

## THE AGE OF FINE ROOT CARBON MAY NOT INDICATE THE AGE OF ROOT

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### ABSTRACT

For root carbon age estimation by bomb radiocarbon method, the fine root samples from ingrowth cores with known maximum root age (1 to 6 years) from three Scots pine (*Pinus sylvestris* L.) stands from boreal forests of Finland were collected and analyzed. The stands were 1) Ilomantsi (maximum root age one year), 2) Jämijärvi (maximum root age one year), 3) Punkaharju (maximum root age 2, 4 and 6 years). The ingrowth core root samples originate from the years 1985 to 1993. Two root diameter classes were selected; i) < 0.5mm, and ii) 1.5-2.0 mm.

The overall goal of this study was to assess whether or not the root C age estimated by <sup>14</sup>C method coincides with the known maximum root age. For this purpose, we analyzed the bomb root C age of carefully sorted live and dead fine roots by bomb radiocarbon method and compared it with the known maximum fine root age. Since the structural carbon (cellulose) is not replaced after the root is formed, the root cellulose C age should represent the real age of the root, with the assumption that the cellulose C originates from recent photosynthesis. Hence, the bomb <sup>14</sup>C was analysed both in bulk roots (i.e. without removing any structural or non structural compounds from the roots) and in only root cellulose (other root constituents removed).

In our study, the radiocarbon content of the archive roots of known maximum age and corresponding atmospheric air <sup>14</sup>C values from the years when the ingrowth cores were in soil were supportive to each other in most of the cases but not in all. For Jämijärvi and Ilomantsi sites, both <sup>14</sup>C age and known maximum root age supported each other. However, this was not the case for the Punkaharju site. At this site, the ingrowth cores were placed in soil in 1987, and sampled in the years 1989, 1991 and 1993. The radiocarbon content of *bulk* live fine roots ( $\varnothing < 0.5$  mm), sampled during 1989- 1993, was in the range of 187-147 ‰, close to that of recorded atmospheric levels (175 - 123 ‰). However, the radiocarbon content of bulk live fine roots (339 - 156 ‰) of larger diameter class (1.5 - 2 mm) sampled during 1989-1993 remarkably exceeded that of recorded atmospheric levels. This means that the <sup>14</sup>C age of these fine roots was up to 12 years older than the known maximum age of roots.

The live root *cellulose* of both diameter classes had similar root <sup>14</sup>C content as in the atmosphere, except the roots sampled in May 1989 with extremely high values of 262 ‰ (for the roots < 0.5 mm) and 296 ‰ (for the roots 1.5 - 2mm in diameter). These values substantially exceeded the atmospheric air <sup>14</sup>C value of 160 ‰; i.e. fine root cellulose had older C dating to 1980-81 than the known root age of 1987-89. While it can not be completely excluded that the non-supportive results were caused by sampling error or contamination, it is more likely that the <sup>14</sup>C signature of fine roots is not always indicative of root age, e.g. because of addition of C from storage, retranslocation within the root system, organic C uptake, or incorporation of older respired CO<sub>2</sub>.

Keywords: cellulose, fine root age, ingrowth core, *Pinus sylvestris*, radiocarbon, root carbon