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试论晚白垩世以来气候、地理等因素的变化对鼍类的进化及地理分布等影响

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关键词 鼍 进化 地理分布

内容提要

现存的鼍属只有两个种：即东亚的扬子鳄及北美的密河鳄。虽然这两个种的性质、纬度分布以及生态环境等都十分相似；但两者的水平分布的距离却几有地球的半圈。本文根据有关鼍类的进化、迁徙等的历史资料，对此进行了初步的探讨。

世界上现存鳄类有3科、8属、21种。其中绝大多数的种类都分布在热带和亚热带地区。栖息于北温带的只有两个种。它们在分类上归于鳄目、鼍科、鼍属。一种是产于我国长江下游的扬子鳄，又名鼍；另一种是产于北美密西西比河流域的密河鳄。这两个种都分布在相同的纬度地带，而且它们的生态环境也十分类似。然而两者的水平分布的距离却几有地球的半圈。这是有其历史的原因的。

现在已知的最早的鼍科化石是在北美的晚白垩世地层中发现的。在东亚的同时代的地层中虽然还没有找到鼍科的材料，但是在我国的东北及蒙古等地都找到了副鳄的化石。康尤可娃(1954)认为，副鳄很可能是由中颚类进化到鼍类的过渡类型。据 Frakes (1979), Douglas and Williams (1982) 等研究，在白垩纪，全球各地的气候普遍很温暖。在东亚与北美的动物群之间具有许多共同的属种，不仅两地的恐龙类是相同的，而且有许多哺乳类也是一样的。由此可见，当时的白令陆桥是走廊式的，畅通无阻的。

在古新世到始新世期间，白令陆桥从走廊式转化为过滤式了 (McFarland 等，1979)。这可能是因为白令陆桥位于高纬度地区。自从晚白垩世到古新世期间气温下降以后，虽然始新世气温已有回升，但毕竟不如白垩纪那么暖和了。而高纬度地区的寒冷气候可能起着过滤的作用。在这段时间内，鼍科在北美相当发育，出现了许多新的种类；在我国广东南雄的古新世地层中也找到了鼍科的化石 (*Eoalligator chunyii*)。杨钟健 (1964) 认为，它不但与北美同时代的鼍 (*Allognathosuchus*) 很相似，而且与扬子鳄也相接近。据 Estes 等 (1980) 报道，*Allognathosuchus* 不仅出现在纬度较低的地区，也出现在北极附近的埃尔

斯来尔岛上。而且在欧洲的始新世地层中也发现了这个属的化石。据 McKenna (1980) 研究,埃尔斯来尔岛上化石产地的古纬度为北纬 77° 左右。所以,当时白令陆桥的气候只是对某些种类(如有袋类等)起着阻拦的作用,但它还不至于对鼍类的迁徙起阻隔的作用。所谓过滤式,就是这个意思。

在始新世末渐新世初,世界上出现了一次幅度相当大的降温事件(Frakes, 1979; Wolfe, 1979, 1980; 徐钦琦, 1982)。或许是受了降温的影响,或许是由于海面上升淹没了白令陆桥,从此以后并在渐新世,白令陆桥是断开的,世界上其它几条主要的陆桥也是断开的 (McFarland 等 1979)。于是东亚与北美的动物群的面貌出现了相当大的差异。这种差异主要表现在哺乳动物群上,因篇幅有限,不在这里讨论了。在渐新世,鼍属 (*Alligator prenasalis* and *A. visheri*) 在北美开始出现了。Mook (1923), Steel (1973) 等认为,它们可能起源于 *Allognathosuchus*。但在东亚的渐新世地层中则还未见鼍属 (*Alligator*) 的踪迹。这一现象或许与白令陆桥的断开有关。

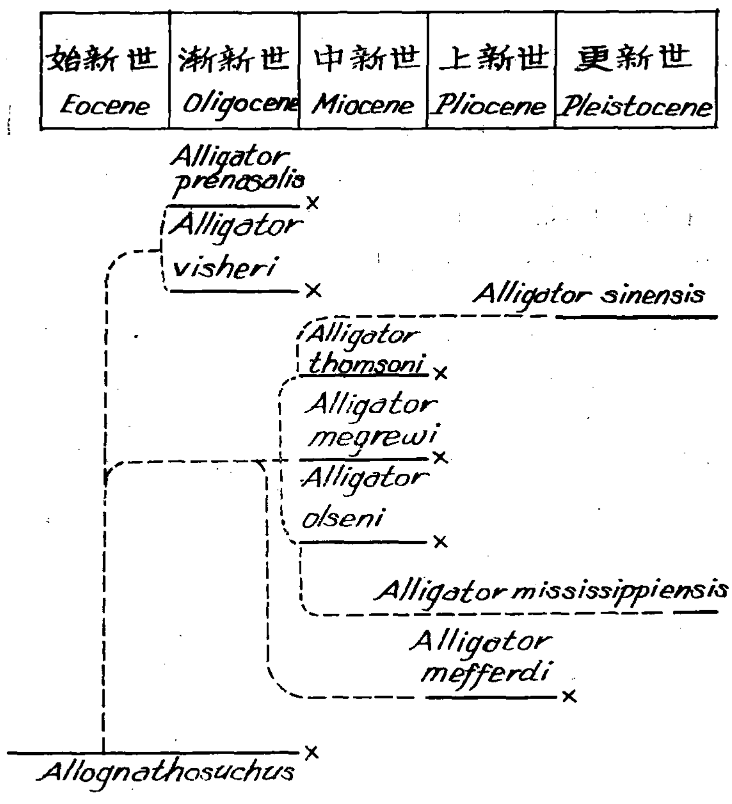

图 1 鼍属的系统进化示意图

Fig. 1 Phylogenetic evolution of *Alligator*

在中新世,全球气候再度转暖 (Frekes, 1979; Wolfe, 1979, 1980)。根据 Wolfe (1980) 研究,在阿拉斯加的东南部还长有许多水杉、水松等喜暖的乔木。由此可知,中新世的高纬度地区还是相当温暖的。正是在这个时期,鼍属 (*Alligator*) 也在我国出现了(周明镇、王伴月, 1964)。在北美, *Alligator thomsoni*, *A. megrewi*, 及 *A. olseni* 等取代了*A. pre-*

nasalis 和 *A. visheri* Steel (1973) 认为，*A. thomsoni* 可能是扬子鳄的祖先类型；而 *A. visheri* 则可能是密河鳄的先驱(图 1)。看来，正是在中新世这个气候再度转暖的时期，鼍属 (*Alligator*) 经白令陆桥，从北美传播到了东亚。

在中新世末期和上新世，世界上出现了又一次幅度相当大的降温事件 (Frakes, 1979; Wolfe, 1979, 1980)。也许还有别的原因，上新世的东亚动物群与北美动物群已显示了很不相似的面貌，由此推测：白令陆桥在当时又一次断开了。这一气候变冷的趋势的继续导致了第四纪大冰期的开始。从此以后，除了少数耐寒的种类外，对于绝大多数的种类而言，白令陆桥是无法通过的，从而使东亚与北美演变成两个不同的生物地理区。正是因为这个缘故，自上新世开始白令陆桥成了鼍属不可逾越的障碍。

近年来，在我国陆续找到了不少鼍属的新材料。黄万波 (1982) 等鉴定的似扬子鳄生活在距今 24—28 万年前的长江下游地区。周本雄 (1982) 报道的扬子鳄在新石器时代 (距今约 6000 年)出现在黄河流域。在历史时期(即 19 世纪 50 年代以前)，扬子鳄在长江中下游地区还广泛地分布着。

总之，自进入上新世以后，东亚的鼍与北美的鼍似乎再也没有机会相互交流了。长期的地理隔离使两大洲的鼍类演变成为两个完全不同的物种，即东亚的扬子鳄和北美的密河鳄。

鉴于有关鼍类的材料甚少，所以关于它的起源、进化、迁徙等问题尚未研究清楚。本文只是对现有的材料作一初步小结，并把地质历史上气候、地理等因素的变化与鼍类的进化、迁徙等问题联系起来作一点探索，恐怕错误是难免的。蒙侯连海、李锦玲提供帮助、陈瑨清绘插图，作者谨志谢意。

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参 考 文 献

中国科学院«中国自然地理»编辑委员会，1979：中国自然地理：动物地理。科学出版社。第 1—121 页。
文焕然等，1981：试论扬子鳄的地理变迁。湘潭大学自然科学学报，第 1 期，第 112—122 页。
孙艾玲，1958：松辽平原 *Paralligator* 一新种。古脊椎动物学报，**2** (4)，277—280。
杨钟健，1964：中国新发现的鳄类化石。古脊椎动物与古人类，**8** (2)，189—208。
周本雄，1982：山东兖州新石器时代遗址中的扬子鳄遗骸。考古学报，第 2 期，第 251—262 页。
周明镇、王伴月，1964：江苏南京浦镇及泗洪下草湾中新世脊椎动物化石。古脊椎动物与古人类，**8**(4)，341—354。
周明镇，1964：中国第四纪动物区系的演变。动物学杂志，**6** (6)，274—278。
徐钦琦 1982：广西百色第三纪哺乳动物群与气候变迁。古脊椎动物与古人类，**20** (4)，327—336。
黄万波等，1982：安徽和县猿人化石及有关问题的初步研究。古脊椎动物与古人类，**20** (3)，248—256。
渡部摩娜等，1982：应用卫星遥感技术对扬子鳄栖息地初步观测。自然杂志，第 11 期，第 852—854 页。
Douglas, J. G., and Williams, G. E., 1982: Southern polar forests: the early Cretaceous floras of Victoria and their paleoclimatic significance. *Palaeogeography*, Palaeoclimatology, Palaeoecology, **39**, p. 171—185.
Estes, R., and Hutchison, J. H., 1980: Eocene lower vertebrates from Ellesmere Island, Canadian arctic archipelago. Palaeogeography, Palaeoclimatology, Palaeoecology, **30**, p. 325—347.
Frakes, L. A., 1979: Climates through geological time. Elsevier, Amsterdam, 310 pp.
Huang Chu-chien (黄祝坚), 1981: The chinese Alligator. *Oryx*, **10**, p. 139—140.
Huang Chu-chien (黄祝坚). 1982: The ecology of the chinese alligator and changes in its geographical distribution. *I. U. C. N. Crocodiles*. p. 54—62.
Konjukova, E. D., 1954: Newly discovered crocodiles from Mongolia. *Trav. Inst. paleozool. Acad. Sci.* S. S. S. R., **48**, p. 171—194.
Kuhn, O., 1973: Handbuch der Palaoherpetologie, Teil 16. Gustav Fischer Verlag, Stuttgart, Portland-

USA.

McKenna, M. C., 1980: Eocene paleolatitude, climate. and mammals of Ellesmere Island. Palaeogeography, Palaeoclimatology. *Palaeoecology*. **30**, p. 349—362.

McFarland, W. N., *et al.*, 1979: Vertebrate life. New York. London. 875 pp.

Romer, A. H., 1966: Vertebrate paleontology. Chicago and London. 468 pp.

Steel, R., 1973: Crocodylia. 116 pp. (in Kuhn. O., 1973).

Watanabe, M. E., and Huang Chu-chien (黄祝坚), 1982: Yangzi Alligator. I. U. C. N. Amphibia-Reptilia. Red Data Book, Part 1, p. 283—286.

Wolfe, J. A., 1978: A paleobotanical interpretation of Tertiary climates in the Northern Hemisphere. *American Scientist*, **66**, p. 694—703.

Wolfe, J. A., 1980: Tertiary climates and floristic relationships at high latitudes in the Northern Hemisphere. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **30**, p. 313—323.

Wolfe, J. A., and Tanai, T., 1980: The Miocene Seldovia Point flora from the Kenai Group. Alaska. U. S. *Geol. Surv.* Prof. pap., 1105, 52 pp.

SOME PROBLEMS IN EVOLUTION AND DISTRIBUTION OF *ALLIGATOR*

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Key words *Alligator;* evolution; distribution

Summary

Most scientists divide the present-day crocodilians into 3 families, 8 genera, and 21 species. They are in general adapted to a semiaqatic life in a warm environment. There is only one genus *(Alligator)* which lives in the north temperate zone. It is composed of two species. Both are distributed over the same latitudinal areas under the similar ecological environment. However, *A. sinensis* is in the lower reaches of the Yangtze River in Eastern Asia; while *A. mississippiensis* in the southeastern U.S.A. The fact may be related to its evolutionary history.

Of the Cretaceous alligators the earliest species *(Brachychampsa montana)* was recovered from the Hell Creek Beds of Montana, North America. The fossil mammals found in the Eastern Asian and North American Cretaceous rocks are surprisingly similar. Their close relationship indicates that migration of land animals between east Asia and western North America was possible in the Cretaceous. The existence of such a connection is also supported by the distribution of Cretaceous dinosaurs, and by the reconstructed location of continents. Frakes (1979) pointed out that the Cretaceous must be recognized as a time of great warmth over the globe. The climate was characterized by extremely equable temperatures with very little variation from day to night, from summer to winter, and from north to south.

Paleocene and Eocene epochs apparently experience cool changes. The trans-Bering Bridge acted as a selective filter, for it located at the high latitudes. It is probable that cool

conditions may have excluded some forms of animals or, alternatively, appropriate foods to sustain their passage may have been unavailable in these regions. During these epochs, some new alligators appeared in North America, such as *Allognathosuchus*. In Eastern Asia, *Eoalligator chunyii* was discovered in Paleocene fossil beds of Nanxiong, Guangdong Province. This species may bear some resemblance with *Allognathosuchus,* even with the recent species *Alligator sinensis*. *Allognathosuchus* was living at the high latitudes, as well as at the low latitudes in Eocene. Some fragmentary materials of *Allognathosuchus* were found at 79° N in the Ellesmere Island. On the basis of the most recent paleomagnetic data available, McKenna (1980) calculated a paleolatitude of 77.5° N ± 6°. So it seems to us that the cool climate at the Bering Bridge would not prevent the alligators from migrating in late Paleocene and early Eocene.

At the end of the Eocene, a major climatic deterioration occurred. The cooling continued until Oligocene. Besides, the Bering Bridge was submerged in late Eocene and Oligocene. It is in the Oligocene that *Alligator prenasalis* and *A. visheri* made their first appearance in North America. Mook (1923) and Steel (1973) suggested that the probable alligator morphological series begins in the Eocene with *Allognathosuchus*. In the Oligocene beds of Eastern Asia, any materials of *Alligator* have not been found yet. This matter may bear much relation to the major climatic deterioration and the submerging of the bridge.

From oxygen isotopes, global trend in Miocene paleotemperatures is significant warming. The trend is supported by a broad range of data from other sources. Just as mentioned above, the land bridge was submerged in late Eocene and Oligocene. However, it emerged again in the Miocene. Approximately 60 species of megafossil plants were discovered in the Miocene beds in Alaska. The flora includes *Glyptostrobus* and *Metasequoia*. Therefore, the climate in Alaska was very warm during the Miocene time. It is during the Miocene that *Alligator* made its first appearance in Eastern Asia. In North America, *A. thomsoni, A. megrewi,* and *A. olseni* replaced *A. prenasalis* and *A. visheri*. It is probable that *Alligator* crossed Bering Bridge and arrived at Eastern Asia during this warm epoch. Steel (1973) held that the short-snouted *A. thomsoni* have been antecedent to an unknown species which spread into Asia and became the progenitor of *A. sinensis,* while the long-snouted *A. olseni* might have given rise *in situ* to *A. mississippiensis*.

At the end of the Miocene, another major climatic deterioration occurred. This cooling continued and was capped in the Pleistocene by a period of major glaciation. The cold climate in Bering Bridge became an insuperable barrier for *Alligator* and other forms adapted to a warm climate.

Recently, *Alligator* cf. *sinensis* was found in Middle Pleistocene deposits (at about 240, 000—280, 000 years B.P.) in Hexian, Anhui Province. According to Zhou Benxiong (1982), the distribution of *A. sinensis* by about 6000 years ago had reached northward the Huang-Huai Plain in the area round 36° N, but at present it is limited to the lower reaches of the Yangtze River.

In short, it happened that the common progenitors of *Alligator* of both Asia and America of present-day, being no migrating between Eastern Asia and North America after the Miocene, might have given rise to two different species in these two continents under isolating conditions, i.e. *A. sinensis* and *A. mississippiensis*.

That is the story told by fossil alligators.