1965 #4

OSMOREGULATION IN Squalus acanthias IN HYPEROSMOTIC ENVIRONMENT

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According to Smith, the dogfish obtains free water to form its hyposmotic urine from the sea by movement of water down a concentration gradient across the gill membrane. The concentration gradient for water is supplied by the addition of urea to the plasma electrolytes, raising the total osmotic concentration of the fish to approximately 50 mosmols above the sea water.

To exercise this hypothesis, dogfish were placed in cooled, aerated tanks containing sea water to which was added marine salt (2 experiments) commercial NaCl (2 experiments), urea (3 experiments) and sucrose (1 experiment) in amounts sufficient to reverse the normal osmotic gradient across the gills. The fish were studied for from 1 to 5 days during which plasma and urine osmolality, sodium and urea concentration were followed. The following preliminary conclusions may be drawn:

(1) Regardless of the substance used to increase the osmotic concentration of the sea water, the dogfish plasma osmolality increased over the course of 3-5 days to exceed that of its environment.

(2) This increase in plasma concentration is effected by an increase in plasma sodium concentration, not by urea.

(3) During the time that the environment is more concentrated than the fish, hyposmotic urine continues to be formed.

(4) As urine osmolality increases, urea forms the principle contributing substance to this increase.

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DYNAMICS OF SULFABROMOPHTHALEIN SECRETION BY THE LIVER OF THE SPINY DOGFISH, Squalus acanthias, WITH SPECIAL REFERENCE TO MEASUREMENT OF HEPATIC BLOOD FLOW

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The comparative physiology of the liver is as yet poorly defined. The large liver of the dogfish is of especial interest (10-12% of body weight, about 30% fat). The following data continue studies begun by us in 1956. Not all analyses were completed when this abstract was written, so the facts and conclusions given below may require reinterpretation.

Studies on dog and man indicate that BSP (sulfabromophthalein) is taken up by the liver by a process of accumulation—or storage—into what may be defined as a constant volume of distribution, and then transferred into the bile by a limited transfer system. At low concentrations, the extraction of BSP from the blood is sufficiently large to permit an estimation of hepatic

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blood flow. The dogfish was approached within this ideological framework.

BSP-Na was measured colorimetrically, and as S^{35} will be measured later. In 12 experiments BSP was given intravenously (lateral abdominal vein) in a single dose, and in 10 experiments, as a constant infusion (calibrated Harvard pump). Arterial blood from the caudal artery was sampled. Fish were free in a small tank, as experiments indicated that fish tied to a "shark-board" were depressed. Bile was taken repetitively directly from the gall bladder following ligation of the bile duct. Plasma volume was measured by the T-1824 method.

The results show that BSP is removed from the blood less rapidly than in mammals, averaging 1.56% per minute for 3 fish in contrast to 15% per minute in man. BSP storage and transfer gave preliminary values for transfer maxima from 0.42 to 0.51 mgm per minute, approximately one-third those observed in man. Definition of storage proved difficult due to loss of dye into non-hepatic tissues. S^{35} data should clarify this area.

BSP concentration in the bile was as much as 1000 times greater than that in the plasma, with low bile flows of 0.4-13 lambda per minute, tending to vary inversely with biliary BSP concentration. Because of the time required to establish an equilibrium between infusion and biliary excretion, accurate BSP clearances were difficult to obtain. In one case with nearly 24 hours of perfusion with a fish in excellent condition, biliary clearance averaged 1.78 ml per minute, with average bile flow of 3.92 lambda per minute. Terminal plasmas were: arterial, 1.23 mg%, indicating an extraction (E) of 32.8%, which gave an estimated hepatic blood flow (EH^{BF} = BSP clearance/E) as 5.35 ml per minute. It seems that the liver of the dogfish is relatively ischemic since perfusion per unit weight of liver amounts to no more than 1.8 ml per 100 grams per minute in contrast to man and dog in whom perfusion is 1/ml per gram per minute. Even allowing for the high hepatic fat content, the hepatic blood flow is low compared to a mammal.

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SODIUM TRANSPORT BY THE RED BLOOD CELLS OF THE DOGFISH (Squalus acanthias) UNDER AEROBIC AND ANAEROBIC CONDITIONS*

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The characteristics of sodium transport by the nucleated red blood cells of the dogfish shark, Squalus acanthias, have not yet been studied. Definition of these characteristics should be of considerable interest not only because the sodium concentration of dogfish plasma is approximately 250 mEq/L, but because active sodium transport, as well as all other endergonic biologic processes, in this species must be sustained in vivo at temperatures ranging from 12 to 16°C. Experiments were performed on washed red blood cells after overnight incubation in Na^{22} containing dogfish Ringer's at 4°C. Na^{22} efflux rates and net sodium transport were measured during a 4 hour period at room temperature (16-22°C). Measurements were made under both aerobic and anaerobic conditions. Anaerobiosis was obtained by using 100% nitrogen as the gas phase; the nitrogen was passed through an oxygen trap en route to the incubation flasks. In

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