1	1	Moderately toxic
IB 11/80	IB 12/80	1	1	IB 12/80	IB 13/80	1	1	Moderately toxic
IB 13/80	IB 11/80	2	4	IB 11/80	IB 11/80	0	0	Slightly toxic
d ² = 6 r = 0.7				d ² = 2 r = 0.9				

The present study also confirms earlier observations^{7,8} that the new oil dispersants are comparatively less toxic than the older types. However, further studies on the sublethal effects of these dispersants on marine organisms are essential as it has been stressed that a compound is not necessarily harmless when lethal concentrations are avoided⁹. In this connection, it has been pointed out by Lonning and Hagstrom¹⁰ that changes in cytoplasm and cell surface have been observed after exposure to low levels of dispersants.

All the dispersants were fairly stable and removed about 7.5 to 10 times their own weight of oil. Dispersants IB 2/80 and IB 11/80 had the highest efficiency, but present toxicity experiments showed that IB 2/80 is completely soluble and highly toxic, while IB 11/80 is efficient and less toxic.

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