phosmethyl was apparent (Table III). While with leaves kept in the dark no degradation products could be detected, exposure to sunlight for 8 h resulted in spots of various intensity indicating the appearance of *N*-methylbenzazimide on corn leaves and *N*-methylbenzazimide sulfide (or disulfide), benzazimide, and the oxygen analogue of azinphosmethyl on both corn and bean leaves. The spot developed for the latter compound was most pronounced with extracts from bean leaves. In the experiment described previously with [^{14}C]azinphosmethyl exposed on glass surfaces to sunlight, only traces (a slight shadow at R_f 0.34) of the oxygen analogue of azinphosmethyl could be noticed. It appears, therefore, that a factor present primarily in bean leaves enhanced the formation of the oxygen analogue from azinphosmethyl due to irradiation with sunlight.

Effects of Formulations of Azinphosmethyl on Its Photodecomposition under Environmental Conditions. Azinphosmethyl was applied as a liquid and a granular formulation to primarily glass surfaces, water, and a loam soil as described. After exposure of these treated materials to sunlight for 8 h, analyses were conducted for the remaining azinphosmethyl. Results obtained after application of insecticide emulsions and irradiation by sunlight were identical with those obtained with analytical grade insecticide. With granules, however, the insecticide was more persistent since nearly all of the azinphosmethyl applied was recovered from glass surfaces and soils after exposure to sunlight, while only 64% was recovered from water. Photodecomposition of granular formulations of the insecticide was largest in water, where the protective cover of the insecticide was apparently disrupted, thus making it more accessible to light. With analytical grade insecticide and emulsions, 78 and 79% of the applied azinphosmethyl, respectively, were recovered from glass surfaces, 16 and 17% from water, 99 and 96% from soil, and 90 and 93% from bean leaves. In comparison to previous tests, relatively high recoveries of azinphosmethyl were observed after its application as analytical grade material. This could have been related to its extremely high application rate of 2 mg per treatment, as opposed to 0.1 mg in all previous experiments. Lichtenstein and Schulz (1959b) showed that persistence of insecticides in soils was increased with higher application rates when expressed in percent of the applied dose.

Results presented in this study clearly indicate that the effects of various environmental factors have to be considered when the photodegradation of agricultural chemicals is being investigated.

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Soil Persistence and Aquatic Bioaccumulation Potential of Hexachlorobenzene (HCB)

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Soil was treated with 0.1 to 100 ppm of HCB and stored under aerobic (sterile and nonsterile) and anaerobic nonsterile conditions for 1 year in covered containers to retard HCB volatilization. No soil-incorporated HCB was lost at any treatment rate or under any storage condition. Five species of aquatic organisms were exposed to three water concentrations of HCB for 3 to 33 days in aquatic model ecosystems. Bioaccumulation potential among the organisms averaged 0.6 to 2.0 × 10^3 water content for algae (*Oedogonium cardiacum*), snails (*Helisoma* sp.), daphnids (*Daphnia magna*), and mosquito fish (*Gambusia affinis*), and 6 to 16 × 10^3 for catfish (*Ictalurus punctatus*). Further studies confirmed that catfish consistently accumulated more HCB than did the other four species.

The direct importance of hexachlorobenzene (HCB) to agriculture is minor. In 1971 only about 6800 kg was used as a seed fungicide, its only registered use. However, its indirect importance to agriculture, via environmental contamination, may be much larger. For example, HCB found in Louisiana cattle was apparently related to airborne industrial emissions, while residues in sheep from Texas and California were traced to pesticides contaminated with HCB (EPA Report, 1973). HCB residues have

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also been found elsewhere in the environment. For example, the mean HCB concentration found in eight species of fish taken from 15 states ranged from 0.001 to 16.0 ppm (Johnson et al., 1974). Tern (*Sterna hirundo*) eggs collected on two islands in Lake Ontario contained HCB residues (Gilbertson and Reynolds, 1972).

The major reason for environmental concern about HCB centers around quantities produced annually. Most HCB is produced as a by-product in the waste stream during the manufacture of perchloroethylene, carbon tetrachloride, trichloroethylene, and other chlorinated hydrocarbons. In 1972, an estimated 1.1 and 2.2 × 10^6 kg of HCB were produced from these industrial processes (Mumma and Lawless, 1975). Also, until recently, HCB was a major impurity in the herbicide dimethyl tetrachloroterephthalate (dacthal) and the fungicide pentachloronitrobenzene (PCNB).

HCB has entered our environment and will probably continue to do so at some undetermined rate in future years. Unfortunately, little is known about its fate and behavior after it reaches the environment. This paper describes both the persistence and stability of soil-incorporated HCB and describes its distribution pattern and bioaccumulation potential in an aquatic model ecosystem.

MATERIALS AND METHODS

Soil Persistence. Matapeake silt loam (pH 5.3; organic matter content 1.5%; sand, silt, and clay contents of 38.4, 49.4, and 12.2%, respectively) was treated with HCB at the rate of 0.1, 1, 10, and 100 ppm and held under aerobic (sterile and nonsterile), and anaerobic nonsterile only conditions for 1 year.

Treatments were as follows: Three 3-kg samples of air-dried soil were simultaneously treated with $HgCl_2$ (1 g/kg), glucose (1 g/kg), and a diethyl ether solution of HCB (sterile aerobic treatments) or glucose and HCB (nonsterile aerobic and anaerobic treatments). After drying, the soils were thoroughly mixed, divided into three 1-kg lots (three replications), and placed in 1-l. beakers. After a 20% (w/w) soil moisture content was established, the beakers were covered with aluminum foil and stored. Anaerobic conditions were maintained by storing in an incubator under a CO_2 atmosphere at 20–22 °C. Sterile and nonsterile aerobic treatments were stored in the greenhouse (20–30 °C). Water was added to the beakers as needed to maintain the 20% moisture content. Soil samples were taken for analysis after 0, 1, 3, 6, and 12 months storage. Five-gram fractions of HCB-treated soil, at each sampling date, were extracted with a mixture of hexane–acetone (1:1, v/v) and analyzed by electron-capture gas chromatography, using the extraction and cleanup procedures as described by Woolson (1974). The gas chromatograph was equipped with a 1.9-m column of 10% DC-200 and 15% OF-1 (1:1, w/w).

Besides the above treatments, 10 kg of air-dried soil was treated with 10 ppm of HCB (plus 1 μCi/kg [^{14}C]HCB) and glucose (1 g/kg) for experiment III of the aquatic studies. After drying, the soil was thoroughly mixed, equally divided into four glass trays (34 × 21 × 5 cm), brought to 20% moisture, and covered with aluminum foil. The trays were stored in the greenhouse (20–30 °C) for 1 year. Water was added as needed to maintain the 20% moisture content.

Aquatic Studies. Three experiments were performed. In each, [^{14}C]HCB was adsorbed to soil or sand and placed in the bottom of glass aquaria. Table I summarizes the treatment, rate, and replication details of the three experiments.

Experiment I. The model ecosystem was described

Table I. Soil and Sand HCB Application Rates and Replications

Total HCB added per tank, μg	Amount of soil or sand combined with HCB,[a] g	Final soil HCB concn, ppm	No. of replicates
	Experiment I		
1000	M-100	10	3
100	M-100	1	3
10	M-100	0.1	3
0	M-100	0	3
	Experiment II		
61	S-100	0.61	3
9	S-100	0.09	3
1	S-100	0.01	3
0	S-100	0	3
	Experiment III		
4600	M-500	9.2	3
0	M-500	0	1

[a] M = Matapeake silt loam, S = sand of particle size 125–500 mm.

previously (Isensee et al., 1973; Isensee and Jones, 1975). Briefly, control and HCB-treated soils were placed in tanks, which were then filled with 4 l. of reference water (Freeman, 1953). One day later, ~100 daphnids (*Daphnia magna*), eight snails (*Helisoma* sp.), a few strands of an alga (*Oedogonium cardiacum*), and 10 ml of old aquarium water containing various diatoms, protozoa, and rotifers were added. Water lost by evaporation was replenished as needed. Two-hundred-milliliter samples of water were taken at 30 days and extracted twice with 50-ml quantities of diethyl ether (extraction efficiency 95%). At 30 days, daphnids were sampled (20 to 30 mixed age organisms per sample) for analysis and two 0.15–0.25-g mosquito fish (*Gambusia affinis*) were added. Three days later all organisms were harvested and two 2.0–2.5-g fingerling channel catfish (*Ictalurus punctatus*) were added to each tank and exposed for 8 days.

Snails, mosquito fish, and catfish were homogenized whole in methanol and the homogenizate was assayed directly by scintillation counting. Daphnids were rinsed with distilled water, patted dry with cheese cloth (to remove surface moisture), weighed, and added to 15 ml of scintillation cocktail (composed of 750 ml of Triton X-100, 2250 ml of *p*-xylene, 16.5 g of 2,5-diphenyloxazole, and 1.2 g of 1,4-bis[2-(5-phenyloxazolyl)]benzene) for direct counting. Algae were rinsed with distilled water and patted dry; subsamples were weighed directly into combustion boats, and immediately combusted in a stream of oxygen. The $^{14}CO_2$ was dried by passing through a column of anhydrous $CaSO_2$ and trapped in 10 ml of monoethanolamine/2-methoxyethanol (1:7, v/v). A 5-ml aliquot of the trapping solution was assayed for radioactivity by standard liquid scintillation methods.

Control water and organism samples were taken at each harvest and processed and analyzed the same as treatment samples. These control values were subtracted from corresponding treatment values before tabulation. All HCB data were based on ^{14}C recovered in analyzed samples.

Experiment II. This experiment was carried out to further investigate the unexpectedly high HCB accumulation by catfish observed in experiment I. Commercially available "playsand" was dry sieved and then washed to retain 125–500-μm particles and air dried. Three 1.8-kg lots were treated with a diethyl ether solution of [^{14}C]HCB at the rate of 0.01, 0.1, and 1.0 ppm, dried, thoroughtly mixed, and stored in flasks. Treated sand (100-g lots) was placed in glass aquaria and flooded with

Table II. Persistence of HCB in Soil at Three Concentrations under Sterile, Nonsterile, and Anaerobic Conditions

Soil treatment	HCB added to soil, ppm	HCB concn (ppm)[a] after indicated storage time (months)				
		0	1	3	6	12
Sterile aerobic	0.1	0.094 ± 0.009	0.085 ± 0.002	0.082 ± 0.0	0.085 ± 0.003	0.100 ± 0.006
	1	0.89 ± 0.09	0.91 ± 0.05	0.94 ± 0.01	0.90 ± 0.01	0.95 ± 0.03
	10	9.0 ± 0.6	9.6 ± 0.3	10.0 ± 0.0	9.5 ± 0.2	9.6 ± 0.1
	100	105.0 ± 5.0	114.0 ± 3.0	117.0 ± 3.0	106.0 ± 3.0	109.0 ± 3.0
Nonsterile aerobic	0.1	0.081 ± 0.006	0.075 ± 0.001	0.082 ± 0.002	0.082 ± 0.001	0.080 ± 0.002
	1	0.73 ± 0.018	0.80 ± 0.01	0.87 ± 0.03	0.87 ± 0.01	0.86 ± 0.03
	10	7.9 ± 0.2	9.2 ± 0.2	9.4 ± 0.1	9.0 ± 0.1	9.1 ± 0.2
	100	91.0 ± 5.0	109.0 ± 5.0	109.0 ± 3.0	113.0 ± 5.0	109.0 ± 2.0
Nonsterile anaerobic	0.1	0.075 ± 0.003	0.080 ± 0.002	0.093 ± 0.003	0.091 ± 0.002	0.093 ± 0.002
	1	0.76 ± 0.02	0.81 ± 0.0	0.93 ± 0.02	0.95 ± 0.0	0.89 ± 0.03
	10	8.7 ± 0.4	8.9 ± 0.0	9.5 ± 0.2	9.7 ± 0.1	9.3 ± 0.4
	100	98.0 ± 6.0	106.0 ± 4.0	107.0 ± 5.0	102.0 ± 2.0	113.0 ± 1.0

[a] Means ± standard errors for three replications.

4 l. of tap water. One day later, 10 fingerling catfish were placed in each tank. At 4-day intervals, the fish were transferred to tanks containing fresh quantities of treated sand and 4 l. of water. At each transfer, two fish were retained: one was frozen and the other was placed in untreated water for 4 days "desorption" before harvest. Exposure periods were 4, 8, 12, 16, and 20 days. The frozen fish were homogenized whole in methanol and analyzed as described above.

Experiment III. This experiment reports the use of a modified ecosystem design and the introduction of HCB that had been "aged" in soil for 1 year. The modified ecosystem was basically similar to the one used above except that the tank was larger (16 l.) and fish were exposed for 30 vs. 3 days. Through a combination of compartments, screen, and recirculating pump, fish and daphnids are sufficiently separated to enable the daphnids to both maintain a stable reproducing population and to be a food supply for the fish (Figure 1). Specifically, four all-glass aquaria (41 × 20 × 24 cm) were divided into two compartments (36 × 20 × 18 cm, 5 × 20 × 18 cm) with glass sheets. An aluminum screen (1-mm openings), 3 cm high, was cemented to the top of the glass partition. The glass partition and screen were cemented in place using General Electric "Clear Seal" silicone rubber.

Five-hundred grams of "aged" [^{14}C]HCB-treated soil (9.2 ppm, sp act. 0.062 μCi/mg) was placed in the large compartment (of three tanks) and flooded with 16 l. of water. A fourth control tank, using 500 g of untreated soil, was also prepared. The final water level was 1 cm above the glass partitions. An air powered "percolator" type pump was built to pump water and fecal matter from the small to the larger compartment. Algae, snails, and daphnids were introduced into the large compartment and four fingerling bluegill (*Lepomis macrochirus*) into the small compartment. Enough algae was added and positioned to further reduce daphnid movement through the screen. Water lost by evaporation was replaced daily to maintain the 1-cm depth above the glass partitions. After 30 days, all organisms were harvested and analyzed as described above. One-liter quantities of water were extracted twice with diethyl ether and analyzed as described above.

RECIRCULATING STATIC MODEL ECOSYSTEM

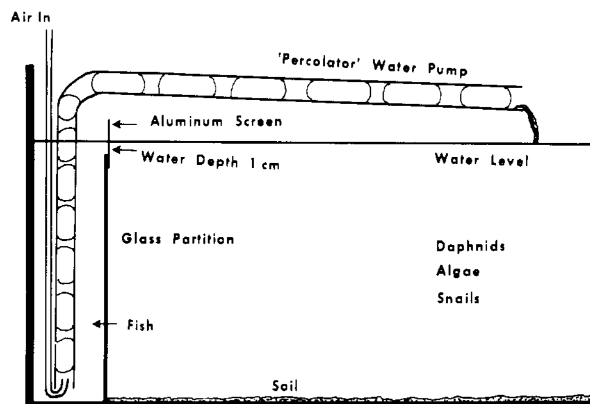

Figure 1. Modified model ecosystem used in experiment III; tank 41 × 20 × 24 cm, containing 16 l. of water.

RESULTS AND DISCUSSION

Soil Persistence. Table II shows the HCB recovered from soil samples taken after each storage interval. No HCB loss was observed after 12 months storage under the experimental conditions of this study, indicating that HCB is very persistent in soil. However, its stability may have been affected by the storage conditions, since all beakers were covered with aluminum foil which retarded its volatilization and loss of soil moisture. HCB is sufficiently volatile (vp 1.089 × 10^{-5} mmHg at 20 °C) so that one air drying of moist soil or biological samples causes a 10 to 20% HCB loss. Beck and Hansen (1974) found that the half-life of HCB in soil (incorporated at 10 kg/ha) stored in plastic-covered plastic pots averaged 4.2 years. In a simulated pasture experiment, Beall (1975) found a 55% HCB loss from the surface 2 cm of soil in 2 weeks, with no HCB loss from the 2–4-cm depth during 19 months. Clearly, volatilization is a major route of loss from soil and avenue of entry into the atmosphere.

Aquatic Studies. *Experiment I.* Table III shows the distribution of [^{14}C]HCB among five species of aquatic organisms. The amounts of HCB accumulated were directly related to treatment concentrations, undergoing approximate order-of-magnitude increases. For each treatment rate, algae, snails, daphnids, and mosquito fish accumulated similar amounts of HCB (within an order of magnitude), while catfish accumulated about 10 times or more HCB than did the other organisms. Higher food chain organisms (snails and mosquito fish) always contained 1.5 to 2 times more HCB than lower food chain organisms (algae and daphnids). This indicates that some biomagnification occurred within the food chain and/or that a species-specific response was important.

The BR (concentration in fresh tissue/concentration in water) averaged 0.6 to 2.0 × 10^3 for algae, snails, daphnids, and mosquito fish and 6 to 16 × 10^3 for catfish. Catfish, which were exposed for only 8 days, accumulated far more HCB than did any of the other organisms. No mortality or other toxicity symptoms were evident among organisms and all organisms in both treatment and control tanks

Table III. Distribution of [^{14}C]HCB among Several Organisms in a Model Aquatic Ecosystem

Soil[a] treatment, ppm	H_2O concn,[b] ppb	Algae	Snails	Daphnids	Mosquito fish	Catfish
				ppm		
0.1	0.03	0.019 ± 0.004[c]	0.052 ± 0.012	0.032 ± 0.007	0.039 ± 0.005	0.191 ± 0.028
1.0	0.22	0.154 ± 0.037	0.329 ± 0.030	0.168 ± 0.053	0.333 ± 0.040	2.144 ± 0.323
10.0	1.72	1.561 ± 0.190	2.805 ± 0.252	1.612 ± 0.359	3.509 ± 0.550	27.262 ± 0.361
				Bioaccumulation Ratio[d]		
0.1	0.03	610	1360	1030	1260	6 160
1.0	0.22	710	1510	770	1530	9 830
10.0	1.72	910	1630	940	2040	15 850

[a] Concentration of HCB in 100 g of silt loam soil added to each tank. [b] Concentration of HCB in water after 31 days. [c] Means ± standard errors for three replications. [d] Concentration in tissues (fresh weight)/concentration in water.

Table IV. Accumulation of [^{14}C]HCB (ppb)[a] in Catfish as Influenced by Time, Treatment Concentration, and Flushing

Treatment,[b] ppm	Days exposed[c] 4	8	12	16	20
			Not Flushed[d]		
0.01	59 ± 24	92 ± 12	160 ± 10	200 ± 13	280 ± 25
0.09	200 ± 58	410 ± 63	680 ± 110	940 ± 300	940 ± 400
0.61	1120 ± 19	2780 ± 300	4170 ± 160	5860 ± 400	6800 ± 1200
			Flushed[e]		
0.01	40 ± 3	84 ± 7	170 ± 29	150 ± 50	170 ± 32
0.09	180 ± 45	430 ± 85	750 ± 160	470 ± 120	720 ± 390

[a] Means ± standard error for three replications. [b] Concentration of HCB in 100 g of sand added to each tank. [c] Every 4 days, fish were transferred to new tanks containing 100 g of treated sand. [d] Fish killed and frozen. [e] Fish placed in clean water (free of HCB) for 4 days, then killed and frozen.

Table V. Accumulation of [^{14}C]HCB by Several Organisms from Water Overlying Aged HCB-Treated Soil

Soil treatment,[a] ppm	H_2O concn,[b] ppb	Algae	Snails	Daphnids	Bluegill
			ppm[c]		
9.2	7.9	4.51 ± 0.46	0.58 ± 0.17	0.95 ± 0.10	3.20 ± 0.69
			Bioaccumulation Ratio[d]		
		570	75	120	400

[a] Concentration of [^{14}C]HCB in 500 g of silt loam soil aged 1 year. [b] Concentration of HCB in water after 30 days. [c] Means ± standard error for three replications. [d] Concentration in tissue (fresh weight)/concentration in water.

prospered (daphnids increased in population and snails laid numerous egg clusters on tank walls).

Metcalf et al. (1973) used a terrestrial–aquatic model ecosystem to estimate the environmental properties of HCB and several other organochlorine pesticides. Their ecological magnification (EM) values (equivalent to BR) were similar for algae and snails, but only one-fifth of the BR's shown in Table III for daphnids and mosquito fish. When they plotted the log water solubility vs. log EM of fish for 12 organochlorine pesticides, they found HCB was "obviously aberrant", i.e., it fell below the linear relationship for the other pesticides. (The theoretical log EM (HCB) was 4.4, whereas their experimentally derived value was 2.5.) The average log of the BR for mosquito fish and catfish (Table III) was 3.2 and 4.0, respectively, both considerably closer to their theoretical log EM. These results suggest that the HCB BR values obtained in this study compare well with results obtained for other organochlorine pesticides in model ecosystem studies.

Experiment II. The unexpectedly high HCB accumulation by catfish prompted another study where catfish were exposed to freshly supplied HCB (Table IV). At all treatment rates, the amount of HCB accumulated increased steadily with time, but the rate of accumulation began to decline after 12 days. Also, catfish flushed (exposed to water free of HCB) for 4 days (after 4 to 20 days exposure) did not lose significant amounts of HCB. However, the frequent handling and short flushing period may have impaired the development of valid elimination rates. Only 20% of the flushed catfish contained significantly different amounts of HCB than did unflushed catfish. The total amount of HCB accumulated by unflushed catfish at the 0.01, 0.09, and 0.61 treatment rates was 51.0, 22.5, and 23.6%, respectively, of the total amount of HCB introduced into the tanks during the 20-day exposure period.

Catfish exposed to the 0.09- and 0.61-ppm treatments for 8 days (Table IV) contained slightly more HCB than catfish exposed for 8 days in the ecosystem (Table III). These similar results from two independent experiments confirm the higher accumulation potential of HCB by catfish compared to the other aquatic organisms used in these studies.

Experiment III. Table V shows the availability of "aged" HCB to aquatic organisms. Tissue and water concentrations were different than those obtained at similar treatment concentrations in experiment I (Table III). However, all results were well within an order of magnitude, the normal variation of model ecosystem-derived data. The water concentration was considerably higher than in experiment I, while tissue concentrations were generally lower, resulting in much smaller BR values. Thus, these two experiments may not be comparable since experimental conditions (aged vs. freshly treated soil) were different and may have accounted for the difference. However, the experiment did indicate that aged soil HCB

residues are readily available to aquatic organisms.

This study has shown that HCB has considerable potential to bioaccumulate in the aquatic environment, and is very persistent when soil incorporated. The combination of these two characteristics makes HCB a potentially hazardous compound to the environment. A soil contaminated with a large amount of HCB would presumably retain HCB for many years. If this soil is removed by erosion, HCB can be introduced into a nearby aquatic environment and become available to aquatic organisms. Thus, known HCB sources should be prevented from directly or indirectly being introduced into waterways.

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Translocation and Metabolic Fate of Monosodium Methanearsonic Acid in Wheat (*Triticum aestivum* L.)

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The distribution and metabolic fate of the arsenical herbicide monosodium [^{14}C]methanearsonate (MSMA) in wheat (*Triticum aestivum* L. var. Waldon) was investigated 2, 4, and 13 weeks following foliar applications. Atomic absorption was used to analyze arsenic and liquid scintillation spectrometry was used to analyze ^{14}C residues in roots, leaves, and seeds harvested from wheat. Results suggested primarily symplastic, but some apoplastic movement of [^{14}C]MSMA. A total of only 0.2% of the leaf applied 89 μg of [^{14}C]MSMA was detected in the seeds. ^{14}C (20% of that applied) exuded out of the roots into the soil. Using unlabeled MSMA at 3.36 kg/ha resulted in increased residues in wheat seed grown in greenhouse conditions. Thin-layer and ion-exchange chromatographic analyses of extracts from root, shoot, treated leaves, and seeds indicated that the carbon–arsenic bond remained intact during the 3-month study.

The use of organic arsenical herbicides has increased over the last decade. MSMA/DSMA (monosodium and disodium methanearsonate) is registered for selective weed control in cotton and citrus crops (*Fed. Regist.*, 1972). Application is postemergence because the organic arsenicals have little preemergence activity at rates used for weed control (Hiltbold, 1975).

Application is by directed spray before bloom to minimize residues in the cottonseed (Baker et al., 1969). Their primary entrance into plants is through leaves and stems. The degree of absorption and translocation of methanearsonates depends upon the rate of application, temperature, and plant species (Arle and Hamilton, 1971; Keeley and Thullen, 1971). Several workers have reported that methanearsonates are translocated by acropetal (apoplastic), as well as basipetal (symplastic), processes (Rumburg et al., 1960; Sckerl and Frans, 1969; Duble et al., 1969; Sachs and Michael, 1971; Keeley and Thullen, 1971).

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There is little evidence that the C–As bond of MSMA is severed in plants. Very little $^{14}CO_2$, which indicates bond rupture, was evolved from [^{14}C]MSMA treated purple nutsedge (Duble et al., 1968) or coastal Bermuda grass (Duble et al., 1969). MSMA is usually found unchanged or in a complexed form in plants. Sachs and Michael (1971) showed that in bean plants (*Phaseolus vulgaris* L.), MSMA formed a complex with some plant component. Similar complexes were reported by Sckerl and Frans (1969) in Johnsongrass treated with MAA (methanearsonic acid), and by Duble et al. (1969) in coastal Bermuda grass (*Cynodon dactylon*) treated with DSMA. Braman (1975) suggested that grass sprayed with arsenicals may metabolize them to gaseous methylarsines, but Sachs and Michael (1971) did not detect arsine gas evolution from bean plants treated with cacodylic acid.

Wild oat (*Avena fatua* L.) is considered a major weed problem on approximately 100 million acres of land in the United States and Canada. Estimated yearly crop losses from wild oat are $1.5 billion in the Northern United States and adjoining Canadian provinces. MSMA has shown considerable promise as a foliar spray to control wild oats in wheat (Moore, 1975). However, basic information concerning uptake, translocation, metabolic fate, and persistence of MSMA in wheat plant or seeds is not known. This study was undertaken to determine the movement,