

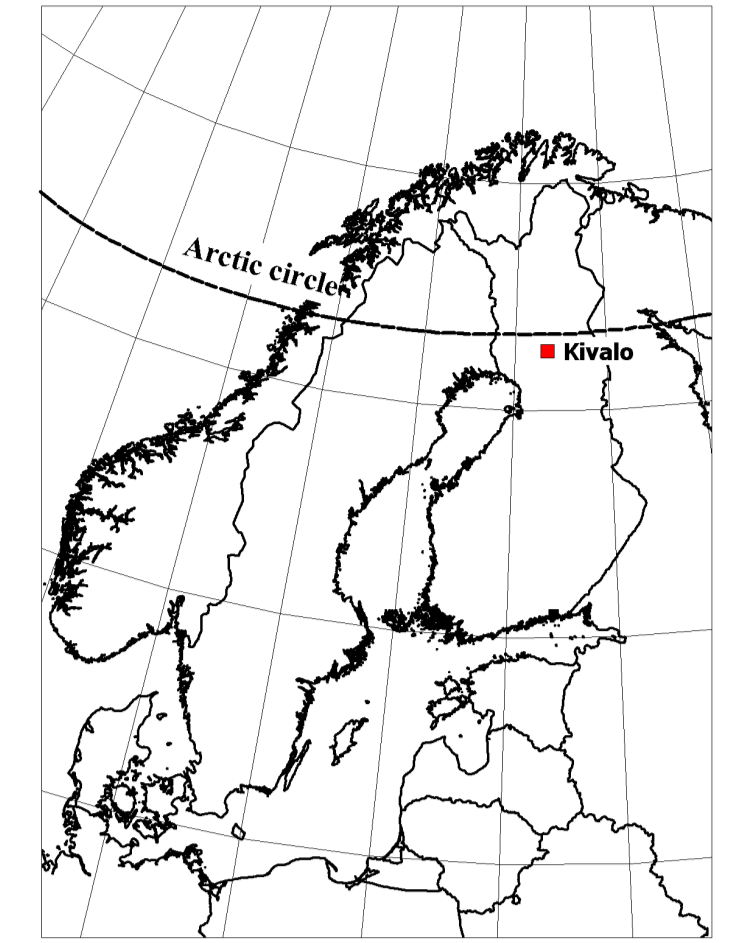
Radiocesium in mycorrhizal macro fungi in Finnish Lapland during 1981-2011



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Introduction

STUK- Radiation and Nuclear Safety Authority has monitored radioactivity concentrations in mycorrhizal macro fungi in the Kivalo research area 70 km southeast of Rovaniemi since early 1980s. In this study statistical values of radiocesium concentrations were calculated and ecological half-lives in fungal species estimated. The aim of this study was to explore changes in ^{137}Cs concentrations with time in various mushrooms in different habitats.

Materials and Methods

Samples of *Suillus variegatus*, *Lactarius rufus*, *Lactarius vietus*, *Russula decolorans*, *Russula paludosa*, *Russula xerampelina*, *Russula vinosa*, *Cortinarius armillatus* and *Rozites caperatus* (Fig. 1) were collected in four forest stands (Fig. 2). In laboratory the mushrooms were cleaned, sliced, dried at 105 °C and homogenized before gamma spectrometric measurement. The small samples collected in Kivalo in 1981 - 1985 were obtained from archives of the Finnish Forest Research Institute in Rovaniemi and represent pre-Chernobyl accident levels.



Fig 1. Four different genus of fungi: *Lactarius (rufus)*, *Russula (vinosa)*, *Cortinarius* and *Rozites*.



Fig 2. Four different habitats of fungi: pine (*Pinus sylvestris*), spruce (*Picea abies*), birch (*Betula*) and mixed stands.

Results and Discussion

^{137}Cs concentrations varied in 1981 – 1985 from 280 to 6500 and in 1989 – 2011 from 120 to 9030 Bq/kg d.w. The statistical values of fungi are presented in Table 1 (number of samples, min, max, mean ^{137}Cs Bq/kg d.w.) The mean concentrations are presented in Fig. 3 with dots and bars which indicate the minimum and maximum values of the sampling year. The lowest values were measured in *Russula* and the highest in *Cortinarius armillatus* (non-edible) and *Rozites caperatus*. The ecological half-lives, $T_{1/2}$, for the concentration decrease were estimated using loglinear regression analysis. After sampling period 1989 – 2000 the $T_{1/2}$ values were estimated to vary from 8 to 18 years, except for *Cortinarius* 30 years. After a longer sampling period 1989 – 2011 the estimated $T_{1/2}$ of all mushrooms varied 10 – 17 years. The longest half-lives were measured in fungi from fresh heath.

Table 1. The statistical values of analysed samples.

Era	Statistic value	n	(1981-1985)			(1989-2011)			
			min	max	mean	n	min	max	mean
<i>Suillus variegatus</i>		5	350	3100	1740	35	190	3250	1550
<i>Lactarius rufus</i>		10	450	1590	880	50	200	2660	760
<i>Lactarius vietus</i>		5	870	1720	1330	19	300	2090	1110
<i>Russula decolorans</i>		9	420	780	510	34	220	1270	530
<i>Russula paludosa</i>		7	450	1290	660	27	170	960	530
<i>Russula xerampelina</i>		12	330	700	460	29	150	1510	570
<i>Russula vinosa</i>		12	280	970	510	19	120	580	300
<i>Cortinarius armillatus</i>		9	270	6520	3000	60	720	9030	3600
<i>Rozites caperatus</i>		3	440	1240	970	35	250	5200	2430

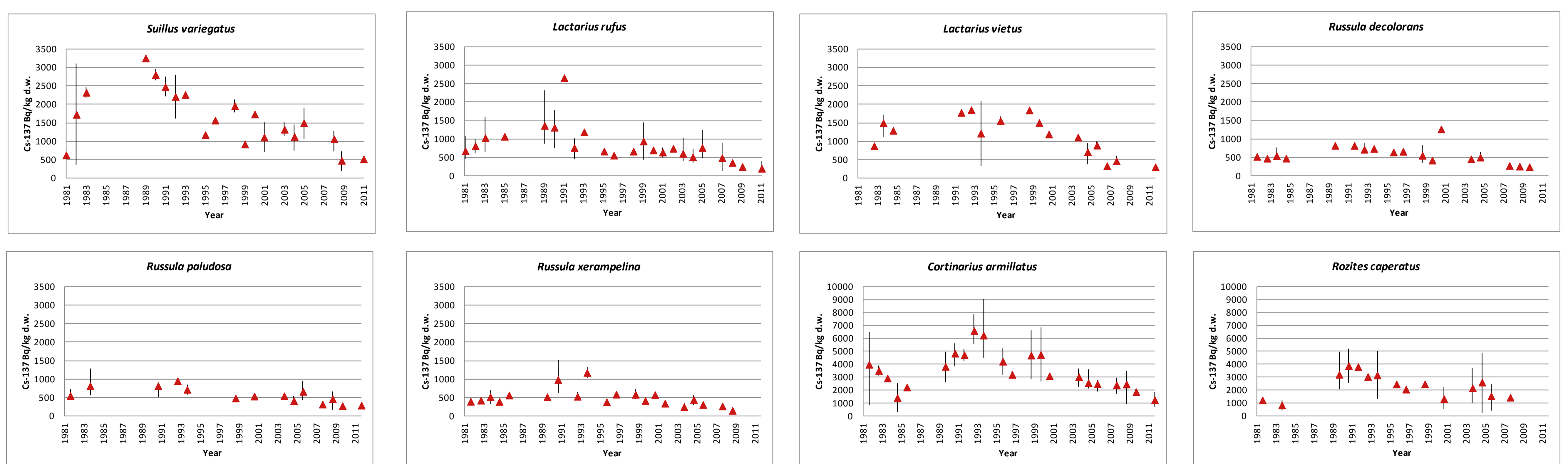


Fig 3. ^{137}Cs concentrations (Bq/kg d.w.) in mycorrhizal macro fungi during 1981 - 2011.

Conclusions

After the Chernobyl accident in 1986 the ^{137}Cs concentrations in environment consisted of both the global and Chernobyl fallout. For the present the mushroom ^{137}Cs levels in Northern Finland are not higher than before the accident and in all edible mushroom species they remain below the EU recommendation (600 Bq/kg f.w.). According to this study, the most sensitive fungus is *Cortinarius armillatus*, which grows mainly in fresh heaths. ^{137}Cs concentrations in *Cortinarius* still increased 5 – 6 years after the Chernobyl accident whereas the concentrations of other species decreased. *Cortinarius* is not edible, but it is an excellent indicator for Cs in a late phase of fallout situation. A small amount of Fukushima derived ^{134}Cs (1.2 Bq/kg d.w.) was observed in *Cortinarius* in mixed stands of the Kivalo research area in 2011.