高原鼠兔（*Ochotona curzoniae*）对环境低氧的适应

杜继曾　李庆芬

PHYSIOLOGICAL ADAPTATION OF THE PIKA *OCHOTONA CURZONIAE* TO ENVIRONMENTAL HYPOXIA

Du Jizeng　Li Qingfen

(Northwest Plateau Institute of Biology, Academia Sinica)

ABSTRACT

It is well known that the pika *Ochotona curzoniae* is a native species of Qinghai-Xizang Plateau and one of the predominant population of small mammals in the alpine meadow ecosystem. It is very important to study the mechanism of physiological adaptation of the pikas to high altitude in expounding maintainance and development of the population.

It would be one of the approaches to explore the mechanism of the fitness to hypoxia by means of comparative study of environmental fitness between native and laboratory animals introduced to plateau. Since lots of evidences at organ levels have been provided, the current studies shcould be focused on subcellular and molecular levels.

A proledure of simulated altitude in hypobaric chamber was basically employed in our laboratory in order to produce a different altitude. *O. curzoniae* has been a well-selected model for hypoxia research in our laboratory.

1. Adaptation at organ levels

In general, the body and organ weight are changeable during acclimation to lower oxygen pressure, so their changes reflect ability and status of animal tolerence and adaptation to hypoxia. In adjustment phase in animals introduced (i.e. rats) during first period of hypoxia-exposure to 5000 m elevation for 24 days losing weight occurs often either acutely or chronically, but after this the body regains. However, nothing can be observed in *O. curzoniae*. As to the adult individual, keeping relative constant body weight is also an inherent character. Neither absolute nor relative weight of adrenai gland, kedney, liver, spleen and heart of the pikas bas been changed while in rates, spieen and heart gain 104.5% and 41.2% (cardiac hypertrophy) respectively except for others under the hypoxia mentioned above (Du & Li, 1981). These suggest that metabolic levels of *O. curzoniae in response* to hypoxia of altitude are quite stable, and it seems that inhanced function of heart and blood circulation by a compensation is not mainly responsible for against to lower oxygen tension. In contrast, material metabolisms of translated-animals are easy to be disturbed during hypoxia acclimation, the compensation-adapted and/or disorder of cardiac and circular function are popular events.

2. Alteration in hemotology

An increased ventilation would result from inspiring lower partial pressure O_2 and then alterations in blood-homeostasis would have occurred. Whether or not the shifts have been kept within normal range would be an important index for showing adaptable levels. In the acclimated state of exposure to 5000 m for 24 days, the PO_2, SO_2 and percentage of oxygenutilization in arterial blood of the pikas are kept unchanged with an inherent high levels, but PO_2, SO_2 of venus blood are tremendously low, compared with those in rats, showing ef-

fective delivery of oxygen from blood to tissues in the pikas. As to acid-base balance, nothing shifts in pikas, but pH tends to alkalizations, HCO_3^- and T-CO_2 display a drop in rats, which suggest that CO_2 loses breathly from accelerated ventilation.

Hb-electrophoresis indicates there are two bands in rats, but only one in the pikas. The pika's Hb might be of high affinities for oxygen.

Hemoglobin and hematocrit contents in the pikas and rats are 25.9%, 15.8% and 37.1%, 57.3% respectively. These suggest that oxygen is carried and transported to tissues and cells by increasing amount of red blood cells and hemoglobin in rats, while this is not essentially responsible for the acclimatization in the altitude residents, at least not all (Du & Li, 1981).

3. Fitness to altitude at metabolic and oxygen-utilized levels

It must be emphasized that O_2-utilizations in the pikas and rats are 66.3% and 23.9% (at 5000 m for 24 days) respectively, the former is 3 times as much as the latter, it appears that high O_2-utilization might be an important and excellent mechanism in fitness to hypoxia environment. At this point, the pika's metabolisms are much better than rat's (the filial generation of lowland rats introduced to the plateau).

The evidences of hepatic metabolism in comparison with several small mammalian species bave been provided among 2300 m, 5000 m and 8000 m altitude for 24 h. The consumption of glycogen of liver is much less in the pikas with a rise of the elevation, comparing with other species, for exsample *O. daurica*, rats, mice and guinea pigs.

The accumulation of total hepatic lipids in the pikas has not been exhibited under above condition by contrast with other above species. Those display the pika's tolerence to hypoxia is much greater.

4. Changes in endocrine adrenocortical function

In the stress of environmental hypoxia, the hypothalamo-pituitary-adrenocortical system is activated, and the corticosterone contents in both adrenal and blood plasma increase by about 2 and 10 fold; 2 and 8 fold between 5000 m and 8000 m altitude VS at 2300 m respectively in introduced rats, whereas none of these shifts show in the native pikas, this suggests that the stimulating intensity with lower oxygen of 8000 m is not strong enough for the plateau pikas (Du & Li, 1983).

5. Changes at subcellular levels

It has been demonstrated that hypoxia caused the alteration of permiability of cytoplasmic menberanes. We have compared of sGPT and sGOT levels among *O. curzoniae*, *O. daurica*, rats, mice and guinea pigs at 5000 m and 8000 m for 24 h, and found none of alterations observed in the two formers existed, but other species show up an increase in certain degree VS those at 2300 m. The hepatic cell menbranes of the two formers were quite steady in response to exposure to severe lower oxygen.

Lysosomal membranes of liver are easy to be disturbed by hypoxia when the membranes are damaged, its marker hydrolase enzymes, for instance, acid phosphatase and aryl sulfatase will be released into inner environment of the liver cells and the activities of the enzymes will go up. This process would result in a cytolysis and necrosis. The type of injuries of lysosomes will take place in *O. curzoniae* and *O. daurica* only at 8000 m, in contrast, lysosomal damage in mice, rats and guinea pigs will appear even at 5000 m (Du et al., 1982, 1986).