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DISTRIBUTION OF P^{32} IN *AMBROSIA ARTEMISIIFOLIA*; ITS IMPLICATION FOR TROPHIC TRANSFER STUDIES

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Abstract. Tracer studies on temporal changes in P^{32} distribution in ragweed (*Ambrosia artemisiifolia*) indicated significant differences in P^{32} activity in different organs. Activity density of flower tissue was significantly greater than of other organs throughout the study. Differences between root, stem and leaf activities were only present early in the experiment when activity densities of all organs were at their highest. The total isotope pool was originally greatest in leaf tissue, being surpassed by flower tissue during the latter part of the experiment. The differences in activity density levels indicate variable amounts of P^{32} available to consumers which feed at different sites on ragweed. Leaf, flower, or whole plant activity density give quite different results in estimates of trophic transfer indices for two consumer species. Use of activity density measures from the actual site at which a consumer feeds is recommended for a more accurate estimation of trophic transfer.

In connection with general studies of the effect of diazinon on an old-field ecosystem (Malone 1969, Shure 1968), we have investigated the insecticide effects on trophic structure. The methodology of these trophic studies involves the incorporation of P^{32} in a dominant plant species with subsequent analysis of P^{32} transfer through consumer trophic levels (Pendleton and Grundmann 1954, Odum and Kuenzler 1963, Marples 1966). A "stem well" method of introducing isotopes into plant tissue was utilized, following the procedure of Wiegert and Lindeborg (1964). In describing the technique, Wiegert and Lindeborg also pointed out that the isotopes they introduced (Fe^{59}, Sr^{85}, Zn^{65}) became differentially concentrated within different plant tissues.

Later, however, Wiegert, Odum and Schnell (1967) used P^{32} as a tag to measure trophic transfer from two dominant plant species in first-year fields. No evaluation of the isotope distribution within plant organs was apparently made during their study. In calculating their trophic transfer indices they used the formula

$$\text{Trophic transfer index} = \frac{\text{mean activity density consumer (cpm/mg)}}{\text{mean activity density plant foliage (cpm/mg)}} \times \text{Total consumer biomass (dry wt.) sampled}$$

which represents the mean concentration factor (C.F.) times the population biomass. The activity density of leaves, however, was used as the sole measure of isotope density within plant tissue.

This procedure led us to pose several questions before proceeding with the analysis of trophic transfer in our studies: 1. Is there a uniform distribution of P^{32} activity density in the organs of ragweed (*Ambrosia artemisiifolia*)? 2. If not, does the activity density of roots, stems, leaves and flowers show characteristic variations with time? 3. If significant differences exist between P^{32} activity in plant tissues, then from which plant organs do consumer species obtain their nutrients? 4. What plant activity density should be used in calculating trophic transfer indices for different consumer species?

METHODS

The studies were conducted in a first-year field adjacent to Hutcheson Memorial Forest (Botkin and Malone 1968) on the Piedmont of central New Jersey. The field had been plowed and abandoned on May 9, 1968. A 100 m^2 plot was established in the field, and 200 ragweed plants were tagged with P^{32} for analysis of the trophic transfer by consumer species. As an additional study 32 plants were similarly labeled from within a 15-m buffer zone around the 100 m^2 plot. The analysis of temporal changes

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in isotope distribution in these plants forms the basis of this report. The 32 plants were selected for uniformity of size and appropriateness for a stem well. On July 26, 1968, 15 μc of P^{32} were introduced into each well, and the isotope was quickly taken up and translocated throughout the plant.

Eight of the 32 plants were systematically chosen for harvesting on days 6, 19, 31 and 42 following P^{32} labeling. Each plant was carefully removed from the soil to minimize the possibility of loss of root material. The entire plants were bagged and taken to the laboratory for dissection into inflorescence, leaf, main stem, branch stem and root components. Three small subsamples were systematically removed from the organ components of each plant for P^{32} assaying. All radioactivities were determined in a gas-flow counter (Nuclear Chicago Model 470) with an automatic planchet changer. All plant tissue was dried at 100°C for 24 hr and weighed using a pan balance (± 0.1 g) for organ components and a semimicro analytical balance (± 0.1 mg) for subsamples. All activities were corrected for physical decay of the isotope with no self-absorption corrections attempted. The statistical design of the experiment enabled the use of a partially hierarchic design for the analysis of variance. The least significant difference (Lsd, Steel and Torrie 1960) was used in determining significant differences.

Results

Plants were tagged at about one-fourth their asymptotic biomass and were approaching maximum size by the end of the experiment. The results then represent conditions covering most of the growth period of ragweed. The biomass studies also illustrated, not surprisingly, that significant differences existed between the biomass of different plant organs. These differences also changed over time when comparing plant organs such as roots and flowers. In other words, there were significant differences between plant parts, at different times and from the interaction of these factors (Table 1). In general, root biomass changed only slightly over time whereas

Table 1. Partially hierarchic design for the analysis of variance in biomass changes in ragweed

Source of variation	*df*	SS	MS	F
Total	159	715	—	—
Time	3	131	43.8	6.3**
Plants (time)	28	196	7.0	
Plant parts	4	238	59.5	69.0**
Time × plant parts	12	53	4.5	5.2**
Plants (time) × plant parts	112	94	0.9	—

**Significant at .01 level.

main stems, branch stems and leaves apparently reached maximum size about half-way through the experiment. Flowers, which were absent at the start, became a major biomass component by the end of the study.

Activity density levels of plant tissue were significantly different with respect to time, plant parts and their interaction (Table 1, Fig. 1). Activity density comparisons showed all tissue means were significantly different on day 6 except for leaves and main stems. The activity density of flowering tissue remained significantly higher than of all other plant components throughout the experiment. Differences among roots, stems and leaves were lost after the day 6 sample. The variation in activity levels over time (Fig. 1) is attributed to a possible loss

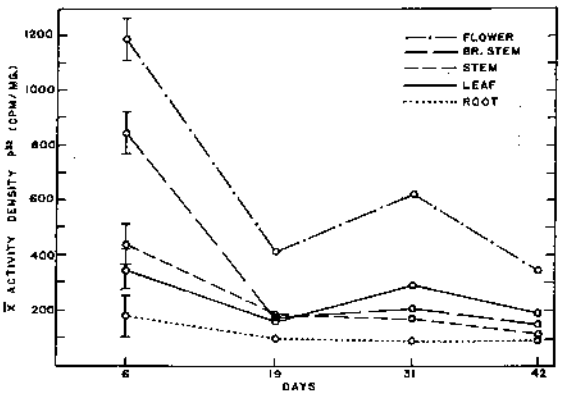

Fig. 1. Activity density changes in organ components of ragweed. Means represent three subsamples from each organ component of each of eight plants harvested (N = 24). Least significant intervals (± Lsd/2) used on day 6 apply throughout the study.

Table 2. Partially hierarchic design for the analysis of variance in activity density changes in biomass

Source of variation	df	SS(×10⁶)	MS(×10⁶)	F
Total	479	61.9	—	—
Time	3	13.6	4.54	13.7**
Plants (time)	28	9.3	0.33	12.2**
Plant parts	4	15.4	3.84	56.3**
Time × plant parts	12	7.3	0.61	8.9**
Plants (time) × plant parts	112	7.6	0.07	2.5**
Replication (Plants (time) × plant parts)	320	8.7	0.03	—

**Significant at .01 level.

of P^{32} by leaching and by the dilution effect created by a near tripling of plant biomass with no further isotope addition. This latter factor probably accounts for the decreased activity levels between day 6 and 19, which is correlated with a large simultaneous increase in plant biomass. The concentration of isotope near the stem well may move continually to other plant parts; this may explain the small rise in activity on day 31.

The total P^{32} available in plant organs on each date was estimated by multiplying mean activity density by mean biomass (Fig. 2). This estimates the relative size of the isotope pool available in different plant organs. Isotope availability was highest in leaf tissue until around day 27 (Fig. 2), when it was surpassed by flowering tissue. An explanation for the large increase in total flower activity is difficult as the data did not show a corresponding decrease in other organs. This may represent a movement of P^{32} from the well area to the actively growing inflorescences. Mean activity density in the main stem 1 cm above the well was 2,465, 932, 498 and 282 cpm/mg respectively on the four sample dates reflecting the steady drop in P^{32} activity from this region.

Biomass and activity density for *Lygus pratensis* (Hemiptera, Miridae), which were observed feeding on flowers, and for *Melanoplus femurrubrum* (Orthoptera, Acrididae) which are leaf feeders, were obtained from within the 100 m² labeled plot. These data (Table 3) illustrate the effect of using activity densities of leaf tissue, flower tissue or entire plant averages to calculate trophic transfer indices for these consumers. For *Lygus*, the flower feeder, the use of leaf or whole plant activity density more than doubles the trophic transfer index, and

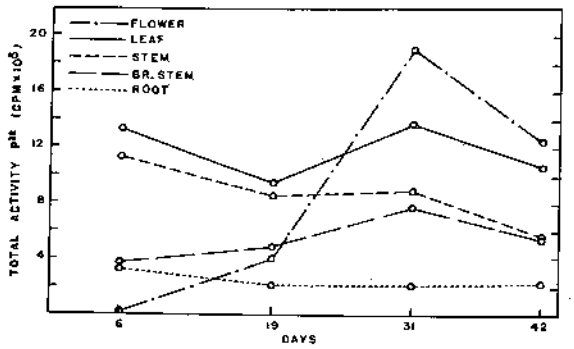

FIG. 2. Total P^{32} activity in organ components of ragweed. Data represent mean organ activity (activity density × biomass) for eight plants harvested on each sample date.

TABLE 3. Trophic transfer indices of flower feeding and leaf feeding consumers using mean activity density of leaf, flower or entire plant tissues

Species	Feeding site	Trophic transfer indices		
		Leaf	Flower	Whole plant
Lygus pratensis	Flowers	143	55	114
Melanoplus femurrubrum	Leaves	474	184	379

thus the apparent relative importance of this consumer. On the other hand, the use of leaf or whole plant activities in computing indices for *Melanoplus* gave similar results, whereas the use of flower activity density underestimated the importance of this species.

CONCLUSIONS

This study has shown significant differences in biomass and activity density of P^{32} in the component tissues of ragweed. Thus, care must be taken in the choice of activity density representative of the producer. If, in trophic transfer studies, the site at which a consumer feeds is known, appropriate activity densities for that site should be used in calculating the trophic transfer index. If, as is usually the case, the feeding sites are unknown or variable, we recommend that the mean activity density for the entire plant tissues available to the consumer be used to calculate trophic transfer indices. Plant activity densities should also be calculated over the entire period when trophic transfer indices are estimated, as these plant activities can change significantly over short periods.

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AN INEXPENSIVE PRESSURE CHAMBER FOR XYLEM WATER TENSION MEASUREMENTS

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Abstract. An inexpensive, easily constructed pressure chamber is described which can be used for estimating xylem water tension. Such a chamber apparatus can be assembled for as little as $60 and can measure tensions greater than −100 bars. The static testing of the finished chamber with either water or oil is necessary before it can be used.

The pressure chamber method of estimating xylem water tension has been used both in the field (Scholander et al. 1965, Waring and Cleary 1967, Klepper 1968) and in the laboratory (Boyer 1967). Its easy and rapid measurements provide data in minutes which had taken hours by other, less precise field methods. It can be calibrated against a thermocouple psychrometer to read water potential (Boyer 1967, Kaufmann 1968), but even