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Chlordecone (Kepone) Accumulation on Estuarine Plant Detritus

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This research investigated accumulation of Kepone on decomposing estuarine macrophyte detritus - an important energy source at the base of many estuarine food webs.

After completing growth, plant tissues including the marsh grass utilized in this research, become senescent and decompose to form detritus. Concomitant with changes in organic and inorganic composition, detritus particles are reduced in size from an entire leaf or stem, down to particles several microns in diameter. This decreasing particle size and corresponding increasing surface area, along with a metabolically-active microbial decomposer community, an ion-exchange capacity, and suspension in water of changing ionic strength make detritus particles almost ideal sites of sorption reactions. For example, accumulation of DDT on detritus particles and in detritus-consuming fiddler crabs, *Uca pugnax*, was reported from a Long Island marsh (ODUM et al. 1969). Recently the accumulation of a variety of anthropogenic pollutants on detritus has been reviewed (ODUM & DRIFMEYER 1978).

Kepone is transfered "from particulate or food web processes to higher trophic levels with relatively efficient mechanisms for biological magnification..." (NRC 1978). SALEH et al. (1978) noted an association of Kepone with colloidal and particulate matter, while BOURQUIN et al. (1978) observed increased Kepone levels in sediments and detritus relative to concentrations in water.

Important species including: oysters *Crassostrea virginica*, mysids *Mysidopsis bahia*, grass shrimp *Palaemonetes pugio*, sheepshead minnow *Cyprinodon variegatus*, and spot *Leiostomus xanthurus* accumulate Kepone from both water and items in their diets (BAHNER et al. 1977). A variety of estuarine fauna far downstream of the source of contamination have been found to contain Kepone in excess of 1 ppm (EPA 1977).

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METHODS

Dead leaf blades of giant cord grass, Spartina cynosuroides, still attached to standing stems were collected during January 1974 from the banks of the York River near the Ware Creek tributary. This location was far removed from the source of Kepone contamination and Kepone was nondetectable (<50 parts per trillion) in York River water (EPA 1975). After air-drying in the laboratory, equivalent weight samples of the leaf blades were placed in numbered litter bags (mesh size 2 mm). On 6 November 1974, 16 of these litter bags were suspended in the water column at Bailey Creek - simulating autumnal export of detritus from the marsh. This tributary of the James River is impacted by a variety of industrial effluents and domestic waste from an area near Hopewell, VA, where Kepone was manufactured from 1964 to 1975. Levels of Kepone in Bailey Creek water were 1-4 parts per billion during the summer and fall of 1975, while bottom sediments contained as much as 10 ppm Kepone although the average was between 1 and 4 ppm Kepone (EPA 1975). Replicate litterbag samples were collected after 14, 42, 83, and 119 days of decomposition.

A suitable method of Kepone extraction from detritus was developed. Samples of the Kepone-free plant material were dried, pulverized, and spiked with 1.0 μg/mL Kepone solution. Ten replicate samples were Soxhlet-extracted for 12 h with 1:1 petroleum ether:ethyl ether, reduced in volume, and cleaned with activated Florisil (EPA 1975). The concentration of Kepone was determined by an electron capture gas chromatograph. Column I was packed with 1.5% OV 17/95% OV 210 while Column II contained 4% SE-30/6% OV-210. An average of 92 $\pm$ 9 percent of the added Kepone was extracted from the plant material. The same procedure of extraction, cleanup, and analysis was employed for the detritus from Bailey Creek. Independent analyses of separate litterbag samples for the various sample dates showed excellent agreement among replicates.

RESULTS AND DISCUSSION

Concentrations of Kepone in detritus increased markedly with time (Table 1). Detritus not exposed in Bailey Creek (control) contained no detectable Kepone, detritus allowed to decompose in Bailey Creek contained up to 4.5 μg Kepone/g dry wt. This concentration is not necessarily the maximum level of Kepone to be found in detritus, since concentrations were still increasing when the experiment was terminated.

TABLE 1

Average Kepone® concentration ± 1 standard deviation (μg/g dry wt in giant cord grass, _Spartina cynosuroides_ detritus after varying periods of decomposition in Bailey Creek, Virginia.

Days of decomposition	Kepone concentration (μg/g dry wt)
14	0.5 ± 0.06
42	0.8 ± 0.04
83	2.2 ± 0.4
119	4.5 ± 0.5

Possible mechanisms accounting for the accumulation of Kepone in detritus were not investigated, but might include: uptake by resistant microorganisms (ORNDORFF & COLWELL 1978); sorption by fine particulate material (SALEH et al. 1978); and/or complexation with organic molecules of the detritus (PELLENBARG 1978). It is not known which, if any, of these processes account for Kepone accumulation on detritus. Sorption of 95 percent of the Mirex in an aqueous solution onto dead bacterial cells, kaolinite, and montmorillonite was reported in 2, 7, and 30 days, respectively (BROWN et al. 1975). Others noted that transport of a variety of organochlorine compounds in seawater occurs by sorption on fatty cell membranes of microorganisms (VIND & MATHEWS 1975).

Accumulation of Kepone on estuarine plant detritus may be an important mechanism by which the contaminant enters estuarine food webs. Many estuarine animals are dependent on detritus as an energy source. At certain times of the year, the standing crop of both detritus and detritivores may be large. Detritivores may consume quantities of detritus that are large, relative to body weight, in order to satisfy basic metabolic needs. Experimental exposure to Kepone in water at concentrations much lower than those observed in _S. cynosuroides_ detritus from Bailey Creek, were toxic to the sheepshead minnow, _Cyprinodon variegatus_ (HANSEN et al. 1977). Detritus is an important dietary component for this fish, but the relationship between toxic effects of Kepone in water vs food items is not known (WARLEN 1964, ODUM & HEALD 1972).

Kepone sorption onto small detritus particles may also contribute to distribution of the contaminant in the estuary. Detritus particles in suspension may move with the tides for a considerable distance and period of time. As decomposition progresses and the rate of degradation slows, several months may be required to further degrade the non-labile detritus. Tidal transport of detritus would be particularly important in the partially stratified James River estuary (PRITCHARD 1952). In fact, there is a pronounced increase in Kepone levels in bottom sediments at a considerable distance downstream from Bailey Creek. Sediments in the vicinity of Hopewell contained approximately 0.1

ppm, while levels near Jamestown, some 40 miles downstream, contained an excess of 0.4 ppm Kepone (EPA 1977). The sorption of Kepone onto suspended detritus and sediment particles and the transport of these particles in the two-layered circulation pattern of a partially stratified estuary may constitute a mechanism by which Kepone has been distributed throughout a major estuary and accumulates to potentially deleterious levels within the area of shoaling.

In summary, giant cordgrass S. cynosuroides detritus sorbs Kepone from contaminated brackish waters during decomposition. Concentrations of Kepone on detritus increased substantially with time. An average of 4.5 μg Kepone/g dry wt. detritus was found after 119 days of decomposition. The accumulation of Kepone on detritus and the role of detritus as a major energy source for a variety of estuarine fauna provides a means of entrance of the contaminant into estuarine food webs.

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