

Seasonal variation of cesium 134 and cesium 137 in semidomestic reindeer in Norway after the Chernobyl accident

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Abstract: The Chernobyl accident had a great impact on the semidomestic reindeer husbandry in central Norway. Seasonal differences in habitat and diet resulted in large variations in observed radiocesium concentrations in reindeer after the Chernobyl accident. In three areas with high values of cesium-134 and cesium-137 in lichens, the main feed for reindeer in winter, reindeer were sampled every second month to monitor the seasonal variation and the decrease rate of the radioactivity. The results are based on measurements of cesium-134 and cesium-137 content in meat and blood and by whole-body monitoring of live animals. In 1987 the increase of radiocesium content in reindeer in Vågå were 4x from August to January. The mean reduction in radiocesium content from the winter 1986/87 to the winter 1987/88 were 32 %, 50 % and 43 % in the areas of Vågå, Østre-Namdal and Lom respectively.

Key words: radioactivity, fallout

Introduction

Reindeer eat lichens predominantly during winter, with lower intake during the rest of the year. The slow-growing lichens are predisposed to high levels of radionuclides, due to absorbing nutrients and nutrient analogues from water (rain) and air. Radiocesium concentrations in lichens do decrease with an effective half-time of 3 to 8 years (Martin and Koranda, 1971).

The rate at which elements are eliminated from ruminant animals is influenced by factors such as body size, age, sex, physiological condition and activity (Reichle, Dunaway, and Nelson, 1970). Cesium turnover in reindeer is two or three times faster during summer than in winter (Holleman, Luick, and Whicker 1971).

The seasonal change in habitat and diet in

Rangifer, Special Issue No. 3, 1990: 35-38

addition to the biological factors, resulted in large seasonal variation in observed radiocesium concentration in reindeer, in central Norway after the accident in Chernobyl. This study monitored the seasonal changes and yearly reduction in concentrations of cesium 134 (Cs-134) and cesium 137 (Cs-137) in reindeer.

Material and methods

Samples were collected between 1986 and 1988 from reindeer in three herds, all in Central Norway, which suffered high levels of radiocesium (Cs-134 and Cs-137).

The herds were located in Østre-Namdal (North Trøndelag), Lom, and Vågå (Jotunheimen).

Every second month about fifteen reindeer

were slaughtered for measuring concentration of radiocesium (10 adults and 5 calves). Whole body counting of radiocesium activity or blood samples of about 10-30 living reindeer were also taken.

The measurement of Cs-134 and Cs-137 concentrations in skeletal muscle was done by a Canberra 35, 3x3 inch NaI-crystal at the National Institute of Radiation Hygiene. The skeletal muscle samples were taken from the front leg (*biceps brachii*) with wet weight about 400 grams. The muscle samples were counted for 1 to 10 minutes. The blood samples were counted by spectrometry, using a LKB Wallac, 1280 Ultragamma with a NaI (Tl) scintillator at the Isotope Laboratory, Agricultural University of Norway. The blood samples were 5 ml, mainly based on analysis of red blood cells (RBC) and were counted for 30 minutes. Whole body counting was done by a mobile equipment, a Canberra 10 plus with a 3 inch NaI (Tl) detector with a multichanal analyser. The measurements were made for one minute between the animals back legs.

Results

Cs-134 and Cs-137 concentrations in reindeer were lower in winter 1987/1988 compared to winter 1986/1987 in all three areas. In Vågå, Østre-Namdal and Lom the mean reduction of radiocesium in adult reindeer (>1 yr) from the winter of 1986/1987 to that of 87/88 was found

to be 32% (53.0-36.0), 50% (46.0-23.0), 43% (25.5-14.5), respectively. The corresponding figures for calves were 42% (45.0-26.0), 45% (40.0-22.0) and 24% (18.3-14.0) (Figure 1). The figures in brackets are the mean values in kBq/kg, all adjusted to skeletal muscle values.

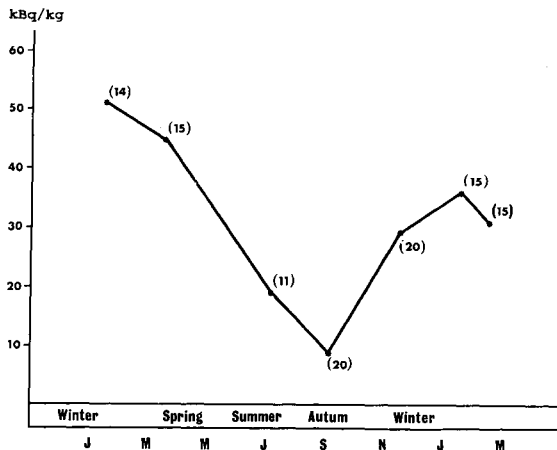


Fig.2. Seasonal variation of cesium 134 and 137 in reindeer (adults and calves) from Vågå. (In brackets - no. of samples).

Figure 2 illustrates the seasonal variation in the concentration of radiocesium in reindeer through out the year. All groups of animals are pooled together to show the main seasonal pattern for a reindeer herd as a whole. The values recorded range from 56.0 kBq/kg in January 1987, and the lowest 13.9 kBq/kg in September 1988.

In Lom the concentration of radiocesium in calves was about two times higher than in females (4.7 and 2.7 kBq/l, respectively) in July

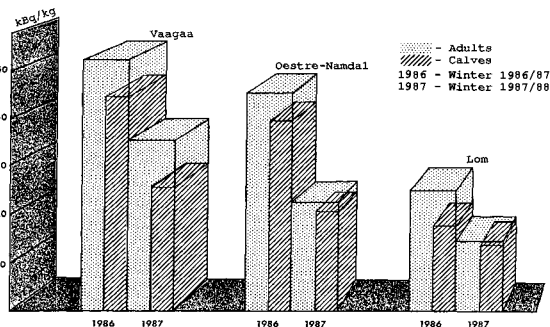


Fig. 1. Reduction of cesium 134 and 137 in reindeer (adults and calves) from Vågå, Østre-Namdal and Lom.

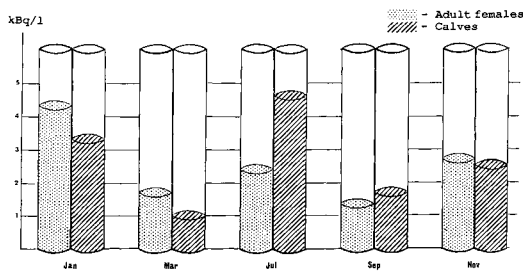


Fig.3. Cesium 134 and 137 in red blood cells (RBC) in reindeer females and calves at different seasons in Lom.

(Fig. 3). In November however, concentrations in calves and females were approximately the same. In late winter the relationship reversed, so that females had the highest values (4.8 and 3.3 kBq/l, respectively).

Discussion

The annual reduction of Cs-134 and Cs-137 in reindeer in the three areas investigated is greater than expected based on data from earlier studies (Martin et al., 1971, Reichle et al., 1970). However, the results are in accordance with other investigations of Cs-burdens in reindeer carried out in relation to the Chernobyl fallout (Skogland 1987, 1988). The main reason for this reduction of Cs-burden may be great reduction of radiocesium concentration in lichens and other plants during the first year after the reactor accident (Gaare 1988, 1989; Rognum 1987).

The seasonal variation in the concentration of radiocesium in reindeer during winter was up to five times higher than in summer. The same pattern has previously been shown by Hanson, Whicker, and Lipscomb (1972). The high intake of lichens with a high concentration of radiocesium in winter (September to May) is obviously the main reason for the increase. The decrease in concentration of radiocesium in reindeer during summer was primarily due to decrease in radiocesium intake. Summer food, namely deciduous shrubs, grasses and sedges, contains less radiocesium than do lichens. However, more rapid kinetics associated with the summer diet are likely to have contributed to a lower radiocesium concentration in the animals. Holleman et al. (1971) observed that during the summer the kinetics of cesium are accelerated, being 2 to 3 times more rapid than during the winter.

Especially during summer, the results show a marked difference in radiocesium concentration, comparing adults and calves. Despite this, the data for these two groups are pooled together to form the basis for Figure 2. This is to

show the main seasonal pattern for a reindeer herd as a whole.

The high radiocesium concentration values in suckling calves, compared to their mothers during summer may be caused by accumulation of radiocesium in reindeer milk (Eikermann, unpub.). When suckling decreased in autumn, the concentration of radiocesium in calves declined to approximately the same level as their dams.

The results presented are preliminary, but are expected to show the main seasonal patterns in radiocesium accumulation in reindeer. Further studies will include other aspects of the radiocesium dynamics in reindeer.

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