Yttrium Localization in the Desert Pocket Mouse *Perognathus penicillatus.** (26890)

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Since a considerable array of radioisotopes appears in fallout as a result of atomic detonations, there is an increasing need for information concerning localization patterns and factors regulating ion translocation and subsequent deposition. Studies of this nature, however, may involve first, procedures wherein radio-decay leads to formation of other isotopes which may then result in intense localized cellular fields of radiation or lead to stable isotopes which though presenting no radiation problems may behave differently biologically. Thus, the decay of Y^{90} gives rise to radioactive zirconium while Y^{91} leads a stable isotope of zirconium. Differential activity in a biological system may be expected at the molecular level when these 2 isotopes are used, though the final morphological expression may be negligible. Complications in interpretation of localization data may also appear from the fact that little or nothing is known concerning the influence of differential energy spectra or shifts in elemental species on permeability and ion mobility.

Of further interest to biologists are studies concerning rates of turnover of elements in biological systems and pathways in the ecological food chain. $Yttrium^{91}$ has been discovered in fallout from nuclear weapons testing(1) and is believed to follow the distributional patterns of localization of calcium and strontium in vertebrates. In particular, Y^{91} has been found to adsorb on the surfaces of bones(2) and to deposit in small completed Haversian systems. The desert pocket mouse was chosen for this study on yttrium translocation and deposition particularly because this animal appears to be able to thrive in absence of free water and is further thought to resorb water *via* the kidneys, releasing but very slight quantities of urine. Thus, though a large part of injected yttrium is excreted in the urine in some animals within 2 days(3) this opportunity appears to be absent in the desert mouse. It was, therefore, considered of special interest to investigate the distribution pattern of this radioisotope in presence of a reduced mechanism for urinary excretion.

Materials and methods. Adult desert pocket mice, *Perognathus penicillatus* obtained from the desert surrounding Tucson, Ariz. were used. Two males weighing 13.8 g and 15.5 g and 2 females weighing 13.7 g and 15.7 g were used. $Yttrium^{91}$ as YCl_3 in dilute HCl was injected intraperitoneally through the posterior ventrolateral surface of each animal, care being taken to avoid all internal viscera. Amount injected was 18.5 μc in one ml of distilled water per animal. Food consisting of pieces of prickly pear cactus and dry seeds was freely available during the experimental period. After 48 hours the animals were etherized and approximately 0.1 g samples of a spectrum of the major organs and tissues removed. Extraneous radioactivity was removed by washing with running tap water. The pieces were then dried at 80°C, weighed and placed in plastic tubes. Radioactivity was measured by means of a Nuclear Chicago deep well scintillation detector and an ultrascaler. Ten-minute counts were taken in all instances. Appropriate corrections were applied to the data and specific activities were determined in terms of cpm/mg/min. of exposure after initial injection.

Results. The results are summarized in Table I. Although considerable variation was apparent in the comparative accumulation of yttrium in the various organs it remains quite clear that the kidneys retained

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TABLE I. Yttrium Localization in Desert Pocket Mouse, *Perognathus penicillatus*, 48-Hr Accumulation.

cpm/mg/min. $\times 10^{-4}$

Structure	Animal ♀ 15.7 g	♀ 13.7 g	♂ 15.5 g	♂ 13.8 g
Brain	.10	.02	4.00	.14
Skin	.05	.59	1.04	17.29
Blood	.35		.38	
Muscle	.39	.11	.22	.52
Diaphragm	1.34	.12	2.56	1.33
Bladder	2.37	.06	1.31	.64
Stomach	3.97	1.35	1.72	2.09
Caecum	3.59	.72	1.86	6.82
Liver	4.20	.89	1.88	7.27
Heart	4.25	.51	.77	5.49
Spleen	4.95	.97	3.45	2.02
Small intest.	6.90	.55	.44	4.73
Tooth	7.95	2.11	3.99	7.39
Gonad	8.68	.00	1.11	2.39
Lung	12.21	.67	.91	3.87
Femur	12.61	.87	3.59	5.34
Kidney	42.80	4.66	10.50	39.96
18.5 μc Y^{91} inj. per animal				

the greater amount of activity. The isotope was localized in the tissue of the kidney itself and not in urine since only a piece of this organ was tested from each mouse, and washing procedures were thorough. The teeth and bones were found to have concentrated this isotope also at high levels of concentration. Muscle, blood and brain accumulated but slight amounts of activity except in one female where considerable quantities were apparent in the brain. In one animal, also, amounts of activity in the skin were found to be very high, probably because this particular sample was taken near the site (4,5) of injection.

Discussion. A fundamental difficulty in studies involving ion translocation may exist in the method(6) of administration of the material in question. It is difficult, especially in intraperitoneal injection to be certain that the same injection site is used in each instance. Thus, changes in site might result in considerable variation in subsequent vascular pathways for ion carriage. It has been suggested(7) that the ventral surface of the tail might be an area of choice in isotope injection for outlining the dynamics of ion spread in the bodies of experimental animals. Where this was done in Swiss albino mice, yttrium (Y^{90}) was most actively accumulated initially by the liver and later was translocated. Care was taken in this research to avoid the blood vessels in the tail and to inject relatively large amounts (50 μc) of the radioisotope in small volumes (0.1 ml) into the connective tissue area just under the skin. In other vertebrates (8) Y^{91} has been found to form a colloidal suspension in blood plasma with little apparent accumulation in erythrocytes, and deposition of this ion into visceral and osseous tissue as well as its retention is believed(9) to represent a chemical incorporation of rapidly formed metal-amino acid complexes into various proteins.

Because of the lack of availability of urine in the desert pocket mice it was not possible to check excretion of this cation during the experimental period. In rats, however, it has been shown that about 5% of injected yttrium appears in the urine in 24 hours. Aside from a possible role in supportive structures in vertebrates, a metabolic role for yttrium remains obscure. The concentration of this element in the kidney of the desert pocket mouse probably follows a usual excretory pathway for cations. Subsequent elimination by this means, however, probably does not occur at rates found in non-desert forms.

Summary. Forty-eight hours after intraperitoneal injection of radioactive yttrium (Y^{91}) into the desert pocket mouse *(Perognathus penicillatus)* large quantities of this isotope were discovered in the kidney tissue. Teeth and bones also concentrated this element to a large extent. Very little isotope was found in either blood or muscle.

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