Radio-sensitivity and ^{40}K, ^{3}H, ^{14}C levels in dark-striped field mice, *Apodemus agrarius coreae*, as a potential biological monitor for enviro-radiation and radionuclides

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Social concerns over radiation safety remain a very important issue in the management of nuclear power plants and the installation of facilities for radiation waste storage. To understand how environmental effects of radiation and radionuclides from radiation facilities relate to human beings, the development of an unmanned monitoring system is required. For the reasons of that, the International Atomic Energy Agency (IAEA) suggests a method to evaluate the effects of radiation emitted from radiation facilities on marine water, freshwater, and habitats for land animals and plants on its Technical Report Series 190, 288, and 332. Recently, International Commission on Radiological Protection (ICRP) Publication No. 91 (2003) was consecutively published to protect non-human animals and plants from environmental radiation and radioactive materials [1]. Existing radio-environmental surveillance systems can be classified into physical and biological monitoring systems. Wild small animals, such as *Clethrionomys glareolus* was reported to be effective biological indicator of enviro-radiation after the Chernobyl incident. Moreover, livestock such as cows and plant, Tradescantia [2] were used with confounding factors. On the other hands, ^{3}H and ^{14}C are leaked out from nuclear power plants and ^{3}H is leaked from light-water reactor, respectively. As these radionuclides exist in nature and become the major cause of environmental exposure, we need to have an accurate understanding of their dynamic movements to evaluate the surrounding environments of radiation facilities. Nevertheless, not many studies have been done on this topic. In order to understand the movements of radionuclides in the environment has been evaluated by physiological methodologies [3]. However, it is not easy to evaluate the effect of radionuclides in human beings, because many confound factors, such as temperatures and humidity, intervene in the process of ingesting radionuclides into the human body and the biological half-life of each radionuclide that is ingested varies [4]. Thus, we have not developed a biological indicator that can be used along with the existing physiological indicator to substitute human being in the evaluation of the environmental movements of radionuclides. In this study, we sets up the following requirements to select a biological indicator: 1) it must be an animal species that is clearly classified from other species 2) it must have a consistent ecological characterization 3) it must inhabit areas with human being 4) its habitat must be limited 5) it must eat and drink from its habitat; 6) it must have a considerable length of lifespan; 7) it should indicate a clear dose-response relationship with high sensitivity and 8) it must provide information on the radioactivity of natural radionuclides in its bodies. This study examined the potential usefulness of dark-striped field mice as a biological indicator of enviro-radiation and radionuclides around nuclear power plants and radioactive waste storage facilities. For this purpose, dark-striped mice were collected in regions of Korea where there are no radiation facilities. Their external morphological characters and isoenzyme patterns were observed. As a result, the most dark-striped mice that scattered in Korea are *Apodemus agrarius coreae* [5]. Their survival rate and damages of bone marrow of *A. a. coreae* were observed after irradiate (0, 0.5, 1, 3, 5, 7 , 9 Gy) and $LD_{50/30}$ was approximately 5 Gy (Table 1). The tooth-wear of the captured dark-striped mice was observed and only middle-staged age was selected to measure gamma-ray emitted radionuclides. Results show that only ^{40}K was detected with average radioactivity of 17Bq per mice. The average radioactivity of ^{3}H and ^{14}C in each organs of *A. a. coreae* was 39.3Bq/gm and 23Bq/gm, respectively. The radioactivity of the liver, lung, heart, and kidney was about twice that of other organs (Table 2). The results from this study proved the potential usefulness of *A. a. coreae* as a biological monitor of enviro-radiation and the dynamic movement of radionuclides around site of radiation waste storage.

Table 1. $LD_{50/30}$ between *Apodemus agrarius coreae* and ICR mice

Animals	**$LD_{50/30}$ (Gy)**
Apodemus agrarius coreae	5
ICR	7.9

The $LD_{50/30}$ of animals was estimated with data of survival rate and micronuclei in polychromatic erythrocytes in peripheral blood after irradiation.

Table 2. Radionuclides in organs of dark-striped field mice, *Apodemus agrarius coreae*

Organs	**Activity (Bq/gm) of**	
	^{3}H	**^{14}C**
Liver	59±17 [a]	28±2.6[a]
Lung	61±12[a]	24±0.9[bc]
Heart	43±10[ab]	25±1.5[ab]
Kidney	46±17[ab]	26±3.2[ab]
Spleen	23±0.6[b]	21±0.2[cd]
Thymus	21±3.5[b]	20±1[cd]
Adrenal gland	22±3.2[b]	21±1[cd]

The same mean with the letters in vertically is not significantly different (SAS, ANOVA, Duncan's multiple range analysis, n=5).

$P<0.0016$: Activity of ^{3}H and ^{14}C in organs of *Apodemus agrarius coreae.*

$P<0.0009$: Activity of ^{14}C in organs of *Apodemus agrarius coreae.*

References

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