glomerular development in the dogfish implies a capacity for high rates of urine formation, and these have actually been observed by Smith[2] in fresh water elasmobranchs.

Injections of thephyldine and salyrgan, which are effective in producing diuresis in mammals under certain conditions, give no increase in urine flow in the dogfish. Phlorizin produces moderate diuresis, possibly in consequence of the osmotic activity of the glucose appearing in the urine. Adrenalin in large doses both induces diuresis and partially blocks the tubular reabsorption of urea, causing in one experiment a 55 fold increase in urea clearance and a change in urine flow from 16 to 75 cc. per kilo per day.

The effect of diluted sea water on renal activity was investigated in six fish, which were kept for 12 hours in 80 per cent sea water and then transferred to 70 per cent sea water. No significant changes were observed in 80 per cent sea water, but the succeeding urine collections in 70 per cent sea water showed a progressive increase in urine flow. The U/P ratio of inulin remained remarkably constant, the inulin clearance rising in proportion to the urine flow. One fish which in sea water had given a flow of 20 and a glomerular clearance of 90 cc. per kg. per day, showed in the second 12 hour period in 70 per cent sea water a urine flow of 61 and an inulin clearance of 272 cc. per kg. per day. The physiological means by which this increase in inulin clearance is effected is unknown.

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THE EXCRETION OF URINE IN THE SEAL

HOMER W. SMITH

Department of Physiology, New York University College of Medicine

Marine mammals, because they may spend their entire lives in the sea and never have access to fresh water, present an interesting problem in regard to urine formation. The harbor seal, *Phoca vitulina,* Linnaeus, has been examined with special reference to the rate of urine formation, the osmotic pressure and nitrogenous composition of the urine, the excretion of phosphate, chloride, sulphate and magnesium, and simultaneous renal clearances of inulin and creatinine. Urine was collected by catheterization of the female and blood samples were obtained by cardiac puncture.

In the fasted animal the rate of urine formation was relatively low, ranging from 0.06 to 0.1 cc. per minute, in an animal weighing 40 pounds. When a meal of approximately 1000 gr. of fresh herring was fed, the rate of urine formation increased, reaching a maximum of 1 cc. per minute between 4 and 7 hours after the ingestion of the food; during the next 12 to 24 hours the rate fell again to the fasting level. The preponderant nitrogenous constituent in the urine, in both

[2] Smith, H. W., 1931; Am. J. Physiol., *98*, p. 279.

the fasting and fed animal, was urea, although creatinine, and what is more noteworthy, creatine, were present in large amounts. The presence of creatine in the urine of mammals is usually anomalous, and consequently an examination was made of the creatine excretion in the seal after feeding herring (which contains relatively large amounts of preformed creatine) and clams (which contain practically no preformed creatine). It was found that whereas a large increase in the rate of excretion of creatine occurred after a meal of herring, this phenomenon was not observed after a meal of clams. If allowance is made for the excretion of creatine in the fasting condition, there appears to have been no increase in creatinuria after the meal of clams. It is therefore concluded that the creatine excreted in the urine after a meal of herring represents preformed creatine ingested in the food. The animal upon which these observations were made was probably not over five-months old, and it seems possible that the creatinuria observed in it is physiologically comparable to the creatinuria observed in young mammals of other species.

The urine at no time contained any significant quantities of magnesium, and the sulphate excretion was no greater than was to be expected from the degradation of protein. No significant quantities of magnesium or sulphate could be recovered by rectal irrigation. The urinary chloride in the fasting urine was relatively low and increased to a variable but never excessive extent during the absorption of food. From these facts it is concluded that, in neither the fasting nor the fed animal, is any significant quantity of sea water swallowed, for if such were the case it would be reflected in either a magnesium and sulphate residuum in the intestines, or an excessive magnesium and sulphate excretion in the urine, and the excretion of chloride would be greater than could be explained on the basis of ingested food.

Apparently the seal derives its urinary water exclusively from preformed water of its food and from the oxidation of foodstuffs. This conclusion explains why the urine flow is low in the fasting animal, and increases in the fed animal. The total quantity of water excreted over a period of 24 hours is not greater than that which could be accounted for in this manner.

The osmotic pressure (freezing point depression) of the urine of fasted and fed animals varied from —1.9 to 4.0°C., the lowest osmotic pressure tending to occur at the lowest rates of urine flow (i.e., during fasting). The highest osmotic pressure tended to occur at intermediate, rather than at the highest rates of urine flow, several hours after a meal. The results are explicable if it is supposed that the rate of water excretion in the seal is under independent physiological control, as in other mammals.

Simultaneous inulin and creatinine clearances are essentially identical, indicating that there is no secretion of creatinine in this animal.

Since this work was completed, Irving, Fisher and McIntosh[1]

[1] Irving, L., K. C. Fisher and F. C. McIntosh, 1935; J. Cell. Comp. Physiol. *6*, 387.

have reported chloride analyses of the urine and feces of the harbor seal that have led them to conclude, as we have, that this animal does not drink sea water.

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