Original Research Article

The paleo-ecological environment and its evolutionary trajectory of Mesozoic scaly in Inner Mongolia-A study based on comparative analysis of paleo-environment

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Abstract: The Mesozoic paleo-ecological environment in Inner Mongolia is complex and diverse, providing a rich place for biological survival and evolution. In this paper, the systematics and taxonomic diversity of the Late Cretaceous squamates in Inner Mongolia were studied. The collected fossil specimens were subjected to CT scanning, three-dimensional reconstruction and morphological characteristics analysis to preliminarily identify the fossil taxa. The phylogenetic tree of the squamates was constructed by using the branch systematics method, and the phylogenetic relationship of the squamates was analyzed. The results show that the classification diversity of Late Cretaceous scaly in Inner Mongolia is high and widely distributed. This study provides new evidence for the in-depth understanding of the evolution and geographical distribution of scaly, and has important scientific significance for promoting the study of paleontology and geology. The results of this study provide a basis for the further development of related fields.

Keywords: Inner Mongolia; Late Cretaceous; There are scales; Systematics

1. Introduction

The complex and diverse paleoecological environment of the Late Cretaceous in Inner Mongolia, China provides a rich data basis for the study of the evolution and taxonomic diversity of squamates. Although some studies have revealed the initial ecological environment of squamates in this period, systematic and taxonomic diversity studies are still insufficient. In this study, through detailed fossil collection and analysis, CT scanning and three-dimensional reconstruction techniques were used to deeply explore the ecological environment and evolution trajectory of Mesozoic squamates in Inner Mongolia, fill the research gaps in this field, and provide more comprehensive ecological and taxonomic diversity data.

2. Fossil records of Late Cretaceous scaly in Inner Mongolia

2.1. Fossil collection and preservation

From 2019 to 2021, the collection of fossils was carried out in Inner Mongolia, China, mainly in Bayanmanduhute area, Inner Mongolia. The total duration was about 4 months. The tools used included hand shovel, geological hammer, brush, reinforcing agent and binder. Combined with previous geological data exploration and collection. Detailed records were made on the collected specimens, mainly lizard fossils. Most of the fossils are incompletely preserved, mainly some skulls or jaws. The fossils will continue to be studied in detail after post-processing. These specimens are stored in the Liaoning Paleontological Museum of Shenyang Normal University for further research and analysis. The current research work is ongoing.

2.2. Preliminary identification of fossil taxa

After the fossil collection, the preliminary identification was carried out, including the careful observation and recording of the morphological characteristics, skeletal structure and other anatomical characteristics of the fossil. The observation tools such as microscope and CT scan were used to help determine the location of the fossil classification. Lizards (Lacertilia), snakes (Serpentes) and another group of lizards (Amphisbaenia) are the main taxonomic groups of fossils, and their fossil forms are different[1]. The long body without limbs and the spine are characterized by the slender and backward bending of teeth, which shows the structure of snakes. The fossil limbs of the lizard are short or not cylindrical, the skull is thick, the teeth are small, and the shape is dense [1]. This preliminary identification record provides the diversity and complexity of the Late Cretaceous phosphorus fauna in Inner Mongolia based on the undergraduate data of system science and taxonomic diversity. The evolutionary history and ecological environment of these paleontology will reveal more evidence through further detailed analysis and comparison.

3. Comparative analysis of ancient environment

3.1. Analysis of climatic conditions

During the Late Cretaceous, the climate in Inner Mongolia was generally warm and humid, but it also experienced some significant climate fluctuations. According to the sediment and plant fossil records in the strata, it is speculated that there were obvious seasonal changes at that time. The warm and humid climate provides abundant food resources and suitable living environment for scaly species [2]. The lizard fossils in Inner Mongolia are mainly concentrated in Bayanmanduhu area, which is related to the climate change at that time. The early freshwater lakes and rivers became hot and dry and even desert climate at the end of the period. The discovery of lizard fossils also has a good indication of environmental changes.

3.2. Analysis of vegetation types

Changes in vegetation types directly affect the distribution and diversity of scaly plants. During the Late Cretaceous, the vegetation in Inner Mongolia mainly included ferns, gymnosperms and angiosperms. Ferns usually grow in a humid environment, providing a hidden and food source for lizards. The emergence of gymnosperms and angiosperms indicates the diversification of vegetation types, which provides more niche options for scaly plants. Through the joint analysis of plant fossils and lizard fossils, it was found that the richness of vegetation was positively correlated with the diversity of scaly species.

3.3. Changes in the geological environment

Changes in the geological environment are also a key factor affecting the diversity of scaly species. During the Late Cretaceous, Inner Mongolia experienced many geological events, including volcanic activity, crustal uplift and sea level change. These geological events have led to frequent changes in habitats, thus affecting the distribution pattern of scaly species. Volcanic activity may lead to environmental degradation in the short term, but it will then lead to new ecological environments and provide new habitats for squamates. Crustal uplift and sea level change affect the distribution of water and vegetation, thus indirectly affecting the survival and evolution of scaly[3].

3.4. Comparative analysis of the environment

Through the comparative analysis of different strata and fossil sites, we can see the influence of the diversity and change of the Late Cretaceous paleoenvironment in Inner Mongolia on the scaly. There are few lizard fossils in dry areas, mainly concentrated in relatively humid and vegetation-rich areas. Snakes are more common in humid environments, indicating that different scaly species have significant differences in their ability to adapt to the environment.

The complex paleoenvironmental changes during the Late Cretaceous in Inner Mongolia have had an important impact on the diversity and distribution of squamates. The diversity of climate, vegetation and geological environment provides a variety of niches for the survival and evolution of squamates, thus promoting the formation of their taxonomic diversity and the complexity of their evolutionary trajectories.

4. Research on classification diversity

4.1. Diversity index calculation

In this study, the diversity of Late Cretaceous scaly taxa in Inner Mongolia was assessed using a variety of indices, including Shannon index and Simpson index. The Shannon index reflects the diversity of taxonomic groups by calculating the proportion of each species in the total population and taking logarithms. It is an information entropy measurement method based on considering species richness and evenness. The Simpson Index is more focused on the description of species dominance, that is, any two samples in the group, taken from different species, the probability of Shannon index is 3.27, Simpson index is 0.85, through the detailed classification and counting of the late Cretaceous scaly fossils in Inner Mongolia [4]. These results showed that the classification of scaly species had higher diversity and more uniform species distribution during this period. The high Shannon ‘s index showed that there were more different species of scales, while the high Simpson ‘s index showed that these species had higher evenness and higher stability in the ecosystem.

4.2. Geographical distribution and evolution trend of taxonomic diversity

The squamates in Inner Mongolia are mainly distributed in the Cretaceous period. Through the analysis of the geographical distribution of fossil sites, the regional characteristics are obvious. These fossils are mainly concentrated in several specific geological horizons showing rich taxa and complex ecosystems [5]. Lizard fossils are mainly distributed in relatively dry areas, while snakes are more common in humid environments. These distribution characteristics reflect the specific needs and adaptability of different scaly species to habitats. Therefore, the evolution trend of the classification diversity of lizard fossils in different scaly environments shows that a stage of significant increase in scaly diversity is in the late Cretaceous. Geological records show that the climate and environment in Inner Mongolia changed greatly during this period, which promoted the obvious changes of scaly species that adapted to radiation faster. Warm and humid climatic conditions provide abundant food resources and suitable habitat for lizards and snakes, while diverse topography provides a rich ecological environment for lizards. On the other hand, the ecological environment of lizards and snakes is also the environment and ecological factors play an important role in the formation of taxonomic diversity. Specifically, climate change affects the distribution of scaly species, vegetation types affect the diversity of scaly species, and geological events change the classification complexity of scaly species. Based on the comprehensive analysis of the above factors, it is found that the taxonomic diversity of Late Cretaceous scaly in Inner Mongolia not only

reflects the changes of ecological environment at that time, but also provides an important scientific basis for understanding the evolution of scaly. From the results of this study, we can see that environmental and ecological factors play an important role in the formation of scaly taxonomic diversity, and also provide a useful reference for us to better understand the ecological environment and evolution trajectory of scaly.

5. Conclusion

This study systematically analyzed the paleoecological environment and taxonomic diversity of Late Cretaceous scaly fossils in Inner Mongolia, revealing the complexity of the paleoecological environment and the rich diversity of scaly fossils during this period. The results show that the climate and environment of Inner Mongolia changed significantly in the late Cretaceous. The warm and humid climate and diverse topography provide abundant resources and habitat for the survival and evolution of squamates. These environmental conditions prompted the scaly to show a high level of taxonomic diversity and complex ecological adaptability during this period [8]. Through the detailed analysis of fossil records and the application of CT scanning technology, this study not only enriches the understanding of the paleoecological environment of scaly, but also provides an important basis for further exploring the distribution and migration patterns of scaly in geological history. These discoveries have opened up new horizons for paleontological and geological research, and also provided valuable reference for future related research in other regions.

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