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Remaining State Acclimatized to High Altitude Environment

By *Hirokichi Tatsunuma**

Purpose:

When climbing 7,000 to 8,000 meters high Himalayan mountains, it is recognized that there are subjective different senses between those who have experiences of climbing such high mountains and those who have not. Generally, in a low-oxygen environment there is a certain limit to physico-chemical and histologic structures; even if environmental changes have acted on the human body, the effect will disappear soon. Material consumption is caused in the human body by this action, and if such consumption lasts long, the stock in the human body is used up to adjust this consumption — a limit of the stock. The human body, as an organic body, has an adjusting power by which it is acclimatized to any environment, and the stock consumed is gradually recovered. In order to recover, all the nervous and endocrinous gland work, and this is an adjusting power limit. If these three limits are passed, the human body loses a balance, and in some cases, the unbalance unfortunately cannot be retrieved. Therefore, when working in a low-oxygen environment, it is essential to determine the extent of these three limits. It is possible to investigate the relations between subjective symptoms and the limit of the power of the adjusting organs while people are climbing mountains, however, as to the limit of physio-chemical structure, it was found very difficult to search for it. Therefore, animal tests were carried out for the purpose of finding a limit on a supplemental basis. It is usual that there is an interval of one to two years between the first climbing and the next one, and it may be considered that climbers subjectively have remaining acclimatization. However, as to the energy-reinforcing (enzymic acclimatization) Pathway of electron transfer, which is associated with the use of

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energy in a low-oxygen environment, on the acclimatizational organs, as well as how long the action will last, evidence should be found.

Method:

The livers of 36 six-months-old male dd mice having the average weight of 23 grams were used in the tests. The period of acclimatization was set at 1/30 of that to be spent in the case of man. In man changes occur in his adjusting function when he works at the altitude of 5,000 meters (405 mm Hg), therefore, the mice were subjected to a low pressure load for three hours per day during a period of one week (equivalent to 29 days in the case of man). Comparisons were made between a control group of 10 mice (not acclimatized), an acclimatization group of 20 mice and a group of 4 mice to which enzyme was given. Under mild anesthesia with either, the abdomen were incised and cut below the diaphragm, and the liver were extracted. The livers were then cleansed with physiological solution of sodium chloride, minced and the cells were broken in a mortar, and the broken cells were floated on 5 cc of M/10 phosphate buffer solution of 38°C (pH 7.0) and after having been shaken, the upper layer was taken and subjected to centrifugal separation (3,000 rpm, for 30 minutes). The fluid thus extracted was transferred to a container. A platinum electrode and a Calomel standard electrode were immersed in the container, which was placed in a desiccator of 38°C, and the pressure was reduced to 100 mm Hg. Then recording was made on the progress of the lowering of electric potential for 60 minutes. The averages of the initial electric potential, lowered electric potential and final electric potential were compared.

Results:

As to the 10 mice (not acclimatized) and 20 mice (acclimatized), including three mice which died during the acclimatization period, the changes in oxidation reducing electric potential were observed immediately after the acclimatization, as well as after 4 hours, one week (equivalent to one half year), 2 weeks (equivalent to one year), 3 weeks (equivalent to one and a half year) and 5 weeks (equivalent to two and a half year). The average values thus obtained were compared. They are shown in the below Table.

In the mice to which Glutathione or Cytochrome c was given, the electric

		No. of case	Initial electric potential (mV) t=1.58	Lowered electric potential (mV) t=2.9	Final electric potential (mV) t=3.9
Not acclimatized group	Not treated	10	128	138	−15
	Glutathione	2	157	127	30
	Cytochrome c	2	180	217	−37
Acclimatized group	Died	3	168	71	90
	Immediately after	3	126	140	−50
	After 4 hours	2	37	168	−30
	After 1 week	4	160	92	68
	After 2 weeks	4	150	135	15
	After 3 weeks	4	182	95	88
	After 5 weeks	2	191	117	79

potential dropped in a peculiar curve. However, no subjective differences ocurred despite that these substances were administered in men while they were climbing. No significant differences were observed in the average values between the dead cases in the acclimatization group and the mice which did not die in the same group. The electric potential immediately and 4 hours after the acclimatization, and the final electric potential are remarkably low.

Discussion:

In the testing the mice were sacrificed after their acclimatization, and the livers were extracted and treated as mentioned above. Therefore, as to the components of the enzymic system, the aspects of acclimatization can be detected, however, the aspects may not be applied same to a living body. In mice to which reducing Glutathione or Cytochrome c was given, peculiar curves, which seemed to have checked dropping of electric potential, were observed. However, in the case of men, no subjective effects were observed when such substances were given while they were actually climbing mountains. The fact that despite that no significant differences were observed in the electric potential curves between the mice which died in the course of acclimatization test and those which survived the test in the same group may probably be due to disorders of the electrolytic and adjustment systems, and also due to individual differences. If the fact that Himalayan climbers sensed a subjective unbalance immediately after they came

down to the sea level and the fact that they objectively had a reactionary increase in their lymph cells are taken into consideration, the fact that the final electric potential dropped remarkably immediately and 4 hours after the acclimatization is suggestive of one unbalanced state due to the rapid increase in the oxygen partial pressure.

Conclusion:

Aspects of enzymic acclimatization, as viewed from oxidation-reduction electric potential, can be conjectured by using the said method. However, as to acclimatization aspects in other behaviors of the human body, for example, electrolytic changes, adjustment of the autonomic nerve system, etc., no conjecture can be made. Immediately after acclimatization, some disorder or unstability is present in the enzymic system. It seems that the enzymic acclimatization is still remaining three weeks (one and a half years in man) after acclimatization. This fact corresponds with the subjective symptoms in man.