DDT Uptake and Metabolism by a Marine Diatom

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Introduction

It had been observed (3) that shrimp in aquaria were sensitive to small amounts of certain insecticides, but that similar levels of these chemicals when applied in a natural environment, apparently had no effect on the shrimp. This indicated the possibility of the presence of natural detoxifiers which might be responsible for this modification of toxicity. The most probable detoxifiers are the microorganisms in the water and especially the diatoms, since they are known to store food as oil and leucosin rather than starch and might be expected to serve as storage or "pickup" organisms for oil soluble pesticides.

Methods

Twelve one liter erhlenmeyer flasks each containing 200 ml of culture media were inoculated with the diatom Cylindrotheca closterium, Reimann and Lewin. Four flasks served as untreated

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controls, four as DDT treatments (containing .1 ppm DDT), and four as acetone controls, since acetone was the vehicle for the DDT.

At the conclusion of a three week incubation period, the contents were millipore filtered (0.46 pore size), stored temporarily at -70°C, lyophilized and analyzed for DDT and its metabolites by gas chromatography using a Micro-Tek Model MT 220 equipped with a Nickel 63 electron capture detector.

Results and Discussion

It had been postulated in the introduction of this paper that there might be marine organisms which served as storage sites for oil soluble pesticides or which might be capable of detoxification of these chemicals. Results shown in Table 1 tend to support this hypothesis. Gas chromatography showed that C. closterium adsorbed or absorbed DDT from culture media and on the average concentrated it about 265 times. Data in Table 1 also showed that there was a pickup of DDT by diatoms not deliberately exposed to this insecticide. It is thought that these amounts came from DDT that was naturally occurring in the water or from minute residuals found on the glassware.

TABLE 1

DDT Uptake and Conversion to DDE by *Cylindrotheca closterium* after 21 Days Culture Period

Treatment and Replicate	DDT and DDE Content p-p'DDT (ppm)	p-p'DDE (ppm)	DDE as Percent p-p'DDT
Control			
1	7.5064	1.0795	14.4
2	9.6078	.6209	6.5
3	4.5183	.3502	7.8
4	7.6404	.3370	4.4
$\bar{x}_1$	8.0682	.5969	7.4
Acetone Control			
1	2.4228	.2296	9.5
2	2.1671	trace	--
3	1.7319	trace	--
4	3.7347	.3554	9.5
$\bar{x}_2$	2.5141	.1462	5.8
DDT Exposed[1]			
1	26.4066	1.9502	7.4
2	41.6924	3.1407	7.5
3	15.6668	.5286	3.4
4	26.5044	4.1036	15.5
$\bar{x}_3$	27.5675	2.4307	8.8

[1].1 ppm p-p'DDT added to media; no DDT added to media of controls; DDT present in control from natural occurrence in water or contamination.

Confidence Levels

$\bar{x}_1 - \bar{x}_2$	NSD	NSD
$\bar{x}_1 - \bar{x}_3$	.01>p>.001**	.02>p>.01*
$\bar{x}_2 - \bar{x}_3$	p<.001***	.01>p>.001***

* = Significant (95% confidence)
** = Highly Significant (99% confidence)
*** = Highly Significant (99.9% confidence)

There was no significant difference in amounts of DDT between the control and acetone control flasks of diatoms. The amounts of DDT in each of these treatments were fairly consistent. Highly significant differences between either of the control groups and the DDT exposed diatoms, as regards p-p' DDT content, was shown. Even if the 8 ppm average DDT content of the control diatoms was subtracted from the 27 ppm DDT content of the exposed diatoms, there would still be a significant 190-fold concentration of DDT by C. closterium.

Data in Table 1 also indicated a fairly uniform conversion of DDT to DDE (dichlorodiphenyldichloroethylene). This is a detoxification process by dehydrohalogenation. While there were relatively small amounts of DDE detected, the amounts were uniform when expressed as a percentage of p-p' DDT. Since DDE is considerably more water soluble than DDT it would be less likely to accumulate in diatoms or other similar aquatic organisms.

It is interesting that C. closterium converted DDT only to the less toxic metabolite DDE, and it would be reassuring to ecologists if this were typical of all diatoms. Indeed, it has been demonstrated by Barker, et al. (1), Stenersen (4),

Johnson, et al. (2) that certain bacteria may convert DDT not only to DDE but to the equally or more toxic analogue DDD (dichlorodiphenyldichloroethane).

It would be well if this work could be repeated on a wide spectrum of marine as well as fresh water diatoms and using labeled DDT, since the apparent ubiquity of this pesticide allows it to appear even in "controls".

Conclusion

Cylindrotheca closterium, Reimann and Lewin, was capable of absorbing and concentrating DDT above the level in seawater. DDT was metabolized by this organism only to DDE.

References

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