Distribution of cesium-137 in reindeer[1]

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Summary: The influence of the Chernobyl accident in 1986 on the Finnish reindeer herding area was much smaller than the effects of the nuclear bomb tests in the 1960s. Only in one small area somewhat more Cs-137 was deposited than in the rest of the reindeer herding area. From that area 20 reindeer were chosen for investigation of the distribution of Cs-137. All tissues, organs, the skeleton, digestive tract, hide, head and hooves were sampled quantitatively. Three reindeer were pregnant and also the foetuses were studied. The Cs-137 amounts were determined by gammaspectrometric measurements.

The results showed that the differences in the Cs-137 concentrations between muscle tissue from different parts of an individual reindeer were not more than 10 percent. Thus it is not essential from which part of the reindeer meat samples for surveillance purposes are taken. The concentration of Cs-137 in edible tissues other than muscle was lower except in the kidneys and scapula cartilage.

Key words: Cs-137 distribution, reindeer, gammaspectrometry, environment, fallout, radiocesium

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Introduction

The influence of the Chernobyl accident in 1986 on the Finnish reindeer herding area was much smaller than the effects of the nuclear bomb tests in the 1960s because of the northern situation and favourable winds at the time of the accident (Rahola and Miettinen 1977, Rissanen et al. 1987, Rissanen and Rahola, 1988 and 1989). Only in the southeasternmost corner of the reindeer herding area was somewhat more Cs-137 deposited than in other parts of the reindeer herding area (Fig. 1, area V). But even here the amounts of radiocesium deposited were smaller than in the more southerly reindeer herding areas in Sweden and Norway.

The Cs-137 concentrations in reindeer meat have been followed closely since the accident on the whole reindeer herding area by taking samples from slaughtered reindeer. In Finland 130.000 - 150.000 reindeer are slaughtered each year, about 800 of these in area V (Fig. 1). These 800 reindeer did not create any radiation protection problem even in 1986, but were ideal for investigating the distribution of radiocesium in reindeer. From the surveillance point of view Cs-137 concentrations in meat samples are the most important. Samples are taken from the neck of slaughtered reindeer in Finland but in Sweden from the shank. The aim of this study was to investigate differences in radiocesium concentrations between different muscles and in different organs and other tissues of the reindeer.

Material and methods

Twenty reindeer from area V were selected for investigation at the end 1986. The animals were slaughtered between January and March 1987, five at a time. Age, sex, weight and time of slaughtering are presented in Table 1. The age and sex distribution of these animals is typical of the main group of slaughtered reindeer in this area. Before slaughtering the reindeer were kept together and fed lichen containing 6000 - 8000 Bq Cs-137/kg dry weight, similar to the lichen in their natural pasture. Under normal conditions these animals would have strayed to other areas of lower Cs-137 concentration in

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the lichen. Therefore they had to be herded continously. The slaughtering was done in the open in temperatures of -10 to -35°C, and blood samples were also taken at that time. Carcase, all internal organs, digestive tract, hide, head and hooves were transported 400 km to the laboratory in Rovaniemi for further preparation.

The meat of the carcasses were cut into sections (Fig. 2). The skeleton was separated into individuals bones; the leg bones were further divided into diaphysis and epiphysis. Bone marrow and cartilage were sampled. All internal organs, including the whole digestive tract were sampled. Rumen contents was sampled qualitatively from the first five reindeer and quantitatively from the remainder.

Three of the reindeer were pregnant and two foetuses were big enough to enable sampling of their organs and tissues. The third reindeer was less than 1 year old; its foetus was very small and had to be measured undivided.

All samples were homogenized and some were dried before measurement. The gamma-spectrometric measurements were performed with high purity lithium drifted germanium detectors and the results calculated as described in earlier publications (Rissanen et al, 1987).

Results

Both Cs-134 and Cs-137 were measured but only the Cs-137 results were used for comparison. All Cs-137 concentrations presented in this paper are given as Bq/kg fresh weight. Shown in Figures 3–6 is a male reindeer, 1,5 years old used as an example for indicating Cs-137 concentrations in its muscle tissue, bones, organs and digestive tract. Fig. 7 shows the same Cs-137 concentrations in its digestive tract as in Fig. 6 but in Bq/kg dry weight. The corresponding mean vaules and variations for all the 20 reindeer are given in Figures 8–11. The Cs-137 concentrations of the foetuses and mothers are presented in Table 2.

Discussion

The differences in Cs-137 concentrations in muscle tissues from different parts of a single reindeer did not exceed 10 per cent. It is therefore not essential from which part of the animal samples for surveillance purposes are taken. The same conclusions could be drawn also from earlier published investigations (Rahola and Jaakkola, 1975, Rydberg, 1988). In Finland the neck is chosen since a sample taken from there does not reduce the market value of the carcase.

Cs-137 concentrations in edible tissues besides meat were lower, except in the kidneys and scapula cartilage. Fat did not contain Cs-137 and therefore the more fat in a tissue the lower the Cs-137 concentration. The concentration in whole blood was about 10 per cent of that in meat.

Acknowledgements

We would like to thank all reindeer herders of the Halla reindeer herding district for making it possible to perform this study. We also thank the employment bureau at Rovaniemi for placing people preparing samples at our disposal.

Table 1. Time of slaughtering, number, sex, age and mean weight of the twenty reindeer studied.

Time of slaughter	Number of reindeer	Sex	Age year	mean weight kg
07.01.87	1	F*	6	59
	1	M	4.5	92
	1	F	<1	47
	2	M	<1	48
24.01.87	1	M	1.5	66
	1	F	<1	41
	3	M	<1	45
15.02.87	1	F*	3–4	65
	4	M	<1	46
02.03.87	1	F*	<1	48
	4	M	<1	45

* pregnant

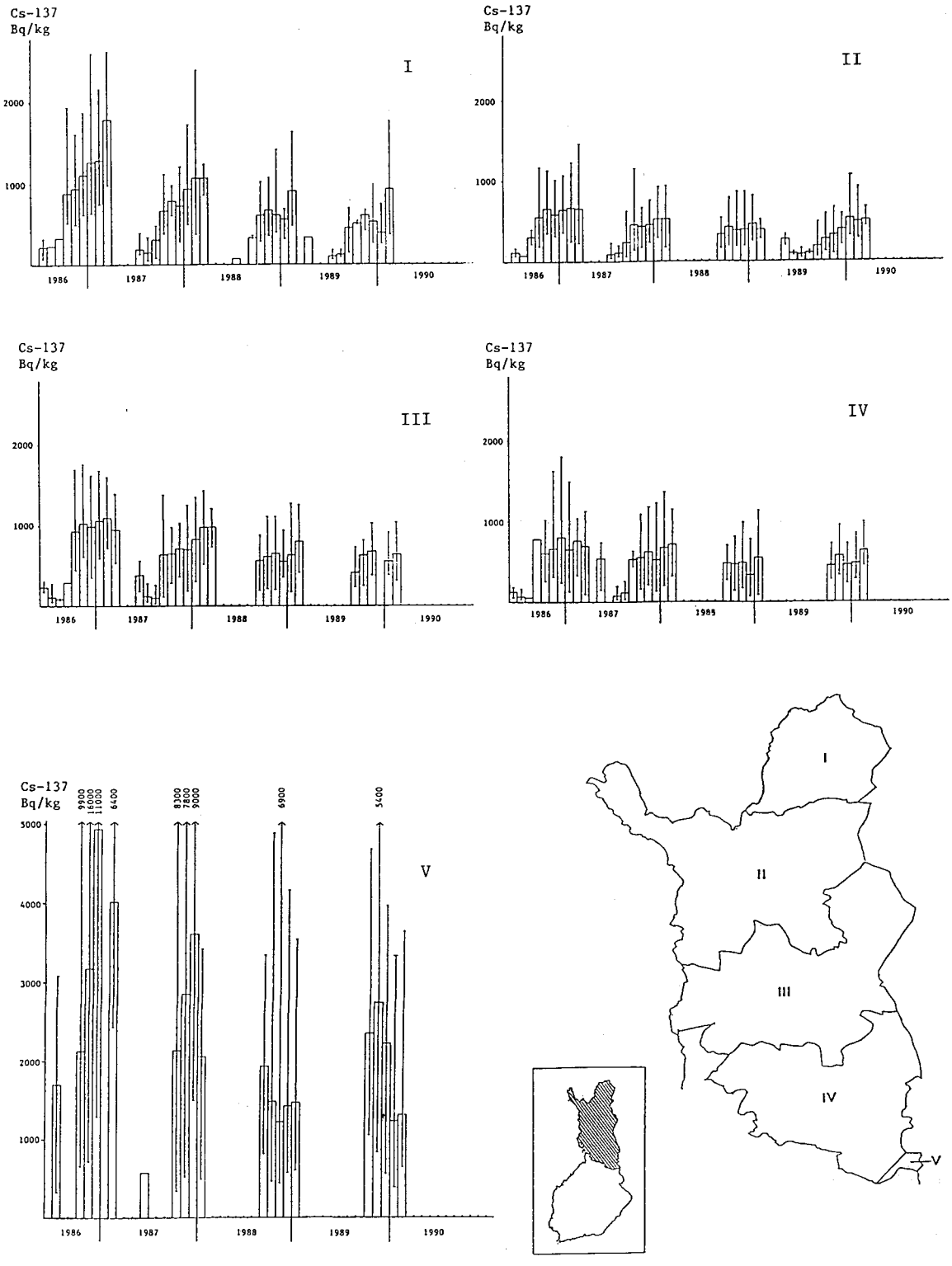

Fig. 1. Mean seasonal variation of Cs-137 concentrations in reindeer meat in region I–V of Finnish reindeer herding area, the indicator line shows minimum and maximum concentration. Results from June 1986 – February 1990.

Table 2. Cs-137 concentration, Bq/kg fresh weight, in reindeer and its foetus. The relation of Cs-concentration in their organs.

		Cs-137		foetus / mother
		mother	foetus	
Reindeer 59 kg	*rump steak*	4470		
	ovaries	2310		
(foetus 360 g)	uterus	2060		
	embryo water	370		
07.01.87	embryo water sack	1200		
	placentra	3380		
	kidneys	8220	2580	0,31
	liver	3620	2500	0,69
	heart	3960	2020	0,51
	lungs	2560	2390	0,93
	muscle	4540	1910	0,42
	bones	610	1440	2,40
Reindeer 65 kg	*rump steak*	9030		
	ovaries	3710		
(foetus 1130 g)	uterus	3100		
	embryo water	810		
15.02.87	embryo water sack	2070		
	placentra	6380		
	kidneys	12700	5070	0,40
	liver	4740	4860	1,00
	heart	6500	4620	0,71
	lungs	3870	5000	1,30
	muscle	9070	4240	0,47
	bones	1040	2860	2,80
Reindeer 48 kg	*rump steak*	6520		
	ovaries			
(embryo 32 g)	uterus	1490		
	embryo water	780		
02.03.87	embryo water sack	1180		
	placentra	3050		
	embryo (whole)		1500	

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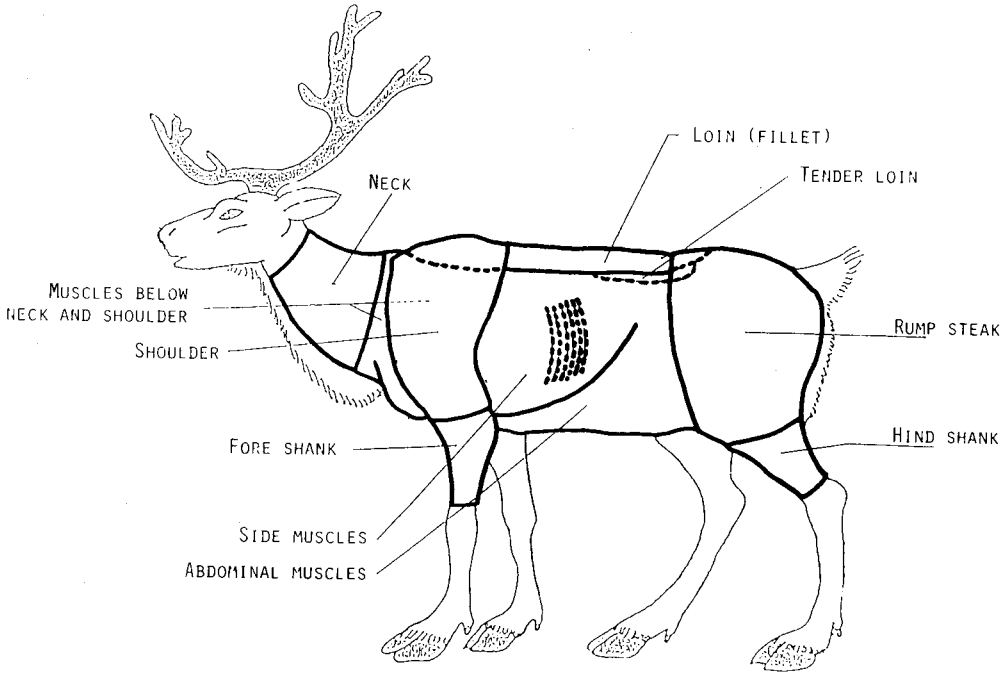

Fig. 2. The meat quantitatively taken from the carcasses was cut into sections as shown above.

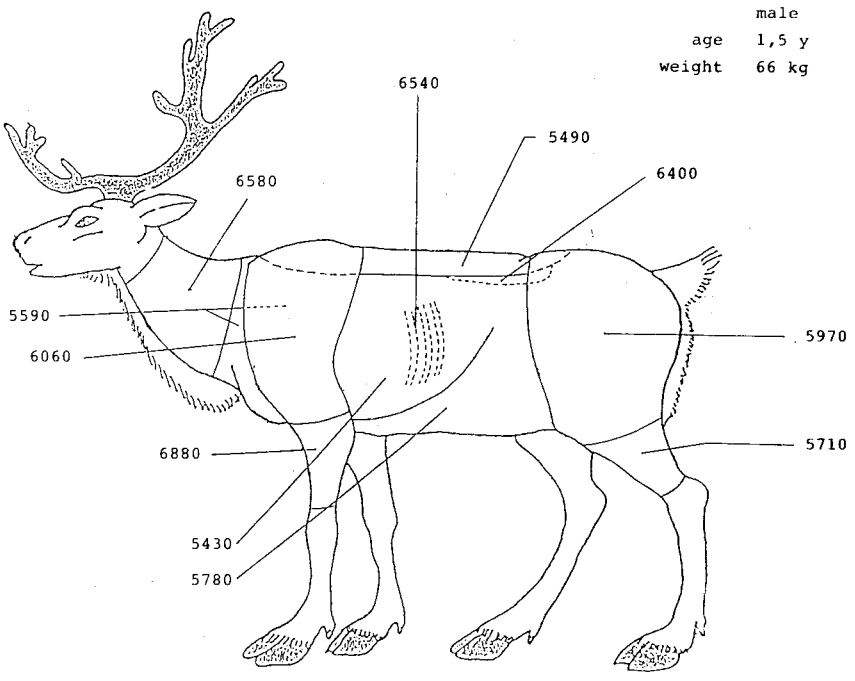

Fig. 3. The concentration of Cs-137 (Bq/kg fresh weight) in different muscle tissues of the 1.5 year old male reindeer used as an example.

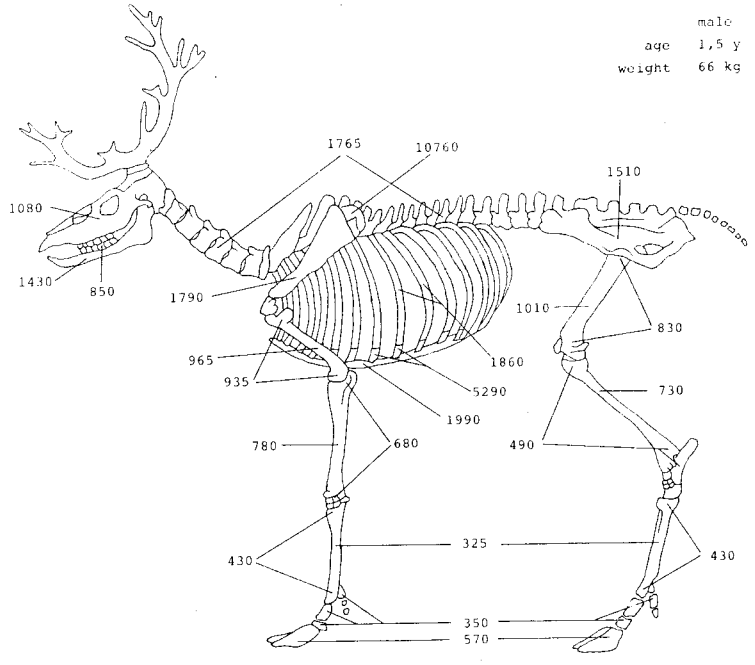

Fig. 4. The concentration of Cs-137 (Bq/kg fresh weight) in bones of the 1.5 year old, male reideer used as an example.

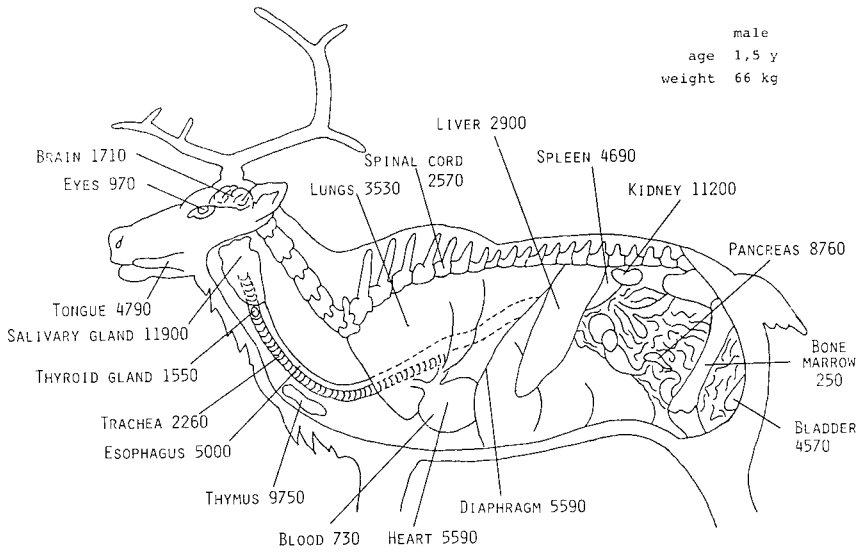

Fig. 5. The concentration of Cs-137 (Bq/kg fresh weight) in the organs of the 1.5 year old, male reindeer used as an example.

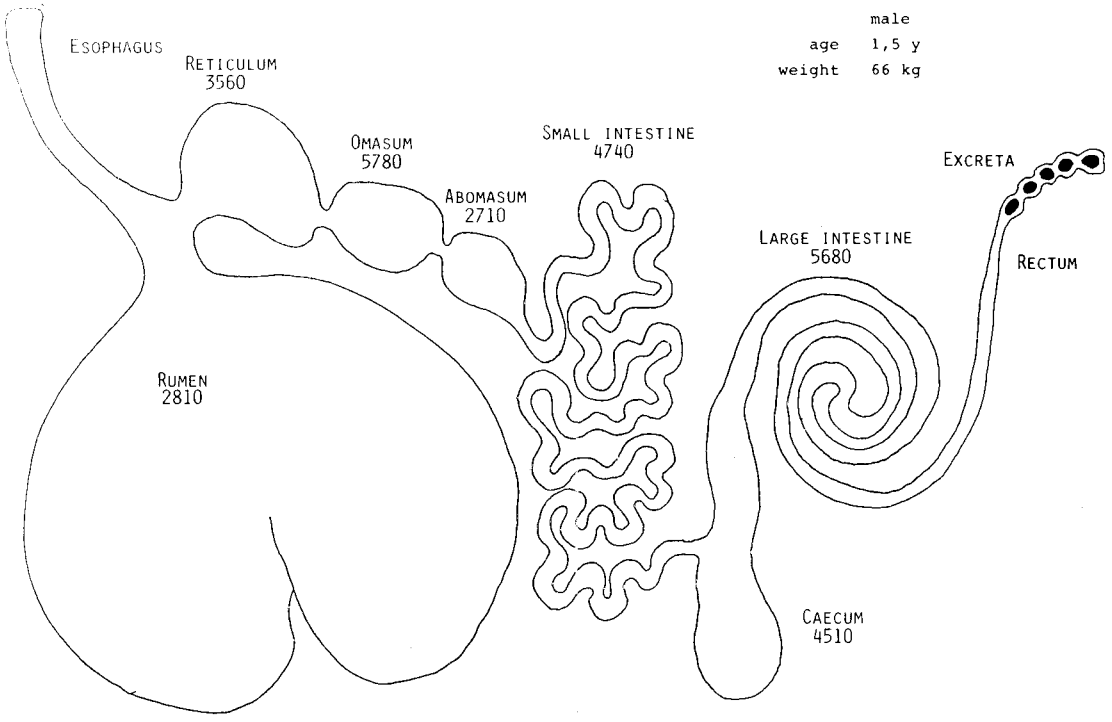

Fig. 6. The concentration of Cs-137 (Bq/kg fresh weight) in the contents of the digestive tract of the 1.5 year old, male reindeer used as an example.

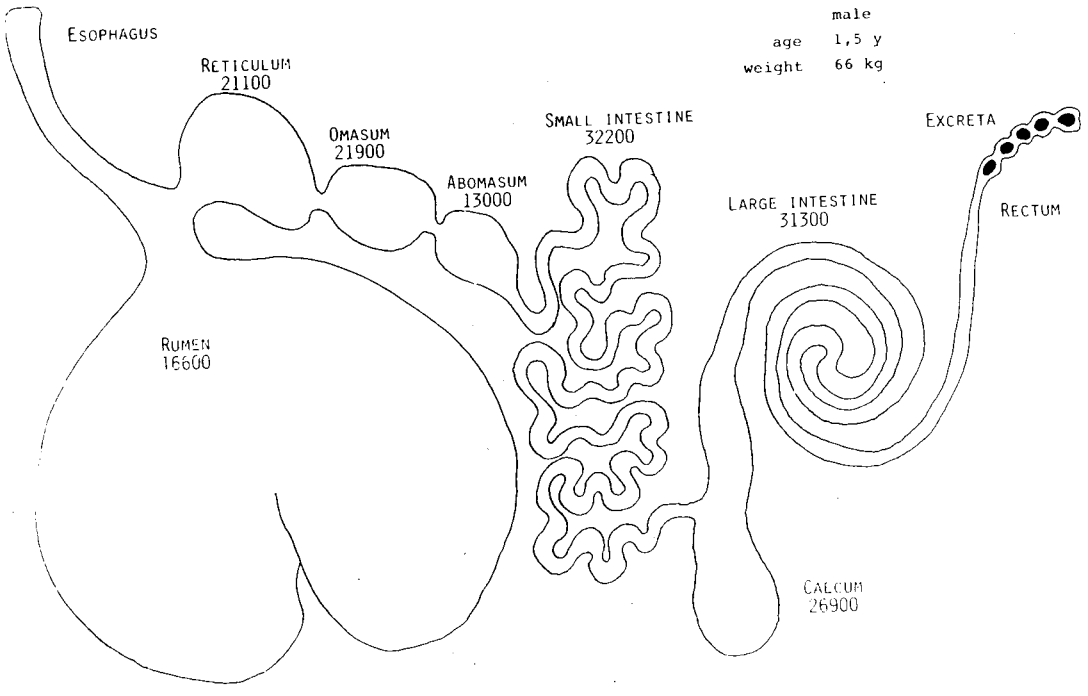

Fig. 7. The concentration of Cs-137 (Bq/kg dry weight) in the contents of the digestive tract of the 1.5 year old, male reindeer used as an example.

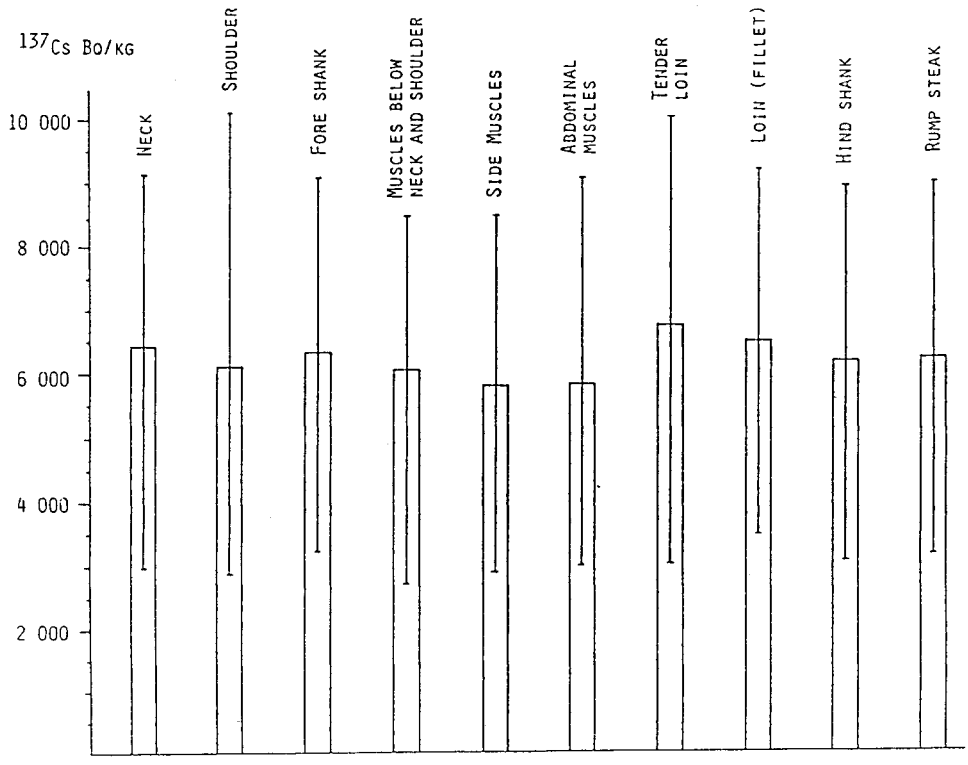

Fig. 8. Mean Cs-137 concentration (Bq/kg fresh weight) in the muscle tissues from 20 reindeer. The indicator line shows minimum and maximum concentration.

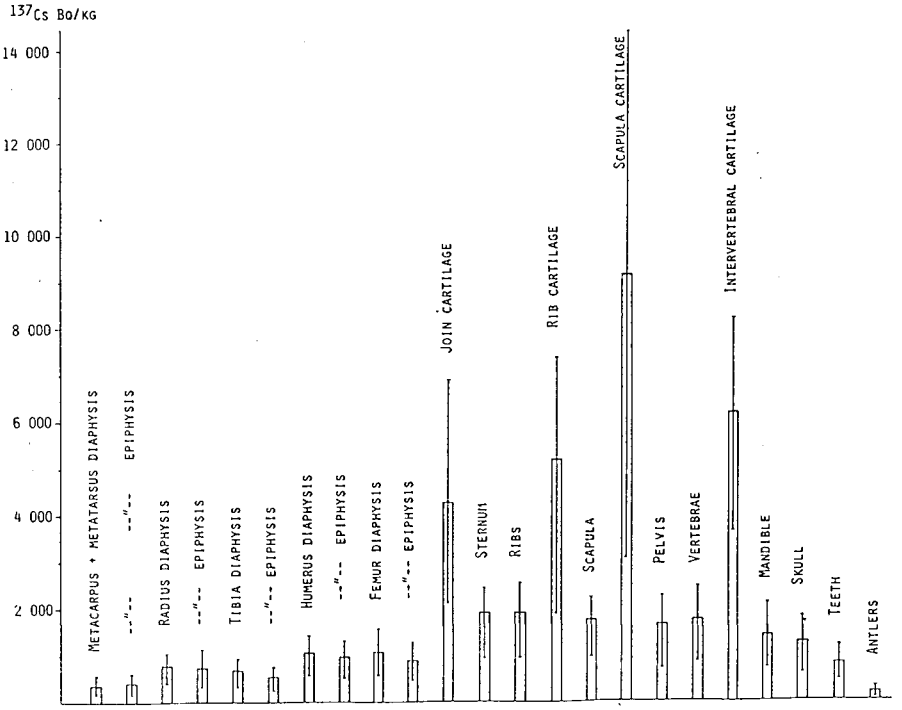

Fig. 9. Mean Cs-137 concentration (Bq/kg fresh weight) in the bone tissue from 20 reindeer. The indicator line shows minimum and maximum concentration.

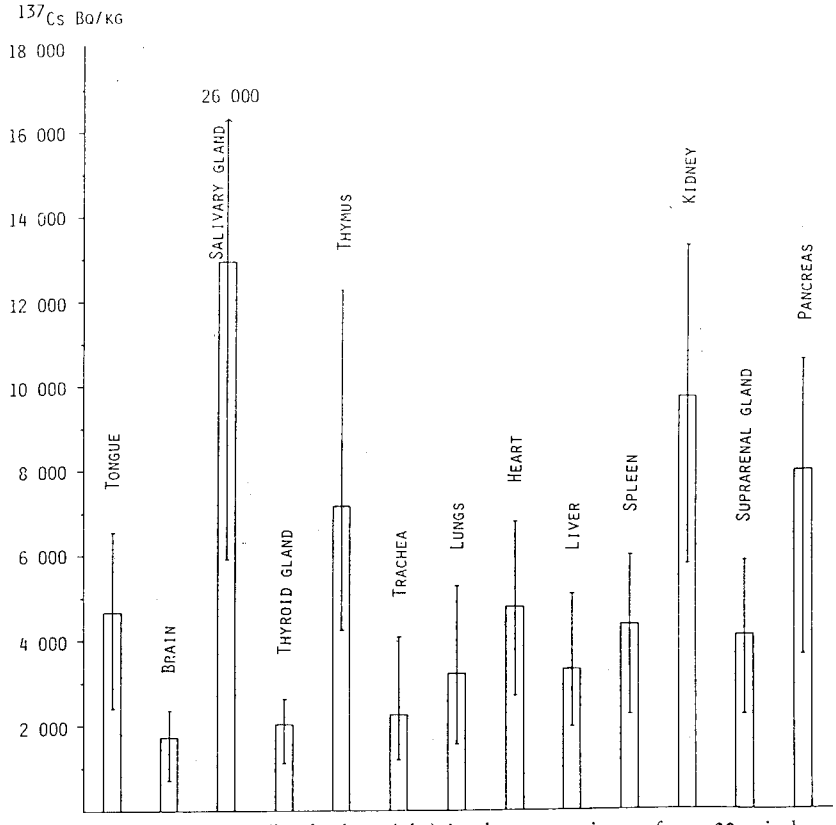

Fig. 10. Mean Cs-137 concentration (Bq/kg fresh weight) in the organ tissues from 20 reindeer. The indicator line shows minimum and maximum concentration.

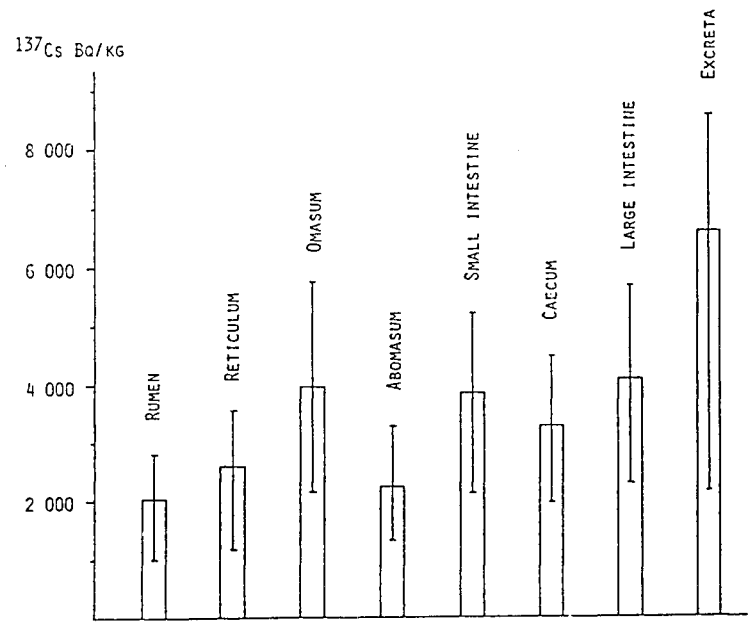

Fig. 11. Mean Cs-137 concentration (Bq/kg fresh weight) in the contents of the digestive tract from 20 reindeer. The indicator line shows minimum and maximum concentrations.

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