Studies on the Distribution of Trace Elements in *Agkistrodon blomhoffii brevicaudus* Stejneger

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Abstract: -The distribution of trace elements in various organs and tissues of *Agkistrodon blomhoffii brevicaudus Stejneger* was studied by ICP-AES. The results show that there are more than 17 kinds of trace elements in the snake, namely, Cu, Zn, Fe, Mn, Se, Sr, Al, Si, Al, Ni, Ba, Co, Pb, Ge, Cd, Mo, La, etc. The amount of each kind of trace element is quite different in the various organs and tissues. The contents of Zn, Fe, Al and Cr have the highest value; Cu and Mn have the medium value; Se, Sr, Si, Ba, Pb, Ge and Mo have the lower value; and Ni, Cd, Co and La have the lowest value. The results suggested that the distributional characteristics of trace elements in *Agkistrodon blomhoffii brevicaudus* Stejneger correspond with the snake's physiological and biochemical functions.

Key words: Reptilia, Serpentes, *Agkistrodon blomhoffii brevicaudus* Stejneger, China, trace elements.

Introduction

According to recent literature, there are four species which belong to the genus *Agkistrodon* in northeast China. They are *A. blomhoffii brevicaudus* Stejneger, *A. saxatilis* Emelianov, *A. shedaoensis* Zhao, and *A. ussuriensis Emelianov* (Zhao and Adler, 1993). Xü et al. (1993) reported the distribution of trace elements in *A. shedaoensis* Zhao and *A. ussuriensis* Emelianov and the results showed that there existed interspecific differences. This paper reports the quality and quantity observations of trace elements in the various organs and tissues of *A. b. brevicaudus* Stejneger. It will provide experimental data for comparative physiology and contribute also to the classification of pit-vipers.

Materials and Methods

Four specimens of *Agkistrodon blomhoffii brevicaudus* were provided by Kunshan Snake Museum at Kunshan County, Jiangsu Province, China in December, 1993. The snakes were decapitated and various organs and tissues were freshly removed. All samples, except serum, plasma and bile, were stored in an incubator at 105^{0}C for 5 hrs., cooled down and weighted after incubation. Then, the samples were immersed in mixed acid (HNO3 : HCl=4 : 1) for 24 hrs, then heated continuously until clear and transparent, and transferred into a 10 ml graduated tube by adding double distilled water.

The trace elements of all samples were measured through ICP-AES (Leeman Co., USA). The data was analyzed with a micro-computer, then they were randomly arranged as a trace elements graph.

Results

The results show that there are more than 17 kinds of trace elements, such as Cu, Zn, Fe, Mn, Se, Sr, Al, Si, Ni, Ge, Cd, Ba, Mo, Co, Pb, Cr and La in various organs and tissues of *A. b. brevicaudus*. The contents of each kind of trace elements in the various organs and tissues are as follows:

Skin, Muscle and Skeleton.

The trace element graphs of the skin, muscle and skeleton are very similar, but they still have their own characteristics. The contents of Zn, Fe and Al are higher in skin, the order is Al > Fe > Zn, and the Al content in skin is the highest among all organs and tissues. The contents of Cr, Mn, Cu, Pb and Ba have a medium value, and Se, Sr, Ni, Ge, Cd, Mo and La have a lower value in the skin. The trace elements showed different contents in the different segments of the skin (Figs. 1a, 1b, and 1c).

The skeletal muscle has more Fe and Zn and less Al, compared with those of the skin. Other elements have no more differences. Ge can not be tested out (Fig. 2).

There are more Zn, Sr and Ba and less Fe, Al and Cr found in the skeleton than in the skin and skeletal muscle. The skeleton has more Sr than in other organs and tissues. But, Ge and La can not be tested out in the vertebrae (Figs. 3 and 4).

Cardio-Vessel System, Lung and Trachea.

The similarity of elements distribution in the cardio-vessel system, lung and trachea is the presence of more Zn, Fe, Al and Cr, then Cu and Mn, and less Ni, Ge, Cd, Mo, Co, and La (Figs. 5-10).

There are more contents of Cu, Zn, Fe and Al found in the heart, vessel and lung than in the blood and trachea. But, the contents of Ge and Se are the opposite. The Cu content in the heart is ahead of the other organs, and La and Ge can not be tested out in the lung and trachea.

It reveals that most trace elements are found in bile, e.g., Cu, Mn, Se, Sr, Al, Ge, Ba, Mo, Pb, Cr, especially Cu, Ba, Mo, Pb, and Cr are much more than those in the serum. The Cr content is the highest among all samples. The La and Cd can not be tested out in the serum (Figs. 6 and 10).

Digestive Tract, Liver, and Pancreas.

The contents of Zn, Fe, Al, Mo and Cr found in the digestive tract and mesentery have a medium value, then the Cu, Mn, Se, Sr, Ba, and the other elements are very small (Figs. 16-21). The Al content is obviously less than that of the skin.

The liver, spleen and gall-bladder have similar contents of trace elements. They contain considerable amounts of Zn and Fe. The other elements, like Se, Sr, Si and Ge, are more than those of the digestive tract, mesentery and other organs. There are no difference of Cu, Mn, Se, Ni, Ba, Co, Pb and La among them (Figs. 11-15).

Besides, the contents of Fe and Mo in the liver and Zn in the pancreas are the highest among all the samples. It suggests that the liver is the important place to store Fe.

Kidney and Reproductive Organs.

There is a large amount of Mn, Se, Ba and Cr in these organs, but very little of Si, Ni, Cd, Mo and Co (Figs. 22-25). Furthermore, there are more Zn, Fe, Al, Cu and Pb in the oviduct, Fallopian tube and uterus than in the kidney.

The Al content of the kidney is similar to that of the digestive tract, but clearly less than that of the skin.

Brain, Spinal Cord and Poisonous Gland.

The graph of the brain resembles that of the spinal cord; both contain abundant elements in the order of Zn > Fe > Cr > Cu > Al > Mn > Se > Sr > Ni > Ba. The Fe content of the brain is just lower than that of the liver, but the Ge and La in the brain can not be tested out (Figs. 26 and 27).

The Zn content in the poisonous gland is higher than that of the brain and spinal cord, and the La content is the highest among all samples. Se, Ge and Mo can not be examined (Fig. 28).

Discussion

There are 17 kinds of trace elements found in *Agkistrodon blomhoffii brevicaudus* through ICP-AES. The contents of each element are quite different in the various organs and tissues. The results showed that the trace elements are the important parts of life substances in the snake. And, the distribution characteristics of trace elements correspond with the animal's physiological and biochemical functions.

There are abundant amounts of Zn, Fe, Al and Cr, then Cu, Mn, Se and Sr found in the organs and tissues, especially in the cardio-vessel system, lung, liver, spleen, brain, oviduct, etc. It suggests that these

Fig. 1a Skin of Neck

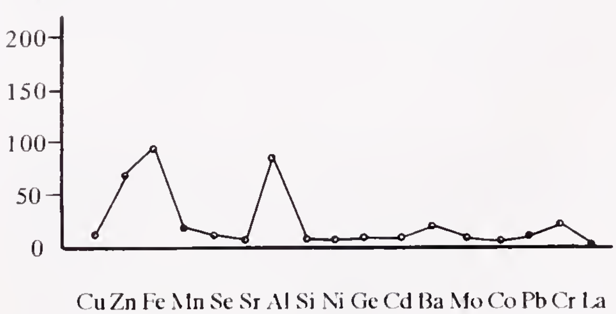


Fig. 1b. Skin of Thorax

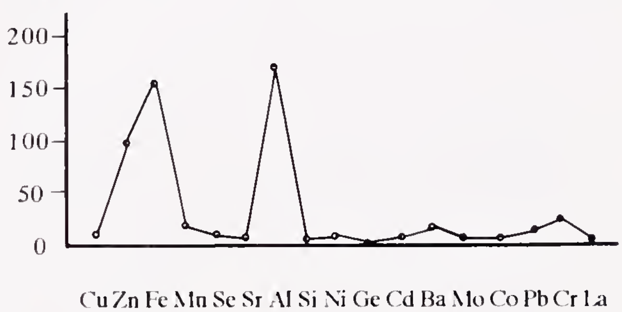


Fig. 1c. Skin of Abdomen

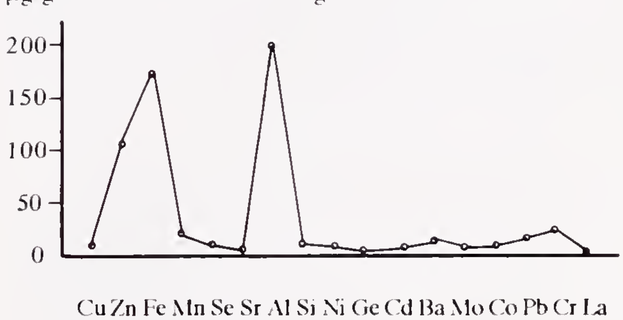


Fig. 2. Skeletal Muscle

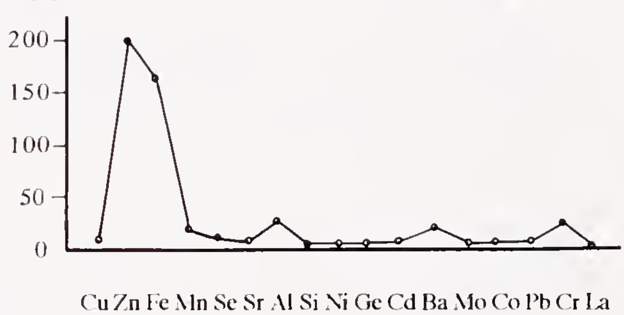


Fig. 3. Vertebra

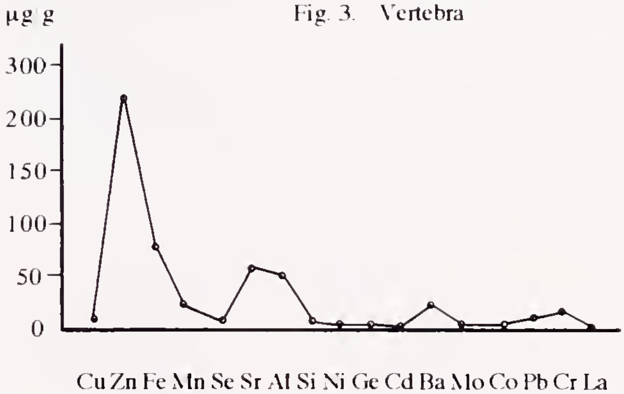


Fig. 4. Rib

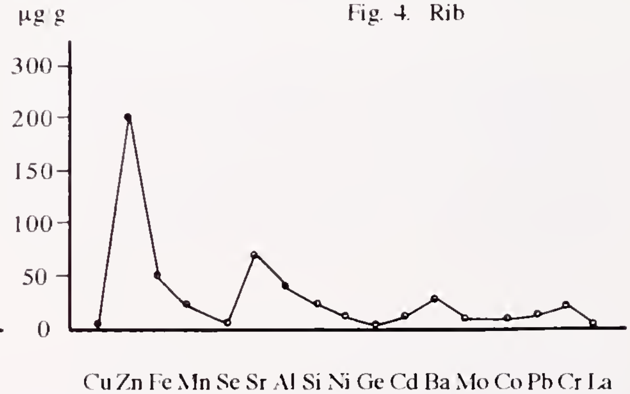


Fig. 5. Heart

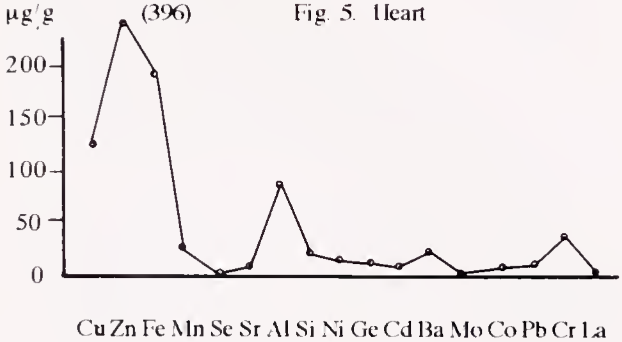


Fig. 6. Serum

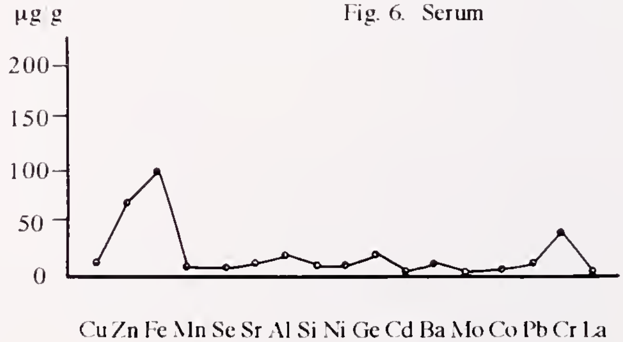


Fig. 7. Plasma

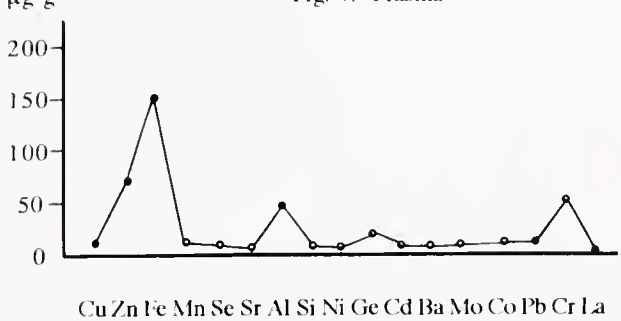


Fig. 8. Vessel

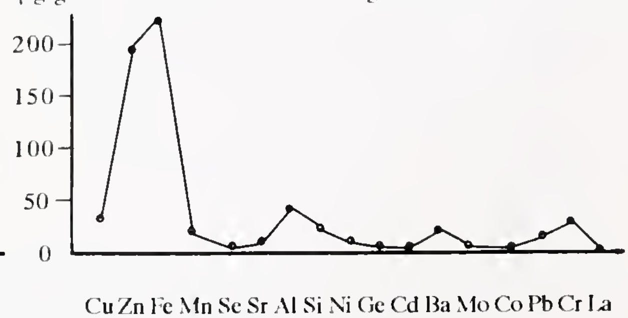


Fig. 9. Lung

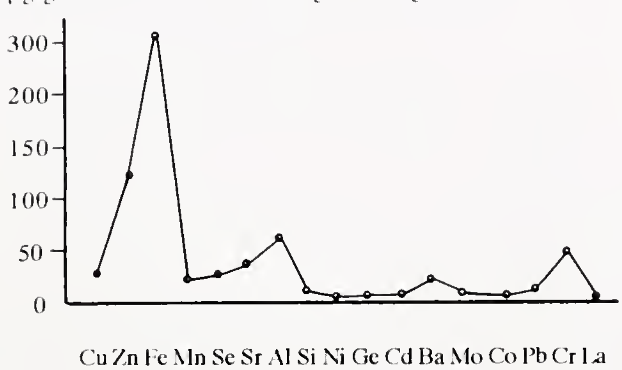


Fig. 10. Trachea

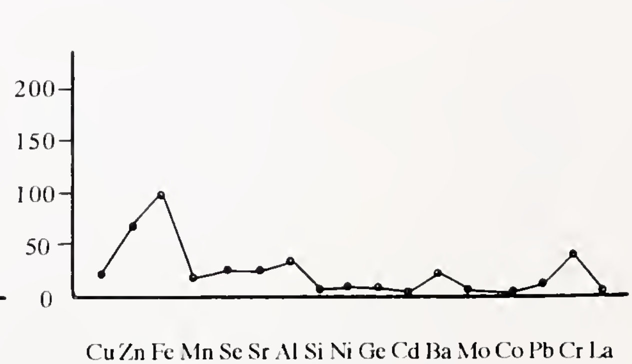


Fig. 11. Spleen

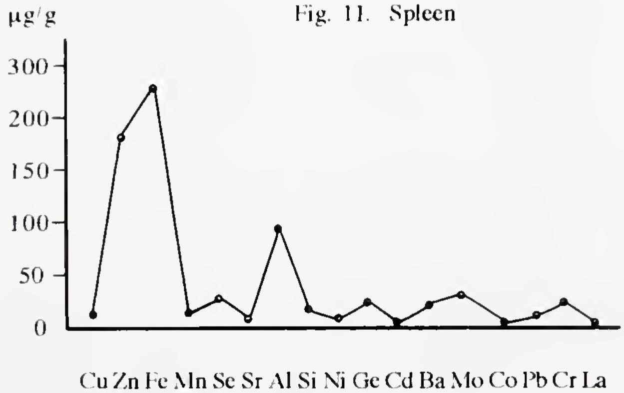


Fig. 12. Bile

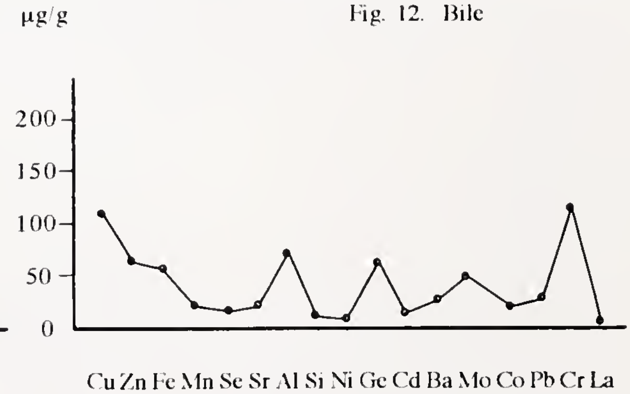


Fig. 13. Pancreas

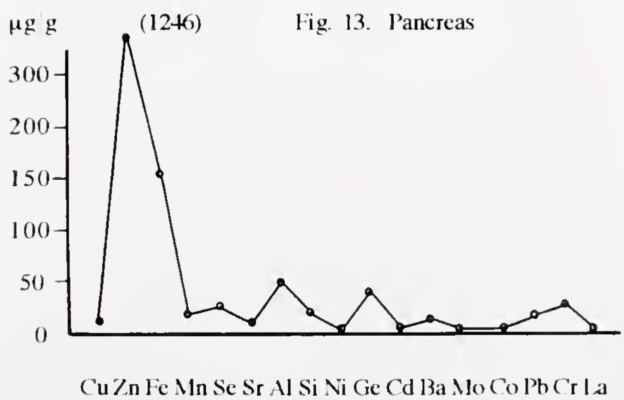
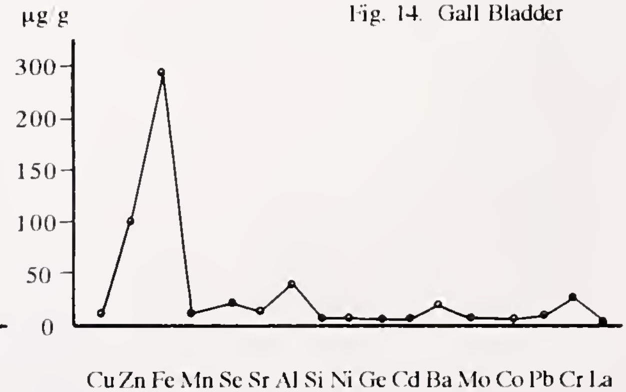


Fig. 14. Gall Bladder



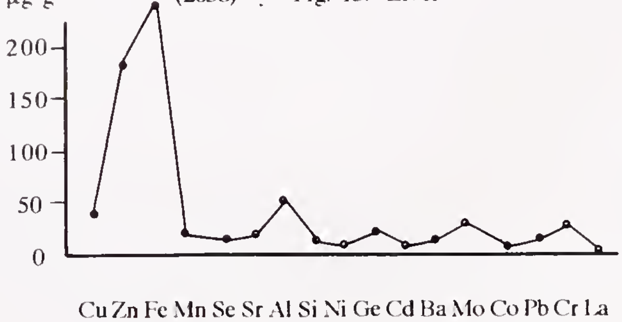


Fig. 15. Liver

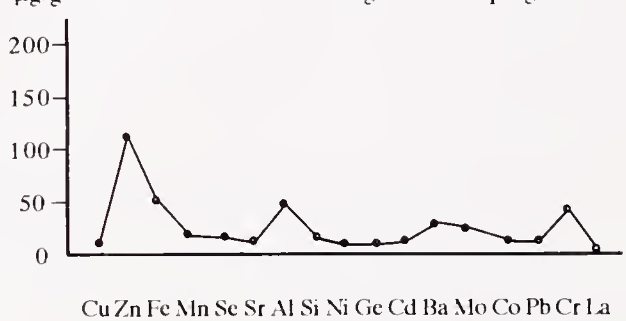


Fig. 16. Oesophagus

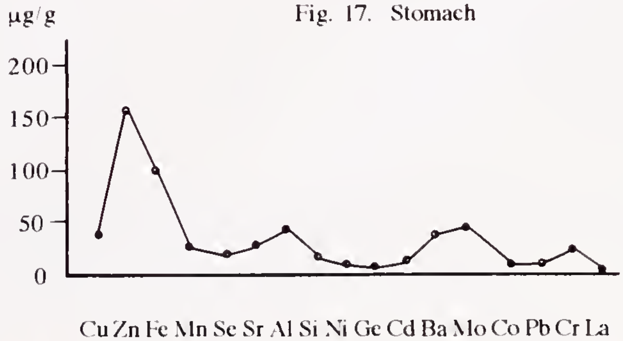


Fig. 17. Stomach

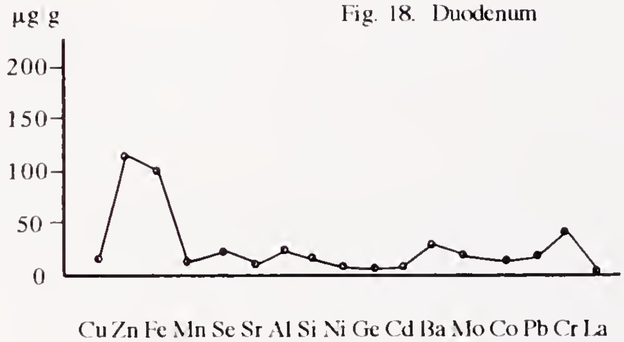


Fig. 18. Duodenum

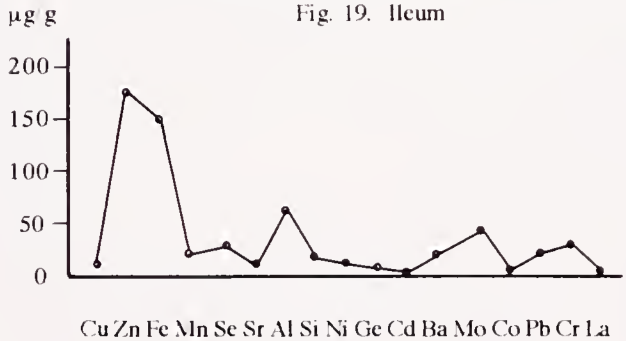


Fig. 19. Ileum

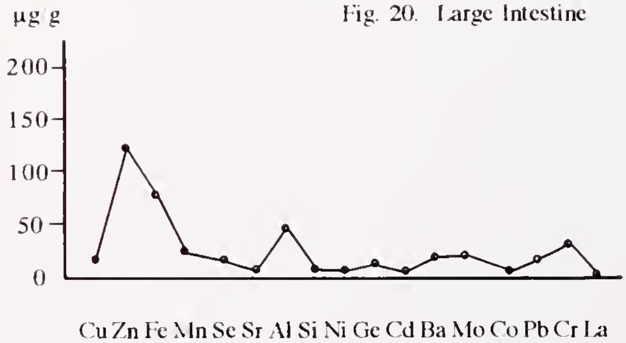


Fig. 20. Large Intestine

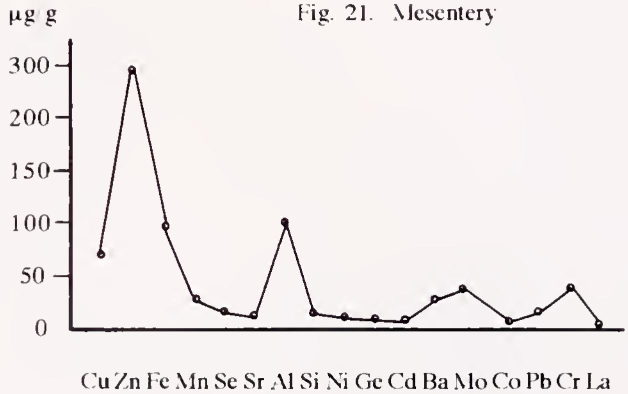


Fig. 21. Mesentery

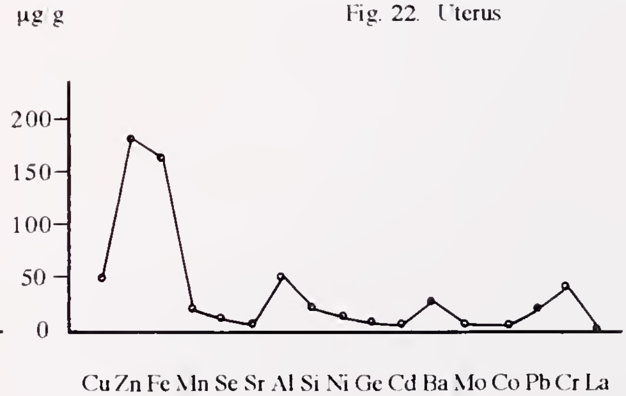


Fig. 22. Uterus

Fig. 23. Fallopian Tube

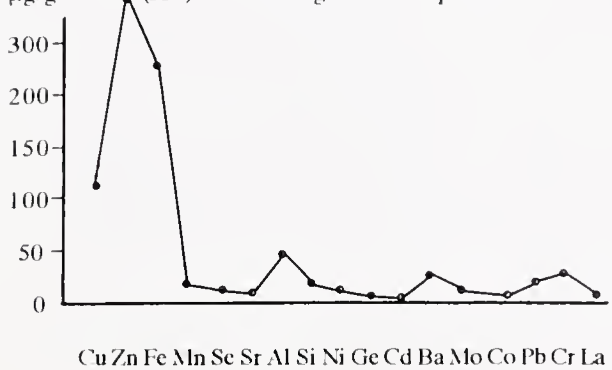


Fig. 24. Oviduct

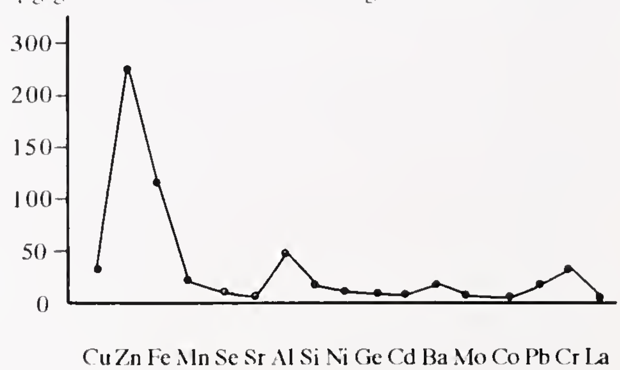


Fig. 25. Kidney

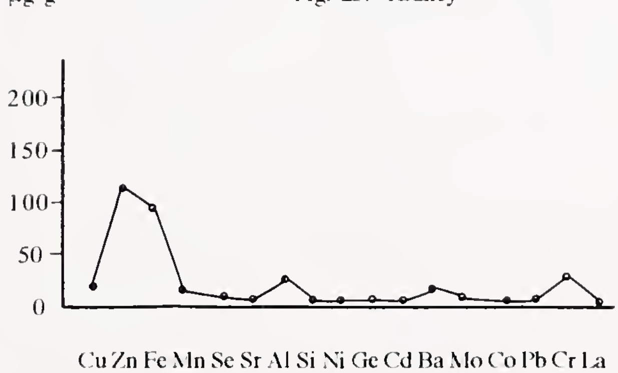


Fig. 26. Spinal Cord

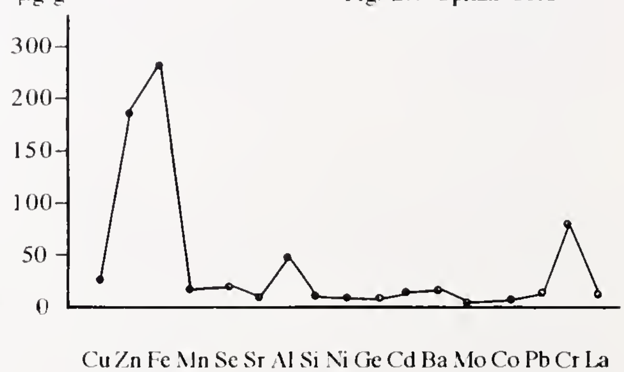


Fig. 27. Brain

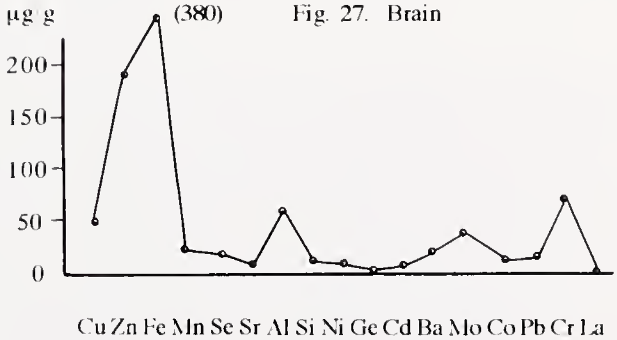
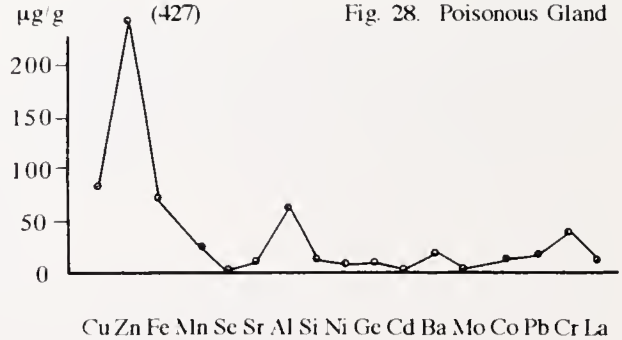


Fig. 28. Poisonous Gland



elements have a close relationship to the growth and development, the metabolic process, the enzyme synthesis and reproduction. But, how the trace elements take part in the regulation of physiological and biochemical functions and which is the essential or non-essential element needs to be further studied.

There contains much more Al (just less than Zn and Fe) in most organs and tissues, especially in the skin; and the Al contents in the heart, lung, spleen etc. are higher than those in the kidney and digestive tract. It show that the skin can collect Al. The authors thought that the skin of *A. b. brevicaudus* may be the place to store and excrete Al. It is known that Al is harmful to humans and mammals, but what is the reason for the high Al content in the body of the snake is still a question to be solved.

The characteristics of element graphs in bile is the balanced content of most elements, and there contain more Cu, Cr, Ge, Pb, Sr, Cd and Mo than those in other the organs and tissues. The ratio of Cu/Zn (2.00) is the highest among the organs. The results may be due to the concentrating mechanism of bile.

In addition to morphological differences, there are also changes in metabolic activity between species due to the divergence of the genetic constitution, ecological surroundings and living habits. So, the authors suggest that trace element detecting is a way to help classify the pit-vipers.

Literature Cited

XU, K. M., Y. K. ZHAO, J. LIN, AND J. L. LI. 1993. Studies on the interspecific differences in the distribution of trace elements in various organs between *Agkistrodon shedaoensis* Zhao and *Agkistrodon saxatilis* Emelianov. Pp. 68-74. *In* Proceedings of the First Asian Herpetological Meeting (eds. Zhao, E. M., B. H. Chen, and T. J. Papenfuss). China Forestry Press, Beijing. [In Chinese].

ZHAO, E. M. AND K. ADLER. 1993. Herpetology of China. SSAR in cooperation with CSSAR, Contributions to Herpetology 10. 522 pp.