

Review Article

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Integrating Ecology and Evolution in Reptile Conservation Programs

Xinghao Li, Jia Xuan ✉

Institute of Life Sciences, Jiyang College of Zhejiang A&F University, Zhuji, 311800, Zhejiang, China

✉ Corresponding author: jia.xuan@jicau.orgInternational Journal of Molecular Ecology and Conservation, 2024, Vol.14, No.4 doi: [10.5376/ijmec.2024.14.0018](https://doi.org/10.5376/ijmec.2024.14.0018)

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Abstract This study analyzes the importance of integrating ecology and evolution in reptile conservation, emphasizing conservation strategies based on species niches, habitat adaptability, genetic diversity, and evolutionary history. The case analysis highlights that the Galápagos marine iguana (*Amblyrhynchus cristatus*) faces unique conservation challenges due to its distinct evolutionary adaptations and population structure, providing insights applicable to other species. Meanwhile, innovative conservation approaches, such as genomic tools, remote sensing, environmental DNA, and artificial intelligence, are driving more precise and sustainable conservation decisions. Future conservation efforts should strengthen the integration of ecological and evolutionary research with practical actions to develop more scientific and adaptive conservation strategies. This study calls for a systematic approach to enhance the long-term viability of reptile populations and contribute to the achievement of global biodiversity conservation goals.

Keywords Reptile conservation; Ecology; Evolution; Biodiversity; Conservation strategies

1 Introduction

Reptiles, as the most species-rich group of terrestrial vertebrates, face significant conservation challenges due to a lack of comprehensive understanding of their extinction risks. Currently, only 45% of described reptile species have been assessed by the International Union for Conservation of Nature (IUCN), with 20% of these species threatened with extinction and 19% classified as Data Deficient (Tingley et al., 2016). This knowledge gap underscores the urgent need for targeted conservation efforts and a deeper understanding of the ecological and evolutionary processes that influence reptile biodiversity. The integration of ecological and evolutionary insights into conservation strategies is crucial for addressing these challenges and ensuring the effective protection of reptile species (Vasconcelos et al., 2018).

Reptiles play a vital role in maintaining ecological balance and biodiversity. They are integral to food webs, acting as both predators and prey, and contribute to the regulation of insect populations and seed dispersal. Despite their ecological importance, reptiles are often underrepresented in conservation planning compared to other vertebrate groups such as birds and mammals. The global distribution of reptiles reveals unique richness patterns that differ from other taxa, highlighting the need for specific conservation actions to protect these species, particularly lizards and turtles, which are poorly represented in existing protected areas. Addressing these conservation needs is critical to preserving global biodiversity and ecosystem health (Gonçalves-Souza et al., 2022).

Ecology and evolution are fundamental to understanding the dynamics of species populations and their interactions with the environment. Incorporating ecological knowledge, such as species distribution and habitat requirements, alongside evolutionary insights, such as genetic diversity and adaptive potential, can enhance conservation strategies (Kay et al., 2016). For instance, using molecular and landscape tools to target evolutionary processes in reserve design can improve the effectiveness of conservation programs, particularly in regions with high levels of endemism. Additionally, understanding how species traits influence responses to environmental disturbances can guide conservation efforts by prioritizing species that are more vulnerable to ecological changes (Hu et al., 2020).