

## BIOCHEMISTRY AND BIOPHYSICS

### THE MECHANISM OF RETENTION OF AN INDIFFERENT GAS IN A STATE OF SUPERSATURATION

#### COMMUNICATION II. THE EFFECT OF CERTAIN HORMONES ON THE DEGREE OF PERMISSIBLE SUPERSATURATION AND ON THE ASSOCIATED BIOPHYSICAL AND BIOCHEMICAL INDICES

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It was shown in a previous communication [3] that the degree of permissible supersaturation (DPS) of the body with nitrogen has a statistically significant connection with the composition of the serum proteins, and is less closely connected with the hydrophilia of the skin.

There are reports in the literature of possible changes in susceptibility to decompression sickness. The causes of these changes are not yet fully understood. It may be postulated from certain findings [9, 10] that the general intensity of the metabolism plays a part of definite importance here. The state of the central nervous system is probably important also [1, 5, 10].

The object of our research was to produce changes in the DPS by using some form of agent affecting metabolism and at the same time influencing the activity of the nervous system. From our previous findings, it was necessary to select an agent which, so far as we knew, would alter both the composition of the blood proteins and the water balance of the body.

We decided to use the hormone of the thyroid gland and of the adrenal cortex. The function of these glands of internal secretion is connected on the one hand with the regulation of protein and water-salt metabolism [1, 4, 7, 12], and, on the other hand, it affects the central nervous system [2, 6, 8].

#### EXPERIMENTAL METHOD

The individual (basal) DPS of dogs was determined over a period of several days, after which one or another hormone preparation was given. When clear signs of action of the preparation were apparent, the DPS was again estimated. Parallel investigations were made of the indices of the general condition of the animals and of the biophysical and biochemical properties of the blood, and the hydrophilia of the skin was tested. In the blood, the relative volume of the cells, the total plasma protein concentration and serum protein concentration, and the albumin and globulin concentrations were determined. The zinc sulfate precipitation test was used for qualitative differentiation of the proteins.

The method of determination of the DPS and of the other indices was described in the first communication.

For studying the effect of the thyroid gland on the DPS, a standard thyroidin preparation and methylthiouracil were used. Thyroidin was given by mouth, in a dose of 0.6 mg/kg body weight/day. Methylthiouracil was also given by mouth, in a dose of 40 mg/kg body weight. The total daily dose of each preparation was divided into two halves which were given separately.

Of the preparations of adrenal cortical hormone, the only one used in the experiments was desoxycorticosterone acetate. So that the desoxycorticosterone should have an appreciable effect on the protein as well as the water-salt metabolism, a large dose was given — 1 mg/kg body weight/day. The preparation was given intramuscularly in the form of a 0.5% oily solution. The dogs were given water as desired.

## EXPERIMENTAL RESULTS

The first series of experiments was carried out with thyroidin. Both experimental dogs developed the typical picture of hyperfunction of the thyroid gland on the 9-10th day. The body weight fell by 1.5-2.0 kg and the temperature to 39.5-39.6°, and the pulse rate rose by 50-65%. Dryness of the skin, dyspnea and polydipsia appeared. The ESR was raised to 10-35 mm in 1 hour.

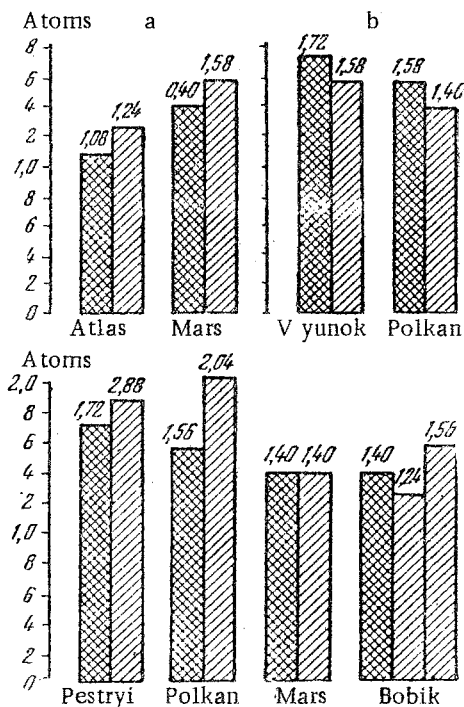


Fig. 1. The effect of thyroidin (a) methylthiouracil (b) and desoxycorticosterone (c) on the DPS. The cross-shaded columns indicate the initial value of the DPS characteristic of each dog.

Determination of the DPS at this period showed that in both dogs it was raised by 0.16 atmos (Fig. 1, a). At the same time, several changes were observed in the blood proteins. The total concentration of the plasma and serum proteins was slightly decreased. The albumin concentration was raised and that of the globulins lowered. There was a corresponding rise in the albumin-globulin ratio (Fig. 2, a). The relative corpuscular volume remained practically unchanged. Thyroidin had a definite action on the hydrophilia of the skin: the time taken for a vesicle of physiological saline to absorb was considerably shortened (Fig. 3, a).

In the second series of experiments, methylthiouracil was given to two dogs. Suppression of thyroid gland function became evident at the end of the third week of administration of the drug. This effect was clearly shown by a fall in the pulse rate of 15-20%. Only one dog — V'yunok — showed an increase in body weight. The DPS of the dogs fell by 0.16 atmos (Fig. 1, b). The blood showed a tendency for the total concentration of the plasma and serum proteins to rise, and changes occurred in the composition of the protein fractions. A biphasic change took place in the albumin and globulin concentrations: the albumin-globulin ratio at first rose and then began to fall, and, in the case of V'yunok, it fell below the initial level (Fig. 2, b). The corpuscular volume remained unchanged. V'yunok showed no alteration in hydrophilia of the skin, and, in Polkan, a biphasic variation was observed (Fig. 3, b).

In the third series of experiments, the effect of desoxycorticosterone acetate (DOCA) on the DPS was studied.

We know from the literature [11] that with daily injections of the doses which we used, maximum changes appear in dogs on the 10-11th day. We therefore began to determine the various indices on the 8-9th day. At this time, a small reduction in the pulse rate was observed in all 4 experimental dogs (by 10-15%).

In one dog (Mars), the DPS remained unchanged, whereas in the remaining dogs it was increased, and in the dog Bobik the variation was biphasic in character (Fig. 1, c).

Desoxycorticosterone produced no perceptible change in the total protein concentration. The albumin-globulin ratio increased in all cases (Fig. 2, c). In the zinc sulfate test, a reduction in the turbidity by 15-25% was observed, which indicated a fall in the  $\gamma$ -globulin concentration. No obvious changes appeared in the relative volume of plasma and corpuscles. The hydrophilia of the skin was changed differently in the different dogs (Fig. 3, c).

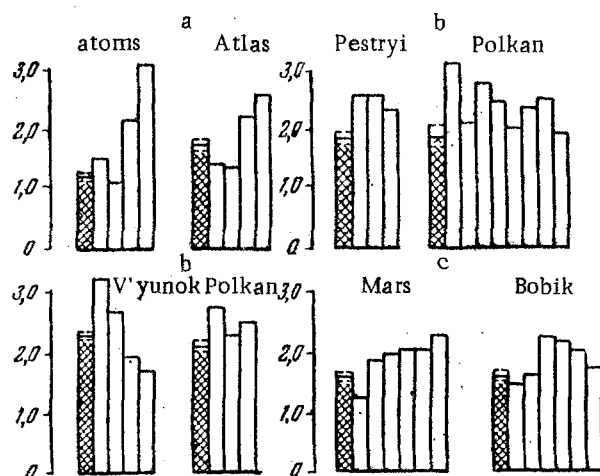


Fig. 2. The effect of thyroidin (a), methylthiouracil (b) and desoxycorticosterone acetate (c) on the albumin-globulin ratio. The shaded columns give the initial values of the albumin-globulin ratio.

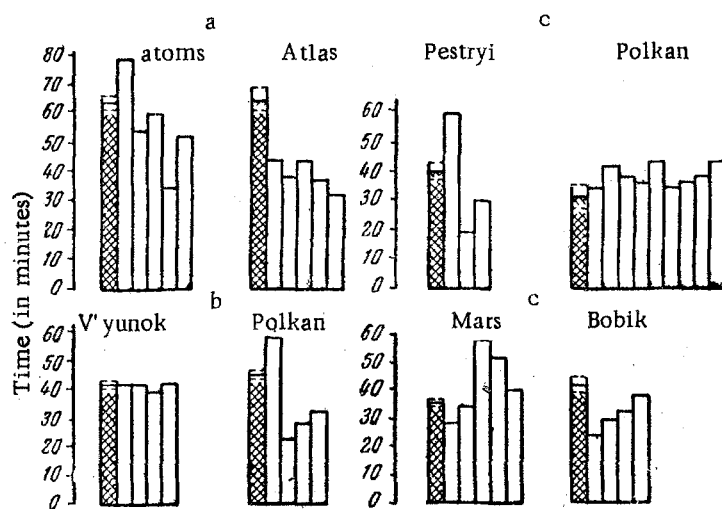


Fig. 3. The effect of thyroidin (a), methylthiouracil (b) and desoxycorticosterone acetate (c) on the rate of absorption of physiological saline injected intradermally. Legend as in Fig. 2.

The results described were evidence of the existence of hormonal influences on the DPS. Under these circumstances, an increase in thyroid gland function caused a rise in the DPS, and a decrease in this function, to a fall in the DPS. Administration of an excessive dose of adrenal cortical hormone in the form of desoxycorticosterone, as a rule, increased the animal's power to retain nitrogen in a state of supersaturation.

The present experiments afford some confirmation of our previous observations that the DPS is connected with the qualitative features of the serum proteins of the blood. So far as the connection between the DPS and water metabolism is concerned, the results obtained are not sufficiently definite in this respect.

## SUMMARY

It was established in experiments on dogs that the hormones of the thyroid gland and of adrenal cortex may influence the value of the admissible nitrogen oversaturation of the body.

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