Current Status of Macroscopic Zoological Research and Development Trend in the Next Five Years

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[Abstract] This paper discusses the research status of animal systematics, animal behavior, and conservation biology at home and abroad and the development trend in the next five years, and puts forward some suggestions for the development strategy of macroscopic zoology in China.

[Keywords] Macro-biology; Animal systematics; Animal behavior; Conservation biology; Status quo and trends

1. Introduction

Macro-zoology includes systems science, morphology, biogeography, ecology, behavioral science, conservation biology, and interdisciplinary biodiversity, physiology, and behavioral ecology. An obvious feature of modern biological sciences is the close interdisciplinary and infiltration of branches, the natural sciences of mathematics, physics and chemistry, and even the links between social sciences and biological sciences. The distinction between macroscopic and microscopic zoology is primarily to facilitate discipline management. Although macroscopic zoology and micro-zoology have many differences in research fields, categories, objects, and priorities, there is often a large degree of similarity or agreement in research techniques, research strategies, and research goals. This article covers only animal systematics, animal behavioral ecology, and conservation biology.

2. The Scientific Significance of Macroscopic Zoology

Macroscopic zoology has made an indelible contribution to the theoretical system of life sciences. Darwin's establishment of biological evolution was hailed as one of the greatest discoveries of the 19th century science community, a large part of which came from observations and research on animals. After Darwin, many zoologists made an immortal contribution to the development and improvement of the theoretical system of life sciences in the field of macroscopic zoology. For example, AR Wallace proposed the Wallace line in animal geography research; HW Bates studied animal mimicry; HF Osborn proposed the concept of adaptive radiation in evolution; and P. Kropotkin's role in the evolution of mutual help behavior in animal social life. Research; HE Howard's study of bird-occupied behavior; G. E. Coghill's study of the innate behavioral type of the amphibious; RA Fisher's statistical analysis of evolutionary variation; B. F. Skinner's test of animal behavioral motives; K. von

Frisch's discussion of bee communication mechanisms; H. B. D. Kettlewe U's study of moth industry blackening; R. H. McArthur and E. O. Wilson's island biogeography; N. Eldrege and S. J. Gould's theory of discontinuous balance and so on. In the field of macro-zoological research, scientists use nature as a laboratory to conduct large-scale, wide-scale comprehensive research, and continuously discover and solve major theoretical problems in life sciences.[1]

Macro-zoology is a major battleground for animal diversity research. Biodiversity is widely believed to be reflected in genes, at the three levels of species and ecosystems, the latter two levels are in the field of macro-biology research. Macro zoologists study animal life phenomena on large spatial and temporal scales, not only describing and analyzing various life diversity such as species diversity, structural and morphological diversity, distribution diversity, behavioral diversity, and ecological diversity. Wait, and try to explore the emergence, development, and evolutionary trends of these diversity.

Macro-zoological research is an important topic for sustainable development and is closely related to social and economic development. In today's world, the industry is developing at a high speed, on the other hand, the population is increasing faster and resources are experiencing faster. The concept of continuous development has become a very important topic in human economic life, political field and scientific research. Animals are a renewable resource on which humans depend. With the deepening of macroscopic zoology research, animals have been increasingly used as food, feed, industrial raw materials, medicinal materials, natural enemies of pests, pollinators, ornamentals and decorative objects, and the needs of society are increasing. All of this requires macroscopic zoology to provide information on the biology, such as animal habits, reproduction, habitat and distribution, and to understand the interrelationships between animals and the environment, and the ecological aspects of various ecological factors.

On the other hand, due to the deterioration of the environment and the shrinking space for animals to survive, the animal species diversity and the renewability of animal resources are gradually reduced, seriously endangering the sustainable development of nature and humans. Therefore, only from the overall perspective of macro-zoology, can we formulate a scientific strategy that consistently follows the laws of nature and continues to use animal resources in order to maximize the rational use of animal resources without damaging the environment and endangering the development of the animals themselves.

Macro-zoology not only contributes to the protection of the environment in practice, but also provides theoretical guidance for establishing a healthy and sustainable environment. Environmental issues have become an important topic for humanity. The preservation, protection and restoration of the health and integrity of the earth's ecosystems have entered the stage of international cooperation. Macro-zoology

studies the response of animals to various coercing factors from environmental changes at different levels. Study the adaptation process to the environment, study the extinction process in harsh environments, study the relationship between environment and various animal patterns, study the detection of animal pollution, develop, protect and utilize natural enemy animals, and provide decision-making guidance for environmental protection.

3. International Research Status and Development Rrends

3.1 Animal Systematics

In recent years, there have been phenomenal advances in the theoretical study of bio-systems in the world. In the field of systematic studies, different theoretical schools have collided with each other, providing a broad space-time stage for more branches of biology. Following evolutionary systems, numerical systematics, and systems of branch systems, a new doctrine emerged in Germany, the birthplace of systematic systematics: structural morphology. This doctrine advocates the re-construction of biological systems using the principles of hydraulics. Biological evolution is the most basic core concept of biology. The theory of biological evolution now has a greater impact on systems theory and practice than ever before. In turn, systematic research results continue to make a significant contribution to the theory of biological evolution. The pedigree relationship between species based on animal phylogeny based on common ancestors, as a comparative template for studying animal geography and co-evolution, makes animal systematics the core of comparative biology.

Systematicians are constantly freeing themselves from heavy research. Some new technologies, new methods, and new ways have injected new vitality into system science. In this sense, submicroscopy and biochemical techniques only provide some new information and data sources for systematic research, and cannot alleviate the workload of systemologists. Computer technology and artificial intelligence dogs will have major breakthroughs in this regard. The scientific management of intelligent data, intelligent operation, image recognition, multimedia technology, computerized automatic retrieval expert system, and computer systems for inferring phylogeny have become an important trend. Animal systematicians are actively involved in the study of biodiversity at all levels and in all forms. Systemologists do not provide information on species only for biodiversity, but also use their vast knowledge base to conduct in-depth research on theories, strategies, and methods of biodiversity. Enhance human scientific inference ability of animal's natural history, comprehensive analysis ability of animal status and high predictive ability for animal future development. The orderly research results provided by animal systematics provide decision-making advice and scientific guidance for the conservation and utilization of animal resources and biodiversity research.

It is estimated that the total number of biological species on the planet is between 5 and 30 million, and more than three-quarters of them are animal mites. The number of creatures that have been named and described so far is only about one hundred and eighty thousand. Completing the cataloging of creatures is a distant goal. Research units based in museums and scientific research institutions around the world still spare no effort to name, describe, catalog and determine their respective status in the biological world, establish a classification system that conforms to natural history, and compile a corresponding search table. These efforts are still very important, both in terms of biodiversity and the use of biological resources. Molecular biology has been the most influential on animal systematics since the 1970s. Its introduction and infiltration have brought a new milestone in the study of animal systematics. Molecular biology techniques are increasingly used in various classification levels of zoology, from individual variation of reproductive processes within the population to genetic differentiation and isolation of related species, and even to the relationship between the door and the door. The methods and techniques for studying DNA variation have made great strides. In addition to the indirect method of filter hybridization to limit restriction fragment length polymorphism (RFLP), the invention of PCR technology provides a direct route to DNA analysis. PCR technology enables exponential amplification of DNA fragments and provides a large amount of research material for electrophoresis analysis or DNA sequencing. DNA-DNA hybridization is a powerful tool for determining the overall divergence (or overall similarity) of single-copy DNA between two taxa. DNA genetic fingerprinting is a method that is increasingly valued for studying population structure and species affinities. With the deepening of gene sequence research, the amount of molecular information obtained by humans has greatly increased, so it is increasingly important to establish the best method for using these sequences in animal systematics research. Molecular biology data will undoubtedly provide another way for phylogenetic reconstruction.

3.2 Behavioral Ecology

An important feature of behavioral ecology is the combination of behavioral, ecological, genetic, physics and evolutionary theories, combining macro and micro, applying mathematical and economic analysis methods to form their own theoretical systems. Some foreign scientists predict that the development of behavioral ecology theory is likely to cause great changes in the entire ecology. For example, the research on the ecology, community ecology and ecosystem of the scorpion group is based on gene selection, evolutionary stability strategy theory and optimization theory basis: It is of great significance to the development of ecology. With the continuous development of behavioral ecology research, we can not only understand more deeply the nature of animal's complex behavior and its adaptation (innate instinctual behavior adaptation and acquired learning behavior adaptation). It also provides a scientific basis for the development of protective measures for rare and endangered animals and for the effective use of beneficial animals and the control of pests.

Internationally, there are two noteworthy trends in the development of behavioral ecology:

(1) Behavioral ecology research moves from macro description to micro-analysis, and studies the mechanism of behavioral ecology at the physiological, biochemical and genetic levels. Behavioral ecologists pay attention to the basic relationship between behavior, ecology and evolution, trying to understand more deeply the adaptation mechanism of animal behavior to the living environment, and to study the different behavioral activities that genetic differences may lead to.

(2) Economic thinking and methods, mathematics, and control theory are increasingly penetrating into behavioral ecology research. The most commonly used investment-benefit analysis in economics is now widely used in animal behavioral research. Studies of reproductive behavior, domain behavior, fighting behavior, food choice behavior, and various risk-balanced behaviors have introduced economic ideas and research methods. At the same time, the study of behavioral ecology has continually raised new questions about mathematics and control theory, such as non-linear problems in behavioral ecology.[2]

3.3 Conservation Biology

Conservation biology studies the impact of human social and environmental changes on biodiversity and explores effective management and conservation strategies for natural ecosystems. Since Eurington and Hamenstrom first proposed the concept of conservation biology in 1937, conservation biology has made great strides in both theory and practice. It has received increasing attention from heads of state to the public and has become a hot issue in current international public opinion. Due to the promotion of IUCN, the international development trend of conservation biology has the following characteristics:

(1) The concept of nature protection is constantly deepening, and in the past it was understood as pure protection. Sustainable development is now an integral part of nature conservation. At the IUCU conference held in 1984 and 1988, it was clearly stated that the protection and sustainable development of nature reserves should be combined.

(2) Emphasis on habitat protection, which emphasizes the protection of entire communities, ecosystems, landscapes and regions, clearly pointing out that the core issues of conservation biology research are species extinction processes and survival conditions (Shaffer, 1990).

(3) Conservation biology has gradually evolved from a pure natural science to a science in which the natural and human sciences are closely intertwined with the country's economy, law, ethics, education, culture, politics, and even international relations and economic order. In the field of macro-zoology, no sub-discipline has been developed by national governments and international organizations like conservation biology.

4. Research Hotspots in the Next Five Years

4.1 Animal Systematics

(1) Theoretical study of animal systematics. Animal systematics constantly explores theories and methods for inferring the natural history of animals, studies the expressions and pathways of evolutionary information in animal classification systems, and looks for ways to deal with the complex results of trait expression. In systematic theory, branch systematics has become one of the most concerned and influential academic schools. The research hotspot lies in the relationship and expression of evolutionary information and branch analysis; trait evaluation, trait tradeoff, trait coding, tree development criteria, tree optimization criteria, and algorithms for implementing these standards.

(2) Animal classification data computer management, automatic retrieval expert system and phylogenetic inference procedures. Enter all the knowledge of systematics into a high-performance database to establish regional and international informatics networks. Development of animal classification and identification Automatic retrieval of expert systems; development of more efficient computer programs for inferring phylogeny; establishing flexible and reliable linkages between classification databases, expert systems and phylogenetic reconstruction. Develop the use of graphics, image recognition and multimedia technology in systematic research.

(3) The use of animal systematics theory and methods in animal geography. According to the pedigree relationship and branching process between taxonomic units revealed by animal systematics, the historical relationship of animal group distribution patterns on different scales of time, space and type is studied; the evolution history of regional units is explored; Various evolutionary processes such as species formation, adaptation, extinction, etc.[3]

(4) Application of molecular biology techniques and methods. Using molecular biology research techniques and methods, such as RFLP research techniques, PCR techniques, DNA-DNA hybridization, and DNA fingerprinting, to explore the pedigree relationship between taxa. Identify the closely related taxa. Further explore the dynamics and mechanisms of evolution at the DNA level.

(5) Continue to discover and describe new species, compile catalogues of species, and establish a classification system that reflects the natural history of animals.
Achieving this goal requires enormous international efforts and will therefore lead to global cooperation. The Bio-systems 2000 Agenda, published in February 1994, fully reflects this trend.

4.2 Animal Behavioral Ecology

4.2.1 The Theory of Evolutionary Stable Strategy (ESS)

Evolutionary stability strategies are one of the most important concepts in behavioral ecology. The concept of an evolutionary stabilization strategy allows us to see for the first time how an aggregate (such as a population) made up of many independent selfish entities eventually becomes an organized, stable whole. This applies not only to social organizations within species, but also to communities and ecosystems of many species. ESS theory is also constantly challenged. For example, Ehrlich believes that the ESS concept does not explain the evolutionary process in which an evolutionary stabilization strategy is established. Further arguments are needed to illustrate how an ESS strategy is built. In addition, some people have raised the issue of evolutionary instability (P. Marrow and C. Cannings, 1993), and these debates should be taken seriously.

4.2.2 Behavioral Adaptation Studies of Animals in Habitat Selection.

Some animals can only choose specific habitats, while others have strong adaptability to different habitats. Some scholars believe that habitat selection is at least a printed act for birds, but there is no reliable direct evidence. Some scholars believe that habitat selection is basically determined by heredity. In general, most animals have a certain degree of plasticity for habitat selection. Habitat selection has a close relationship with the food supply and the nesting site. Assuming habitat selection is adaptive, since habitat conditions include complex abiotic and biological factors, it is not possible for an animal to meet all conditions or achieve optimality in one habitat at the same time. When there is a contradiction in demand, the priority of the behavior contributes to habitat selection. Because animal habitat selection behavior involves the impact of global climate change on animals, it involves the design and planning of nature reserves, involving the survival of some endangered species after returning to nature under captivity, and also involves some harmful animals to escape from habitats by changing habitats. In many respects, the behavioral adaptation of animals in habitat selection is an emerging area of research.

4.2.3 Evolutionary Research on Gender Conflict and Sexual Selection

In the behavioral ecology, the conflict of interest between the sexes is regarded as the core issue of sexual reproduction. In the study of sexual selection, there are currently three main theories, namely Darwinian Theory, Fisher's theory and Trivers theory. Sexual selection studies mainly include sexual selection of multi-spoken animals, sexual selection of single-parent animals, sexual selection and polymorphism, selection mating and non-selection mating, and mate selection criteria for females.

4.2.4 Research on Kinship and Kinship Identification

From the perspective of behavioral ecology, kinship identification is not only required by the parental individual to the tending behavior of the offspring, but also avoids inbreeding. Animal phylogenetic recognition appears to be chemical and may be a

complex mixture of special compounds that are genetically determined. Research on kinship and kinship identification will prompt us to develop new understandings of population structure and mating strategies.

4.2.5 Research on Animal Signals and Communication

The social interaction of any species involves communication problems. So far, research on animal communication behavior is still a very active field, mainly to study how various animal signals can achieve efficient communication through the role of natural selection. Ecological factors and the response of the signal receiver to the signal are two natural selection pressures that have an impact on the animal's signal. Habitat types also affect the effectiveness of various communication methods.

4.2.6 Universal Attention to General Fitness

We generally refer to the fitness of animals as the ability of animals to spread their offspring through direct reproduction. This is the basis of Darwin's fitness and the main way of natural selection, but Darwin is powerless in explaining the complex behavior of social insects. The concept of generalized fitness (inclusive fitness) introduced in the 1960s greatly broadens the understanding of behavior. It can explain the altruistic behaviors common to animals, especially Dawkins (1976) Selfish Genes. The advent of the world has deepened people's understanding of the conclusion that "behavior can be altruistic, but genes are always selfish."

4.2.7 The Role of Animal Learning Behavior in the Evolutionary Process

The importance of learning behaviors of animals in their natural state is widely recognized. The animal's instinctive behavior is Darwinian evolution, that is, evolution through natural selection and the learning behavior is Lamarckian evolution, which is to pass the learned behavior to the offspring, and so if the innate behavior is Mendelian inheritance, then the learning behavior is for "cultural communication." The efficiency and variability of cultural communication complement and congenital behaviors promote each other and accelerate and modify the ability of animals to feed, escape from predators and sexual selection. Human beings stand out in the animal world by relying on learning and traditional help. The generalized learning behavior is not uncommon in insects, amphibians and reptiles, birds and beasts, and its role cannot be ignored.[4]

4.2.8 Comprehensive Extension of Behavioral Ecology Theory to Anthropology, Sociology, and Psychology

In the 1970s, E. O. Wilson was strongly attacked when he published "Social Biology", but it is now widely recognized. Many sociologists, anthropologists, psychologists, and philosophers have interpreted a wide range of human behaviors with natural selection and general fitness. Every year, a large number of papers on human behavioral ecology appear in numerous publications. The main contents of the research are mate selection criteria and sexual selection, human evolutionary dynamics, genetic-cultural interactions and spiritual origins, and even applications in research on crime and medical care.

4.3 Conservation Biology

4.3.1 Research on the Status of Threatened Species and the System of Threatened Grades

The World Conservation Union (IUCN) divides threatened species into endangered (En), gradual (V.), rare (R.), extinct (Ex.) and undetermined levels in its famous Red Book. Because the evaluation system is qualitative and has more subjectivity, it has faced new challenges in the 1990s. Maca and Lande (1991) proposed a new hierarchical system in which threatened species were classified as Critical (Eritical), Endangered (Endan¬gered), Vulnerable (Vulnerable), and analyzed by population viability (PVA). The foundation puts forward some simple quantitative standards, trying to make the evaluation of threatened species more objective, and further develop the management of endangered organisms in the direction of scientific, precise and informational. The current international application of the Mace-Lande standard to re-examine the degree of threatened vertebrate taxon is rapidly progressing, and in 1991 reports on primates, deer, cats and certain birds.

4.3.2 Research on Population Viability Analysis

In recent years, the analysis of population viability (PVA) has become one of the focuses of conservation students' physiology research (Shaffer, 1990). The main conclusion from the PVA study is the minimum viable population (MVP), the smallest population that survives for a certain period of time with a certain probability. With the continuous development and deepening of PVA research, two MVP concepts have emerged. One is the concept of population statistics, defined by Shaffer (1987) as the smallest isolated population of any particular population that survived for 99 years with a probability of 99% in a particular habitat. The other is the concept of genetics, which mainly considers the effect of genetic drift on population genetic variation and fitness, i.e. the minimum population required to maintain a certain genetic variation in a given time (Gilpin and Soule, 1986). MVP has become an important criterion for designing nature reserves (Soul 6 and Simberloff, 1986).

4.3.3 Island Biogeography and Conservation Biology Research

Island biogeography is one of the most important basic disciplines for conservation biology. At present, the global natural habitat area is shrinking, breaking into many fragments, and as the number of debris increases, natural habitats have been island-like and form habitat islands. The study of island biogeography has three implications for the development of conservation biology: (i) the design principles of some nature reserves can be derived (Diam0nd, 1975; Wilson and Willis, 1975); (ii) the law of species extinction (Patterson and Atmar, 1986); (iii) can be used to test the correctness of some theoretical models (Belovsky, 1987, Shaffer, 1987). An important issue to be solved by island biogeography at present is how to combine the number of species with the extinction time and the size of the island and its adjacent configuration, and correctly predict the extinction quantity and survival of the species through the island area.

4.3.4 Research on the Overall Change of Community, Ecosystem, Landscape and Region

This type of research abroad mainly analyzes the causes and dynamics of debris formation and development in ecosystems, the effects of marginal effects and debris and patches on communities, ecosystems, landscapes and regions, providing a theoretical basis for the protection of intact ecosystems.

4.3.5 Research on the Design Principle and Practice of Nature Reserves

Under the impetus of IUCN, by 1989, the world's protected areas exceeded 42.5 million hectares, accounting for 3.7% of the total area of the Earth. Although the nature reserve is developing rapidly in the world, it is very weak in terms of the design principle of the nature reserve and the theoretical basis of scientific management. At present, there are two hot spots in the study of nature reserves that deserve our attention:

(1) Criticism and debate on the design principles of nature reserves proposed by Diamond et al. Diamond et al. (1975) proposed six principles for the design of nature reserves based on the relationship between species and area of island biogeography and the theory of balance (omitted). Critics who disagreed with the principles of Diamond et al. believe that the number of species in the species-area relationship increases with area, and the relationship of increase are not direct. The area only determines the number of species indirectly, and the main factor determining the number of species is the habitat diversity of the land. In addition, critics also believe that the balance theory of island biogeography has great limitations in application and is not universal. In particular, for the third of the six principles of Diamond et al., critics believe that in many cases, the sum of the total areas equals that a small protected area of a large protected area may have more species than the large protected area. This debate is called the SLOSS (single large or several small) big debate.

(2) The application of Meta-population theory in the design of conservation biology and nature reserves. In the 1970s, bio-geographers and ecologists noted that the heterogeneity of habitats in time and space would have an important impact on population dynamics, community structure, and species diversity and population genetic polymorphism. There is a very important branch in the theory of habitat spatial heterogeneity, the heterogeneous population theory developed by Lavins in the early 1970s. Many previously distributed populations and communities have been transformed into heterogeneous and heterogeneous communities due to fragmentation of habitats. Heterogeneous population theory mainly studies the dynamics of populations and communities and their genetic evolution in the process of habitat fragmentation, and provides a solid scientific basis for the design and management of nature reserves. At present, heterogeneous population theory has been widely used in conservation biology research to ensure that species can be effectively preserved in the process of habitat fragmentation.

4.3.6 Research on the Historical Evolution of Global Species Diversity

Biodiversity has been increasing slowly for a long time, but it has also occasionally been hampered by massive extinction. There have been five mass extinctions so far: At the end of the Ordovician, Devonian, Permian, Triassic and Cretaceous periods, the number of marine organisms at that time was reduced by 12%, 14%, 52%, 12% and 11% respectively. The most extinct event at the end of the Permian was the most serious. Due to human activities, biodiversity is decreasing at an unprecedented rate (Wilson, 1989, May, 1988). What lessons can humans learn from several extinction events? This is a hot issue that many conservation biologists are concerned about.

4.3.7 Monitoring and Planning of Wildlife Habitats by Geographic Information Systems (GIS) and Global Positioning Information Systems (GPS)

In foreign countries, GIS has been widely used for the protection of wild animals and has become one of the basic methods of macroscopic zoology research. In recent years, the development of Intelligent Geographic Information System (IGIS), combining expert knowledge with the enormous functions of computers, has great potential applications, such as monitoring the habitat and migration characteristics of wild animals, and can be used to analyze the distribution of survey populations and dynamic laws. [5]

5. Conclusion

In the next five years, the development of macroscopic zoology in China depends on the efforts of Chinese scientists, but it is also bound to be influenced by the development of international macro-zoology and even other disciplines. Therefore, it is necessary to strengthen international cooperation in various ways and track the frontiers of international research in theory and methods, so that China's macro-zoological research can be squeezed into the forefront of the world. We are moving towards such a great moment of the turn of the century, and China's macro-zoological research faces enormous challenges. Carrying forward the fine traditions of the older generation of scientists, such as hard work, self-improvement, and hard work, hard work, continuous innovation, hard work, and development of China's macro-zoology are the lofty duties of all scientists engaged in macro-zoological research. We have reason to believe that Chinese zoologists will create greater glories in the future.

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