When interpreting these figures we must take into account that the average I found for five groups of adult skulls was: 44.6, 44.7, 45.7, 46.6 and 47.9. If we compare with these figures the values found for the skulls of children, it is seen at once that in man as well as in the anthropoid apes the foramen magnum is shifted occipitally during development. If the number in each group of infantile skulls were more numerous one would sooner feel inclined to draw the conclusion from the averages found that this shifting begins with the eighth year, about simultaneously with the changing of teeth.

Having learnt how to express numerically the position and displacement of the foramen magnum in the Primates, we may now continue our investigation with the determination of the variations of the inclination of the plane of this aperture. This will form the subject of the following communication.

Physiology. — "*On the changes in the blood serum of sharks after bleeding.*" By Mr. F. J. J. Buijtendijk. (Communicated by Prof. H. Zwaardemaker).

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

The blood serum of sharks has an osmotic pressure about equal to that of the salt water in which they live and which varies as the concentration of the salts of the sea or aquarium is changed (Rodier [1]) Botazzi [2])).

This osmotic pressure, measured by the lowering of the freezing point of the serum, is partly caused by the salts, dissolved in the blood liquid and for the rest by the urea which is present in high concentration in the body liquids of these Selachians. Schroeder [3]) found in the blood of Scyllium with large freshly caught animals 2—3 °/₀ urea, which figures have been confirmed by other investigators (Baglioni) [4]).

In relation with my investigations on the diuresis of sharks I put myself the question whether perhaps the blood serum would after

1) Rodier, Travaux de la Station Zoölog. Arcachon 1899 p. 103.

2) Botazzi, Ergebnisse de Physiologie 1908.

3) v. Schroeder, Zeitschr. f. physiol. Chemie 14 p. 5 75, 1890.

4) Baglioni, Hofmeisters Beiträge 9 p. 50.

repeated bleeding contain considerably less urea, than is normally the case.

From the dorsal artery of the animals, with which I experimented, the blood was collected, from which after defibrination with glass beads the blood serum was obtained by centrifugation. Only then the resistance and the freezing point were determined by the usual methods. Part of the serum was then tested for its percentage of urea. This was done by determining by KJEHLDAHL's method the N-percentage after the albumen had been removed. From an oral communication of Dr. BURIAN I knew that in albumen-free blood serum and in the urine of Scyllium no other N-compounds than urea are present in measurable quantities.

The albumen was precipitated a few times by HOFMEISTER's method, in which sodium acetate and ferric chloride are added to the liquid and then a precipitate is formed by heating with a little sodium carbonate. The filtrate was absolutely clear and free from albumen. The value obtained in this way for the percentage of urea was smaller, however, than when the albumen was precipitated cold by alcohol and acid or according to BAGLIONI by a hydrochloric solution of asaprol.

Many times the ash percentage of the serum was tested by turning all the salts into sulphates by means of nitric and sulphuric acid and weighing. It is clear that a comparison of the lowering of the freezing point and the ash percentage indirectly gives an idea of the urea concentration of the serum.

In the same way the ash percentage and resistance give an idea of the quantity of albumen, since with equal quantities of dissolved salt the electric resistance of the liquid can only change by varying the quantity of non-electrolytes (colloids).

In the following summary of the experiments Δ means the freezing point, always determined in the same way with a bath temperature of $-5°$ to -6, an undercooling of $-0.5°$, while the stirring rod moved up and down about twice per second. The freezing was induced by inoculating with a splinter of ice.

R is the resistance expressed in Ω, determined according to KOHLRAUSCH's method and calculated by means of OBACHTS' tables. U is the percentage of urea (behind the figure is indicated by H or A whether the albumen was precipitated by HOFMEISTER's method or by asaprol), S is the salt concentration expressed as sulphates, A the albumen.

EXPERIMENT I.

Scyllium canicula ? kilogr., in the aquarium since three days.
Blood serum (14 cc.).

$\Delta = -2.296^\circ$ $R = 37.584\ \Omega$ at 25.4° $A = 5.5\ ^0/_0$ $S = 2.019\ ^0/_0$

after 24 hours the animal is killed, serum quite clear.

$\Delta = -2.271^\circ$ $R = 37.148\ \Omega$ at 25.3° $A = 4.13\ ^0/_0$ $S = 2.18\ ^0/_0$

EXPERIMENT II.

Scyllium canicula; 2 kilogr., having had no food for 4 days.
Blood serum (25 cc.).

$\Delta = -2.336^\circ$ $R = 34.301\ \Omega$ at $25{,}3^\circ$

after 24 hours 25 cc. of blood serum is obtained.

$\Delta = -2.326^\circ$ $R = 33.2268\ \Omega$ at 25.2°

blood serum obtained after 24 hours.

$= -2.291^\circ$ $R = 27.309\ \Omega$ at 25.3°.

EXPERIMENT III.

Scyllium canicula; 2.3 kilogr.
Blood serum (30 cc).

$\Delta = -2.316^\circ$ $R = 32.459\ \Omega$ at 25.1° $S = 2.27\ ^0/_0$

animal killed after 24 hours, the blood serum is

$\Delta = -2\ 311^\circ$ $R = 31.01\ \Omega$ at 25.1° $S = 2.438\ ^0/_0$

EXPERIMENT IV.

Scyllium canicula; 2.5 kilogr.
Blood serum (25 cc.); $U = 2.07\ ^0/_0\ (H)$

$\Delta = -2.326^\circ$ $R = 37.25\ \Omega$ at 25.1° $U = 2.32\ ^0/_0\ (A)$

after 24 hours, blood serum (30 cc).

$\Delta = -2.336^\circ$ $R = 35.68\ \Omega$ at 25.1° $U = 2.26\ ^0/_0\ (A)$

after 24 hours; blood serum (20 cc).

$\Delta = -2.326^\circ$ $R = 34.0178\ \Omega$ at 25.1° $U = 2.146\ ^0/_0\ (A)$

after 24 hours, animal killed; blood serum

$\Delta = -2.301^\circ$ $R = 31.029\ \Omega$ at 25.1° $U = 1.967\ ^0/_0\ (A)$
$U = 1.64\ ^0/_0\ (H)$

EXPERIMENT V.

Scyllium canicula; 1.5 kilogr., in the aquarium since two days.
Blood serum (30 cc).

$\Delta = -2.331^\circ$ $R = 35.4035\ \Omega$ at 25.2° $S = 2.06\ ^0/_0$ $U = 2.9\ ^0/_0\ (A)$

killed after 24 hours; blood serum

$\Delta = -2.296^\circ$ $R = 30.975\ \Omega$ at 25.1° $S = 2.503\ ^0/_0$ $U = 2.33\ ^0/_0\ (A)$

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 bleeding [1]).

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 ($\Delta = -0.56°$), the urine on the other hand to be very much diluted ($\Delta = -0.22°$ to $-0.17°$ C.). METZNER [2])

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

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