CONTENT OF AMMONIA, GLUTAMINE, AND UREA IN BRAIN TISSUES OF SUSLIKS DURING HIBERNATION

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The ammonia content in the cerebral hemispheres and cerebellum of small susliks increases after the onset of hibernation, while the urea content decreases. The content of glutamine was increased after the second day of hibernation.

Artificial cooling of the warm-blooded animal sharply disturbs the nitrogen metabolism of the brain [1-4]. In rats adapted to cold, the ammonia content in the brain is increased [8, 9]. Hypothermia in such animals is characterized by a further increase in the ammonia concentration in the brain tissue. During hibernation (body temperature 17-16 and 11-10°) the ammonia concentration in the brain also is increased [7]. The content of glutamine [7] and urea in the brain of these animals also varied depending on their body temperature. Accumulation of ammonia in the brain at a low body temperature can be considered to be of adaptive significance.

In the present investigation the dynamics of the concentrations of ammonia and of glutamine and urea, which are connected with its metabolism, was investigated in relation to the period of hibernation.

EXPERIMENTAL

Experiments were carried out on small susliks (Citellus pygmaeus Pallus), caught in the field (Dagestan) in May, 1968.

The animals were kept in an animal house until the beginning of winter. In December, they were placed in individual cages, in near-natural conditions [5], and these were placed in a dark room at a temperature of 2-4°. Since the sleep of susliks falling into deep hibernation in December is not interrupted for a

TABLE 1. Ammonia Concentration (in mg %) in Brain of Susliks during Hibernation

Duration of hibernation (in days)	Cerebral hemispheres					Cerebellum				
	n	M	±σ	±m	P	n	M	±σ	±m	P
Control	10	0,645	0,104	0,033	—	10	0,512	0,066	0,021	—
1	10	1,846	0,084	0,009	<0,001	10	3,265	0,052	0,005	<0,001
2	10	2,156	0,094	0,010	<0,001	10	4,731	0,054	0,006	<0,001
5	10	3,213	0,041	0,004	<0,001	10	5,947	0,062	0,007	<0,00.

Note: Here and in Tables 2 and 3, P was calculated relative to the preceding period of hibernation.

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TABLE 2. Concentration of Glutamine (in mg%) in Brain of Susliks during Hibernation

Duration of hibernation (in days)	Cerebral hemispheres					Cerebellum				
	n	M	±σ	±m	P	n	M	±σ	±m	P
Control	10	4,620	0,629	0,199	—	10	7,800	0,917	0,290	—
1	10	2,745	0,385	0,041	<0,001	10	7,182	0,257	0,027	<0,1
2	10	9,706	0,536	0,057	<0,001	10	16,437	0,682	0,068	<0,001
5	10	6,131	0,403	0,042	<0,002	10	18,066	0,254	0,027	<0,001

TABLE 3. Concentration of Urea (in μmoles/g) in Brain of Susliks during Hibernation

Duration of hibernation (in days)	Cerebral hemispheres					Cerebellum				
	n	M	±σ	±m	P	n	M	±σ	±m	P
Control	10	4,680	0,386	0,122	—	—	—	—	—	—
1	10	3,775	0,046	0,005	<0,001	10	3,588	0,033	0,003	
2	10	3,258	0,013	0,001	<0,001	10	3,160	0,008	0,001	<0,001
5	10	2,687	0,046	0,005	<0,001	10	2,226	0,076	0,008	<0,001

week [10], the investigations were carried out 1, 2, and 5 days after the beginning of hibernation (body temperature of the animals 3-5°). Waking animals kept in the animal house at a temperature of 20-22° acted as the control.

At the required moment, both experimental and control animals were quickly decapitated, and the head was frozen in toto in liquid air. The brain (cerebral hemispheres and cerebellum separately) was ground into a powder. Proteins were precipitated with 5% TCA. The following substances were determined in the supernatant: ammonia, glutamine by Seligson's method [11] as modified by Silakova and co-workers [6], and urea by the urease method.

EXPERIMENTAL RESULTS

Changes in the ammonia concentration in the suslik brain began during the first day of hibernation (Table 1); its concentration in the cerebral hemispheres and cerebellum was sharply increased.

The concentration of glutamine in the cerebral hemispheres was reduced by 1.68 times on the first day of hibernation, while its concentration in the cerebellum remained almost unchanged compared with the control (Table 2). On the 2nd day of hibernation the glutamine concentration in both parts of the brain showed a sharp increase, but after 5 days its concentration in the cerebral hemispheres was reduced by 37% compared with the previous period of hibernation (while remaining 32.7% higher than the control), whereas its concentration in the cerebellum continued to rise (by 9.9%).

The concentration of urea in the brain tissues of the susliks fell by an amount that depended on the duration of hibernation (Table 3), and its levels in the cerebral hemispheres and cerebellum remained the same.

The results of these experiments, together with those of previous investigations [7, 9], demonstrate that during hibernation considerable changes take place in the system concerned with the liberation and fixation of ammonia in the brain. The accumulation of ammonia indicates profound changes in brain metabolism. The changes discovered are not specific for the state of hibernation. Ammonia and amides evidently participate actively in metabolic processes in the brain resulting from a physiological lowering of the body temperature.

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