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Accumulation and Elimination of (9-^{14}C) Phenanthrene in the Reef-building Coral (*Diploria strigosa*)

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Coral reef areas are globally important as ecosystems for their role in the geochemical mass balance of the ocean as well as providing habitats for many important marine organisms (SMITH 1978). The basis of the reef system is the hermatypic (reef-building) corals, and the health of these important organisms can be affected by both natural and man-induced stress (JOHANNES 1978). Coral reefs often lie close to tanker routes as well as areas of off-shore production and oil refining (LOYA 1976). Therefore the effect of oil on coral has been a subject of much interest (LOYA & RINKEVICH 1980). Our studies of the effect of oil pollution on coral in Bermuda led us to investigate the uptake and depuration of petroleum hydrocarbons by coral reef colonies. There have been few previous studies on the uptake and release of petroleum hydrocarbons by coral, and the analytical techniques used sacrifice the whole coral at the time of sampling (MEYERS et al. 1974; PETERS et al. 1981). We modified a well-known method using (9-^{14}C) phenanthrene (SOLBAKKEN et al. 1979) and measured the uptake and followed the depuration of this labeled aromatic hydrocarbon in individual coral colonies. The aim, therefore was to use the radiolabeled compound to investigate the extent of uptake and depuration and investigate the relationship between coral tissue and mucus in these processes.

EXPERIMENTAL

Four colonies of brain coral (Diploria strigosa), approximately 12 cm diameter, were collected from the northern fringing reefs of Bermuda and placed in a clean flowing seawater system in the laboratory (35 ppt. salinity, 24°C temperature, flowrate 5 L/min.) with a controlled lighting regime. After a one week acclimatization the corals were dosed with (9-^{14}C) phenanthrene. The phenanthrene (500 µg of 50µCi, specific activity 19.3 mCi/mmol.) was dissolved in 200 uL ethanol, equilibrated with 100 mL of seawater then thoroughly mixed with 15L seawater in

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the experimental tank (50L capacity). The corals were transferred to the tank containing the labeled seawater for 24 hours; samples of seawater were monitored throughout the experiment. After the dosing period the corals were transferred to a flow-through aquarium with clean, filtered seawater for depuration (flowrate 5L/min.).

At each sampling period, one sample from each of three coral colonies was removed using a cork borer ($1cm^2$). Care was taken not to damage the rest of the coral colony. The tissue was analyzed using a method described previously (SOLBAKKEN et al. 1979). After a four day depuration period, the fourth coral was removed from the tank and inverted over a glass beaker for two hours to drain the mucus. The mucus was analyzed for radioactivity in this coral as well as mucus of the other three corals at the end of the experiment. The surface area of the coral was calculated and all results are expressed as dpm/cm^2 of coral surface area.

RESULTS AND DISCUSSION

The amount of radioactivity in the dosing tank was 111×10^6 dpm which is equivalent to a concentration of 33 ppb. Each coral had accumulated $17 \pm 4\%$ (mean $\pm$ S.E) of the amount of radioactivity present in the water during the one day exposure. The total radioactivity per cm^2 of the coral are given in TABLE 1 and indicate a sharp decrease

TABLE 1: Concentration (dpm $\times 10^{-3}/cm^2$) of radioactivity in the cork borer samples from the coral.

Days after exposure	0	1	2	4	10
Coral number					
1	79	34	15	29	27
2	31	20	24	17	7
3	90	56	23	38	15
mean	67	37	21	28	16
($\pm$ S.E.)	18	10	3	6	6

of radioactivity after the first two days with a much slower depuration rate after day two. At day 10 there was still about 25% of the total radioactivity left in the coral. The concentration of radioactivity at day 10 was (16 ± 6) x 10^{-3} dpm/cm^2 (mean and S.E.) whereas the concentration of radioactivity in the mucus was 4 ± 2 dpm/cm^2 (73 ± 30 dpm/mL). This corresponds to an enrichment of 4,000 times the radioactivity in the tissue than in the mucus.

From this data we conclude that the uptake of (9-^{14}C) phenanthrene by Diploria strigosa is similar to that of other invertebrates(PALMORK & SOLBAKKEN 1980,1981). Depuration, appears to be similar in rate and extent as similar experiments have shown for the horse mussel (Modiola modiolus), (PALMORK & SOLBAKKEN 1981). However there does appear to be a greater intra-colony variation of radioactivity in the coral than was shown for the mussel. There are few data available on the depuration of petroleum hydrocarbons from coral and none that we know using (9-^{14}C) phenanthrene. Therefore, comparison with other work is difficult at this time. PETERS et al. (1981) have investigated the uptake and depuration of petroleum hydrocarbons in coral exposed to 0.1 and 0.5 ppm fuel oil using gas chromatography. The corals exhibited uptake and after 14 days depuration in clean seawater petrogenic hydrocarbons were still present in the tissue. These results are similar to those reported here. The very low concentration of radioactivity in the mucus in our experiment after 10 days is interesting. A mucus sample was not taken at the zero time as this would result in the sacrifice of the coral. The level of radioactivity in the mucus of the coral sampled 4 days after exposure was only 41 dpm/mL. These very low levels in the mucus may be due to a very high turnover rate of mucus by the coral or may be due to the chemical nature of the mucus (DUCKLOW & MITCHELL 1979a,b) and its inability to sorp petroleum hydrocarbons to any great extent. These questions are presently being addressed by our group in Bermuda. Subsequent analyses of mucus from Diploria strigosa that were exposed to Arabian Light crude oil for 6 and 24 hours (20 ppm) showed very low concentrations of petroleum hydrocarbons as analyzed by high resolution capillary gas chromatography (KNAP et al. unpubl. data).

This paper represents the first employment of repetitive, non-destructive sampling of the same coral head for the study of uptake and depuration of petroleum hydrocarbons. The results show that Diploria strigosa accumulate a high amount of phenanthrene from the water, and that the

relatively slow elimination is comparable to that found in mussels. The slow depuration rates exhibited by *Diploria strigosa* indicate that these organisms may prove to be useful bio-indicators of marine pollution incidents in coral reef areas.

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