Joint IES-ICRP Symposium on
ENVIRONMENTAL PROTECTION WITHIN THE ICRP SYSTEM OF RADIOLOGICAL PROTECTION

Radiation Effects and Dosimetry of Large Japanese Field Mice in Fukushima

Tuesday, October 4, 2016
VENUE: Swany (Rokkasho, Aomori, Japan)

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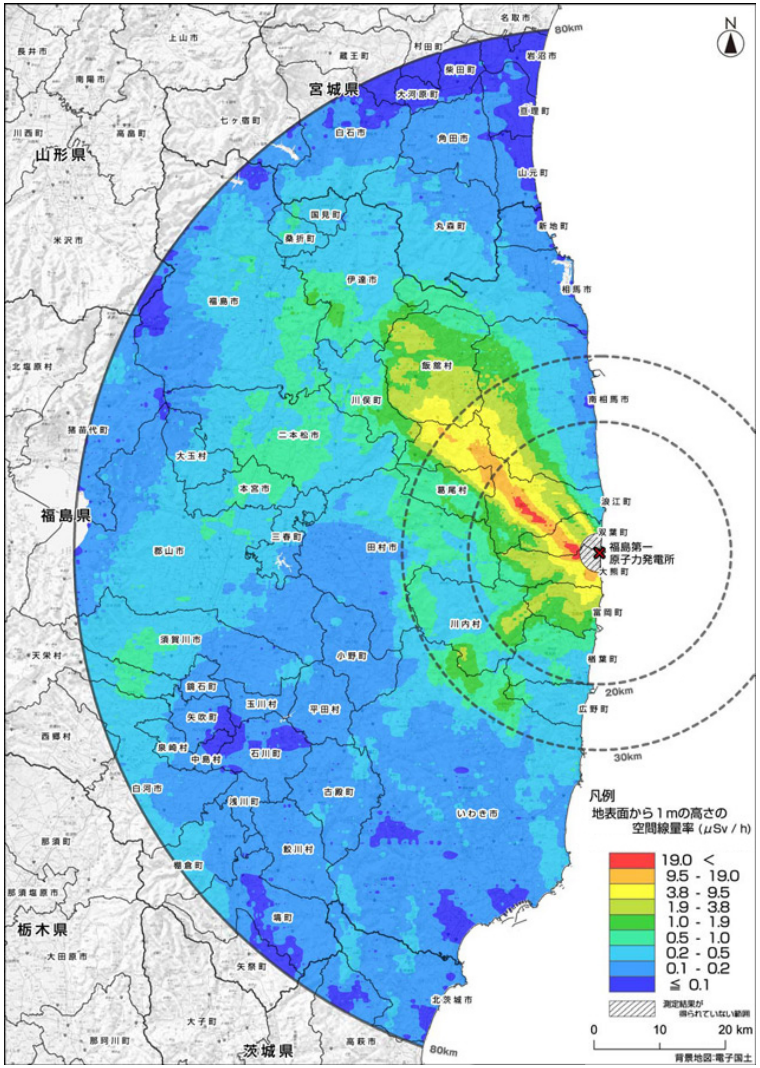
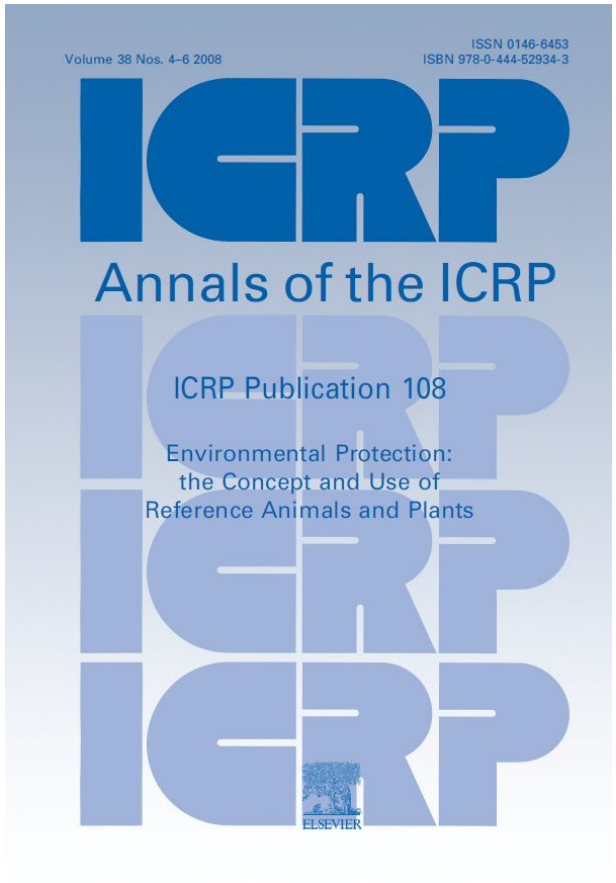
Environmental monitoring after the F1-NPP accident

After the Fukushima Daiichi nuclear power plant (F1-NPP) accident, the environment was contaminated with radionuclides around the F1-NPP. Even though radiation dose rate is decreasing, people are concerned with adverse effects on the organism in the future. It is, therefore, important to assess the effect of radioactive materials on animals.

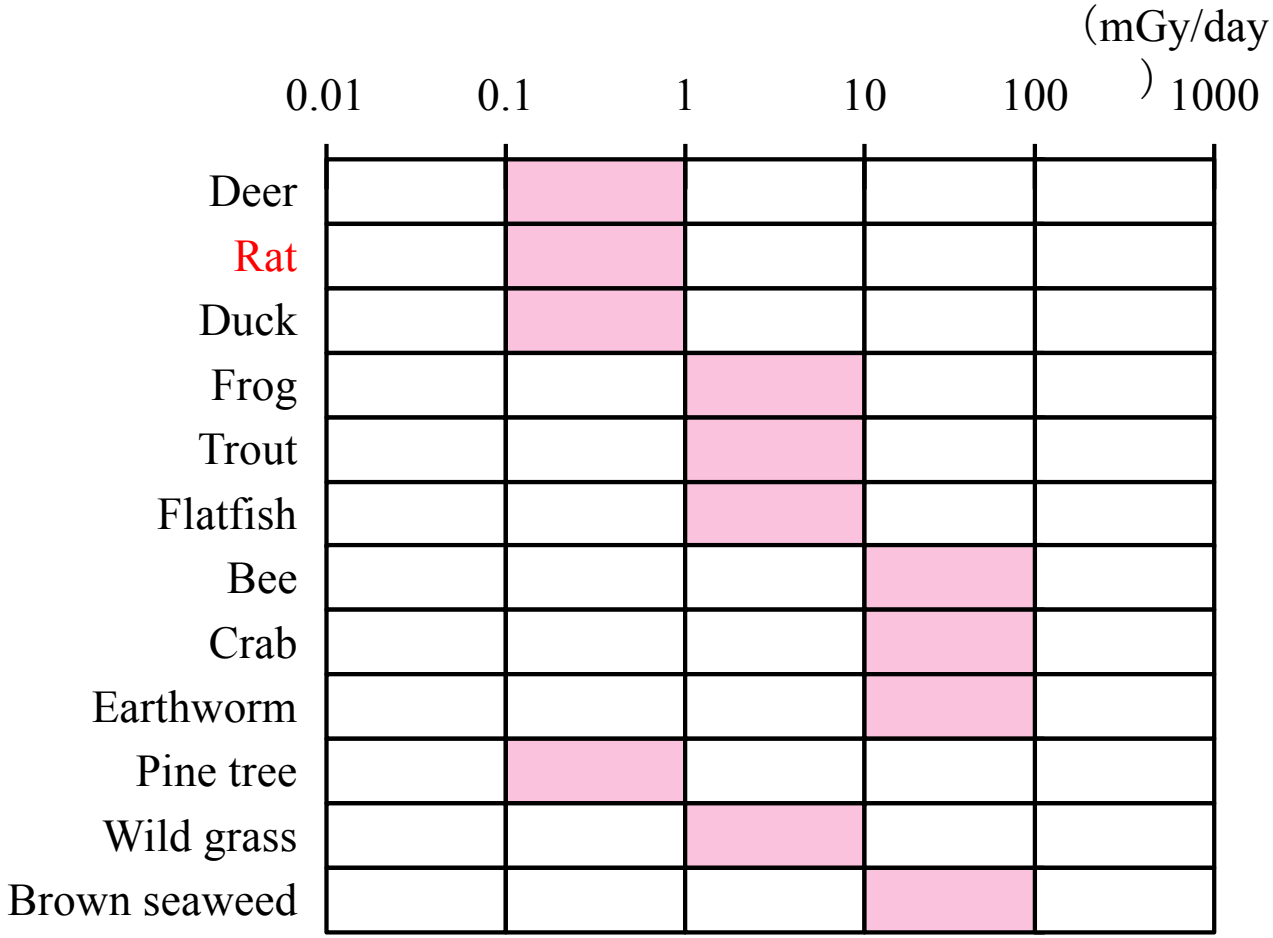


Derived consideration reference levels

This publication introduces the concept of Reference Animals and Plants, and defines a small set.



ICRP Publication 108. Ann. ICRP 38 (4-6).

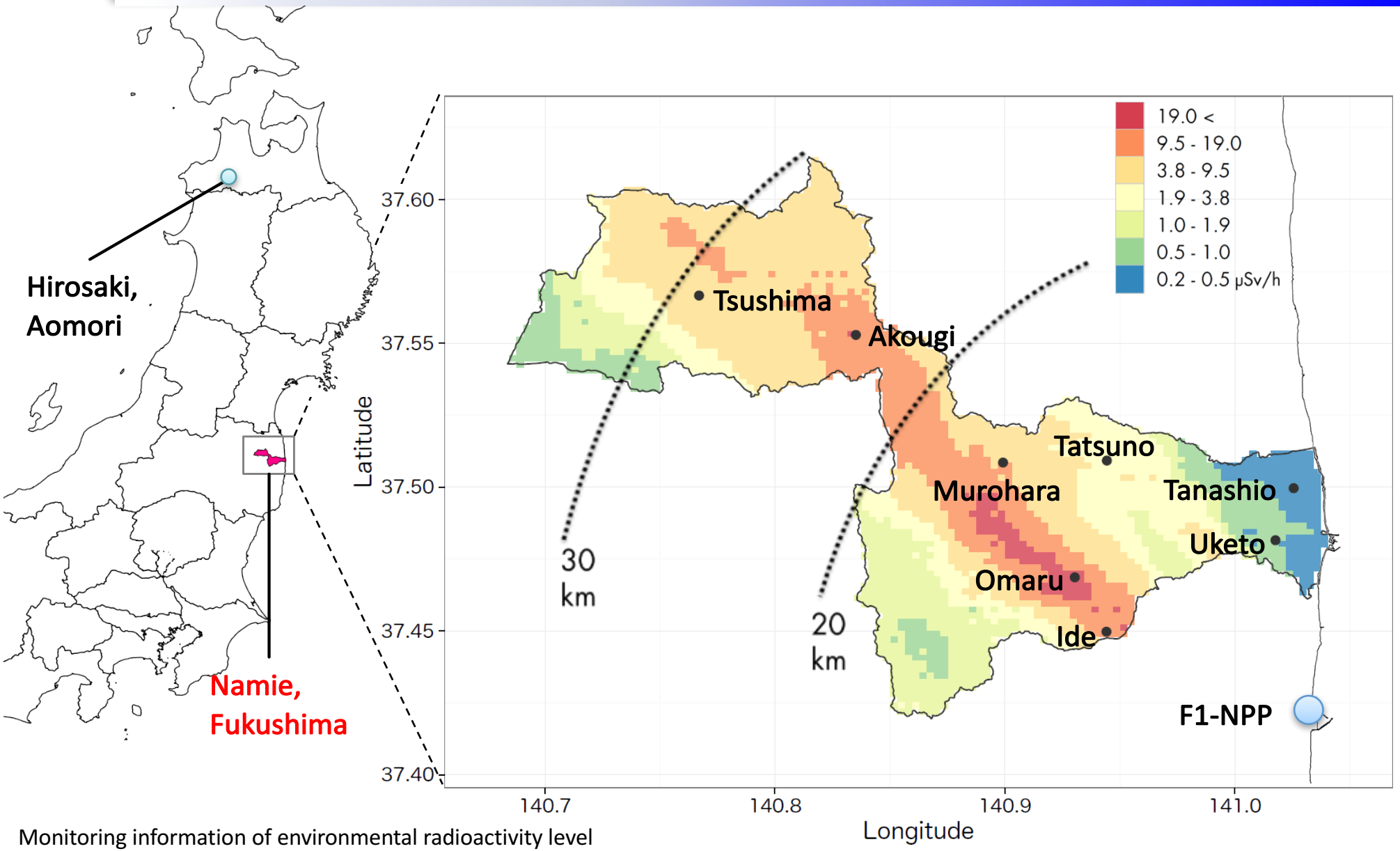


ICRP Publication 108: *Ann. ICRP* 38, (2008)

Contents

1. Field information
2. Biological effects of radiation exposure in Japanese field mice
3. Individual exposure dose of Japanese field mice

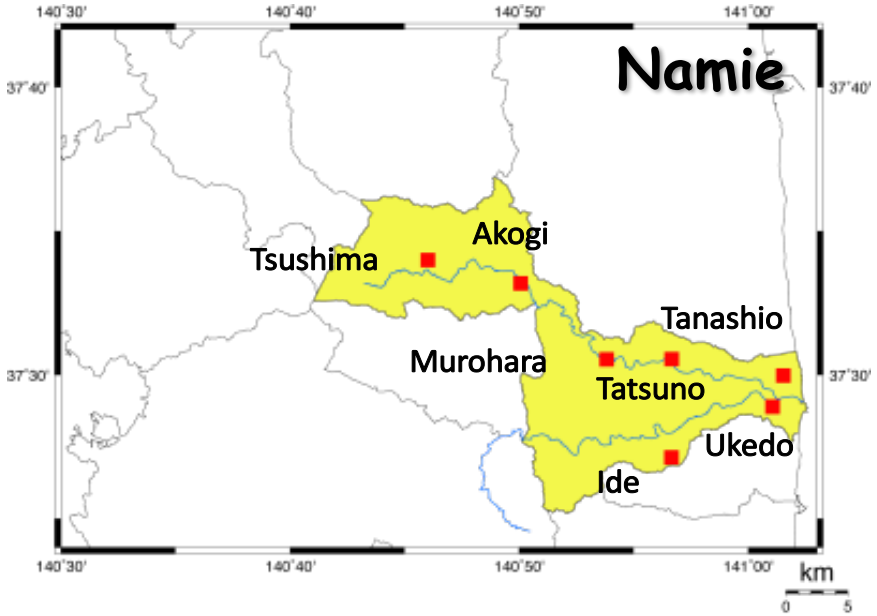
Research area

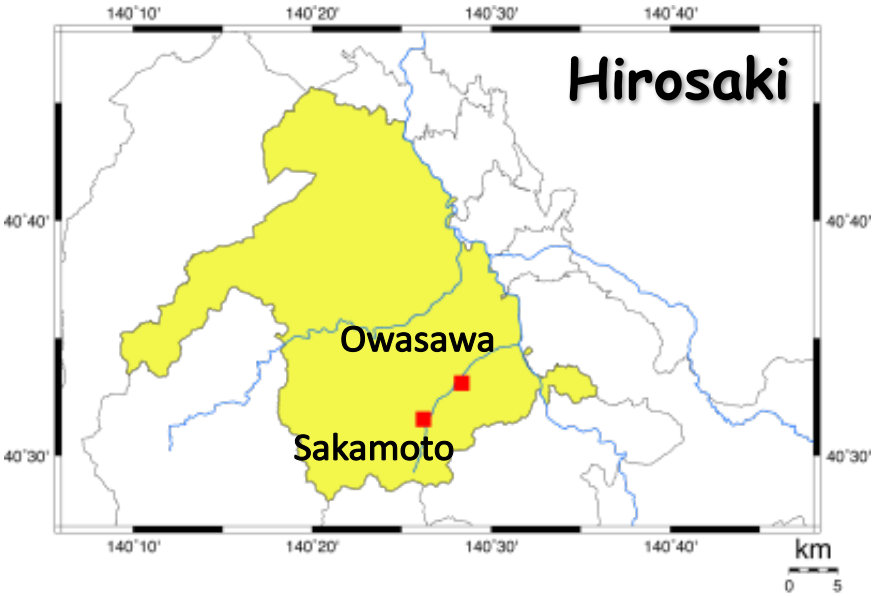


Monitoring information of environmental radioactivity level
http://radioactivity.nsr.go.jp/ja/list/362/list-1.html (Excerpt of Namie-town)

Dose rate in the air

Fields	Distance from F1-NPP (km)	Dose rate in the air (μGy/h)			
		2011	2012		2013
		Autumn	Spring	Autumn	Spring
Namie					
Tsushima	28.5	20.2	-	-	-
Akogi	22.8	29.1	28.9	26.9	15.2
Murohara	15.3	-	15.6	14.2	9.7
Tatsuno	12.6	8.79	-	-	-
Tanashio	8.8	0.59	0.55	0.52	0.66
Ide	8.4	-	25.3	24.5	16.4
Ukedo	6.8	-	0.45	-	-
Hirosaki					
Owasawa	352.1	0.05	0.05	0.05	-
Sakamoto	349.2	0.06	0.06	0.06	-





Contents

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Japanese large field mouse

Apodemus speciosus

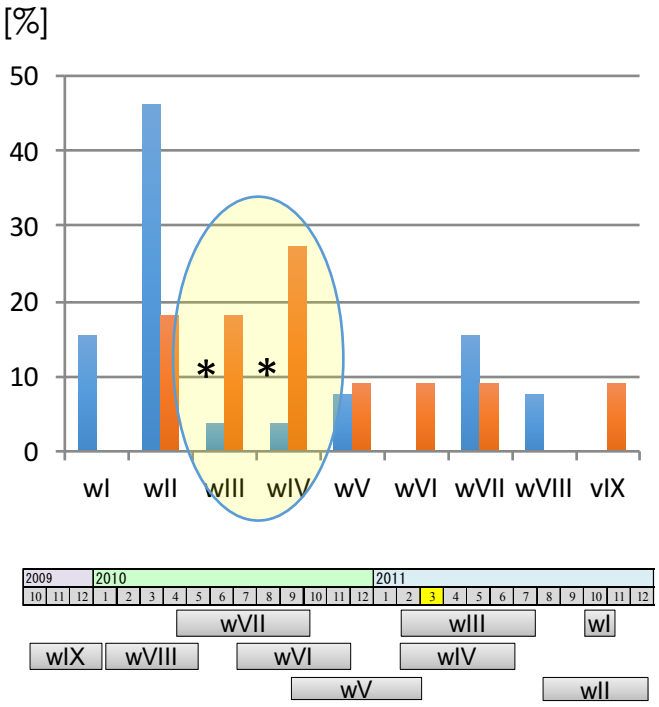
- ✓ *A. speciosus* presents on all Japanese islands, inhibits forests, grasslands and cultivated field.
- ✓ *A. speciosus eats seeds (acorns and walnuts), roots, insect, etc.*
- ✓ The breeding season twice a year.
- ✓ *A. speciosus* burrows a hole in the underground.

Sharman live trap

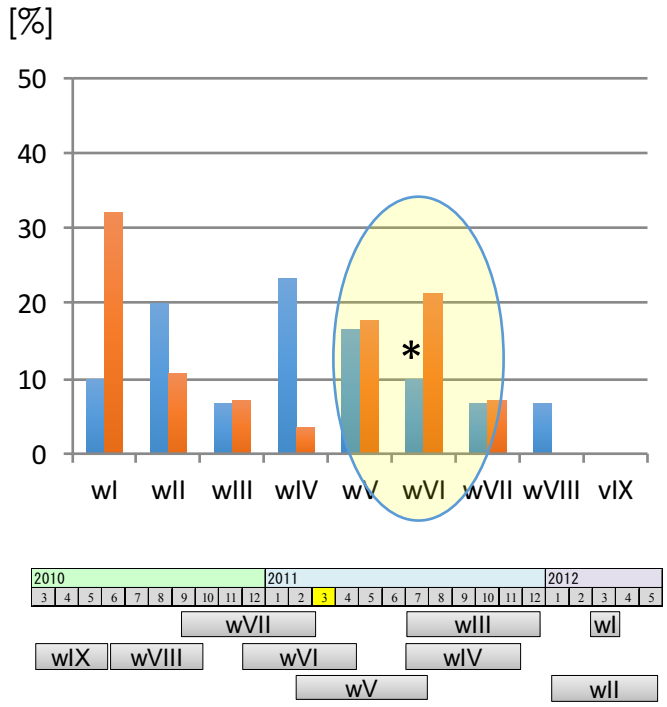
November 2, 2014

Age distribution of *A. speciosus* collected after the F1-NPP accidents

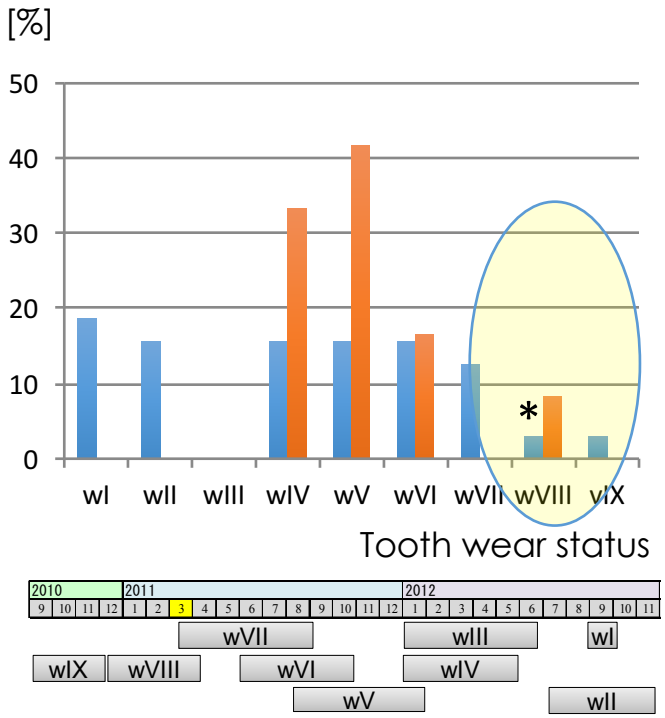
2011 Autumn



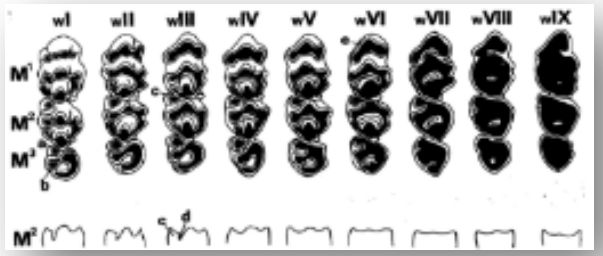
2012 Spring



2012 Autumn



Tooth wear stages of As



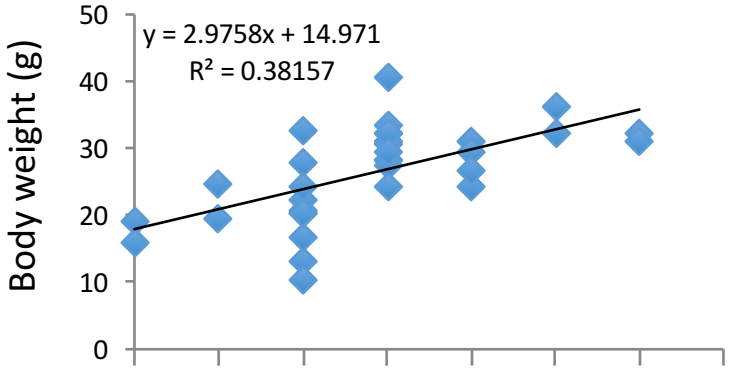
Hikita & Murata, 1980

Wild mice suspected of was born in Namie-town before or after the F1-NPP accident was significantly less than those was born in Hirosaki.

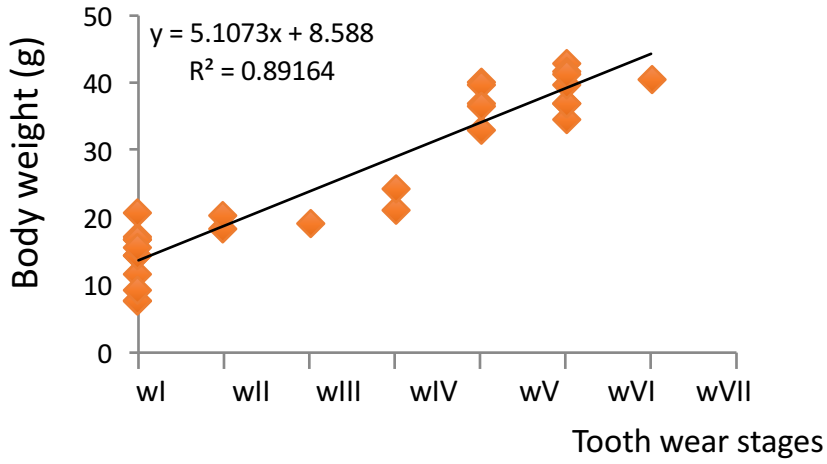
Comparison of the individual growth of *A. speciosus* in Spring 2012

Body weight vs. Tooth wear stages

Namie

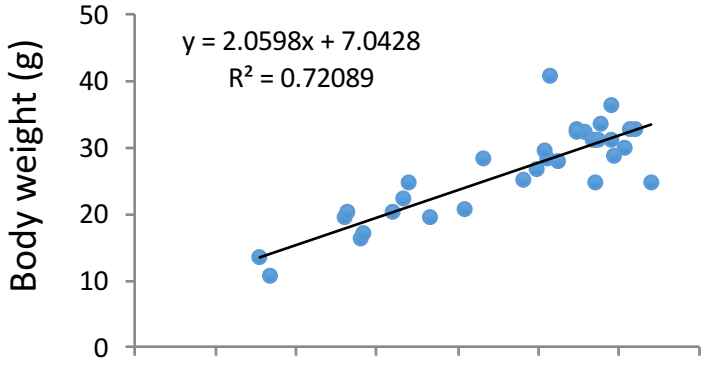


Hirosaki

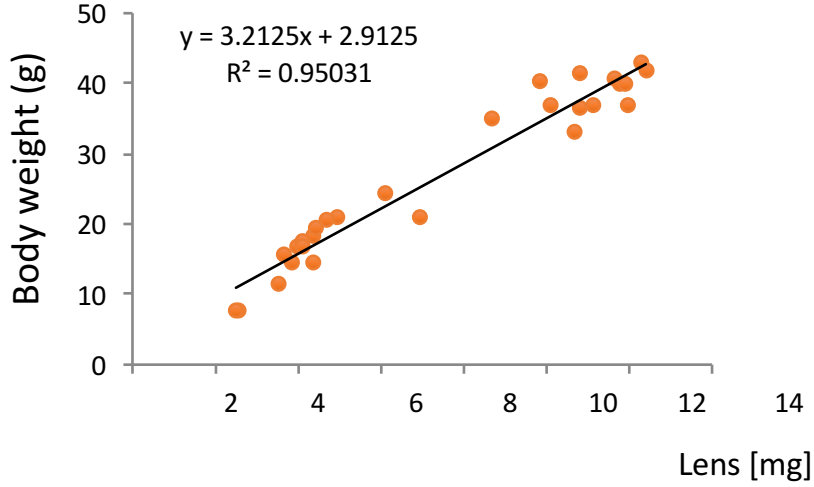


Body weight vs. Lens weight

Namie

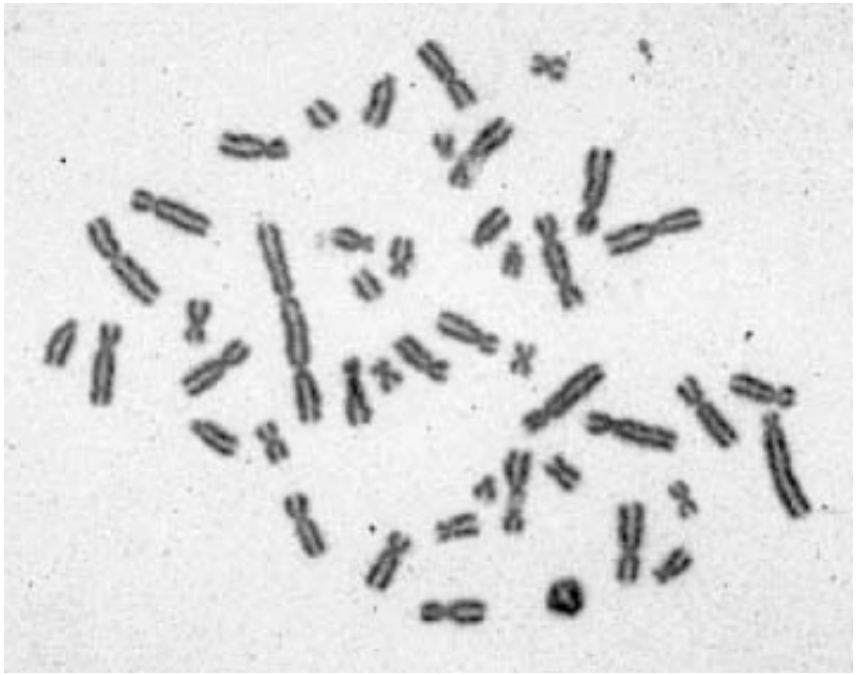


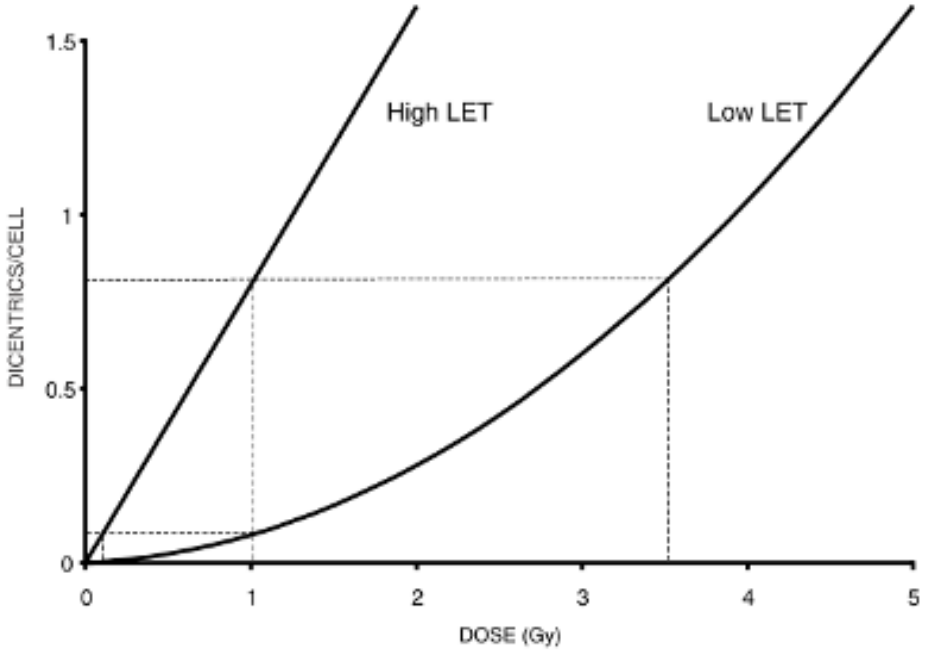
Hirosaki



There was no significant difference in growth between the mice captured in Namie and Hirosaki

Biodosimetry by dicentric assay
- gold standard in cytogenetic biodosimetry -



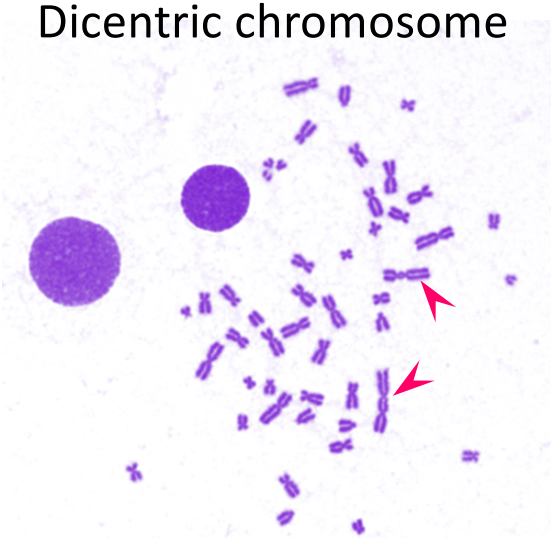


IAEA Vienna 2001

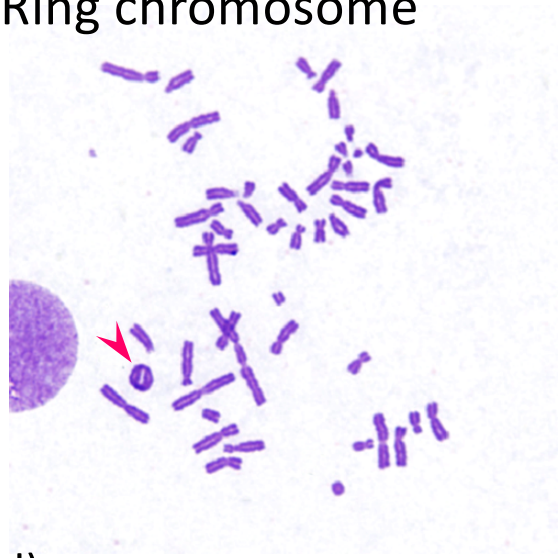
Backgrounds of chromosome aberration study

Radiation-specific cytogenetic Endpoint

Dicentric chromosome



Ring chromosome



References about chromosome aberration study

Chernobyl disaster (wild animal)

Goncharova RI, *et al.: Radiat. Prot. Dosimetry* **62**, 37–40 (1995)
Bol'shakov VN, *et al.: Russian J. Ecol.* **34**, 314–319 (2003)

Natural high background radiation area (human)

Jiang T, *et al.: J. Radiat. Res.* **41** Suppl, 63–68 (2000)

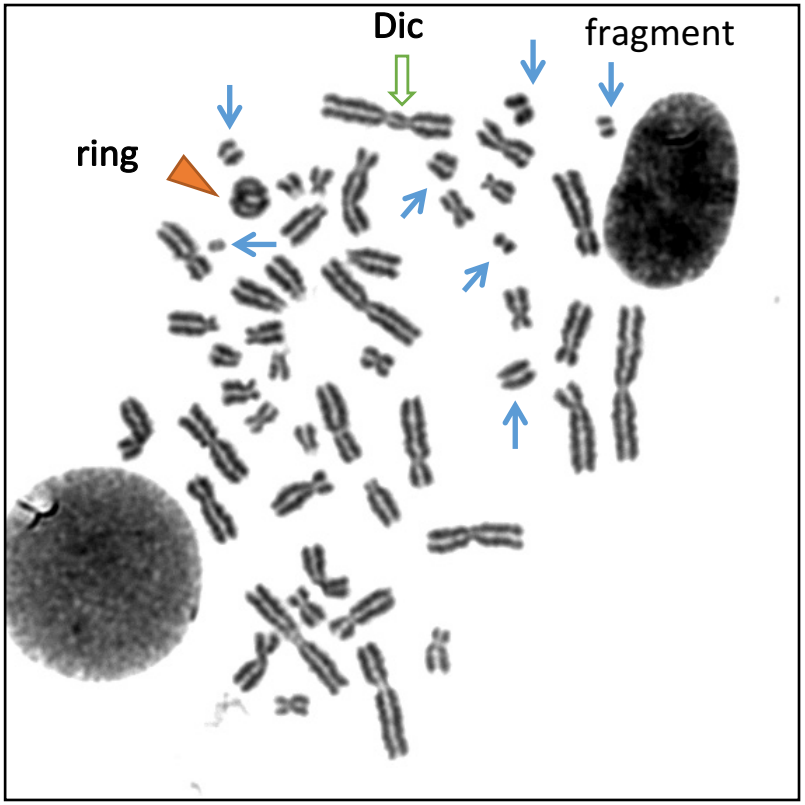
Low dose/low dose rate radiation (mouse)

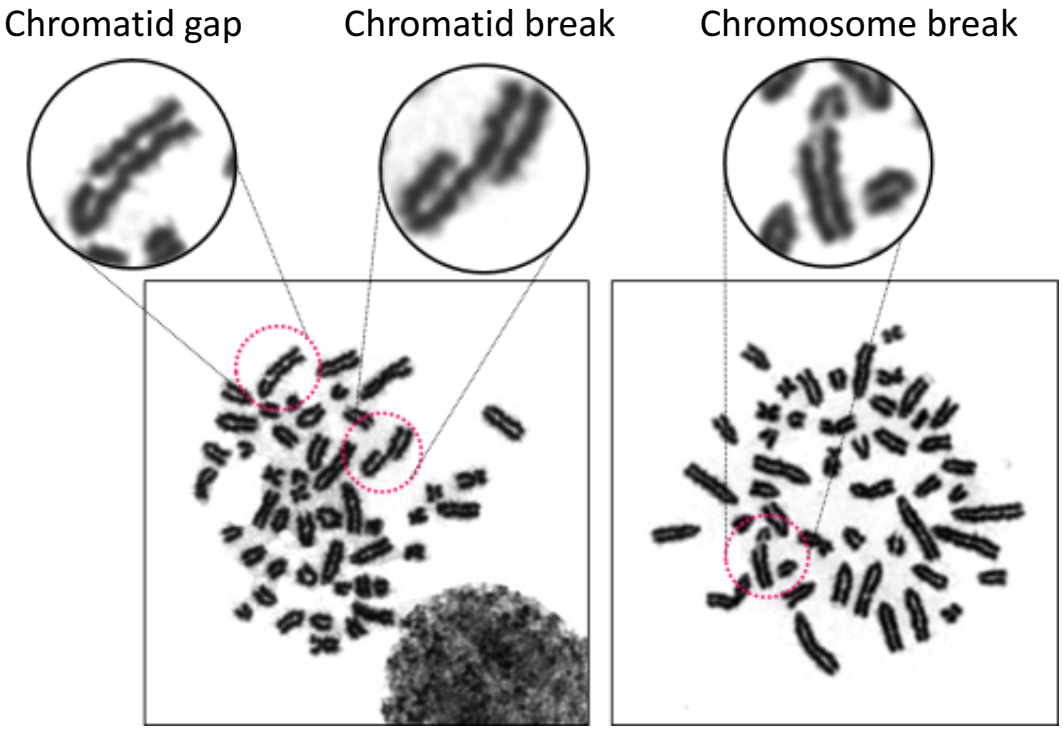
Tanaka K, *et al.: Radiat. Prot. Dosimetry* **159**, 38–45 (2014)

How about wild rodents inhibiting in contaminated area?

Radiation exposure induces many types of chromosomal aberrations

Human peripheral blood lymphocyte

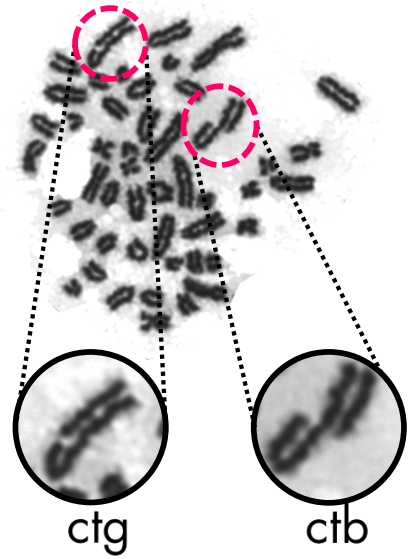


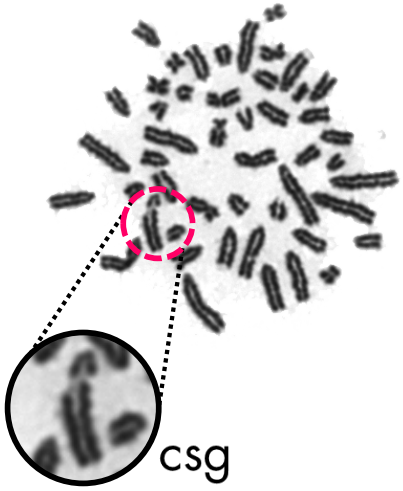


Chromosome aberrations observed in the spleen cells of *A. speciosus* collected in Namie-town

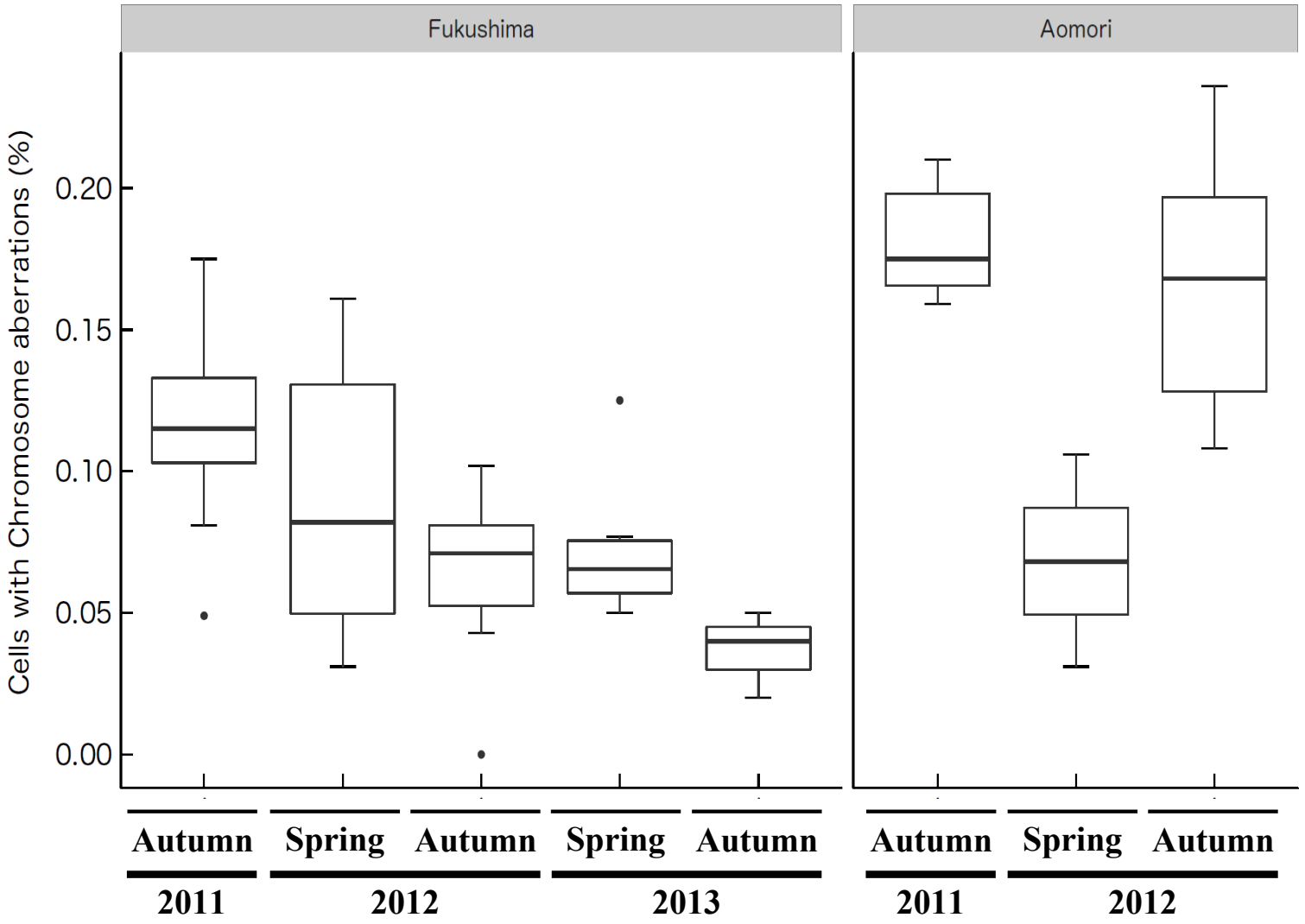
Summary of chromosome aberration analysis

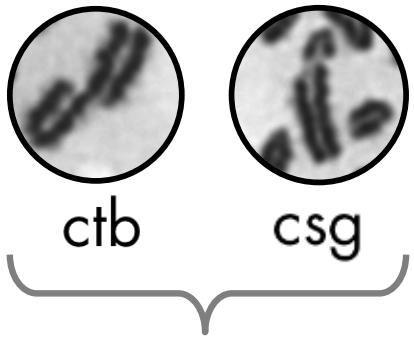
Year, season	Field	Chromosome aberrations (%)					
		ctg	ctb	csg	csb	Dic	ring
2011, Autumn	Namie	7.04	3.23	1.53	2.70	0	0
	Hirosaki	8.45	6.90	2.70	5.19	0	0
2012, Spring	Namie	3.96	1.52	1.83	0.91	0	0
	Hirosaki	4.78	0.00	1.91	1.44	0	0
2012, Autumn	Namie	0.44	0.88	0.44	1.32	0	0
	Hirosaki	7.65	5.96	2.58	3.65	0	0
2013, Spring	Namie	3.30	1.74	0.69	1.04	0	0
	Hirosaki	NA					
2013, Autumn	Namie	1.00	1.33	1.67	0.33	0	0
	Hirosaki	NA					





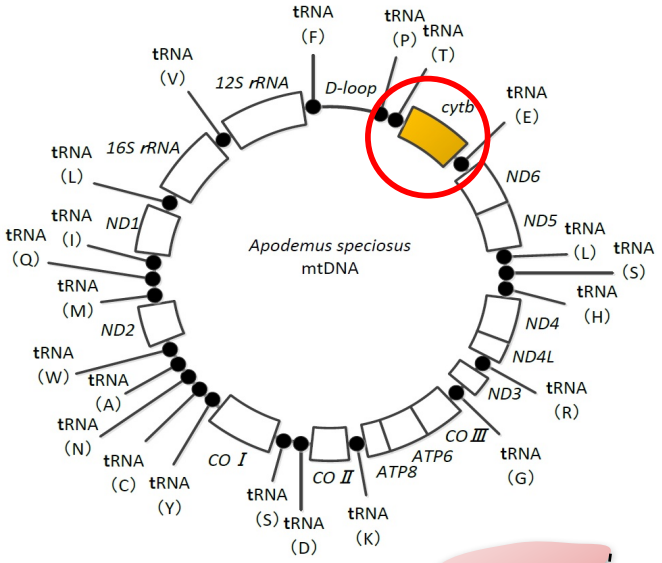
Frequency of cells with chromosome aberration



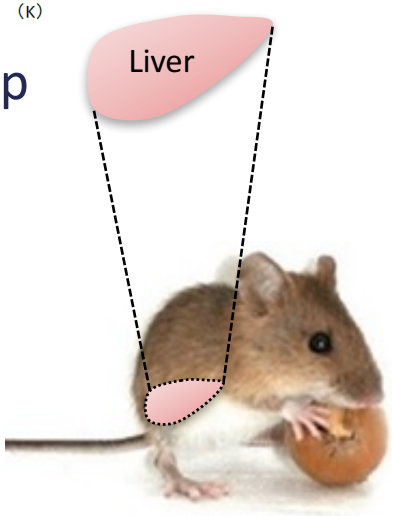


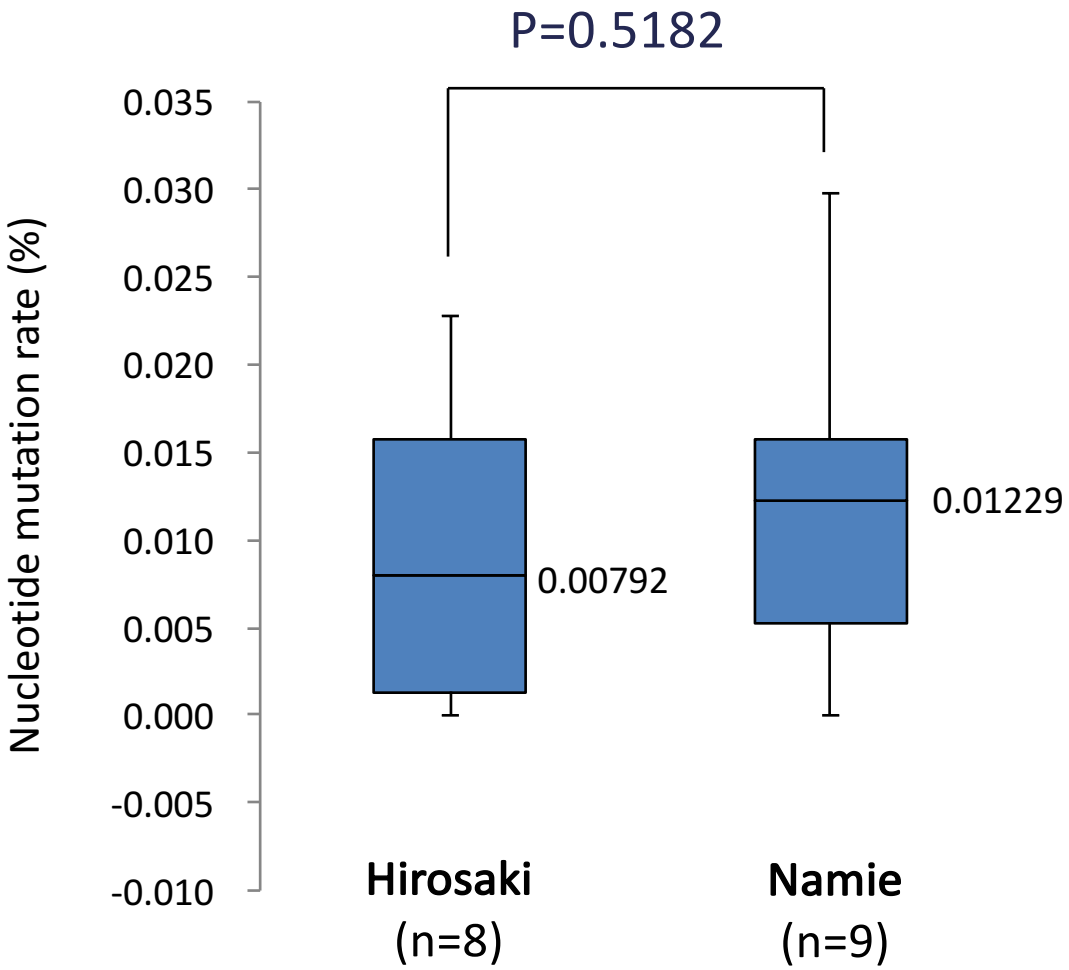
Decreasing
(ρ = -0.57, p < 0.01)

Analysis of base substitution in mitochondrial DNA



- mtDNA: 16kbp
- ***Cytb***: 1143bp





Contents

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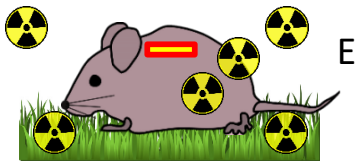
Dose estimation in *A. speciosus*

Radiophotoluminescence glass dosimeter

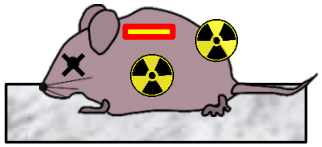
Total exposure



Contaminated area
(Namie, Fukushima)

Euthanasia

Internal exposure



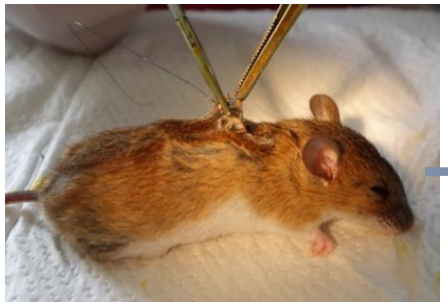
Reference area
(Hirosaki, Aomori)

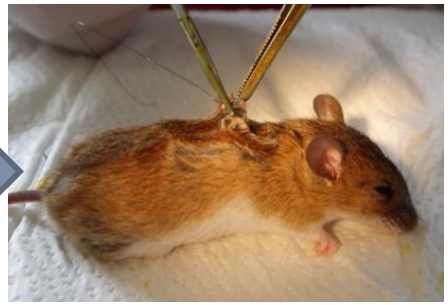
Gamma-ray spectrometry
by germanium semiconductor detector

Surface contamination

Carcass

Internal contamination

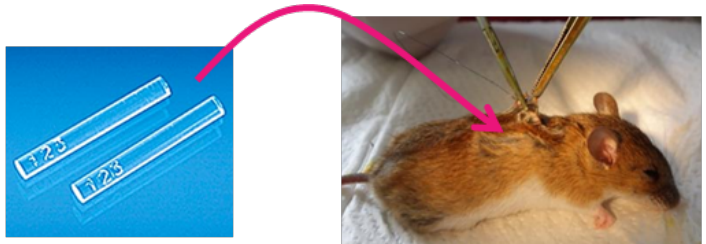


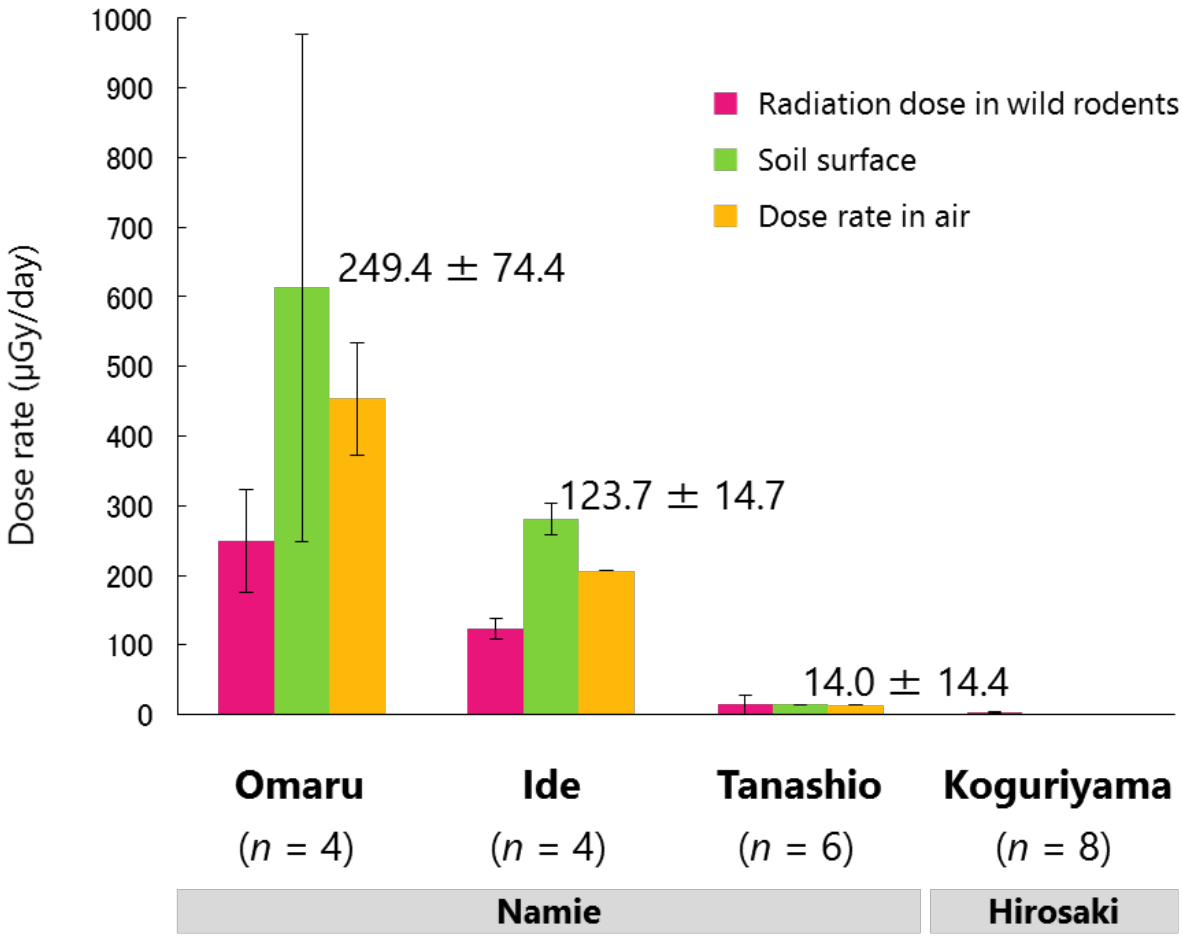


Contaminated area
(Namie, Fukushima)

Reference area
(Hirosaki, Aomori)

Radiation dose in *A. speciosus* and risk evaluation





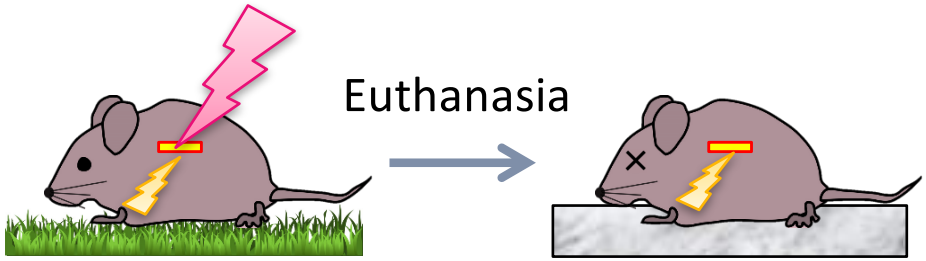
Derived consideration reference level

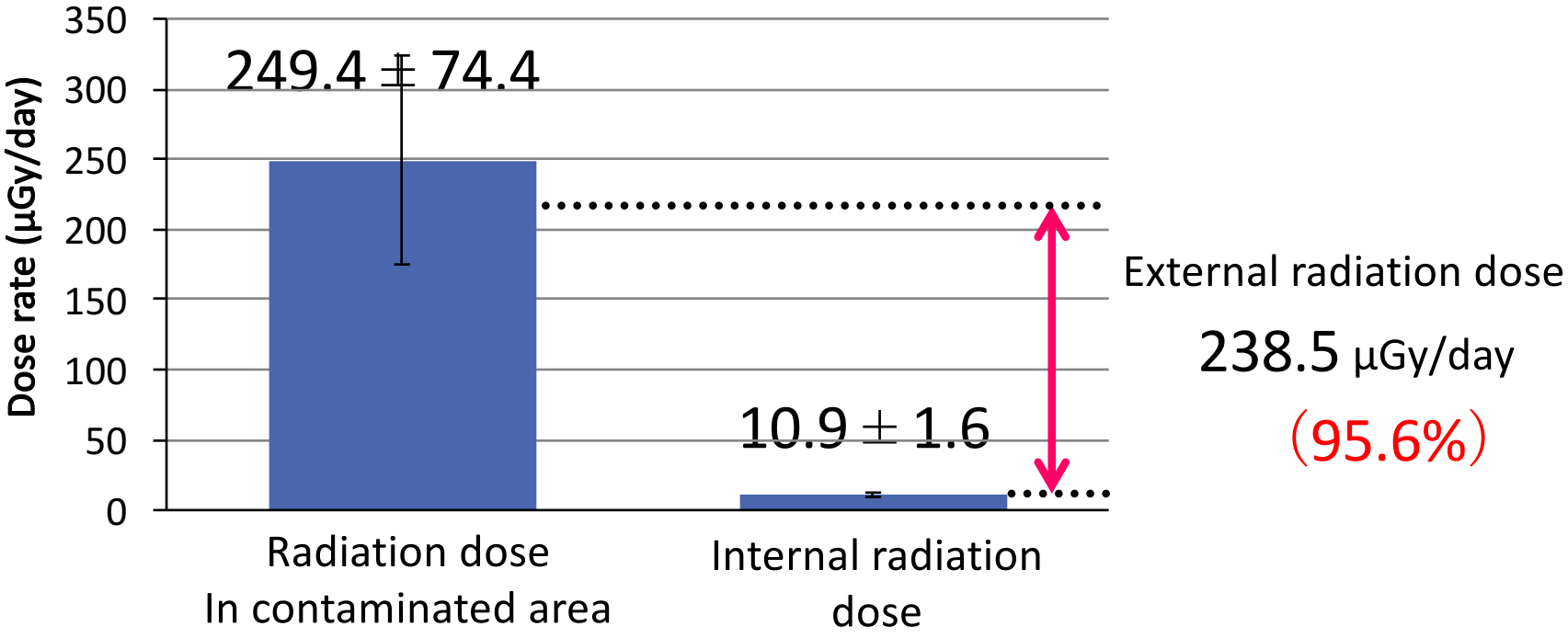
Dose rate (mGy/day)	Reference Rat
>1000	Mortality from hematopoietic syndrome
100-1000	Reduction in life spam
10-100	Increased morbidity Possible reduced lifespan Reduced reproductive success
1-10	Potential for reduced reproductive success
0.1-1	**Very low probability of effects**
0.01-0.1	No observed effects
<0.01	Natural background

ICRP Publication 108: *Ann. ICRP* **38**, (2008)

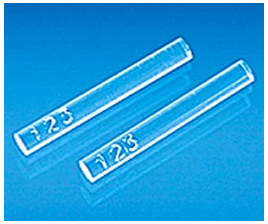
External and internal exposure

Dose in high dose area (Omaru area, Namie-town, Fukushima)



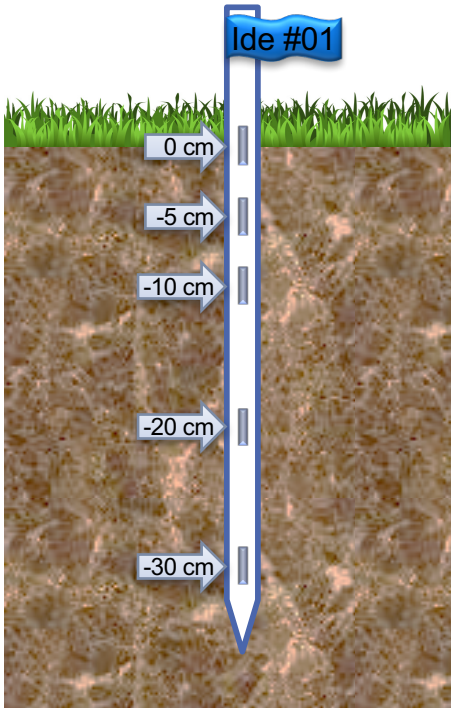


Kinetics of absorbed dose in the vertical direction in the soil



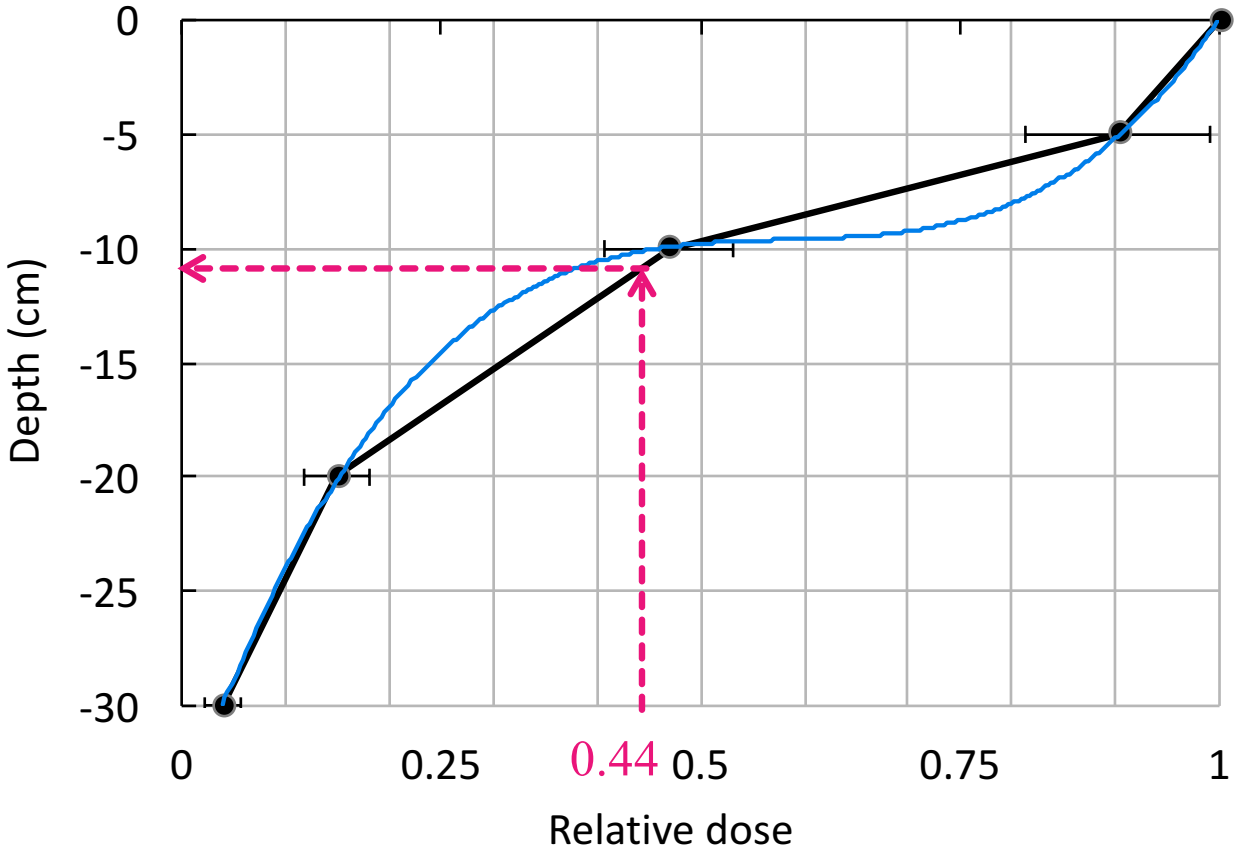
Radiophotoluminescence glass dosimeter

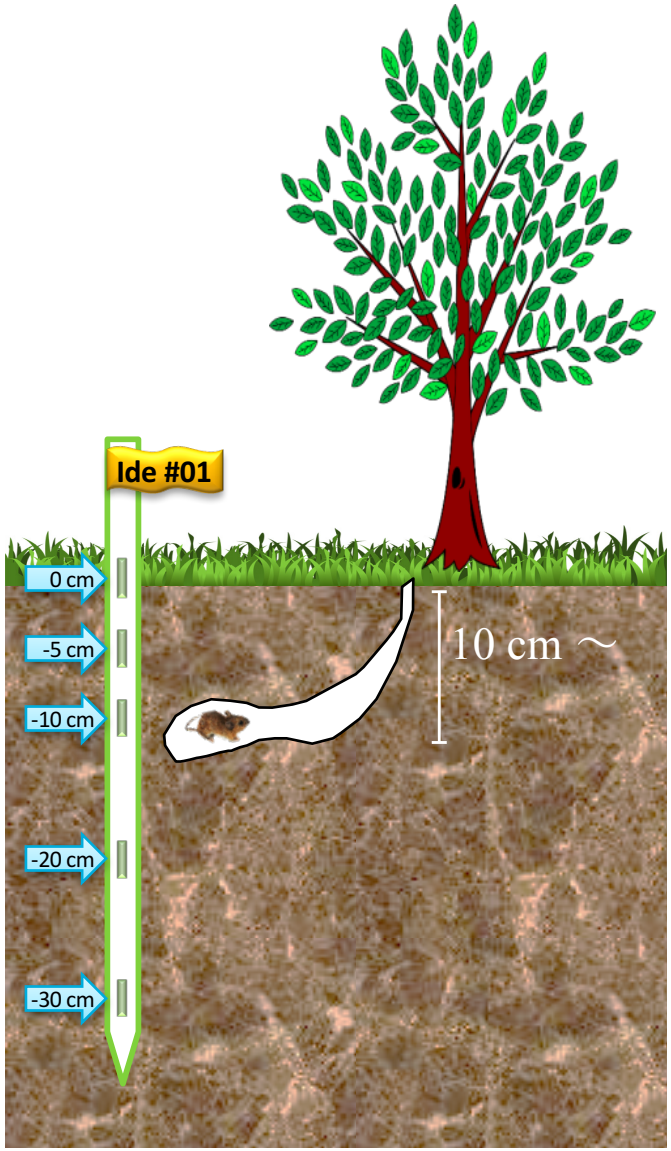
DoseAce (Chiyoda Technol Co. Japan)



Kinetics of absorbed dose in the vertical direction in the soil

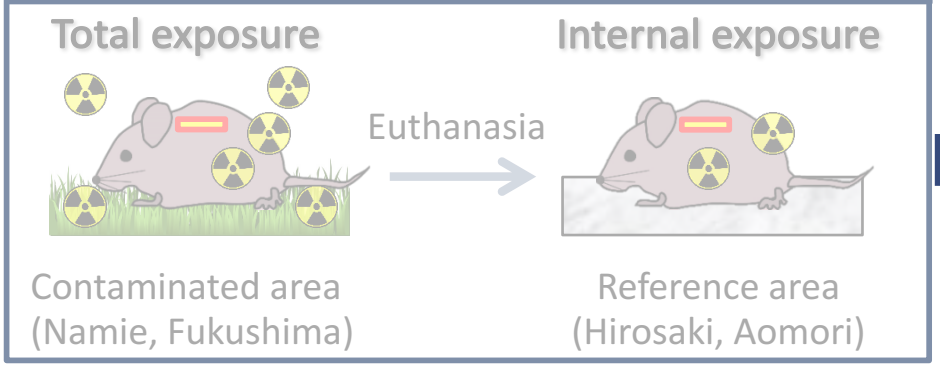
Intermediate air-dose rate area (Ide)



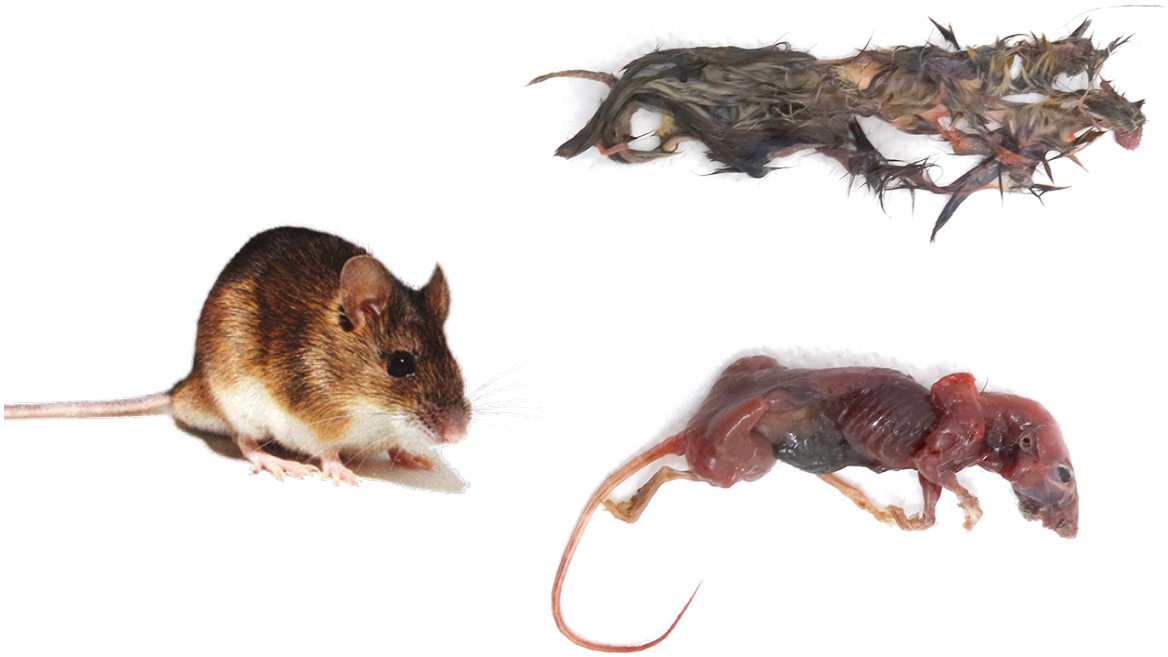


Internal exposure and surface contamination

Radiophotoluminescence glass dosimeter



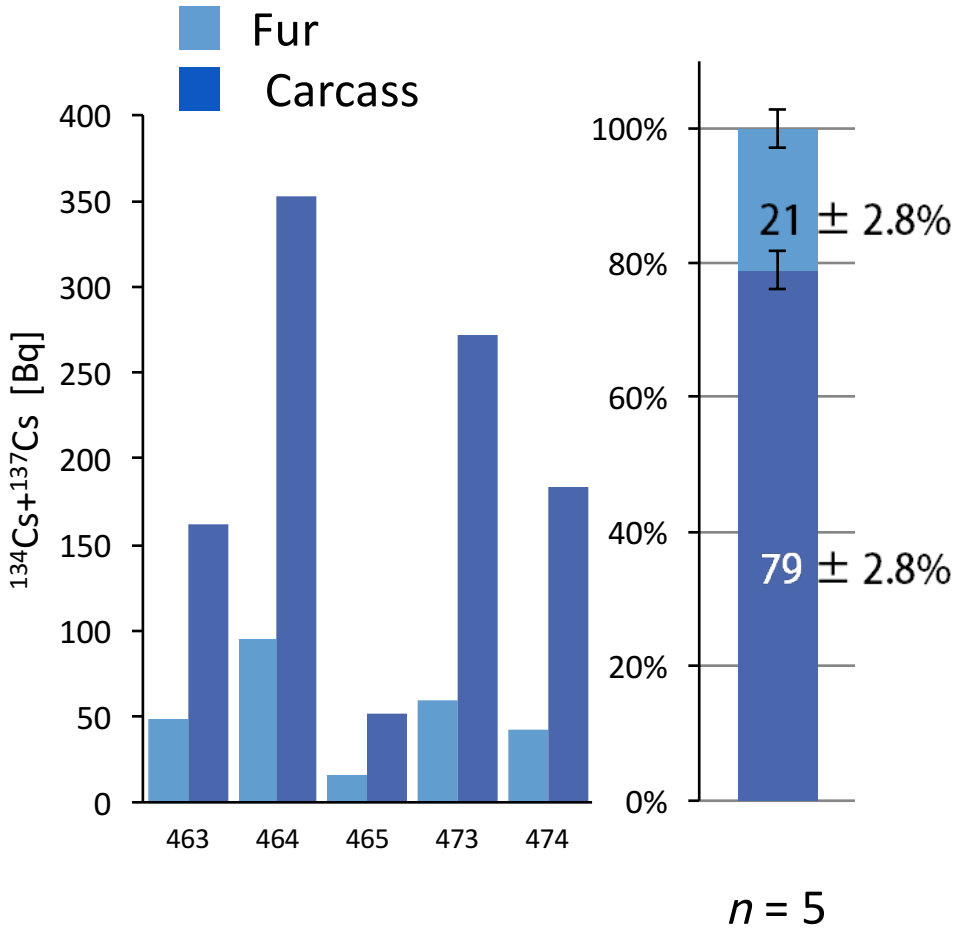
Gamma-ray spectrometry
by germanium semiconductor detector



Gamma ray measurement

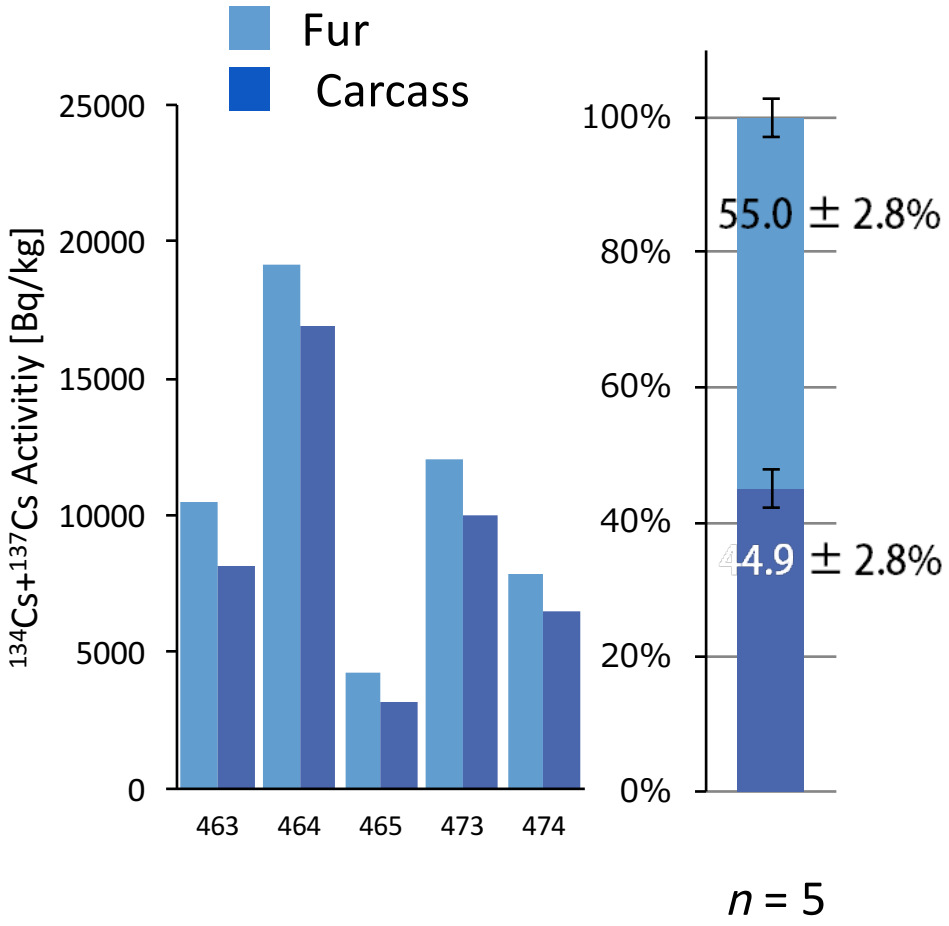
Internal exposure and surface contamination

Total activity



n = 5

Concentration

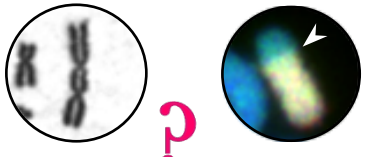


n = 5

Future plan

Dose estimation

Dic Translocation



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Individual dose vs. chromosome aberrations

2011 3/11	2011 Spring	2011 Autumn	2012 Spring	2012 Autumn	2013 Spring	2013 Autumn	2014 Spring	2014 Autumn	2015 Spring	.....

Summary

1. The ratio of mice number born before and after the F1-NPP accident was significantly low in the Fukushima population. However, our results showed that the population of mice in Fukushima has been recovered.
2. There was no significant difference in individual growth between the mice collected in Namie-town and Hirosaki city.
3. There was no radiation-specific chromosomal abnormality in the mice examined.
4. We established the method of individual dosimetry.
5. The radiation exposure dose of wild mice captured in Omaru- and Ide-areas was classified into derived consideration reference levels.

Although the mice in the evacuation area were exposed chronically, the adverse genetic effects of radiation were not detected at present. Continuous investigation of wildlife is necessary to determine biological effects of radiation from the F1-NPP accident.