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# The Role of Systematic Taxonomy in Protecting Endangered Animals

**Yi Hu** [a,*]

[a] *Hubei Key Laboratory of Economic Forest Germplasm Improvement and Resources Comprehensive Utilization, Huanggang Normal University, Huanggang 438000, China*

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ABSTRACT

With the escalating biodiversity crisis, systematic taxonomy is essential to the protection of endangered species, as it supports accurate species identification, guides conservation priorities, and informs recovery strategies. This paper highlights the critical role of taxonomy in endangered species conservation and addresses challenges such as taxonomic gaps, technical limitations, insufficient data sharing, and the disconnect between research and conservation efforts. Suggested solutions include integrating taxonomy research into decision-making, improving technical capabilities, fostering international collaboration, enhancing public engagement, and diversifying funding sources. Through case studies of China's endemic species (giant panda, crested ibis, Chinese giant salamander) and successful global initiatives (EDGE project), the paper illustrates practical strategies for advancing conservation. The discussion also explores future opportunities, including artificial intelligence and environmental DNA technologies, to strengthen taxonomy's impact on conservation. By combining theoretical insights, practical approaches, and graphical data presentation, this paper provides a foundation for innovative biodiversity protection methods.

## 1. Introduction

### 1.1. Research Background

The global biodiversity crisis continues to intensify, making the protection of endangered species a central focus of environmental policies and research across various countries. Reports from the United Nations Environment Programme (UNEP) and the International Union for Conservation of Nature (IUCN) indicate that approximately one million species worldwide are at risk of extinction, with a particularly high number of endangered species found in tropical and high-biodiversity regions (UNEP, 2019). The loss of these species not only jeopardizes the stability of ecosystems but also has significant negative repercussions for the sustainable development of human society.

In this context, systematic taxonomy elucidates the evolutionary history and relationships among organisms through the classification, identification, and naming of species. This process provides crucial scientific support for the identification and protection

* Corresponding author. E-mail address: 18164053837@163.com

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strategies of endangered species. In recent years, the rapid advancement of molecular biology technologies—such as DNA barcoding and genome sequencing—along with bioinformatics, has significantly enhanced the accuracy and efficiency of taxonomic research(Kotze et al, 2011). However, a disconnect persists between taxonomy and conservation actions, particularly regarding the swift integration of taxonomic findings into conservation decision-making and the development of targeted conservation plans based on local cases, which continue to face numerous challenges(Cracraft , 2002).

### 1.2. Research Questions

Although the importance of protecting endangered species is widely acknowledged by various countries, the true taxonomic status of many species remains unclear due to insufficient or delayed taxonomic research. This lack of clarity hampers effective conservation decision-making. Consequently, this paper primarily addresses the following questions:

1.The Core Functions and Values of Systematic Taxonomy in Endangered Species Protection: How Does Taxonomy Specifically Contribute to Species Identification, Priority Setting, and Evaluation of Conservation Effectiveness?

2. Major Taxonomic Challenges: What impacts do regional taxonomic gaps, technical and data-sharing bottlenecks, and the disconnection between research and conservation practice have on conservation efforts?

3. Response Strategies and Future Development Directions: How can we bridge the gap between taxonomy and conservation practice through technological innovation, interdisciplinary collaboration, and policy support? What feasible and practical solutions exist within the context of China?

### 1.3. Research Objectives and Significance

The objectives of this research are as follows:

To clarify the essential role of systematic taxonomy in the protection of endangered species, this text focuses on how precise classification, the determination of evolutionary uniqueness, and biogeographical analysis can inform conservation decision-making(Rubinoff , 2006).

To analyze the current shortcomings in taxonomic research and its practical applications, and to explore solutions from multiple perspectives, including international cooperation, technological advancements, and public engagement.

To propose effective conservation strategies and recommendations based on actual cases of endemic endangered species in China, thereby providing valuable references for the protection of endangered species both within China and globally(DeSalle & Amato , 2009).

The significance of this research primarily lies in three key areas: (1) enhancing the scientific foundation for decision-making in the protection of endangered species by emphasizing the integration of theory and practice within systematic taxonomy; (2) summarizing both domestic and international conservation experiences to offer guidance for the innovative application of taxonomy in the future protection of endangered species; and (3) providing more targeted operational plans for the protection and management of endemic endangered species within the context of China.

## 2. The Primary Role of Systematic Taxonomy in the Protection of Endangered Species

### 2.1. Identification and Classification of Endangered Species

Systematic taxonomy is the cornerstone of efforts to protect endangered species. Accurately identifying species and determining their taxonomic status is essential for effective resource allocation and the development of conservation policies. Traditional morphological methods often face limitations in distinguishing morphologically similar or cryptic species. In contrast, modern molecular techniques, such as DNA barcoding, have significantly enhanced identification accuracy. In China, the application of DNA barcoding technology to screen amphibians in subtropical mountainous regions has led to the discovery of several previously unrecognized species. This has prompted local governments and research institutions to reassess and update their conservation lists(Mace , 2004).

Additionally, environmental DNA (eDNA) technology has been increasingly utilized to monitor aquatic and elusive species, enabling rapid assessments of species distribution and population changes. For instance, in the Yangtze River basin in China, eDNA monitoring of the Chinese giant salamander (Andrias davidianus) and other freshwater species has yielded timely insights into the effects of habitat fragmentation on their population dynamics, providing scientific evidence to support subsequent habitat restoration efforts(Foden et al, 2013).

## 2.2. Determining Conservation Priorities

In the context of limited conservation resources, the scientific allocation of funding and manpower is crucial. Systematic taxonomy aids in identifying key species and those with high evolutionary uniqueness by elucidating the evolutionary relationships and ecological functions among species.

Flagship and Umbrella Species: The giant panda (Ailuropoda melanoleuca) serves as a prime example of a flagship and umbrella species. Taxonomic and ecological research indicates that the giant panda plays a crucial role in conserving the overall biodiversity of its habitat. Consequently, China has established multiple nature reserves within its distribution range and has harnessed public interest to promote the protection of other endangered species(Joseph et al, 2009).

EDGE (Evolutionarily Distinct and Globally Endangered) species: This metric highlights the evolutionary uniqueness of species and their degree of endangerment. For instance, research on the crested ibis (Nipponia nippon) has demonstrated that This species exhibits a significant degree of evolutionary uniqueness within the family Threskiornithidae. At one time, only seven individuals remained in the wild. However, through meticulous taxonomic and ecological research that informed artificial breeding and reintroduction efforts, the population of the crested ibis has been successfully restored(Caro, 2010).

The conservation priorities established through taxonomic methods can assist managers in balancing the evolutionary value and ecological function of species when resources are limited, thereby maximizing the return on investment in conservation efforts.

## 2.3. Monitoring and Assessment of Endangered Species

Taxonomy plays a vital role in monitoring and evaluating the effectiveness of conservation efforts for endangered species. Species Distribution Models (SDMs) that incorporate taxonomic data can predict potential species distributions and assess the degree of threats by integrating factors such as climate, topography, and human activities. This information aids managers in implementing early interventions. For instance, an analysis of various butterflies and birds in the karst mountains of southwest China using SDMs revealed that habitat fragmentation and climate change could increase the risk of local extinctions in the future. Researchers have recommended prioritizing the protection of these areas and enhancing habitat connectivity(Coates et al, 2018).

At the same time, monitoring genetic diversity using molecular markers (such as microsatellites and single nucleotide polymorphisms, or SNPs) can continuously assess the health status of populations. For instance, long-term genetic monitoring of the giant salamander has revealed that while populations in certain areas have recovered, genetic diversity remains low(Haig et al, 2006). This situation necessitates the enhancement of connectivity in waterway corridors to improve gene flow. This type of dynamic monitoring, grounded in taxonomy and molecular genetics, provides a scientific basis for timely revisions of conservation strategies for endangered species.

## 2.4. Providing Scientific Support for Conservation Management

Systematic taxonomic research has a direct and significant impact on conservation management decisions for endangered species(Kitchener et al, 2017). It not only clarifies the status and evolutionary background of species but also provides robust scientific evidence for government agencies, conservation organizations, and the public. In practical applications, the findings of taxonomic research often support several key areas:

### 2.4.1. Adjusting Legal Protection Levels

Taxonomic research can provide more targeted evidence for legal protection by identifying species' uniqueness, population numbers, and evolutionary history. For instance, after reassessing the taxonomic and population status of the Yangtze River dolphin (Lipotes vexillifer), it was confirmed that its endangered status is significantly higher than previously recognized. This prompted relevant authorities to elevate its protection level from "vulnerable" to "critically endangered stricter management and enforcement measures (see reports from the National Aquatic Wildlife Protection Department). This swift transition from scientific research to legal enforcement underscores the critical role of taxonomic findings in shaping conservation policy.

### 2.4.2. Optimizing Habitat Restoration and Management

When taxonomic research reveals that certain species are reclassified as independent species or identified as unique branches in the evolutionary tree, it often necessitates adjustments to existing protected area boundaries or management strategies. For instance, research conducted by BirdLife International

(2008) indicated that the reclassification of specific parrot species lineages ultimately prompted local conservation authorities to expand protected areas to include critical breeding sites and migration corridors. Similarly, in southwest China, if certain alpine plants are identified as new genera or rare independent species, it often necessitates the establishment of new protection zones or adjustments to management models in specific altitudinal or soil condition areas to better accommodate their ecological needs. By integrating the latest taxonomic findings into comprehensive ecological planning, conservation efforts can more effectively address the multiple threats posed by habitat fragmentation, climate change, and human activities.

#### 2.4.3. Promoting Social Engagement and Investment in Funding

Once the uniqueness and endangered status of a species are widely recognized by both the scientific community and the public through taxonomic research, it often attracts significant attention from various sectors of society. This increased awareness typically stimulates additional funding and volunteer efforts for conservation. For instance, the blue-throated macaw (Ara glaucogularis) garnered considerable attention from international conservation organizations after being reclassified as an independent species. This prompted relevant foundations and NGOs to swiftly enhance their investment in habitat management, resulting in a notable rebound in the population (BirdLife International, 2008). Similar instances are not uncommon in China, where species such as the giant panda (Ailuropoda melanoleuca) and the crested ibis (Nipponia nippon) have emerged as "star species" of social concern. The continuous dissemination of research findings has driven substantial social funding and promotional resources into species conservation and ecotourism projects, thereby creating a virtuous cycle of "research - conservation - promotion - funding."

In summary, the value of systematic taxonomy in the conservation management of endangered species lies in its ability to provide scientific and precise guidance for government decision-making, habitat planning, and public engagement. By regularly updating the taxonomic status of species, optimizing the boundaries and management strategies of protected areas, and enhancing public understanding of the ecological and evolutionary significance of these species, we can maximize the chances of survival and recovery for endangered populations(Margules & Pressey , 2000).

## 3. Current Taxonomic Challenges in the Conservation of Endangered Species

In the effort to conserve endangered species, systematic taxonomy encounters several challenges that not only hinder the comprehensive advancement of taxonomic research but also impede the effective implementation of conservation strategies. The primary challenges include taxonomic gaps, technical limitations, data-sharing issues, and the disconnect between taxonomy and conservation practices. The following sections will discuss these challenges in detail.

### 3.1. Taxonomic Gaps

Taxonomic gaps refer to the incomplete or entirely absent systematic classification research on species within certain regions or groups. This deficiency leads to challenges in accurately identifying and classifying these species, ultimately affecting the effectiveness of conservation efforts.

Weak Regional Species Research: Biodiversity hotspots, such as the karst region in Southwest China and the Tibetan Plateau, are home to a rich variety of plants, insects, and small invertebrates(Lysne et al , 2008). However, the complex terrain and harsh climatic conditions in these areas have hindered the advancement of systematic taxonomic research. For instance, in the cave ecosystems of the Southwest karst region, numerous undescribed small invertebrates exist, making them challenging to study due to their unique habitats. Furthermore, the high-altitude environment of the Tibetan Plateau necessitates enhanced taxonomic research on various plant and insect groups to address the existing taxonomic gaps.

Small or Cryptic Species: Small or cryptic species, such as tiny aquatic insects, cave-dwelling organisms, and deep-sea fish, present significant challenges for sampling and study due to their diminutive size and concealed distributions. These organisms often inhabit extreme or inaccessible environments, including deep seas, underground caves, and alpine snowline areas, which restrict scientists' field investigations and sample collection efforts. Additionally, the scarcity of research funding and technical support further exacerbates the delay in taxonomic research on these species. For example, certain tiny aquatic insects possess indistinct morphological features, making it difficult to differentiate them using traditional morphological methods. This situation necessitates comprehensive studies employing molecular biology techniques(Harvey et al , 2011).

Complex Evolutionary Relationships: Certain taxonomic groups exhibit high rates of gene flow or morphological similarity, leading to controversies and challenges in classification. For instance, specific cyprinid fish in the Yangtze River basin demonstrate extensive hybridization among different tributaries, with frequent gene flow resulting in minimal genetic differences between species. This phenomenon complicates the establishment of stable taxonomic boundaries. Furthermore, some plant groups have undergone rapid radiation and adaptive evolution, resulting in diverse morphological features and complex genomic structures, which further complicates systematic taxonomy research.

Taxonomic gaps not only hinder our comprehensive understanding of species diversity but also impact the accuracy of conservation decisions. In the absence of adequate taxonomic information, it becomes challenging to identify species that genuinely require priority protection, resulting in the misallocation of conservation resources and diminished effectiveness. Consequently, addressing taxonomic gaps is a crucial step in improving the efficacy of endangered species conservation.

### 3.2. Technical Limitations and Data Sharing Challenges

The effective application of systematic taxonomy depends on advanced technical methods and adequate data sharing. However, current taxonomic research continues to encounter numerous challenges related to technology and data sharing.

Technical Costs and Equipment Shortages: Although the costs of genomic sequencing technologies have significantly decreased in recent years, they still represent a considerable investment for remote areas and research institutions with limited funding. The procurement, maintenance, and training of personnel for high-throughput sequencing equipment necessitate substantial financial support, making it challenging for many research teams to afford. Furthermore, some advanced molecular biology techniques, such as single-cell sequencing and genome-wide association studies (GWAS), have stringent requirements for experimental conditions and data processing capabilities, which further restrict their application in resource-limited settings(Hey et al , 2003).

Lack of Standardization and Insufficient Data Sharing: Although platforms such as the Global Biodiversity Information Facility (GBIF) and the National Animal Specimen Resource Center in China offer mechanisms for data sharing, numerous practical issues persist regarding data uploading and integration. Different countries and regions exhibit a lack of uniformity in data collection methods, formats, and standards, which complicates cross-national data integration. Furthermore, concerns related to data privacy protection, intellectual property disputes, and a lack of enthusiasm among researchers for data sharing significantly hinder the process. Consequently, many recent taxonomic data sets have not been made publicly available in a timely manner, thereby limiting collaborative advancements in systematic taxonomy research and the conservation of endangered species on a global scale.

Differences in Technical Applicability: Environmental DNA (eDNA) technology, an emerging tool for species monitoring, has been effectively utilized in relatively clean water environments to efficiently and non-invasively detect the presence of target species. However, in polluted waters or regions with extremely high biodiversity, the accuracy and reliability of eDNA technology encounter significant challenges. For instance, pollutants can lead to the rapid degradation of DNA fragments, resulting in increased background noise that adversely affects the accuracy of detection results. Furthermore, in areas with high biodiversity, the DNA of non-target species may be misidentified, complicating data processing. Therefore, selecting appropriate technical methods based on varying ecological contexts is crucial for enhancing the effectiveness of taxonomic research(Morrison et al , 2009).

### 3.3. Disconnection Between Taxonomy and Conservation Practices

Despite significant advancements in theoretical research within systematic taxonomy, there remains a substantial gap in the application of these research findings to actual conservation efforts. This disconnect between scientific research and conservation practices hinders effective implementation.

Delayed Policy and Management Responses: The latest findings in taxonomic research often take considerable time to be integrated into national and local conservation policies. The protection levels for some species have not been updated promptly, and the policy response to new taxonomic discoveries remains relatively inadequate. For instance, certain newly identified independent species have yet to be formally included in national or regional endangered species lists, leading to insufficient attention and support for their conservation efforts. This delay in policy formulation not only diminishes the practical value of taxonomic research but also increases the survival pressures on some endangered species.

Lack of Targeted Funding Allocation: Funding for taxonomic research primarily originates from basic science funding agencies, such as the National Natural Science Foundation. In contrast, funding for endangered species conservation is mainly provided by government environmental protection departments, non-governmental organizations (NGOs), and international aid projects. This fragmented funding landscape results in inadequate coordination and integration between taxonomic research and its conservation applications. Consequently, the findings of basic research are often challenging to translate into specific conservation actions, as funding for conservation initiatives typically does not directly support comprehensive taxonomic research. The absence of targeted funding allocation significantly impedes the effective application of taxonomic research in conservation practices.

Lack of Interdepartmental Collaboration: In practical conservation efforts, there is frequently insufficient communication and collaboration among taxonomists, ecologists, and nature reserve managers. This disconnect hinders the timely translation of research findings into effective management strategies. Taxonomists typically focus on species systematics and identification, while ecologists emphasize the ecological needs of species and the development of conservation strategies. Meanwhile, nature reserve managers are tasked with the implementation of specific conservation actions. This division of responsibilities creates information silos, obstructing the smooth transmission of research findings to management levels and ultimately compromising the scientific integrity and effectiveness of conservation decisions. For example, certain newly discovered independent species have not been promptly incorporated into the protection scope of reserves due to inadequate communication with management departments, leading to delays in conservation measures.

In summary, the disconnect between taxonomy and conservation practices is primarily evident in delayed policy responses, inadequate funding allocation, and insufficient interdepartmental collaboration. These challenges not only hinder the application of taxonomic research findings but also diminish the overall efficiency and effectiveness of endangered species conservation efforts. To address this issue, it is essential to establish a more collaborative mechanism between research and management, optimize the funding allocation structure, and ensure that taxonomic research effectively supports actual conservation work.

## 4. Strategies To Enhance the Role of Taxonomy in the Conservation of Endangered Species

In light of the significant challenges confronting biodiversity conservation today, systematic taxonomy—an essential discipline—plays an increasingly vital role in the protection of endangered species. To fully harness the core value of taxonomy in conservation efforts, this paper proposes several strategies designed to strengthen the integration of taxonomic research and conservation practices. These strategies draw on successful experiences from both domestic and international contexts, balancing the challenges encountered with appropriate measures. Additionally, the paper aims to enhance its intuitiveness and persuasiveness through the inclusion of supplementary charts and data, while also emphasizing innovative developmental directions.

### 4.1. Emphasize the Core Value of Taxonomy and Enhance the Integration of Research and Conservation Practices

In-depth exploration of how taxonomy results guide conservation decisions: The foundation of taxonomy research lies in the accurate identification and classification of species, which reveals their evolutionary uniqueness and provides a scientific basis for conservation decisions. Following species identification and confirmation of their evolutionary distinctiveness, timely communication with relevant conservation departments is essential to include newly discovered species or updated taxonomic statuses in conservation lists or key projects. For instance, after reassessing the taxonomic status of the Yangtze River dolphin (Lipotes vexillifer), it was confirmed that its endangered status had significantly worsened, prompting relevant departments to elevate its protection level from "vulnerable" to "critically endangered" and to implement stricter management and enforcement measures. This process not only illustrates the direct impact of taxonomy results on policy formulation but also demonstrates the close integration of scientific research and policy application(Regan et al , 2002).

Reduce general descriptions of interdisciplinary collaboration and emphasize the application of taxonomy: Interdisciplinary collaboration is essential for the conservation of endangered species, but it must be articulated in terms of its practical application in taxonomy. For example, in the conservation projects involving the Chinese giant salamander (Andrias davidianus) and the crested ibis (Nipponia nippon), the identification of genetic lineages directly influenced the pairing methods used in artificial breeding, thereby promoting greater genetic diversity. Specifically, taxonomists utilized molecular marker techniques to identify distinct genetic groups, while ecologists integrated habitat data to formulate more precise habitat management and population monitoring strategies(Mace & Gaston , 2008). This comprehensive integration of taxonomic data and conservation strategies ensures the scientific validity and effectiveness of conservation efforts, mitigating biases that may arise from a singular disciplinary perspective.

### 4.2. Strengthening Literature Citations and Analysis: Insights From Successful Domestic and International Cases

Giant Panda Conservation: The successful experience of giant panda conservation demonstrates that integrating taxonomy research with ecology and behavioral science is essential for planning effective conservation networks. Through comprehensive studies of the genetic diversity of giant pandas, scientists have identified the genetic structures of different subspecies, which guide the delineation of protected areas and the design of habitat connectivity. Furthermore, behavioral studies have uncovered the breeding habits of giant pandas, allowing for the optimization of strategies for artificial breeding and reintroduction, thereby effectively promoting population recovery(DeSalle & Amato , 2009).

Crested Ibis Conservation: As a critically endangered species, the crested ibis has benefited from comprehensive taxonomic monitoring, enabling scientists to identify its various genetic groups and develop targeted conservation strategies. For instance, specific breeding programs were implemented for groups with low genetic diversity to enhance their gene pool diversity. This initiative has significantly improved the survival rate and adaptability of the crested ibis population.

Giant Salamander Conservation: The conservation project for the giant salamander illustrates the significant potential of environmental DNA (eDNA) technology in monitoring aquatic species. By collecting water samples for eDNA analysis, scientists can rapidly and non-invasively detect the presence and distribution of giant salamanders, allowing for the timely identification of changes in population dynamics. This information provides a scientific foundation for habitat restoration and adjustments in conservation strategies(Isaac et al , 2004).

EDGE Project: The EDGE (Evolutionarily Distinct and Globally Endangered) project highlights the importance of evolutionary uniqueness in conservation decision-making, emphasizing that the historical lineage diversity of species is vital for global biodiversity. By evaluating the evolutionary distinctiveness and endangered status of various species, the EDGE project aids in identifying key conservation priorities worldwide, such as the Asian elephant and the snow leopard, thereby ensuring that limited conservation resources are allocated to the most critical species.

Conservation of Rare Reptiles in the Galapagos Islands: The conservation project for rare reptiles in the Galapagos Islands has identified several new species through taxonomic research, which has directly influenced subsequent conservation planning. For instance, newly identified species resulting from genetic analysis necessitate specific habitat protection measures to ensure that their living environments are not compromised. This case illustrates the direct application and significance of taxonomic research in practical conservation planning.

Assessing Applicability: Combining international experiences with China's national conditions, such as the relevance of the EDGE project in China, necessitates a comprehensive evaluation of our administrative system, funding investment models, and the unique characteristics of our vast and diverse ecosystems. For instance, promoting the EDGE project in China must align with our regional management system, ensuring that the outcomes of taxonomy assessments can be translated into specific conservation measures through collaboration between local nature reserves and national-level protected areas. Furthermore, given the diversity of China's ecosystems, it is essential to customize conservation strategies based on the biodiversity characteristics of different regions.

Develop differentiated protection strategies to ensure that the findings of taxonomic research can be effectively applied across various ecological environments.

### 4.3. Balancing Challenges and Strategies: Specific Measures to Address Issues

#### 4.3.1. Bridging Taxonomic Gaps

Increase taxonomic surveys and investments in specific regions and groups. For biodiversity hotspots such as the Hengduan Mountains and Gaoligong Mountains, conduct comprehensive biological surveys regularly to systematically identify and classify plants, insects, and small invertebrates that have not yet been studied. For instance, in the Hengduan Mountains region, establish long-term ecological monitoring stations and integrate molecular biology techniques to thoroughly investigate the hidden biodiversity in the area.

Establish a "Taxonomic Research Fund" through legislation or special funding initiatives. Develop relevant laws and regulations to create dedicated funds that support fundamental taxonomic research and encourage young scholars to participate in foundational taxonomic work. For example, the National Natural Science Foundation could establish specific taxonomic research projects to provide long-term funding, enabling taxonomists to conduct comprehensive research aimed at addressing taxonomic gaps.

#### 4.3.2. Overcoming Technical Limitations and Enhancing Data Sharing

Fund research institutions to acquire or collaboratively utilize advanced equipment, such as high-throughput sequencers, while also providing personnel training and technical support. Through government funding and international collaboration, assist remote areas and research institutions with limited resources in obtaining advanced sequencing equipment, thereby enhancing their taxonomic research capabilities. Simultaneously, implement systematic technical training to empower local researchers to master the latest molecular biology techniques, thereby elevating the technical standards of taxonomic research(Foden et al , 2013).

Formulate data-sharing standards and legislation, and promote government initiatives that encourage research institutions and protected area management departments to upload taxonomic data to the Global Biodiversity Information Facility (GBIF) or domestic species information platforms in a timely manner. Establish unified data standards, develop relevant laws and regulations, and mandate that research institutions and protected area management departments upload taxonomic data to GBIF or the National Animal Specimen Resource Bank of China in a timely and standardized manner. Through government leadership, promote the institutionalization of data sharing to ensure that taxonomic research results can be rapidly disseminated and applied.

Encourage more local research units to join international cooperation networks and actively participate in the development and maintenance of global biodiversity databases. Through international research collaboration projects, promote local research units' involvement in the construction and upkeep of these databases. For instance, participating in international joint research initiatives can facilitate the sharing of taxonomic data, thereby enhancing China's voice and influence in global biodiversity conservation.

#### 4.3.3. Facilitating the Integration of Research Findings and Conservation Practices

Establish a cross-departmental collaboration mechanism that incorporates taxonomists into the management of nature reserves, policy advisory committees, and environmental protection legislative teams. Create advisory positions for taxonomic experts within nature reserve management agencies, the Ministry of Environmental Protection, and relevant policy advisory committees to ensure that the findings of taxonomic research are promptly integrated into conservation management decisions. For instance, establish a "Biodiversity Advisory Group" composed of taxonomists and ecologists to regularly review and update species lists and management strategies within protected areas.

For major issues such as updates to protection levels, the rescue of endangered species, and habitat restoration, it is essential to promptly organize taxonomists and ecologists to collaboratively assess and ensure that the latest taxonomic findings are integrated into management decisions. For significant conservation challenges, establish a joint assessment group comprising taxonomists and ecologists to facilitate the rapid translation of taxonomic results into specific conservation measures. For example, in endangered species rescue projects, taxonomists can utilize the latest genetic analysis data to identify genetic differences and relationships among species, while ecologists can incorporate habitat data to develop scientifically informed rescue and translocation strategies. This approach not only enhances the scientific rigor and effectiveness of rescue efforts but also ensures that conservation measures accurately address the specific needs of the species involved.

### 4.4. Enhancing Innovation: Perspectives on Future Technologies and Climate Change

#### 4.4.1. AI-Assisted Taxonomy

The rapid advancement of artificial intelligence (AI) technology offers new opportunities for systematic taxonomy. By leveraging machine learning and image recognition technologies, the efficiency of automatic identification of species through photographs or DNA sequences can be significantly enhanced, alleviating the burden of manual screening. For instance, training convolutional neural networks (CNNs) enables the automatic identification and classification of a large number of species images, greatly improving the speed and accuracy of species identification. Furthermore, the application of AI technology in genomic data analysis can facilitate the automatic identification of genetic markers and differences between species, thereby further optimizing the efficiency of taxonomic research.

#### 4.4.2. Taxonomic Expansion in the Context of Climate Change

Climate change has significant impacts on species distribution and adaptive evolution, making it imperative for taxonomy to monitor genetic diversity and adaptive potential in species. By integrating climate models with molecular systematics, taxonomists can predict potential "climate refugee species" and implement proactive conservation strategies, such as translocation or corridor construction. For instance, climate models can be used to forecast future suitable habitat ranges for specific species.

By integrating molecular systematics data, it is possible to identify populations with high adaptive potential and develop a scientifically informed translocation conservation plan. Furthermore, taxonomic research can elucidate the adaptive evolutionary pathways of species in rapidly changing environments, thereby guiding the establishment and management of conservation gene banks to ensure the survival of species under future climate conditions(Carafraft , 2002).

With the advent of artificial intelligence technology and a focus on climate change, the application of systematic taxonomy in the conservation of endangered species will become more comprehensive and nuanced. This approach will enhance the foresight and scientific foundation of conservation decisions, ensuring that endangered species can be effectively protected and restored in the context of global climate change.

## 5. Conclusion and Outlook

### 5.1. Main Conclusions

By emphasizing the fundamental role of systematics in the conservation of endangered species and examining case studies from China and around the world, this paper presents the following key conclusions:

Systematics serves as the foundation for the conservation of endangered species. Systematic taxonomy offers precise and indispensable scientific evidence for the identification and classification of these species. By facilitating accurate species identification, systematics not only elucidates the evolutionary relationships and ecological roles of species but also provides critical references for establishing conservation priorities and managing habitats. For instance, in the conservation of the giant panda, systematic research has clarified the genetic differences among various subspecies, guiding the delineation of protected areas and the allocation of resources. This approach effectively enhances the scientific rigor and targeted nature of conservation efforts(Margules & Pressey , 2000).

Challenges in systematic research primarily revolve around gaps in taxonomy, limitations in technology and data sharing, and delays in the application of research findings. Currently, the key obstacles include insufficient regional studies on species, difficulties in classifying small or cryptic species, and constraints in technology and data sharing. These challenges are particularly pronounced in China, a country characterized by high biodiversity and complex geographical and social environments. For example, in the southwestern karst region, numerous plant and insect groups have not undergone systematic classification research, hindering the accurate implementation of relevant conservation measures. Additionally, the lack of advanced technical equipment and inadequate data sharing mechanisms further restrict the effective application of systematic research outcomes(Kitchener et al , 2017).

The deep integration of systematic taxonomy and conservation practices is crucial for enhancing conservation effectiveness. To improve the overall efficacy of endangered species conservation, it is essential to strengthen the connection between systematic taxonomy and practical conservation efforts. At the management and policy levels, it is important to stay informed about the latest advancements in systematic research and to promote the effective implementation of research findings through inter-departmental collaboration and legal frameworks. For instance, establishing interdisciplinary collaboration mechanisms and including taxonomists in the management of protected areas and policy advisory committees can ensure that systematic data is promptly transformed into specific conservation measures. This approach will enhance the scientific foundation and implementation effectiveness of conservation decisions.

### 5.2. Outlook

With the continuous advancement of science and technology, the potential applications of systematic taxonomy in the conservation of endangered species are extensive. Future development trends are primarily reflected in the following aspects:

The rapid advancement of new technologies creates new opportunities for the application of taxonomy. The integration of genomics, environmental DNA (eDNA), artificial intelligence (AI), and remote sensing technology will significantly enhance the efficiency of species identification and monitoring, thereby providing robust support for informed conservation decisions. The development of genomic technologies enables systematic research to comprehensively analyze the genetic structure and evolutionary history of species. eDNA technology facilitates rapid monitoring of the distribution and dynamics of endangered species through non-invasive detection methods. The application of AI technologies, such as machine learning and image recognition, will further improve the accuracy and efficiency of automated species identification. Additionally, remote sensing technology, through high-resolution geographical data, assists scientists in better understanding changes in species habitats and the impacts of environmental factors.

International cooperation and data sharing are crucial priorities. Globally, promoting the development and utilization of global biodiversity information platforms, such as the Global Biodiversity Information Facility (GBIF), along with collaboration through international research teams, can effectively integrate systematic research resources and conservation funding, thereby enhancing overall efficiency. International cooperation not only facilitates the sharing of systematic data and research outcomes but also addresses common challenges in cross-border endangered species conservation through collaborative research projects. For instance, multinational genomic research and species identification initiatives can help bridge gaps in taxonomy between countries and contribute to achieving global biodiversity conservation objectives.

Targeted strategies within the Chinese context should align with the reform of the national park system and the objectives of constructing an "ecological civilization. investment in systematic research on local species and the enhancement of mechanisms for adjusting species lists and facilitating data sharing at both legislative and policy levels. Specifically, differentiated conservation strategies should be developed, taking into account China's vast geographical diversity and the unique characteristics of its ecological systems. Policies must be promoted to ensure that the outcomes of systematic research are promptly reflected in conservation lists and management measures. Concurrently, data-sharing mechanisms should be improved to facilitate the exchange of information both domestically and internationally, thereby enhancing the overall synergistic effect of biodiversity conservation.

### 5.3. Implications for the Conservation of Endangered Species in China

China has amassed extensive experience in the conservation of endangered species, with the application of systematic taxonomy playing a crucial role. The following points are noteworthy for learning and promotion:

Focus on local cases and emphasize the practical value of taxonomy. Successful conservation efforts, such as those involving the giant panda, the crested ibis, and the Chinese giant salamander, demonstrate that systematic research directly influences the delineation of species conservation ranges, artificial breeding strategies, and public awareness initiatives. Through comprehensive systematic research, the genetic diversity and evolutionary uniqueness of species are elucidated, providing a scientific foundation for formulating targeted conservation measures. For instance, in the conservation of the giant panda, genetic studies have identified distinct subspecies, optimizing the configuration of protected areas and resource allocation, thereby significantly enhancing conservation effectiveness.

Encouraging diverse social participation is essential. By fostering collaboration among research institutions, government agencies, businesses, and social organizations, we can introduce additional funding and technical resources. Developing "citizen science" projects can significantly enhance public awareness of taxonomy and species conservation. Such diverse participation not only provides more resources and support but also improves public understanding and engagement with endangered species conservation, thereby creating a protective environment that involves the entire society. For instance, public involvement in species monitoring projects, harnessing the efforts of volunteers, has expanded the reach of systematic research and improved the efficiency of data collection.

Continuously focus on climate and environmental changes. In light of uncertain future climate patterns, it is essential to establish a dynamic monitoring and evaluation system grounded in systematic data. This system will enable the formulation of preventive and responsive measures for potentially high-risk species in advance. Climate change may result in shifts in species distribution and adaptive evolution, necessitating timely adjustments and optimizations of conservation strategies informed by systematic research. For instance, predicting the future suitable habitat ranges of certain species using climate models, in conjunction with systematic data, can facilitate the development of adaptive translocation conservation plans or the construction of ecological corridors. These measures are crucial for ensuring the survival and reproduction of species in changing environments.

### 5.4. Conclusion

Systematic taxonomy plays an essential foundational role in the conservation of endangered species. With the advent of new technologies and the expansion of global cooperation, systematic research is anticipated to significantly enhance biodiversity conservation on both broader and deeper levels. In China, emphasizing the core principles of systematic taxonomy, bolstering local case studies, and refining conservation policies and funding mechanisms will offer robust support for the protection of endangered species and contribute valuable insights and expertise to global biodiversity conservation efforts.

In the future, as technological advancements continue and interdisciplinary collaboration strengthens, systematic taxonomy will play an increasingly vital role in addressing the global biodiversity crisis and elevating endangered species conservation to new heights. Through ongoing research and practice, taxonomy can not only provide precise scientific evidence for endangered species but also promote the overall health and stability of ecosystems, thereby contributing to the sustainable development goals of global biodiversity conservation.

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