Turnover and Life Spans of Fine Root Carbon in a $^{14}$C-labeled Forest Ecosystem.

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INTRODUCTION

A multi-year experiment is quantifying pathways and rates of C transfer by studying upland-oak plots in a mature forest in eastern Tennessee, USA, which was fortuitously labeled with a large pulse of carbon 14 in 1969 (Huntzinger et al., 2002). This labeling event (Figure 1) allowed a unique opportunity to trace C flows through this ecosystem on timescales of 2 to many years. This multi-disciplinary experiment (the Enriched Background Isotope Study [EBIS]) is using labeled litter, roots, and soils to study transfers of this $^{14}$C from sources (leaf, root litter) to sinks (respiration, leaching, or stable soil forms).

The reconstructed $^{14}$C concentration timeline in Figure 1 indicates:

- The spike was very strong in 1999.
- Levels have returned to near-background subsequently.

The study presented here-part of this larger research project—focuses on the quantification of the turnover rates for fine roots in this forest.

METHODS

Soil cores from plots of 2 cm in diam. were collected at 5 depth intervals to 60 cm in January/February of 2000, 2001, and 2002. Fine roots (< 2 mm) were sorted into size classes (live and dead).

Radiocarbon labeling—expressed as $^{14}$C/$^{12}$C—was determined on graphite targets of composited root samples. Radiocarbon labeling was determined on graphite targets of composited root samples.

RESULTS

Figure 3. The mean $^{14}$C concentrations of fine roots at different depth (0–15 cm) and year (2000 vs. 2001) are shown.

- Dead roots at Time Zero consistently had higher $^{14}$C values than living roots.

DISCUSSION

The diagram in Figure 6 demonstrates important implications of the patterns observed in Figure 3 and 4.

1. Dead roots from Year 0 (2000) had a higher mean $^{14}$C (~410) than did live roots (~370). The dead root pool must have already received a high input of roots with high $^{14}$C that formed during the 1999 spike year.

2. Live pools showed a very small change in $^{14}$C between Year 0 and Year 1 (~370 to ~330). Turnover in this portion of the live pool must have been quite slow and life spans long (>3 years).

3. Large changes in the dead $^{14}$C between Year 0 and Year 1 (~410 to ~310) can only be explained by a large input of very short-lived roots that both formed and died during Year Zero (2000) growing season. These short-lived roots would have a relatively low $^{14}$C (~180)—capable of shifting the mean $^{14}$C of the total dead pool this much—and a mean lifespan of about 3 months.

4. Note that implication #3 is consistent with implication #1. Therefore 2 things must be true:

- A large portion of the Year 1 dead root pools consist of very short-lived roots that both formed and died during Year Zero (2000) growing season.

- The live root pool must contain both roots that both turnover very quickly and roots that live for several years.

REFERENCES


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CONCLUSIONS

*** These data suggest the existence of at least two types of fine roots with radically different turnover times:

1. One type consists of fine roots that live less than the length of one full growing season—average turnover time is approximately 3 months.

2. The other type is considerably longer-lived, probably living 2 to 15 years, averaging between 3 and 5 years.

*** Fine roots of the SAME diameter size class can have very different life spans, form, and function.