A NOTE ON THE OSMOTIC PRESSURE OF THE BLOOD OF VARIOUS ANIMALS

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(With One Text-figure)

THE experiments described below were undertaken originally in conjunction with Dr Dacie of King's College Hospital in an attempt to determine whether a relation exists between the osmotic pressure and the "fragility" of blood corpuscles. It was found, however, that the osmotic pressure differences hardly accounted for the fragility differences, and the experiments were continued on the osmotic pressure alone.

Baldes's (1934) modification of A. V. Hill's (1930) vapour-pressure method was used. The thermocouples had very small loops and were constructed by Mr J. L. Parkinson of 47 s.w.g. (51μ) constantan and manganin wires. The wires were brazed together under a stereoscopic microscope and wound on a former to shape the loops. The couple was then insulated by coating with "Trolitrul" dissolved in benzole, each layer being allowed to dry before applying the next. After removal from the former, two or three coatings of air-drying bakelite varnish ("yacht varnish") were applied and allowed to harden thoroughly under a lamp before the couple was used.

The galvanometer was a highly sensitive moving-coil instrument (Zernicke Zc) read at a distance of about three metres.

A drop of blood was placed in one loop, and a drop of the standard solution (1 % NaCl) in the other, by means of very fine pipettes which passed through the corks of the fluid containers. This operation was carried out in a damp chamber to prevent evaporation. The loops were immediately covered with a tube lined with filter paper soaked in the standard solution. The whole was then placed in a large water thermostat for 10 min. to settle down. In the first 5 min. a mixture of 5 % CO_2 in oxygen was passed slowly through. The difference of vapour pressure between blood and standard was calculated from the readings by calibrating the couples with the known difference between two solutions. Three thermocouples were used and double determinations were made with each; i.e. the blood was placed first in one loop and then in the other, and the mean taken, to eliminate errors due to lack of symmetry.

Great precautions were taken in drawing the blood from the animal, for exertion considerably raises the osmotic pressure (Margaria, 1930). In the case of mammals the blood was drawn from a vein in the neck with the animal as passive as possible, not having been chased and not struggling to get free. Blood from slaughter houses would be useless. Birds were wrapped in a cloth and kept quite quiet while the blood was drawn from a vessel under the wing. With tortoises the head was cut off suddenly and the blood collected immediately. In all cases about 1 c.c. of blood was used and 0·2 mg. of heparin was added to prevent clotting. Special experiments showed that this amount of heparin has no effect on the osmotic pressure.

The osmotic pressures are given in terms of the equivalent percentage of NaCl (g. NaCl in 100 g. H_2O).

Table I. *Osmotic pressures of blood exposed to* 5 % CO_2 *in* O_2: *expressed in equivalent concentrations of* NaCl (*g. per* 100 *g.* H_2O)

Sheep	Six animals:	0·988, 0·971, 0·972, 0·974, 0·973, 0·988 Mean **0·978**
Goat	Five animals:	0·943, 0·957, 0·962, 0·958, 0·955 Mean **0·955**
Horse	Six animals:	0·900, 0·930, 0·922, 0·943, 0·926, 0·940 Mean **0·927**
Cattle	Eight animals:	0·858, 0·950, 0·952, 0·933, 0·921, 0·951, 0·921, 0·923 Mean (neglecting 0·858) **0·936**
Dog	Nine animals:	0·900, 0·947, 0·947, 0·965, 0·928, 0·938, 0·918, 0·931, 0·918 Mean **0·933**
Man (Margaria, 1930, for comparison):		Men **0·945** Women **0·927**
Pigeon	Six birds:	0·980, 1·002, 1·020, 1·025, 0·996, 0·999 Mean **1·004**
Hen	Six birds:	0·992, 1·000, 1·080, 0·997, 1·085, 0·994 Mean **1·025**
Tortoise	Seven animals:	0·808, 1·161, 0·991, 1·010, 1·024, 0·902, 0·805 Mean **0·957**
Frog (Hill & Kupalov, 1930, for comparison, but without CO_2):		
	Eleven animals:	0·762, 0·721, 0·723, 0·733, 0·784, 0·715, 0·739, 0·783, 0·705, 0·686, 0·688 Mean **0·731**

The results of the measurements on fifty-three animals are given in Table I. The average deviation from their mean of the readings on one individual was about 0·012, so the probable error of each value in the table is about 0·005. The variations, therefore, between the different animals of each species are most probably genuine and not to be attributed to errors of observation. The values are shown graphically in Fig. 1. All the values for sheep are higher than any value for goat. The values for horse, cattle and dog are not significantly different and are close to Margaria's (1930) values for man. The values for pigeon and hen are about the same as one another and considerably higher than for any mammal except sheep.

The values for tortoise are so widely scattered that the mean has little significance.

The first four animals were obtained from a shop, and it was thought that the large variations observed might be due to the conditions under which they had been kept. As shipped to this country they are without food and water and they are frequently kept at the dealers still without water. The last three animals were obtained by the kindness of the Zoology Department of University College. These had been kept for some weeks with plenty of green food and water, but they gave large variations

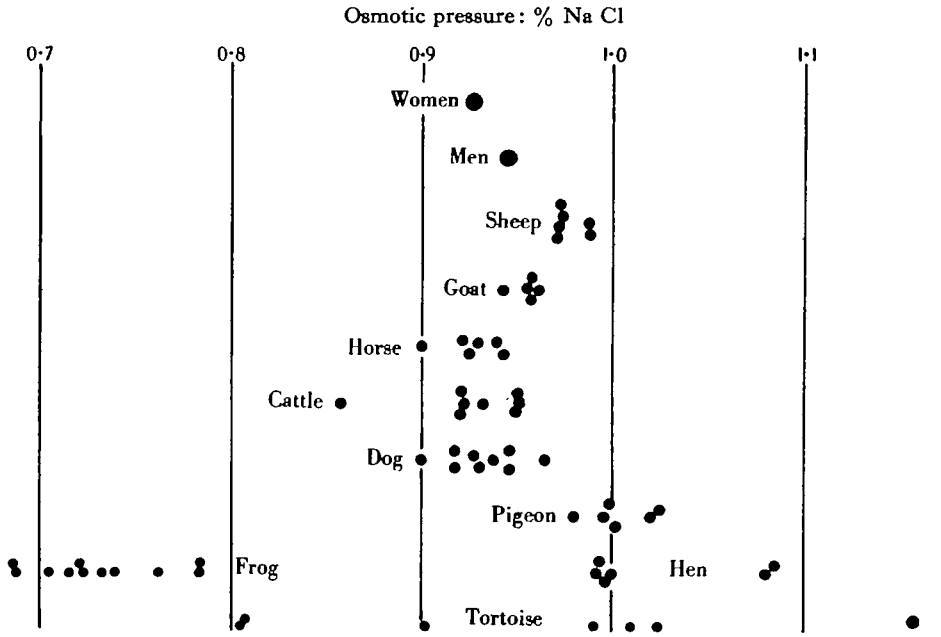

Fig. 1.

still, indeed the highest and the lowest of the seven. No simple explanation, therefore, can be given of the inconsistency, but it is very striking. The values for tortoise are far higher and far more variable than those for frog: indeed Hill and Kupalov's (1930) values for frog are nearly as consistent as those of the mammals and birds in the present series.

I must thank Prof. A. V. Hill for his advice and interest and Mr J. L. Parkinson for his help and for constructing, insulating and testing the thermocouples. I am indebted to the Royal Veterinary College where I obtained most of the blood samples.

SUMMARY

The osmotic pressures have been measured, using the vapour-pressure method, of the blood of six animals and two birds, sheep, goat, horse, cattle, dog, tortoise, pigeon, hen. Precautions were taken to avoid the rise of osmotic pressure due to struggling or movement.

The mean value for sheep is appreciably higher, and that for goats slightly higher than for other mammals. Apart from sheep, the mammals have nearly the same value as man. The birds have a considerably higher value. In tortoises the value is very variable (0·80 to 1·16) and much higher than in frogs (0·73).

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