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Water and Electrolyte Content of Dolphin Kidney and Extraction of Pressor Substance (Renin).

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Former findings on the distribution of electrolytes in the blood[1] and skeletal muscle[2] of the dolphin *(Tursiops truncatus)*, together with the variations revealed in comparisons with terrestrial mammals, actuated a similar examination of the kidneys of the dolphin. The regular occurrence of a pressor substance (renin) in the kidneys of terrestrial mammals stimulated the attempt to demonstrate the presence of such a substance in the kidney of this sea mammal. Therefore, the object of this work was: (1) to determine the water and electrolyte content of the dolphin kidney; (2) to establish the presence of a pressor substance (renin) in this kidney; and (3) to compare the results with corresponding data from the dog as a representative land mammal.

Experimental. One whole kidney weighing 230 g was removed from a live young female dolphin, weighing 80 kg, under sodium phenobarbital anesthesia. The kidney was immediately chilled and frozen. After being wrapped in oiled paper, it was placed in a wide-mouth thermos bottle and shipped by air express from the Marine Studios, St. Augustine, Florida, to our Chicago Laboratories, as described in a previous paper.[1]

The dolphin kidney is a compound organ composed of hundreds of small kidney units, each containing a cortex and medulla. Therefore, an aliquot number of units of the whole kidney was taken for chemical analyses, and the remainder for the extraction of the pressor substance. Units amounting to 40 g in weight were analyzed in triplicate for water, fat, chloride, sodium, potassium, calcium and magnesium, using the procedure and methods described by Eichelberger and Bibler.[3] These data are given in Table I.

The pressor substance was extracted from 190 g of the kidney units by a method to be described later. To test the pressor activity,

1 Eichelberger, L., Fetcher, E. S., Jr., Geiling, E. M. K., and Vos, B. J., Jr., *J. Biol. Chem.*, 1940, **133**, 145.

2 Eichelberger, L., Geiling, E. M. K., and Vos, B. J., Jr., *J. Biol. Chem.*, 1940, **133**, 661.

3 Eichelberger, Lillian, and Bibler, Walter, *J. Biol. Chem.*, 1940, **132**, 645.

TABLE I.
Water and Electrolyte Content of Dolphin Kidney.
The values are given per kilo of fat-free tissue.

	H_2O g	Fat g	Cl mM	Na mM	K mM	Ca mM	Mg mM
	821.0	11.7	65.3	84.2	56.8	1.53	6.3
	Kidneys from 20 normal dogs.[3]						
Mean	802.2	19.7	67.7	82.6	58.3	2.16	5.7
σ*	5.6	9.0	5.3	5.8	4.8	0.53	0.5

*Standard deviation.

the purified extract was injected intravenously into an unanesthetized dog and also into a dog under nembutal anesthesia. Blood pressure of the unanesthetized dog was recorded kymographically by means

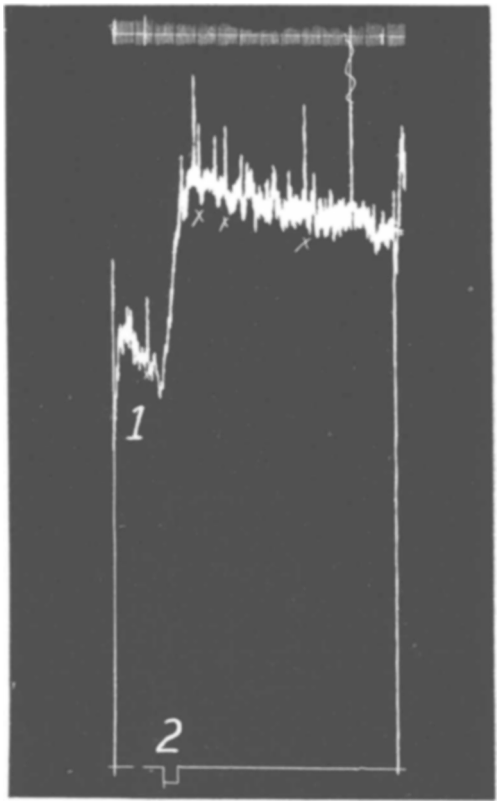

CHART 1.

Unanesthetized dog. Wt 11.6 kg. Upper record shows time in intervals of 5 seconds. Middle curve represents femoral blood pressure. (1) Normal blood pressure, 154 mm Hg. (2) 4 cc extract from dolphin kidney (equivalent to 20 g fresh kidney tissue) injected intravenously, blood pressure 228 mm Hg. "X" signifies washings of the needle.

of a gauge 18 needle in the femoral artery connected with a cannula and a mercury manometer. This tracing is shown in Chart I. It will be noted that the control blood pressure of the 11.6 kg dog was 154 mm Hg. After the injection of 4 cc of extract, equivalent to 20 g of fresh kidney tissue, the blood pressure rose to 228 mm Hg. and was still at 212 mm at the end of 10 min.

Blood pressures of the anesthetized dogs were recorded by cannulas in the carotid artery connected directly to a mercury manometer. This tracing is shown in Chart 2 It will be noted that the control blood pressure of the dog under nembutal anesthesia was 152 mm Hg. After the intravenous injection of 2 cc of extract, equivalent to 10 g of fresh kidney tissue, the blood pressure rose to 184 mm Hg. The blood pressure of the dog returned quickly to normal evidently because the amount of extract injected was too small. Another injection of 2 cc of the extract caused a second rise to 194 mm Hg. After a third injection of the extract, the blood pressure rose from 166 mm to 200 mm Hg. and persisted at a level of 172 mm for 10 minutes when the experiment was terminated.

These results show that a pressor substance (renin), which functions like the renin from dog or pig kidney, was isolated from the dolphin kidney. (1) The control blood pressure of a 8.9 kg anesthetized dog was 118 mm Hg. After the intravenous injection of

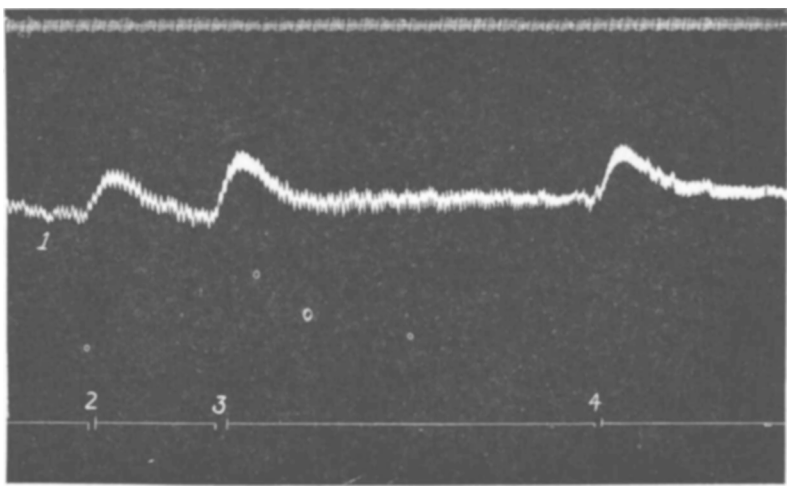

CHART 2.

Anesthetized dog. Wt. 8.2 kg. Records as in Chart 1. (1) Normal blood pressure, 152 mm Hg. (2) 2 cc extract from dolphin kidney (equivalent to 10 g fresh kidney tissue) injected intravenously, blood pressure 184 mm Hg. (3) Second injection of 2 cc of extract, blood pressure 194 mm Hg. (4) Third injection of 2 cc of extract, blood pressure 200 mm Hg.

2 cc of extract made from dog kidney (equivalent to 10 g fresh kidney tissue) the blood pressure rose to 176 mm Hg and was still at 172 mm at the end of 30 min. (2) The control blood pressure of an 8.5 kg anesthetized dog was 110 mm Hg. After the injection of 2 cc extract made from pig kidney (equivalent to 10 g fresh kidney tissue) the blood pressure rose to 240 mm Hg. The blood pressure remained at 170 mm for 15 min., after which another injection of 1 cc extract caused a second rise to 200 mm Hg, which again continued at a level of 170 mm for 15 min. After a third injection of 2 cc extract the blood pressure rose to 190 mm Hg.

Comments. When the content of water and electrolytes in the kidneys of dolphins was collated with comparable data obtained from the kidneys of dogs (Table I), the only difference was the higher water content in the dolphin kidney. The values for sodium and chloride found here, as well as in dog kidneys, are too high to be accounted for by the extra water, assuming that this water is extracellular and contains the concentration of sodium and chloride expected in extracellular fluids. Therefore, it must be assumed that certain cells of the dolphin kidney engaged in the reabsorption of chloride from the glomerular filtrate must contain chloride as well as sodium. Further, the analytical data reflect either of two possibilities: (1) the existence in the lumen of the nephron of an additional fluid phase, varying in composition as it passes down the renal tubules, which must not be different from that found in dogs or else the analytical results would have been decidedly different; (2) if the chloride and sodium concentration representing the extracellular spaces of the kidney is low, as found in the skeletal muscle,[2] then the sodium and chloride concentration in the contents of the collecting tubules must be considerably higher than that found in the dog.

The potassium figures, as in dog kidneys, indicate that the intracellular phase of the dolphin kidney is relatively small and of the same comparative volume. In view of the complexity of the system and the different kinds of kidneys, it is surprising that the data for dog and dolphin kidneys exhibit the degree of consistency portrayed in Table I.

Conclusions. 1. The values for the water content and electrolyte concentrations of a normal dolphin kidney were as follows: Total water, 821.0 g; chloride, 65.3 mM; sodium, 84.2 mM; potassium, 56.8 mM; calcium, 1.53 mM; and magnesium, 6.3 mM per kg of fat-free tissue.

2. A pressor substance was isolated from the kidney of the dolphin which behaved chemically and physiologically like the renin prepared from the kidney of the dog or pig.