

Citation:

Buytendijk, F.J.J., On the constitution of the urine of sharks with normal and increased diuresis, in: KNAW, Proceedings, 12, 1909-1910, Amsterdam, 1910, pp. 380-383

These experiments prove :

a. The osmotic pressure of the blood serum sometimes remains the same after loss of blood, but generally sinks a little.

b. The percentage of albumen is diminished (as is seen from exp. I with the small loss of blood and from the change in resistance in exp. IV and II).

c. The resistance is diminished by bleeding.

d. The ash percentage of the serum increases; since the osmotic pressure remains unchanged or sinks, this means that :

e. the urea percentage of the blood serum decreases after loss of blood, but does not sink below 1.967 % when the albumen had been precipitated by means of asaprol, or below 1.64% when HOFMEISTER'S method had been applied.

Moreover I could state that the blood of animals that had suffered a severe loss of blood, (exp. IV and II) coagulated much more quickly than normally. This phenomenon has also been stated with mammals after bleeding¹⁾.

I think we are justified to conclude that after loss of blood the serum of sharks is diluted by a liquid which is richer in salt and less rich in urea. Perhaps this liquid is salt water from the sea, perhaps lymph which is in its turn supplemented by sea water; but at all events, even after the severest loss of blood a rather high percentage of urea remained in the serum. It seems that this serum is supplied by the liver. In exp. IV after bleeding the liver was extirpated and the urea percentage determined. I found it to be 1.16 %, while SCHROEDER gives 1.36 %.

Physiology. — “*On the constitution of the urine of sharks with normal and increased diuresis.*” Bij Mr. F. J. J. BUIJTENDIJK.
(Communicated by Prof. H. ZWAARDEMAKER).

(Communicated in the meeting of September 25, 1909).

The urine of sharks, as is the case with most cold-blooded animals, has a lower osmotic pressure than the blood serum. Also in man, the urine is under certain conditions more diluted than the serum; in some cases of human polyuria, namely, the blood was found to be of normal concentration ($\Delta = -0.56^\circ$), the urine on the other hand to be very much diluted ($\Delta = -0.22^\circ$ to -0.17° C.). METZNER²⁾

¹⁾ VON DEN VELDEN, Arch. f. exper. Path. u. Pharm. 1909.

²⁾ METZNER, Nagels Handbuch der Physiol. II, Bd, 1e H.

says, that this polyuria is probably caused by "eine Schädigung der Wasserresorption, indes die Resorption gelöster Bestandteile vor sich geht." With the fishes mentioned, and with amphibia this explanation might also assist us to understand the relation of the constituents of the urine and of the blood serum. It was important to know to what extent this retro-resorption did not take place with a quicker flow of urine, thus causing the constitution of the urine to become more and more equal to that of the albumen-free blood serum.

The urine of big specimens of *Scyllium canicula* was collected by a method which is usually applied in the Zoological Station at Naples. By a special shape of the canule it was possible to collect the urine of female animals. This made it certain that no sperm or mucus came into the urine, which accordingly was always clear and free from albumen in the experiments.

After a small part of the urine had been tested for albumen, the freezing point and the resistance were determined and then the percentage of nitrogen was determined by KJEHLDAHL's method. From the values found the urea concentration was calculated. Since diuretics have no effect on sharks I tried to increase the secretion of urine by the "piqûre". After urine had been collected for one or two days, I took the experimental animals from the aquarium for a moment and pricked them with a two-edged lancet in the medulla in the region of the posterior edges of the eye-sockets in the median line. Examination of dead animals proved that the vulneration had affected the lower part of the fourth ventricle or somewhat more towards the tail the medulla. In the most successful experiments the wound was on both sides and the greater part of the dorsal half of the medulla had been cut.

Put back into the aquarium immediately after being wounded the shark swam about in a somewhat restless and uncoordinated manner, besides a slight acceleration of respiration generally existed. These phenomena disappeared after 10—30 minutes; the animal could then in no way be distinguished from the healthy ones.

In the following table, containing a summary of the results of the experiments, Δ means the freezing point, R the resistance, U the percentage of urea, while "prick" means that the animal was wounded in the above mentioned manner.

These experiments show:

a. The urine of *Scyllium canicula* has normally a smaller osmotic pressure than the blood serum. This is caused by the considerable difference between the percentage of urea of the serum and of the urine.

TABLE

	Time in hours	Quantity cc	$\Delta^{\circ} C$	R at 25.1° Ω	U %
experiment I					
urine	48	11	2.241	19.48	0.428
experiment II					
urine	48	10	2.206	20.19	0.38
blood serum	—	—	2.331	34.35	2.18
experiment III					
urine	48	13	2.162	25.48 (at 14°)	0.377
"prick"					
urine	24	10	—	—	—
"	48	25	2.306	26.6 (at 14°)	1.566
"	48	20	2.266	27.2 (at 14°)	1.392
blood serum	—	—	2.326	44.9 (14°)	2.02
experiment IV					
urine	48	9	2.186	20.21	0.48
"prick"					
urine	3	5	—	—	—
"	25	40	2.291	23.4	1.8705
blood serum	—	—	2.316	36.412	2.28
experiment V					
urine	48	8	2.251	20.23	0.712
"prick"					
urine	3	10	—	—	—
"	24	25	2.281	?	2.494
blood serum	—	—	2.336	34.7	2.61
experiment VI					
urine	48	13	2.226	21.608	?
"prick"					
urine	24	15	2.246	22.83	2.03
blood serum	—	—	2.291	36.4	2.33

b. By the described vulneration of the medulla the secretion of urea rose to about double or more.

c. Sugar could never be detected in the urine after the "prick".

d. The osmotic pressure of the urine rises with increased diuresis and hence approaches that of the blood serum.

e. The resistance of the urine for the electric current is increased with stronger diuresis.

f. From d and e it may already be surmised that the percentage of urea has risen with the diuresis. This is confirmed by the experiments. The percentage of urea rose to 3—5 times its original value.

If the filtration theory be true, then, as STARLING says: "Mit wachsender Absonderungsgeschwindigkeit (muss) ceteris paribus Beschaffenheit des Harns nach Zusammensetzung, Reaktion und osmotischem Druck immer mehr der des Blutserums minus Eiweisz sich nähern¹⁾."

The experiments here described afford in my opinion an unexpected confirmation of the accuracy of STARLING's thesis and so a probability for the accuracy of LUDWIG's explanation of the secretion of the kidneys.

Mathematics. — "*On the stable positions of equilibrium of floating parallelepiped.*" By Dr. P. BRANDSEN. (Communicated by Prof. D. J. KORTEWEG.

(Communicated in the meeting of October 30, 1909).

1. In the following paper will be communicated in short something about the stable conditions of equilibrium of floating homogeneous parallelepiped.

Resting on the principle of LEJEUNE-DIRICHLET: "the position in which the potential energy is minimal is a stable position of equilibrium," we shall have to find positions where the common centre of gravity of the floating solid and the liquid is as low as possible.

From this (see APPELL, *Traité de mécanique rationnelle*, T. III, 1903, p. 180—218) the following construction indicated by DUPIN, can be deduced.

To find the position of equilibrium of a solid we have to determine a surface (G) which is the locus in the solid of the centres of gravity of the volumes of liquid, by the immersed parts according to the law of ARCHIMEDES (which centres of gravity coincide for a

¹⁾ Quoted from METZNER (l. c.) p. 242.