13743

Studies Concerning the Site of Renin Formation in the Kidney. II. Absence of Renin in Glomerular Kidney of Marine Fish.*

MEYER FRIEDMAN, A. KAPLAN AND ELEANOR WILLIAMS.

From the Harold Brunn Institute for Cardiovascular Research, Mount Zion Hospital, San Francisco, Calif.

In an earlier study,[1] the absence of detectable renin in the aglomerular kidney of the midshipman fish (Batrachoididae, *Porichythys notatus*) and its presence in the glomerular kidney of the catfish (Ameiuridae, *Ameiurus nebulosus*) and the carp (Cyprinidae, *Cyprinus carpio*) suggested to us the possibility that the formation of renin in a kidney was dependent upon its glomerular or arterial component. The midshipman fish, however, differs from the catfish and carp in that it is a marine variety of fish, whereas the latter species exist only in fresh water. Since the tubular structure of the kidney of the fresh water fish is known to differ from that of the marine fish,[2] it was possible that the absence of renin in the kidney of the midshipman fish was due not to the absence of glomeruli, but to a difference in its tubular properties. For this reason, it was considered advisable to examine the kidneys of other marine fish which had both glomeruli and tubules, in order to determine whether the absence of renin noted in tthe kidney of the midshipman fish was due to the specific absence of a glomerular apparatus or to a type of tubular development common to the kidneys of marine fish whether glomerular or aglomerular.

In the following report, the renin content of the kidneys of 2 marine fish, the sole and cod, is compared with the amount found in the kidneys of 2 fresh water fish, the carp and catfish.

All kidneys used in the study were obtained from freshly caught fish and their renin extracted in the manner previously described.[1] In most of the experiments, the extraction of renin from the dehydrated and defatted kidney powders was carried only to the stage of a crude saline extract, although in one experiment, 35 g of cod kidney were further purified and concentrated by carrying the process to the stage of "Fraction B" of Helmer and Page.[3] The physiological assay of the extracts was performed as previously de-

* Aided by a grant from the Dazian Foundation for Medical Research.

1 Friedman, M., and Kaplan, A., *J. Exp. Med.*, 1942, **75**, 127.

2 Marshall, E. K., *Physiol. Rev.*, 1930, **14**, 133.

3 Helmer, O. M., and Page, I. H., *J. Biol. Chem.*, 1939, **127**, 757.

scribed.[1] Seven anesthetized (pentobarbital sodium) dogs were used, 2 of which had been nephrectomized 24 hours previously.

As reported before,[1] the carp and catfish kidney have numerous large and well lobulated glomeruli and tubular epithelium equipped with a brush border. An occasional concentration of agranular cells at the entrance of the arteriole into the glomerulus was seen, but there was no evidence of secretory action in these cells.

Histological examination of the kidney of the sole and the cod, employing both the hematoxylin-eosin and the Mallory's triple staining methods, revealed no striking difference in their respective tubular epithelium as compared to the tubular epithelium of either of the fresh water fish. However, the glomeruli of both the sole and the cod were about half the size of those found in the kidneys of the catfish and carp and also were considerably less numerous. This last observation previously had been recorded by Marshall and Smith.[4] The kidneys

TABLE I.
Pressor Effect of Extracts from Kidney of Various Fish.

Fish kidney extr.	Dog No.	Extr. administered (g fresh kidney)	Max. rise in blood pressure* (Mm of Hg)	Avg pressure rise per g fresh kidney in extr. (Mm of Hg)
		Cod.		
A	1	4.3	—10	0.0
A	2	10.3	+ 5	0.05
B	2	5.5	0	0.0
B	1	6.6	—15	0.0
C†	3	35.0	+ 3	0.09
Avg		12.3		0.03
		Sole.		
A	2	12.2	—10	0.0
A	3	8.1	+ 5	0.62
Avg				0.3
		Catfish.		
A	7	5.0	+20	4.0
A	8	10.0	+40	4.0
Avg		7.5		4.0
		Carp.		
A	2‡	9.9	+88	8.7
A	3‡	4.5	+30	6.6
B	5	8.0	+28	3.5
C	5	20.0	+20	1.0
D	6	8.0	+48	6.0
E	1	8.0	+24	3.0
E	1	8.0	+26	3.3
Avg		9.5		4.6

*Maximum pressure rise taken 2 to 4 minutes after injection of renal extracts.
†Extraction of kidney tissue carried to Fraction B stage.
‡Recipient dog nephrectomized (24 hours).

[4] Marshall, E. K., Jr., and Smith, H. W., *Biol. Bull.*, 1930, **59**, 135.

of the teleosts also showed an occasional concentration of agranular cells at the entrance of the arteriole into the glomerulus.

The extracts of both the carp and catfish kidney were found to contain a substance which was strongly pressor. Thus, the average rise in the pressure of dogs receiving an extract equivalent to one gram of fresh tissue was 4.6 mm of Hg for carp kidney and 4.0 mm of Hg for catfish kidney (Table I). An extract obtained from an equivalent amount of fresh hog kidney cortex effected a rise of 12 mm of Hg. Further, it was found that the pressor substance in the carp and catfish kidney had a prolonged effect, was effective in a cocainized dog, and was ineffective in a dog previously rendered tachyphylactic to hog renin. In view of these observations, it was concluded that the substance studied was renin.

In contrast to the above findings, similar assays conducted with extracts obtained from the glomerular kidneys of the cod and sole resulted in an extract which had no pressor effect upon the dog. In 5 assays of cod kidney extract, no pressor effect was observed in any of them (Table I), despite the fact that in one assay, the equivalent of 35 g of fresh cod kidney was given. Injections of 2 extracts of sole kidney, likewise failed to exert a pressor effect upon the dog.

Discussion. The apparent absence of renin in the kidneys of the cod, the sole and the midshipman,[1] as judged by the failure of their renal extracts to increase the blood pressure of nephrectomized dogs, contrasted strongly with its abundant presence in the kidneys of the fresh water fish studied. Recently, Bean,[5] too, has reported the absence of renin in the kidney of another species of marine fish, namely, the shark. Although histological examination indicated that the kidneys of the carp and catfish had glomeruli which were both larger and more numerous than those in the kidneys of the cod and sole, this observation did not necessarily explain the apparent complete absence of renin in the latter kidneys. For it was found that whereas the extract obtained from as little as 4.5 g of carp kidney raised the dog's pressure 30 mm of Hg, an extract of 35 g of cod kidney effected no significant change in the pressure of the test animal.

Summary. The absence of renin in the aglomerular kidney of the midshipman, a marine fish, cannot now be construed as suggestive evidence of the probable formation of renin by the glomerular or arterial component of a kidney because the glomerular kidneys of other marine fish studied, also lack renin. The presence of renin in the glomerular kidneys of the catfish and carp, however, suggests

[5] Bean, J. W., *Fed. Proc.*, 1942, **1**, 6.

that the kidney of most fresh water fish contains renin. Just why the kidney of marine fish, whether glomerular or aglomerular, should be devoid of detectable renin and the kidney of fresh water fish richly supplied with this same substance is a question which cannot be answered at this time. As has been noted, already, there is evidence that the tubular function in the kidneys of these two varieties of fish is probably not identical.

13744

Temperature Characteristics for Respiration in the Newt Under Chloretone and Nembutal* Anesthesia.

L. E. GORDON AND C. M. POMERAT.

From the Department of Biology, University of Alabama.

It is well known that various narcotics and anesthetics have a depressing effect upon respiration but this has not been systematically investigated as a function of temperature. Thus, while something is known of the influence of this class of drugs on the absolute respiratory rate, little information is available for changes in the relative respiratory rate.

The newt, *Triturus viridescens*, was used in the present experiments both because it is a poikilothermous animal and therefore useful for temperature analyses and because its respiration has already been investigated by means of a Warburg apparatus suitably modified for this purpose.

The minimum dose required to maintain newts immobile for 24 hours under the conditions of temperature variations was determined experimentally for two suitable drugs. After preliminary anesthesia for 15 minutes in a 1-10 dilution of a saturated aqueous solution of chloretone, animals were transferred to modified Warburg vessels containing 1 cc of a 1-20 dilution of a saturated solution of chloretone. Comparable fluid was introduced into one unit serving as a thermobarometer. Nembutal (sodium pentobarbital) produced the desired effect with an intraperitoneal injection of 0.2 cc of a 0.6% solution.

Thermal adaptation and the procedure for measuring oxygen consumption followed that described by Pomerat and Zarrow.[1]

* Supplied through the courtesy of the Abbott Laboratories.

1 Pomerat, C. M., and Zarrow, M. X., *J. Cell. and Comp. Physiol.*, 1937, **9**, 397.