LETTER TO THE EDITOR

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Biodiversity of Amphibians Along the Elevational Gradient of Mount Leigong: Checklist, Distribution, and Conservation

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Dear Editor,

Mountain systems have long been refuges for many species, often viewed as "islands" that promote speciation due to geographic isolation (Rahbek *et al*., 2019). Their high environmental heterogeneity fosters centers of endemism, and they harbor over 85% of global species diversity (Zhao *et al*., 2022). Consequently, mountains are key systems for exploring biodiversity patterns along elevational gradients, where species richness often follows four recognized models: monotonic decrease, unimodal pattern (forward and backward peak patterns), and low plateau followed by a decrease along the elevational gradient (McCain *et al*., 2010). Currently, our understanding of elevational patterns remains limited compared to latitudinal patterns, yet clarifying them is crucial for the conservation of biodiversity hotspots and threatened taxa (Sun *et al*., 2020). Amphibians are notably susceptible to environmental shifts owing to restricted dispersal capabilities and physiological limitations, with 41% of species globally listed as threatened—much higher than mammals or birds (IUCN, 2025). Their elevational distributions reflect niche differentiation, temperature tolerance, and dispersal limits, making them ideal models for biodiversity studies (Zhao *et al*., 2023; Borzée *et al*., 2025). Leigongshan National Nature Reserve (hereinafter referred to as Mount Leigong), on the Yunnan-Guizhou Plateau, is a hotspot for amphibians and the most species-rich protected area in Guizhou (Figure S1; Hu *et al*., 1973). While early surveys and sporadic updates revealed new species, comprehensive assessments of amphibian diversity and conservation status across elevations remain scarce. In recent years, climate change-induced water scarcity may have affected the survival of amphibians on Mount Leigong. Additionally, human activities such as engineering projects and tourism development may have damaged the habitats of these amphibians. Therefore, our study aims to (1) clarify amphibian species composition in Mount Leigong, (2) analyze their elevational distribution patterns, and (3) evaluate the conservation status of threatened species across gradients.

From January 2023 to December 2024, we conducted 15 expeditions (150 sampling days) with 60 transects (1–3 km) (Table S1). Amphibians were surveyed visually and acoustically at night (19:00–24:00) along streams and wetlands. A total of 42 species were recorded, voucher specimens (non-protected species; 1–4 individuals per species, totaling 81 individuals) were deposited at Guizhou University. For the identification of doubtful species, we applied molecular and morphological analyses. We collected specimens of *Tylototriton maolanensis* Li, Wei, Cheng, Zhang & Wang, 2020 (4 individuals), *Leptobrachella bashaensis* Lyu, Dai, Wei, He, Yuan, Shi, Zhou, Ran, Kuang, Guo, Wei & Yuan, 2020 (1 individual), *Leptobrachella dong* Liu, Shi, Li, Zhang, Xiang, Wei & Wang, 2023 (1 individual), *Leptobrachella wulingensis* Qian, Xiao, Cao, Xia & Yang, 2020 (1 individual), *Brachytarsophrys popei* Zhao, Yang, Chen, Chen & Wang, 2014 (1 individual), *Polypedates braueri* Vogt, 1911 (4 individuals), and *Zhangixalus zhoukaiyae* Pan, Zhang & Zhang, 2017 (3 individuals). Snout-vent lengths were measured with calipers (brand: WD; model: 10150737088; precision: ±0.1 mm). After taking photos, we euthanized them

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using isoflurane and then fixed the specimens in 10% buffered formalin. Tissue samples were taken and preserved separately in 95% ethanol before fixation. Mitochondrial genes (*16S*, *COI*, *ND2*) were sequenced and compared with GenBank data to confirm identifications (Table S2). Species abundance and sampling efficiency were evaluated using the iNEXT package in R 4.2.2. Nomenclature followed Frost (2025) and Amphibia China (2025). Threatened status was assessed based on the IUCN Red List (2025) and China Red List (2020). Based on relevant literature and the vegetation characteristics of Mount Leigong (Zhang *et al*., 2007), elevational bands were set at 200 m (low: 650–999 m; mid: 1 000–1 599 m; high: 1 600–2 178.8 m). Species richness patterns were analyzed with polynomial regression (AICc criterion), and range sizes of all species were mapped.

Through molecular and morphological analyses (Tables S3, S9), seven doubtful species were redefined, including *Tylototriton maolanensis*, *Leptobrachella bashaensis*, *Leptobrachella dong*, *Leptobrachella wulingensis*, *Brachytarsophrys popei*, *Polypedates braueri*, and *Zhangixalus zhoukaiyae* (see Supplementary Figures S2, S4–S8; Tables S4–S8). The sparse extrapolation curve of sampling coverage shows stabilization across species at various elevation gradients, indicating complete sampling and sufficient data for subsequent analysis (Figure S3). A total of 42 amphibian species (23 genera, 9 families) were recorded. Among these species, Mount Leigong was the type locality of 6 species, including 4 endemic species (Table 1). Ranidae was the most abundant family (14 species), followed by Megophryidae (7 species). According to the IUCN Red List, 6 of the 42 species were categorized as threatened, including one Critically Endangered (CR), two Endangered (EN), one Vulnerable (VU), and two Near Threatened (NT) species; while according to the China Biodiversity Red List, 14 of the 42 species were categorized as threatened, including one CR, five VU, and eight NT species (Table 1). Both the overall species diversity and the richness of threatened amphibian species displayed a peak distribution pattern at mid-elevations, reaching their

Table 1 Species composition and threatened status of Mount Leigong.

	IUCN Red List	China Red List
Salamandridae		
Pachytriton inexpectatus	LC	VU
*Paramesotriton caudopunctatus**	NT	VU
Tylototriton maolanensis	NE	NE
Cryptobranchidae		
Andrias davidianus	CR	CR
Dicroglossidae		
Quasipaa shini	EN	VU
Quasipaa boulengeri	VU	VU
Fejervarya multistriata	LC	LC
Bufonidae		
Bufo andrewsi	NE	NE
Bufo gargarizans	LC	LC
Duttaphrynus melanostictus	LC	LC
Microhylidae		
Microhyla butleri	LC	LC
Microhyla pulchra	LC	LC
Microhyla fissipes	LC	LC
Microhyla heymonsi	LC	LC
Megophryidae		
Boulenophrys spinata	NE	LC
*Boulenophrys leishanensis***	NE	LC
Brachytarsophrys popei	NT	NT
*Leptobrachium leishanense***	EN	VU
Leptobrachella bashaensis	NE	NE
Leptobrachella dong	NE	NE
Leptobrachella wulingensis	NE	NE
Rhacophoridae		
Polypedates braueri	LC	LC
*Gracixalus weii***	NE	NE
Zhangixalus dennysi	LC	LC
Zhangixalus zhoukaiyae	DD	NT
Ranidae		
Pelophylax nigromaculatus	LC	NT
Odorrana graminea	LC	LC
Odorrana huanggangensis	LC	LC
*Odorrana leishanensis***	NE	NE
Odorrana lungshengensis	LC	NT
Odorrana versabilis	LC	NT
*Nidirana leishanensis**	NE	LC
Hylarana latouchii	LC	LC
Hylarana taipehensis	LC	NT
Hylarana guentheri	LC	NT
Amolops chunganensis	LC	LC
Amolops sinensis	LC	LC
Rana hanluica	LC	NT
Rana zhenhaiensis	LC	LC
Hylidae		
Hyla annectans	LC	LC
Hyla sanchiangensis	LC	LC
Hyla immaculata	LC	LC

*: Species type locality is Mount Leigong; **: endemic species on Mount Leigong. Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR).

maximum at mid-elevations (Figure 1; Table 2). According to the IUCN Red List, species richness peaked at mid-elevations (1 000–1 399 m) and then gradually decreased. Six threatened species were found at low and mid-elevations, while four threatened species were recorded at high elevations (Figure 1A; Table 1). From the perspective of the China Biodiversity Red List, species richness peaked at mid-elevations (1 000–1 599 m). Fourteen threatened species were identified at low and mid-elevations areas, and nine threatened species were found at high elevations areas (Figure 1B; Table 1). In Mount Leigong, the distribution ranges of two threatened species (*Pelophylax nigromaculatus* Hallowell, 1861 and *Hylarana taipehensis* Van Denburgh, 1909) are extremely narrow (Figure 2). The only critically endangered species (*Andrias davidianus* Blanchard, 1871) is mainly distributed in the low to mid-elevation ranges, with a relatively wide range (Figure 2). The four species endemic of Mount Leigong are all found at mid to high elevations, while the elevational ranges of *Gracixalus weii* Liu, Peng, Wang, Feng, Shen, Li, Chen, Su & Tang, 2025 and *Odorrana leishanensis* Li, Chen, Su, Liu, Tang & Wang, 2024 is relatively narrow (Table 1; Figure 2). In this study, *Tylototriton maolanensis* and *Microhyla pulchra* Hallowell, 1861 were only discovered once and were confined to a very narrow range. Some threatened species exhibit relatively wide elevational distributions but the number of individuals is relatively small (Table 1; Figure 2).

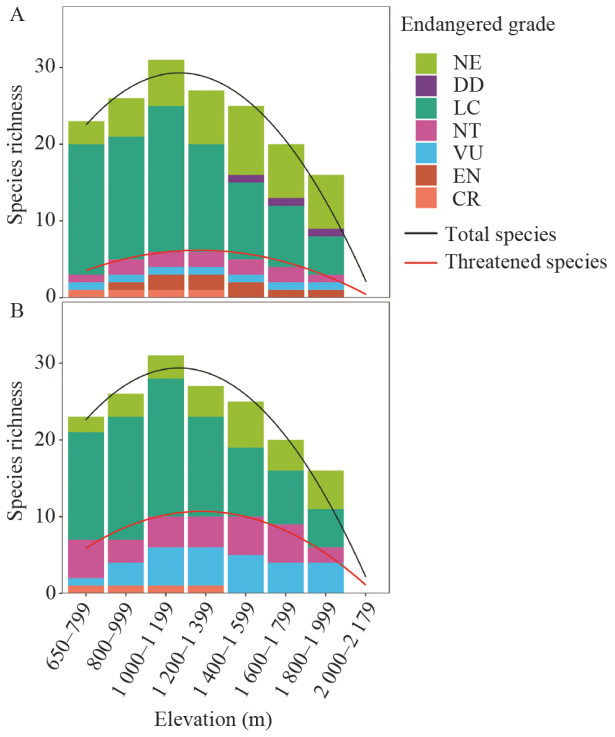


Figure 1 Elevational patterns of total species richness (black) and threatened species richness (red) based on polynomial regression models. (A) IUCN Red List and (B) the China Biodiversity Red List.

Our study updated the amphibian inventory of Mount Leigong, clarified taxonomic identities, and assessed elevational distribution and threat status. Compared with previous surveys (Hu *et al*., 1973; Chen *et al*., 2007; Liu *et al*., 2022), the diversity recorded here is higher, confirming the reserve as the most species-rich amphibian area in Guizhou. Amphibian richness showed a mid-elevation peak, consistent with patterns observed elsewhere (Wang *et al*., 2020; Zhao *et al*., 2022). This pattern is mainly driven by small-ranged species adapted to narrow ecological conditions at moderate elevations, while high elevations (>2 000 m) lacked amphibians, likely due to unsuitable habitats. Threatened species also followed a mid-peak pattern, with most occurring below 2 000 m, underscoring the need for focused monitoring in these zones. Species with extremely restricted ranges, such as *Pelophylax nigromaculatus* and *Hylarana taipehensis*, require priority protection, while rare or newly described taxa warrant continued surveys to clarify distributions. Therefore, we recommend that the management authorities strengthen the management of amphibian habitats, such as ponds, streams, and farmland, raise awareness of conservation through public education, and reduce pesticide use and capture activities among local villagers. In summary, our study refines the taxonomy and elevational distribution of amphibians in Mount Leigong, emphasizes the threatened status of key species, and provides a basis for conservation strategies in the Miaoling Mountains.

Table 2 Results of polynomial regression models.

Polynomial regressions	Total species richness	Threatened species (IUCN)	Threatened species (China)
First-order R2	0.56*	0.31	0.24
AICc	63.40	41.80	50.90
Second-order R2	**0.96*****	**0.97*****	**0.91****
AICc	**53.20**	**25.00**	**42.80**
Third-order R2	0.97**	0.98***	0.98***
AICc	70.90	42.00	50.00

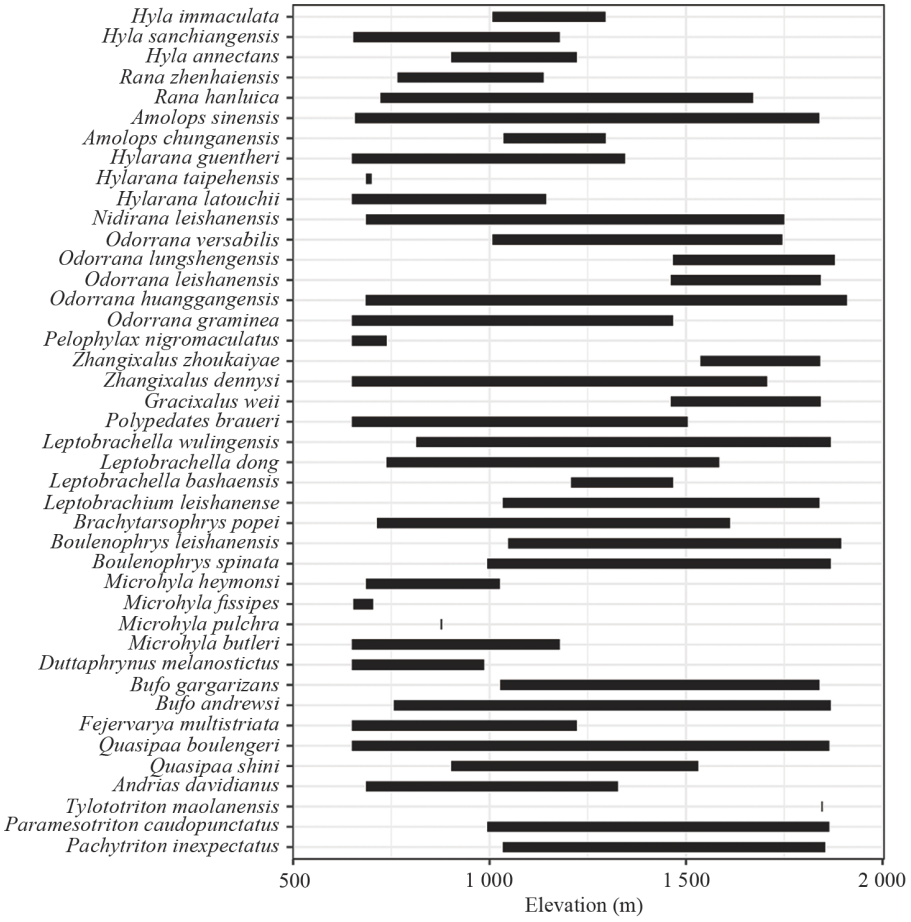


Figure 2 Elevational range size of amphibians on Mount Leigong.

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Supplementary information Supplementary information is available at https://doi.org/10.3724/ahr.2095-0357.2025.0044

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