TABLE 2

ANGIOTENSIN II IN DOGFISH

	Control	Experimental	Recovery
Body Weight, Kg	5.26 ± 0.27 (14)		
Arterial Blood Pressure, cm H_2O	30 ± 1 (14)	29 ± 1 (14)	27 ± 1 (14)*
Plasma Na, mEq/liter	272 ± 3 (14)	283 ± 2 (14)*	288 ± 2 (14)*
Plasma K, mEq/liter	4.2 ± 0.1 (14)	4.6 ± 0.2 (14)*	4.9 ± 0.2 (14)*
Plasma Osmolality, mOs/Kg H_2O	997 ± 7 (14)	1013 ± 6 (14)*	1016 ± 6 (14)
Glomerular Filtration, ml/hr/Kg	1.6 ± 0.3 (8)	1.5 ± 0.3 (9)	1.5 ± 0.2 (9)
Urine Flow, µl/hr/Kg	302 ± 69 (10)	260 ± 68 (12)	253 ± 63 (12)
Urine/Plasma Na Ratio	1.1 ± 0.1 (14)	1.0 ± 0.1 (14)	0.8 ± 0.1 (14)*
Na Excretion, µEq/hr/Kg	83 ± 19 (10)	72 ± 20 (12)	57 ± 17 (12)*
Urine/Plasma K Ratio	14.8 ± 2.0 (14)	16.6 ± 4.0 (14)	23.5 ± 4.5 (14)*
K Excretion, µEq/hr/Kg	20 ± 8 (10)	16 ± 7 (12)	27 ± 10 (12)*

Means ± SEMs. Numbers of observations in parentheses. *indicates $p < 0.05$, paired t test, comparing with immediately preceding clearance period. Angiotensin II was infused during the experimental period (average dose, 23 ± 2 ng/min/Kg body weight; range, 15 - 36 ng/min/Kg body weight).

EFFECTS OF SARALASIN IN *Lophius americanus*

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INTRODUCTION. We have reported on the effects of exogenous angiotensin II in goosefish (Bull. Mt. Desert Island Biol. Lab. 16:5-8, 1976). Following a control clearance period, angiotensin was infused intravenously at rates ranging from 10-100 ng/min/Kg body weight. We observed diuresis, natriuresis, and pressor effects directly related to administered dose in all fish studied. Urine flow, Na excretion, and arterial blood pressure returned to control levels shortly after discontinuing the infusions.

The experiments described below were designed to elucidate the roles, if any, of endogenous angiotensin II in goosefish. Following a control period during which mean arterial blood pressure and various renal functions were measured, a competitive inhibitor of angiotensin II (P-113, Saralasin, 1-Sar-8-Ala-angiotensin II) was infused intravenously and the measurements were repeated. A recovery clearance period was not done since the half-life of Saralasin is relatively long. Instead, a second group--infused with 150 mM NaCl only--was studied to control for possible effects of time on the various parameters.

METHODS. Goosefish were kept in live cars until used, usually the day after capture. The fish were restrained in tanks filled with rapidly running sea water. A small ventral incision was made in an area previously infiltrated with Lidocaine. Both ureters, a hepatic vein, and a celiac artery were catheterized with polyethylene tubing. The arterial catheter was attached to a U-tube manometer which was filled with 150 mM NaCl, and blood pressure was recorded at 5-10 minute intervals throughout the experiments. An intravenous infusion was begun (150 mM NaCl at 0.1083 ml/min) and approximately 60 minutes later, the control clearance period was begun. The usual duration of this period was 60 minutes. Following this, Saralasin was added to the infusate (average rate of administration was 231 ± 15 ng/min/Kg body weight) and approximately 30 minutes later, the first of 2 consecutive experimental clearance periods was begun.

RESULTS. Our observations are summarized in Tables 1 (Control) and 2 (Saralasin). Because of the small supply of Saralasin the large fish were used as controls. In this group, body weight averaged 9.5 ± 2 Kg.

TABLE 1

CONTROL GOOSEFISH

	Control Period	p	Control Period
Body Weight, Kg	9.5 ± 2		
Arterial Blood Pressure, cm H_2O	25.3 ± 1.2	NS	22.7 ± 0.9
Plasma Na, mEq/liter	181 ± 2	NS	185 ± 2
Plasma K, mEq/liter	3.8 ± 0.2	NS	4.8 ± 1.1
Plasma Osmolality, mOs/Kg H_2O	364 ± 6	NS	365 ± 5
Urine Flow, µl/hr/Kg	639 ± 94	NS	546 ± 78
Urine/Plasma Na Ratio	0.36 ± 0.02	NS	0.41 ± 0.03
Na Excretion, µEq/hr/Kg	36.8 ± 3.6	NS	37.5 ± 2.6
Urine/Plasma K Ratio	0.51 ± 0.08	NS	0.52 ± 0.14
K Excretion, µEq/hr/Kg	0.91 ± 0.12	NS	0.96 ± 0.20

Means ± SEMs. N = 3 and 6 for blood (plasma) and urine parameters, respectively. Urine flow, and Na and K excretion rates are per kidney. P value from paired t test. NS, $>p$ 0.05.

TABLE 2

EFFECTS OF P-113 ON GOOSEFISH

	Control Period	p	Experimental Period
Body Weight, Kg	3.76 ± 1.18		
Arterial Blood Pressure, cm H_2O	26.5 ± 1.1	NS	24.8 ± 1.3
Plasma Na, mEq/liter	177 ± 8	NS	181 ± 8
Plasma K, mEq/liter	3.7 ± 0.6	NS	3.4 ± 0.2
Plasma Osmolality, mOs/Kg H_2O	371 ± 10	NS	374 ± 9
Urine Flow, µl/hr/Kg	661 ± 38	$<$0.002	495 ± 68
Urine/Plasma Na Ratio	0.33 ± 0.02	$<$0.002	0.45 ± 0.04
Na Excretion, µEq/hr/Kg	40.1 ± 4.4	NS	37.6 ± 5.6
Urine/Plasma K Ratio	0.37 ± 0.06	NS	0.41 ± 0.08
K Excretion, µEq/hr/Kg	0.80 ± 0.13	$<$0.008	0.57 ± 0.13

Means ± SEMs. N = 6 and 12 for blood and urine parameters respectively. Urine flow, and Na and K excretion rates are per kidney. P value from paired t test. NS, $p>$ 0.05. Saralasin was infused during the experimental period (231 ± 15 ng/min/kg body weight).

All parameters measured in the controls were relatively constant over time; no value during the second and third periods differed significantly from the corresponding value during the first ($p > 0.05$).

It can be seen by comparing the first columns in Tables 1 and 2 that both groups were comparable during the first clearance. The Saralasin infusion significantly decreased urine flow without affecting plasma osmolality and Na and K concentrations. Na excretion tended to decrease, but not significantly; the decrease in urine flow was counteracted by an increase in urinary Na concentration (the ratio urine/plasma Na increased but plasma Na was unaffected). In contrast, the ratio urine/plasma K concentration was not significantly increased, and this coupled with no significant change in plasma K, but a significant decrease in urine flow, resulted in a significant decrease in K excretion. Arterial blood pressure was unaffected.

DISCUSSION. Taken together with the observations made previously, our present results argue in favor of a direct renal effect of angiotensin II in goosefish. That is, angiotensin II administration resulted in a diuresis and administration of a competitive inhibitor of angiotensin II resulted in antidiuresis. In both cases changes in Na and K excretion rates tended to parallel the changes in urine flow, but the changes were not always significant. Changes in excretion rates cannot be ascribed to changes in blood pressure because although angiotensin II increased blood pressure (and urine flow), Saralasin decreased urine flow without affecting blood pressure.

Although there are many reports that exogenous angiotensin II produces diuresis in mammals (Ann. Rev. Pharmacol. 13:57-90, 1973 for several references) our results are the only indication that endogenous angiotensin, at normal levels, may have direct renal effects.

Our results are consistent with published reports that angiotensin II exerts a direct action on Na transport in the kidney (Am. J. Physiol. 212:1153-1157 [1967], Am. J. Physiol. 232:F298-F306 [1977]) and intestine (J. Physiol. 206:323-333 [1970], Am. J. Physiol. 224:1223-1228 [1973]). Because of the poor understanding of the mechanism by which urine is formed by the aglomerular fish, it is difficult to decide the precise mechanism of action of angiotensin II in this animal. It could stimulate entry of water and solute into, or inhibit reabsorption of water and solute from, the aglomerular tubules.

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THE EFFECTS OF SODIUM PENTOBARBITAL ON HEMODYNAMICS AND RESPIRATION IN *S. acanthias*

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The effect of anesthetic agents during long term experimental procedures in poikilotherms is not well documented. In studies involving extensive surgery, the anesthetic most often used for fish has been MS-222 (tricaine methanesulfonate). The data of Stenger and Maren (Bull. MDIBL 7:51-55, 1967) and Peirce et al. (Bull. MDIBL 7:45-47, 1967) show this drug to be ineffective when given intravascularly and deleterious to the fish because of progressive depressant effects on cardiac output when added to the sea water. It is unsuitable for use in cardiovascular research. Sodium pentobarbital has also been used in poikilotherms. In the present study the effects of varying intravascular doses of sodium pentobarbital on the cardiovascular and respiratory systems of the dogfish are characterized.

Twenty male dogfish (1-2 Kg) were allowed to free-swim in a 0.3 M^3 tank supplied with running sea water. After a control period of at least one hour either saline (5 fish) or sodium pentobarbital (15 fish) were administered in the caudal artery. Doses of pentobarbital ranged from 2 to 164 mg/Kg. Opercular rate was counted visually at 10 minute intervals during the control period and for 4 hours following injection. From these data a dose-response curve was constructed.

A second group of 7 dogfish were prepared for recording hemodynamic parameters as described earlier (Bull. MDIBL 16:66-69, 1976). Arterial and venous blood samples were taken before and after sequential doses of sodium pentobarbital (3 mg/Kg, 9 mg/Kg, 30 mg/Kg) and were analyzed for hematocrit, PO_2 and pH (see