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On THE CYCLING OF CL^{36} LABELED DDT IN NATURAL SYSTEMS

For the period

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DISCLAIMER

RESIDUE ANALYSIS

Soil, Plants and Invertebrates

Sample preparation was completed on 150 frozen soil cores collected during 1971-1974. Each core was dried, pulverized and extracted three times with hexane. Most of the resulting 450 samples have been analyzed by liquid scintillation spectrometry (LSS). The 1974 plant collection (N=40) was prepared as leaf and root samples. Monthly collections through November 1974 of earthworms, isopods and slugs have been prepared as LSS samples for analysis. Both earthworms and slugs have been decreasing in concentrations of DDT from 1969 through 1974 (Figs. 1 and 2). The fact that earthworms and slugs decreased in body burdens of DDT over time whereas isopods increased (Peterle, 1975) indicates that the food chain sources of the compound differ among these soil invertebrates.

Vertebrates

The 1972 collection of 36 frozen meadow voles (*Microtus pennsylvanicus*) was dissected and samples of liver, fat, muscle and brain were prepared for LSS analysis. Calculation of DDT levels in *Microtus* liver shows (Fig. 3) that residues increased from 1.2 ppm during June-November 1969 to 6.6 ppm during January-June 1974. This trend of increasing DDT levels may be a consequence of increasing residues in the plants eaten by voles. In an effort to determine if any correlation exists between concentrations of DDT in voles and their food, samples were prepared of the stomach contents of 116 voles whose tissues had been analyzed for DDT content. Comparison of the residue levels of vole liver and stomach contents (Fig. 3) shows that (a) concentrations in the liver tended to follow the same trends as those of the plants eaten, and (b) levels were generally higher in the liver than in the material ingested. Samples of fecal material were prepared from the same gastrointestinal tracts for information on absorption of DDT during digestion. Preliminary examination of the data from these samples indicates that very little of the DDT present in the stomach contents is excreted in the feces.

Fourteen *Microtus* were dissected for samples of subcutaneous fat, muscle, and minced whole carcass. Data on DDT levels in these tissues will be used to construct a predictive curve relating fat and muscle residues to those of the whole body. A similar curve for the short-tailed shrew (*Blarina brevicauda*) was described in last year's progress report (Peterle, 1975).

Thirty nestling *Microtus* from 10 litters collected in the treated area during 1973-74 were prepared as samples for residue analysis. Samples of subcutaneous fat and minced whole carcass were made from each nestling. Information from these samples will be combined with that obtained from embryos, free-ranging juveniles, and adults to examine the relationship between age and body burdens of DDT.

A total of 97 frozen Blarina collected during 1972-74 were dissected for samples of liver, brain, and subcutaneous fat. Residues of DDT in Blarina liver decreased gradually from 1970 through 1974 (Fig. 4). This trend is probably a result of similarly declining residues in earthworms, the major prey item of Blarina (Whitaker and Mumford, 1972). Samples were prepared of the stomach contents from 85 gastrointestinal tracts of shrews dissected for tissue samples, in an effort to determine whether peak DDT levels occurring in the liver during November of 1970, 1971, and 1972 were the result of residues in prey organisms.

Concentrations of DDT in the liver of Blarina tended to decrease as body weight increased (Fig. 5). Levels ranged from 2 to 9 ppm in sexually mature males and females, compared to a range of 2 to 35 ppm in the sexually immature population. The microsomal enzyme system of the liver in breeding shrews may have been stimulated by circulating steroid hormones to metabolize DDT. Alternatively, the metabolic rates of breeding adults may have been higher than those of nonbreeding subadults, resulting in more rapid elimination of DDT from the body.

Dissection of 120 masked shrews (Sorex cinereus) collected during 1971-1974 was completed for samples of muscle, viscera, and skin. Residues of DDT in Sorex muscle increased significantly from 1-2 ppm in 1969 to a mean level of approximately 5 ppm that was maintained from 1972 through 1974 (Fig. 6). Apparently the differences in types of invertebrate prey selected by Sorex and Blarina resulted in an upward trend in body burdens of one species and downward trend in the other. Whitaker and Mumford (1972) reported that the most prevalent food item in the stomachs of S. cinereus was lepidopteran larvae. The evidence suggests that DDT was becoming increasingly available with time to the invertebrate prey of Sorex, perhaps through increasing levels in plants.

Residues of DDT in breeding adult Sorex were significantly ($P < 0.05$) lower than those of the sexually immature subadults (Fig. 7). The mean (± SE) level present in 16 adults was 4.2 ± 0.3 ppm, compared to 5.9 ± 0.8 ppm in 29 subadults. Evidently a similar physiological mechanism is responsible for lower body burdens of DDT in the adults of both species of shrew. Further information on the effect of age on DDT levels in Sorex will be obtained through analysis of samples that have been prepared from 28 nestlings collected during 1972-1975.

LITERATURE CITED

Peterle, T. J. 1975. Biological transfer and loss of ^{36}Cl-labeled DDT in an old field ecosystem. Report No. COO-1358-14, The Ohio State University Research Foundation. Contract No. E(11-1)-1358, U.S. Energy Research and Development Administration.

Whitaker, J. O., Jr. and R. E. Mumford. 1972. Food and ectoparasites of Indiana shrews. J. Mammal. 53:329-335.

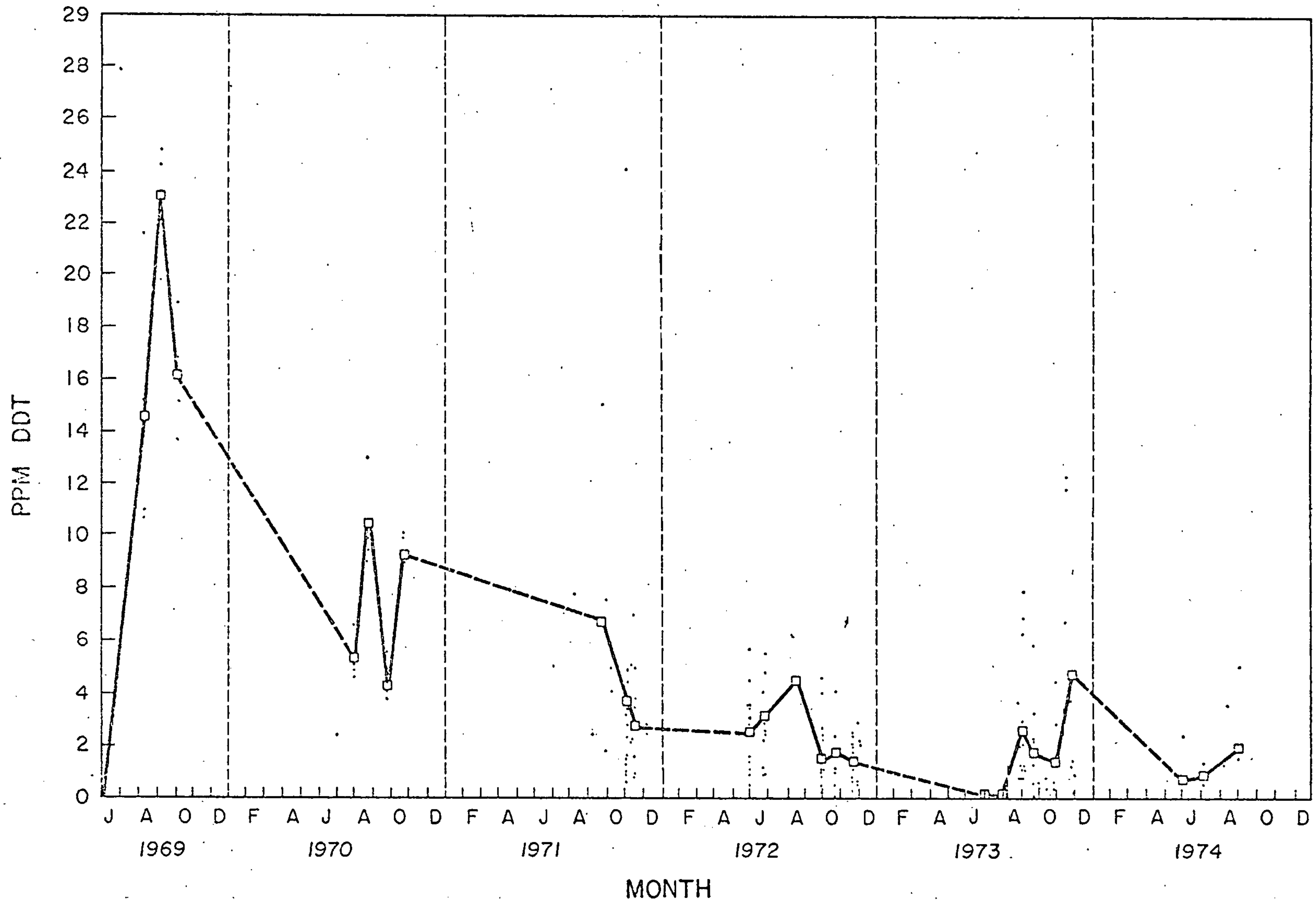

Figure 1. Residues of DDT in slugs (Deroceros laeve) from the treated enclosure, 1969-1974. Each data point represents one sample (1-4 slugs). Monthly mean values are represented by ☐ symbols.

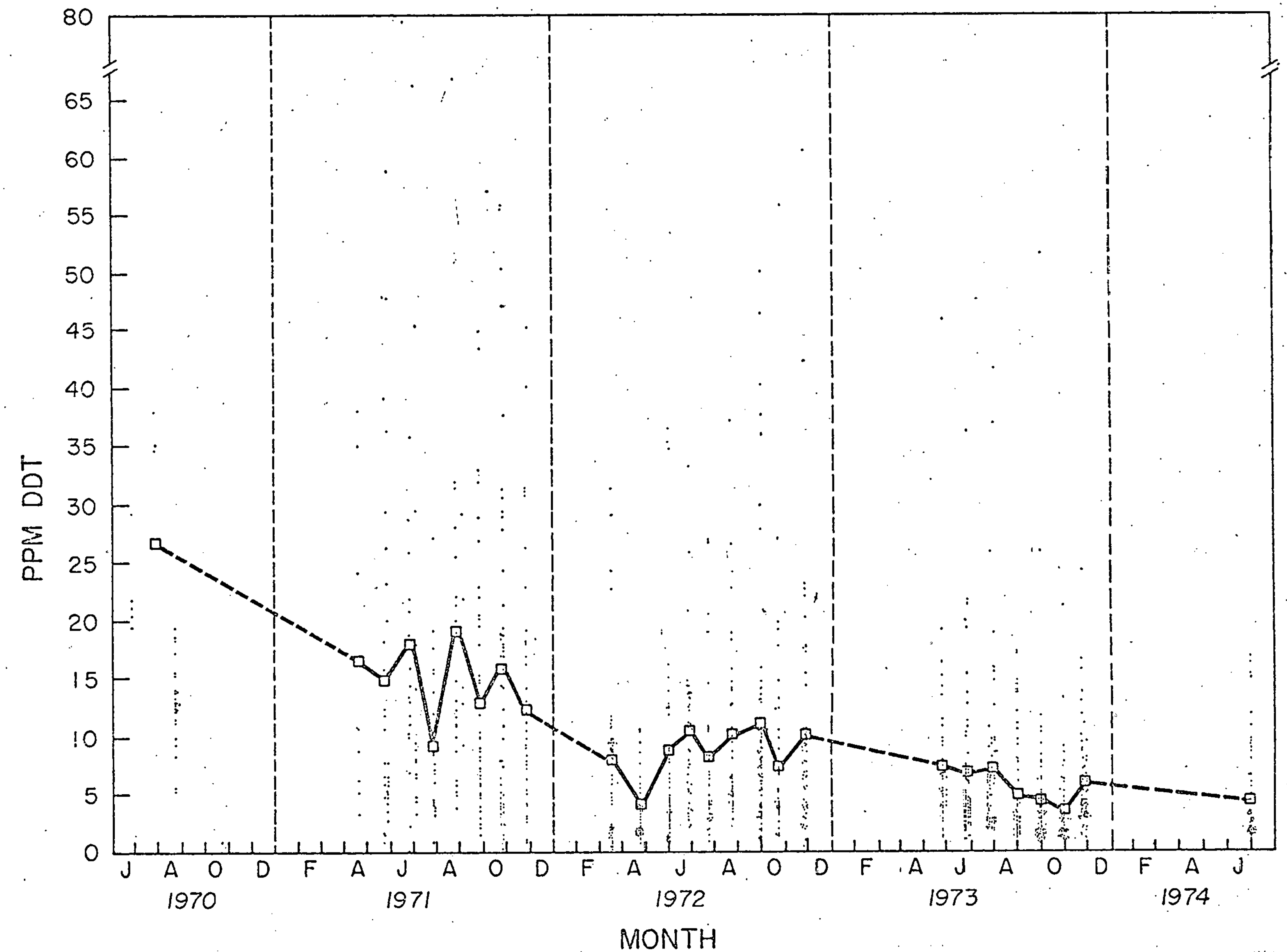

Figure 2. Residues of DDT in earthworms (Lumbricus terrestris) from the treated enclosure, 1970-1974. Each data point represents one sample (1-4 worms). Monthly mean values are joined together by solid and broken lines.

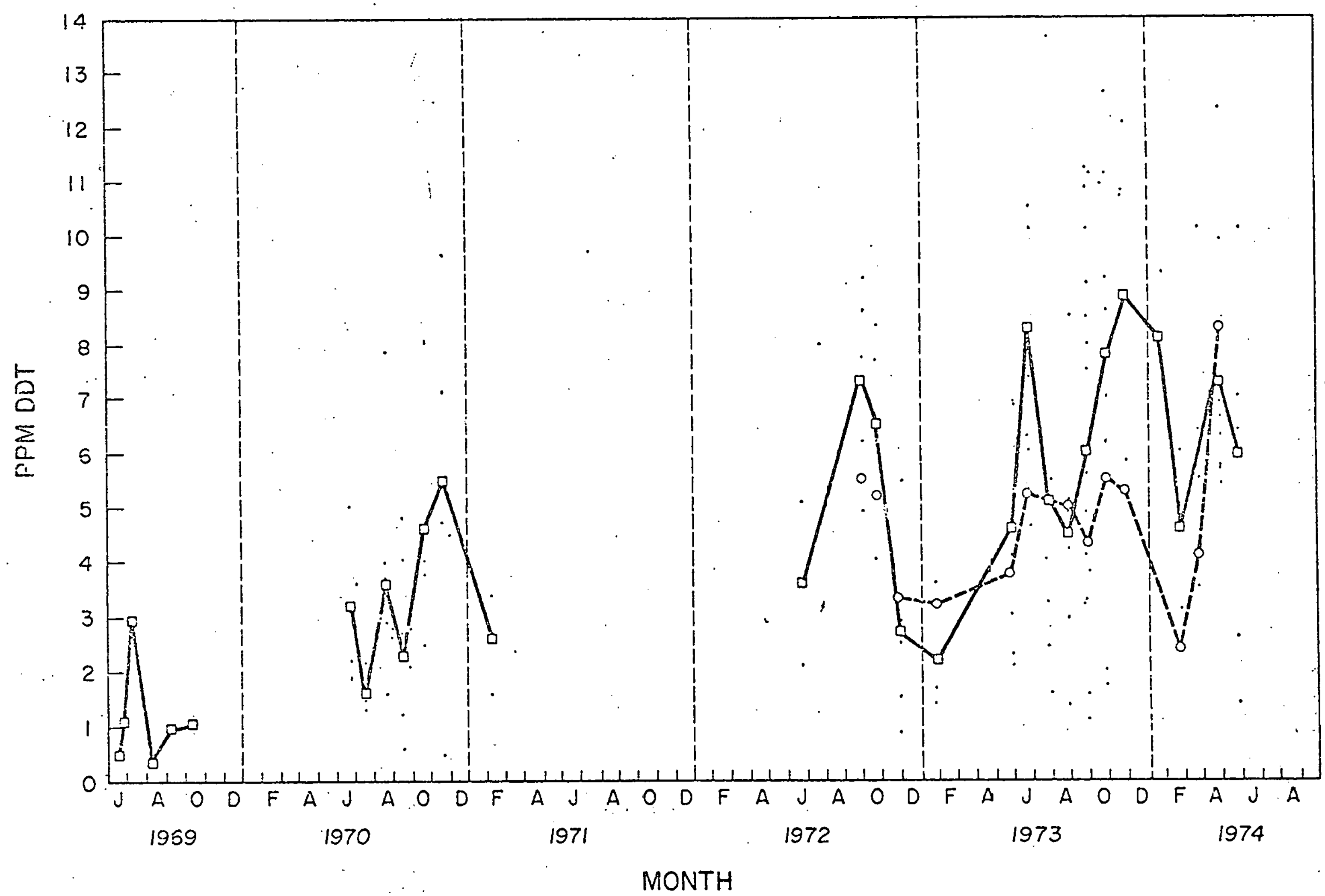

Figure 3. Residues of DDT in the liver of meadow voles (<u>Microtus pennsylvanicus</u>) from the treated enclosure, 1969-1974. Each data point represents one animal. Monthly mean values are joined together by solid lines. The open circles joined by dashed lines are the monthly mean values for stomach contents.

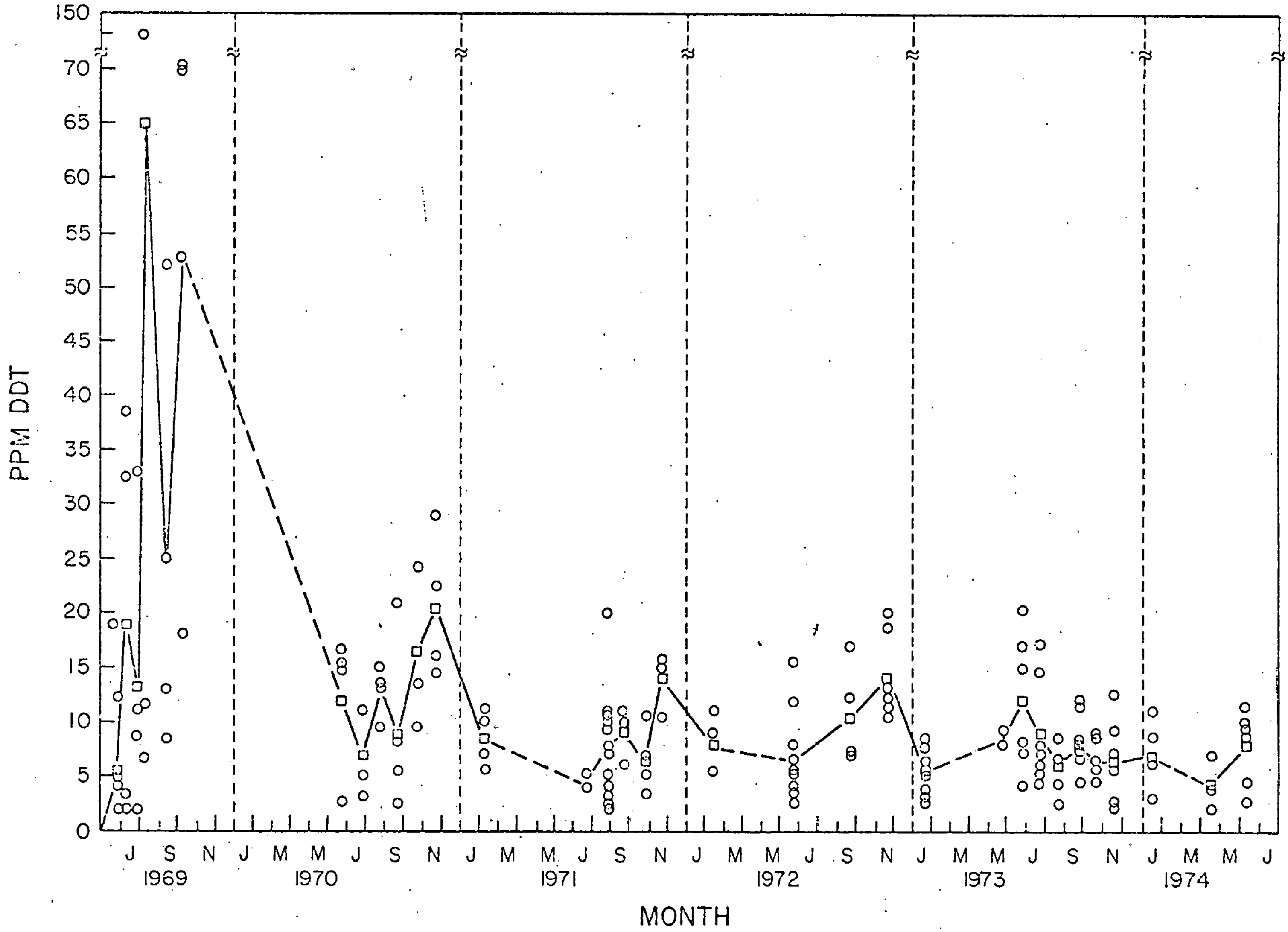

Figure 4. Residues of DDT in the liver of short-tailed shrews (Blarina brevicauda) from the treated enclosure, 1969-1974. Each data point represents one animal. Monthly mean values are joined together by solid and broken lines.

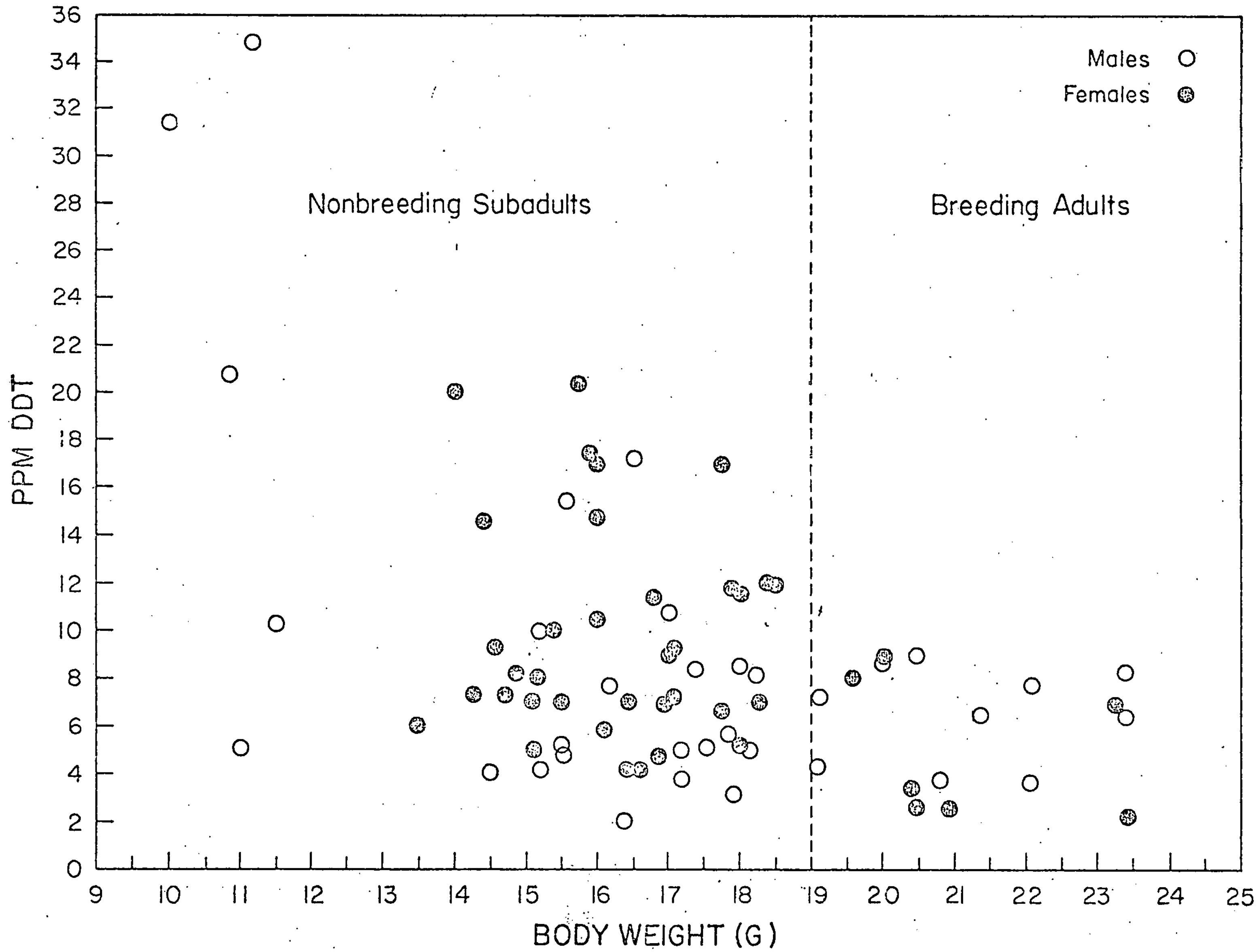

Figure 5. Relationship between age, as indicated by body weight, and DDT concentration in the liver of short-tailed shrews (*Blarina brevicauda*). Each data point represents one animal.

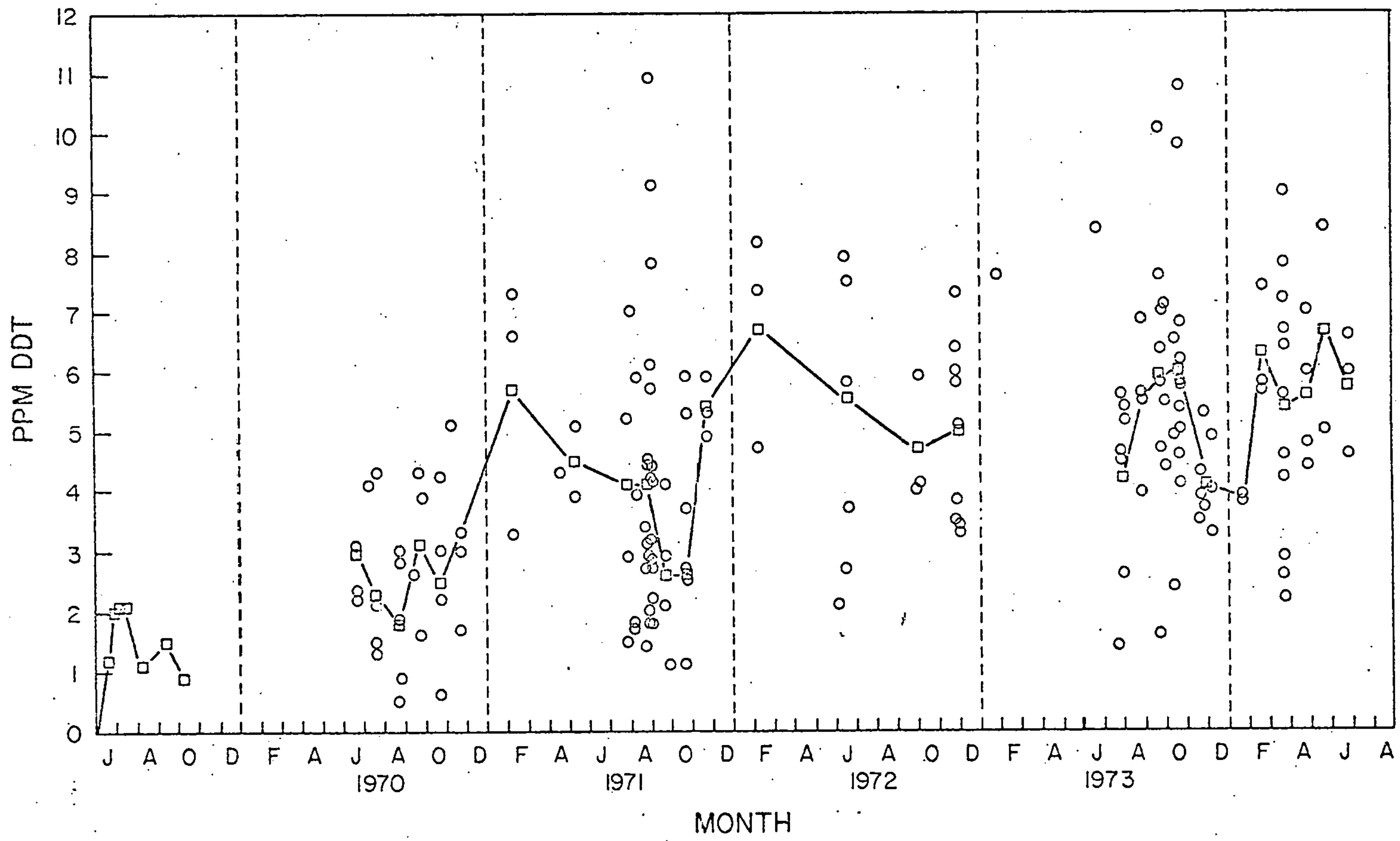

Figure 6. Residues of DDT in the muscle of masked shrews (Sorex cinereus) from the treated enclosure, 1969-1974. Each data point represents one shrew. Monthly mean values are joined together by solid lines.

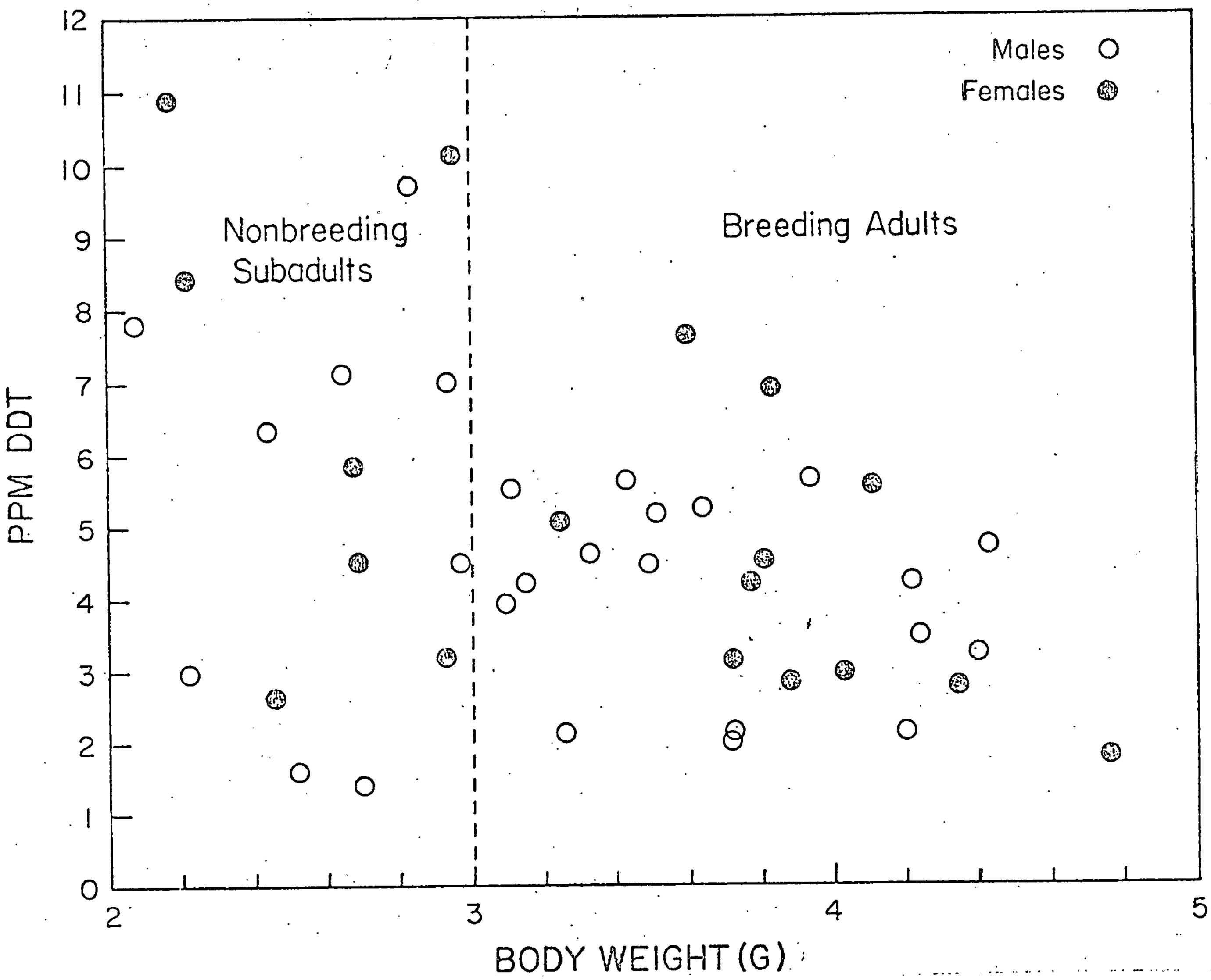

Figure 7. Relationship between age, as indicated by body weight, and DDT concentration in the muscle of masked shrews (*Sorex cinereus*). Each data point represents one shrew.

APPENDIX A

37TH MIDWEST FISH & WILDLIFE CONFERENCE
DECEMBER 7-10, 1975 Toronto

Temporal Variability and Rates of Accumulation of DDT by Small Mammals and Soil Invertebrates in an Old-Field Ecosystem

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Following a single application of C1-36 labeled DDT in June 1969, residues of the insecticide were determined in the biota of 10 acres (4 ha) of enclosed old-field habitat periodically through June, 1974. A slight, but nonsignificant, decline was evident in mean levels of DDT in the liver of shrews *(Blarina brevicauda)* from 12 parts per million (ppm) in June 1970 to 8 ppm in June 1974, with annual peaks occurring in November. Residues in earthworms *(Lumbricus terrestris)* and slugs *(Deroceros laeve)*, important prey items of *Blarina*, decreased by 66 and 45 percent, respectively, from 1970 to 1973. Significant ($P<0.05$) increases occurred in the mean DDT content of the liver of meadow voles *(Microtus pennsylvanicus)* from 3 ppm in June 1970 to 7 ppm in April 1974. Similarly, isopods *(Tracheoniscus rathkei)* increased from 2 ppm DDT in August 1971 to 6 ppm in June 1974. Availability of DDT was therefore increasing for some organisms with time, while decreasing for others. Under field conditions, shrews accumulated an equilibrium level of DDT of 14 ppm (whole-body) by about 40 days, compared to 8 ppm in isopods within 35-40 days, and 11 ppm in slugs by 55 days.