media and infection experiments with pure lines of various species of opalinids should also be attempted.

## 12. THE COMPARATIVE ANATOMY AND PHYSIOLOGY OF THE VERTEBRATE KIDNEY

#### By E. K. MARSHALL, JR., The Johns Hopkins University

A general program of attempting to correlate the morphological structure of various vertebrate kidneys with their function has been undertaken. It is believed that such a comprehensive study will furnish an understanding of renal function from a broad biological viewpoint, will give a basis for the proper evolution of experiments on the lower animals in their bearing on human kidney physiology, and will help to localize the processes concerned in urine secretion in the histological differentiated segments of the renal tubule.

A preliminary study of the glomerulus in various vertebrate kidneys has been recently completed and published (Marshall and Smith, 3). This indicates that the gomerulus is primitively a water excreting organ, but has become modified in mammals to serve as the main route for the excretion of waste products. The hypothesis developed from the above study demands that the rate of urine flow of marine teleosts should normally be very low compared with that of fresh water teleosts. However, such experimental determinations of the urine flow of marine teleosts as have been made are frequently rather high. Doctor A. I. Grafflin, in his report given below, clearly shows that under normal conditions of existence the urine flow of marine teleosts is very low. He has further studied the cause of the increased urine flow under ordinary experimental conditions. His work is important in furnishing for the first time a base line for the functional study of marine teleosts.

There is now clear evidence that both filtration-reabsorption and tubular secretion are concerned in the production of urine by the kidney. An attempt is being made to study the relative importance of these two processes in various classes of vertebrates. A brief report of such work is given below for marine teleosts.

A. The Importance of Filtration-reabsorption and Tubular Secretion in the Kidney of Marine Teleosts.

It is known (1) that glucose is not eliminated by the aglomerular kidney except in merest traces. It is, however, readily excreted under certain conditions by the glomerular kidney. There is in addition strong evidence to believe that the administration of phlorizin prevents the reabsorption of glucose by the tubule. A comparison, therefore, of the glucose concentration in the blood plasma and urine after phlorizination should furnish data for calculating the amount of glomerular filtrate.

In the sculpin, which has been exclusively studied so far, it has been found that the ratio of the glucose concentration in the urine to that in the blood plasma is never over one. On the other hand the ratio for magnesium in urine and plasma is always much greater than one and frequently is as high as 30. This would appear to indicate that tubular secretion is the main process concerned in the elimination of magnesium by the sculpin kidney.

Further work is necessary on the histological structure of the tubule of marine fish. Material has been collected to make such a study on the kidneys of the sculpin, cod, flounder and goose fish.

### B. Urine Flow and Diuresis in Marine Teleosts

A comparison of the rate of urine secretion by glomerular and aglomerular marine teleosts indicates no essential difference between these two groups (1). But, since wide variations in flow occur under experimental conditions in the same species of fish (1, 2), a careful comparison of the two groups has not been possible. There is reason to believe, however, that most of the rates of urine flow obtained on marine teleosts under experimental conditions are much higher than under normal conditions of existence (1, 2, 3). The present investigation was undertaken to determine, 1) the true rate of urine flow under normal conditions, 2) to study the factors responsible for causing the abnormal high urine flow frequently observed, and 3) to investigate the nature of the diuresis occurring under these conditions.

The sculpin (*Myoxocephalus octodecimspinosus*) was used almost exclusively in this work. This fish possesses a glomerular kidney, is quite abundant, and is quite satisfactory for experimental study.

The best criteria of a fish being normal would appear to be obtained by examining the chloride content of the blood plasma and urine. In the blood plasma of sculpins taken within a few minutes after the fish have been caught, the chloride concentration is very constant at about 150 millimols per liter and urine of such fish is uniformly quite low in chloride or chloride free. It has been possible to keep fish for some time in normal conditions by scrupulously avoiding handling or the slightest injury to the skin. In such fish the rate of urine flow is quite low, about 1-3 cc. per kilo per twenty-four hours. The concentration of total nitrogen in such "normal" urine is almost invariably much higher than in urine from diuretic fish.

One of the main factors responsible for causing the diunesis has been found to be injury to the skin whether caused by handling the fish or otherwise. Fish are very easily rendered diurctic by handling, and

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under such conditions have an increased plasma and urinary chloride concentration. Severe injury to the skin causes in a few hours almost a hundred per cent rise in plasma chloride, and a twenty-fold or greater increase in urine flow.

Urine from diuretic fish contains a much higher concentration of chloride, a smaller concentration of total nitrogen and inorganic phosphate, and about the same concentration of sulfate as "normal" urine. Preliminary work on the mechanism of skin injury in producting diuresis has been started, but no definite statements can be made at present.

1. Marshall: Amer. Journ. Physiol., 94, 1, 1930.

2. Smith: Amer. Journ. Physiol., 93, 480, 1930.

3. Marshall and Smith: Biol. Bull., 59, 135, 1930.

# 13. REPORT CONCERNING WORK AT THE MT. DESERT ISLAND BIOLOGICAL LABORATORY, JUNE 15 TO SEPTEMBER 15, 1930

## By S. O. MAST, PERCY L. JOHNSON AND C. LADD PROSSER, The Johns Hopkins University

Several closely correlated lines of investigations were carried on during the season. We shall present a few of the more important results obtained in each.

I. Locomotion and Response in Difflugia pyriformis with Special Reference to the Nature of Protoplasmic Contraction.

Difflugia pyriformis inhabits various ponds on Mt. Desert Island. We found it abundant and in excellent condition in a pond near Town Hill.

Locomotion in Difflulgia consists normally of extension of pseudopods, one after another and attachment to the substratum at the tip, tollowed by contraction which pulls the shell containing the body forward. The fleshy part of Difflugia is in structure much like an amoeba and the factors involved in the extension of pseudopods and in attachment to the substratum are essentially the same in the two forms. The contraction of the pseudopod is the outstanding distinguishing phenomenon in the process of locomotion in Difflugia and also in the process of response. This contraction is rapid and extensive and since it occurs in the simplest sort of cytoplasm, cytoplasm which has no fixed differentiation, it is of great interest.

Numerous observations on the contraction of the pseudopods in the process of locomotion and in response to mechanical stimulation, were made with the best optical equipment obtainable. It was found