Table 2. International intercomparisons jointly organized by IAEA & US EPA in 1995. Results for the Canberra-Packard PicoRad systems.

Target values (Tv)				Reported values (R v)				
Place of exposure	Temp. °C	t_{exp} h	$Rn_{conc.}$ Bq/m^3	Institution	Number of samples	Range Bq/m^3	Mean Bq/m^3	Bias = =Rv/Tv
Twilight Mine - Colorado	20	48	8592	CLOR	4	8303-9282	8750	1.018
		48	8592	IBT	6	7250-7875	7479	0.871
		48	8592	AM	10	8272-9221	8749	1.018
		48	8592	NHI	4	8611-9491	9245	1.076
		72	8390	CMI*)	5	7413-8108	7821	0.932
EPA - Las Vegas laboratory	21	48	720	CLOR	4	730-784	760	1.055
		48	720	IBT	4	530-700	688	0.866
		48	720	AM	6	726-801	764	1.061
		48	720	NHI	4	751-833	776	1.078

*) CMI' own detectors and Quantulus - Wallac liquid scintillation counter.

2.14 MIGRATION OF ^{137}CS IN SOILS AND ITS TRANSFER TO MUSHROOMS AND VASCULAR PLANTS IN MIXED FOREST*

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Vertical migration of radiocesium in forest soils was extensively studied after the Chernobyl accident. It has been shown that downward migration of radiocesium is slow, and that the major part of this radionuclide is being retained in the organic horizons. Therefore, radiocesium is still easily available for mushrooms and vascular plants, thus entering into food chains of animals and man.

The purpose of the study was to determine the vertical distribution of radiocesium and potassium in mixed forest podsol soils and to evaluate a transfer of ^{137}Cs from soil to mushrooms and vascular plants. In calculations of transfer factors (TF), all the nutritive horizons were considered.

The study was performed at two locations in the Kampinos National Park (KNP), at Truskaw and Palmiry; sampling sites at both locations were ~ 200 m x 200 m each. In the mixed forest at Truskaw coniferous trees prevail,

whereas at Palmiry there are mainly oaks and hornbeams. In both locations the soil is of the podsol type.

Samples of soils and litter, mushrooms and vascular plants (leaves and stems) were collected from 20 sites at Truskaw and 36 places at Palmiry.

Samples of soil with horizons Of through B were taken using a 50 cm x 50 cm metal frame or a metal tube of 13 cm in diameter (surface area of 133 cm^2). Horizons were separated and analyzed individually. Samples of mushrooms (*Xerocomus badius* and *Paxillus involutus*) and/or green plants (grass, *Calluna*, *Vaccinium myrtillus*, *Polypodium vulgare*) were taken from the same area as the soil samples or in close vicinity. By visual inspection it was estimated in which horizons the root system of the vascular plants was developed. To evaluate an anticipated increase of ^{137}Cs content locally under the mushrooms after their eventual decomposition, mushrooms and samples of soil were collected from beneath these mushrooms over a surface area of 133 cm^2. ^{134}Cs, ^{137}Cs and ^{40}K were determined by gamma spectrometry.

Average deposition of ^{137}Cs in the soils from the KNP was ~ 3 000 Bq m^{-2}. About 80% of ^{137}Cs was present in the Of and OhAh horizons, being in the OhAh horizon slightly lower than that in the Of horizon. After eight years since the Chernobyl accident, ^{137}Cs remained in almost equal amounts in Of and OhAh (in each about 40%), and it penetrated only in about 20% to the deeper mineral horizons (Table 1).

The high retention of ^{137}Cs in the Of horizons can be attributed to the high content of organic matter. A large difference in the ^{137}Cs content in the OhAh and Ah1 horizons appears to be typical for podsol. The migration of ^{137}Cs from the OhAh horizon is very small, demonstrating thus the high retention in the OhAh horizon.

Mean concentrations of the two cesium radionuclides and of potassium in mushrooms and vascular plants are given in Table 2.

As expected, the concentrations of radiocesium in the *Xerocomus badius* and *Paxillus involutus* were considerably higher than in vascular plants. The concentration ratio $^{137}Cs/^{134}Cs$ in mushrooms and *Calluna* were similar to those in the Of horizon, while in the other plants they were higher.

Table 1. Mean ^{137}Cs and potasium concentrations and ^{137}Cs content in soil horizons at Truskaw and Palmiry in 1994

Horizon	Concentration of ^{137}Cs (Bq kg^{-1} dw)	Content of ^{137}Cs (Bq m^{-2})	Concentration of K (g kg^{-1} dw)	Percentage of ^{137}Cs content in horizon (%)
Truskaw				
Ol	42±17[a]	5.7±3.1	0.9±0.4	0.2
Of	151±67	1363±364	4.7±1.4	41.6
OhAh	71±25	1325±447	6.9±0.8	40.4
Ah 1	25±10	457±169	7.8±0.4	13.9
Ah 2	5.2±4.7	95±38	7.7±0.4	2.9
B	0.8±0.7	32±28	7.5±0.3	1.0
Total		3278±590		
Palmiry				
Ol	62±26	13±7	1.6±0.6	0.5
Of	143±44	1150±496	4.4±1.0	39.8
OhAh	49±19	1029±440	6.0±0.8	35.6
Ah 1	15±7	475±240	6.4±0.7	16.4
Ah 2	4.5±2.4	179±87	6.3±0.7	6.2
B	1.1±0.4	43±4	6.3±0.7	1.5
Total		2889±711		

a - Standard deviation

Table 2. Mean concentration of ^{137}Cs, ^{134}Cs and potassium in mushrooms and green plants at Truskaw and Palmiry in 1994

Plant	^{137}Cs (Bq kg^{-1} dw)	^{134}Cs (Bq kg^{-1} dw)	K (g kg^{-1} dw)	Number of samples
		Truskaw		
Xerocomus badius	2588±1636[a]	58±28	37±11	10
Paxillus involutus	2920±1404	78±43	57±12	9
Calluna	149±56	3.6±1.4	4.4±1.1	7
Grass	63±26	1.1±0.5	10±4	9

	Palmiry			
Xerocomus badius	2434±1081	49±28	39±8	26
Paxillus involutus	3685±1661	97±63	48±15	6
Calluna	176±52	4.0±1.5	5.0±0.9	6
Grass	49±14	1.0±0.5	6.3±2.5	4
Vaccinium myrtillus	92±38	2.0±0.6	4.5±1.1	17
Polypodium vulgare	256±79	4.0±1.1	21±2.4	4

a - standard deviation

Different species of the understorey vegetation take nutrients from different soil layers. In this work, soil horizons for species were assessed on the basis of the depth of the rooting system. In case of roots penetrating through several horizons, the entry of radiocesium from each of the horizons depend on its availability in the horizon. It has been assumed that the avaiability was controlled by the content of organic matter (this content was used as a weighting parameter for calculating the weighted mean concentration).

Transfer factors were calculated as a ratio of ^{137}Cs concentration in mushrooms or green plants (Bq kg^{-1}_{dw}) to the ^{137}Cs concentration in the horizons which have been assumed to be the source of this radionuclide. The largest TF occurred for mushrooms, being in the range from 17.0±1.8 to 25.8± 4.1. TF for *Polypodium vulgare* was 2.30±0.43, whereas for the other green plants it was from 0.44±0.08 for grass to 1.23±0.15 for *Calluna*.

The enrichment of the Of horizon in ^{137}Cs from the decomposing mushroom fruitbodies was evaluated and it was shown that this enrichment can significantly contribute to the horizontal displacement of radiocesium.

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2.15 TRANSFER OF ^{226}Ra TO PLANTS FROM SANDY SOIL

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A soil-to-plant transfer was examined for edible plants (potato tubers, red beet, radish, carrot, parsley, kale, lettuce) and for fodder (grass, alfalfa). Plants were grown in a sandy soil on an experimental field.

^{226}Ra was determined in soil, in edible parts of vegetables after their careful washing, and in unwashed grass and alfalfa. ^{226}Ra was determined by