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Radioecology

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Investigations on the behaviour of ^{137}Cs in wild boar and other bioproducts of forests

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by
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Summary

In this research project the reasons for the relative high ^{137}Cs activity of game, in particular of wild boar, have been clarified in detail. The monitored area is located in the Bavarian Forest, a region particularly affected by the Chernobyl fallout. An important aim of the research project has been the development of a dynamic radio-ecological model suitable to describe the time course of the contamination of roe deer, red deer and wild boar in the past and suitable to forecast the future contamination. The composition of food eaten by wild boar and red deer was determined by analysis of the animal's stomach content. Samples of the relevant food components were taken in the monitored area and their ^{137}Cs activities were measured.

In total 20 **vertical soil profiles** were taken from the soil in the monitored area. The major part of activity turned out not to be in the humus layer, as in the 1980s and 1990s, but in the approximately 8 cm thick zone between the lower part of the humus layer and the mineral soil. Meanwhile the upper 2 cm of the soil in the area B1, which is permanently monitored, contain only 1.4% of the total activity and thus nearly the same amount as the soil layer between 28 and 30 cm with 1.2%.

In order to describe the vertical distribution of ^{137}Cs in the forest soil a radio-ecological model was developed, which divides the soil in compartments of 2 cm. In these compartments migration, fixation and desorption of ^{137}Cs take place. These processes are described by a system of differential equations. A mean deviation of 0.77 % between modelled and measured values is computed.

All examined **plant types** showed a pronounced decrease of the ^{137}Cs activity from 1987 until 2004. The deceleration of the decrease, which can be observed since 1995 for most plant types, continues. The mean ^{137}Cs activity of many plant types was below 1000 $Bq \bullet kg^{-1}$ in the fresh substance (FS). Only few plant types, such as the spinulose woodfern (Dryopteris carthusiana) and bilberry (Vaccinium myrtillus), showed higher activities. The contamination of aboveground fructifying parts of mushrooms varied from 24 $Bq \bullet kg^{-1}$ (Macrolepiota procera) to 2800 $Bq \bullet kg^{-1}$ (Xerocomus badius). However, with an average of 26800 $Bq \bullet kg^{-1}$ the contamination of **deer truffles** (Elaphomyces granulatus) surpassed by a multiple the contamination of all other potential food types of the considered game, which is an important fact in particular for wild boar.

The **food components** of 37 stomachs of red deer and 70 stomachs of wild boar were determined. The analysis of the stomach content of **red deer** showed, that grasses, which have been found in all stomachs and of which 29 different types could be identified, are with 60.2% by far the most important food component of red deer. The food spectrum of **wild boar** reveals much more variety. The examined stomachs of wild boar contained approximately 20% grass, 17% fruits and 17% fodder components, 13% herbs, 12% roots and 11% soil. Mushrooms contributed 7.6%, of which 5.5% were deer truffles. During the beech mast in 2003 the stomachs of wild boar contained mainly beech-nuts during a period of several months.

The ^{137}Cs activity of **red deer** decreased from 1986 to 2004 highly significant (n=205, P<0,0001). Since 1994 no values above 1000 $Bq \bullet kg^{-1}$ were measured, in 2003 no

measured value was above 500 Bq•kg^{-1}. From April 1987 to April 2004 the effective half-life of ^{137}Cs in red deer is 4.6 years. Basing on this trend red deer will show values above 600 Bq•kg^{-1} in only very few cases during the next years.

The ^{137}Cs activity of muscle flesh of **roe deer** shows a pronounced seasonal variation in every year, with lower values in spring and clearly higher values in autumn. By considering the whole examination period from 1987 to 2004, an effective half-life of 6.9 years ($P<0,0001$) is determined. The mathematical estimation of the future temporal course of the ^{137}Cs contamination of roe deer leads to the prognosis, that from the year 2017 on approximately 95% of the animals will be contaminated with less than 600 Bq•kg^{-1} caesium.

The ^{137}Cs contamination of **wild boar** increased from 1987 to 2004 statistically non-significant with a half-life of +78 years. The mean contamination in 2004 was approximately 6710 Bq•kg^{-1} (n=91). In 1988 the mean value was 4810 Bq•kg^{-1} (n=34) in the fresh substance. Deer truffles have to be considered as the most important source of contamination, since they contribute predominantly (with 82%) to the ^{137}Cs input of wild boar. In the next two decades a decrease of the ^{137}Cs contamination is not to be expected. In so-called mast years only the flesh of wild boar can be assumed to have values below 600 Bq•kg^{-1}. It is thus recommended that without any exception the ^{137}Cs contamination of all wild boars, which are shot in the monitored area, is measured.

The radio-ecological models developed for roe deer, red deer and wild boar allow an estimation of the ^{137}Cs contamination. The models contain a detailed description of the dynamics of ^{137}Cs in the essential compartments soil and plants and a modelling of the qualitative and quantitative food intake for roe deer, red deer and wild boar. The fluxes between the compartments are described by a system of differential equations.