Contributed Articles

Amphibians reach 9,000 described species: a summary of ongoing trends, challenges, and opportunities

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Amphibians have officially reached 9,000 described species, according to Amphibian Species of the World (Frost, 2025). Although considerable work remains, this benchmark in described species represents a major milestone for both taxonomy and conservation, resulting from thousands of individual studies conducted by countless amphibian research teams. Notably, these teams have persevered despite chronic underfunding, pandemics, and several other research challenges for this notoriously secretive and imperilled group (Gratwicke et al., 2012; Sterrett et al., 2019; Riccaboni and Verginer, 2022). Despite considerable hurdles, the number of recognised amphibian species has more than doubled within the past 40 years (Figure 1), and the number of annual new species descriptions (Figure 2) appears to have peaked only recently, at 180 and 179 new species in 2017 and 2020, respectively. Assuming an approximately logistic relationship between time and the number of recognised amphibian species (i.e., few species described at first, followed by a considerable spike in new descriptions originating in the late 20th century, and an eventual plateau later), true species richness is crudely estimable as double the known richness of the inflection point year (2017 or 2020), yielding ~15,000–16,000 total species as a reasonable (albeit highly uncertain) "best guess" (Murray, 2007). An empirical logistic model (fitting a global species accumulation curve (SAC) for amphibians better than alternative

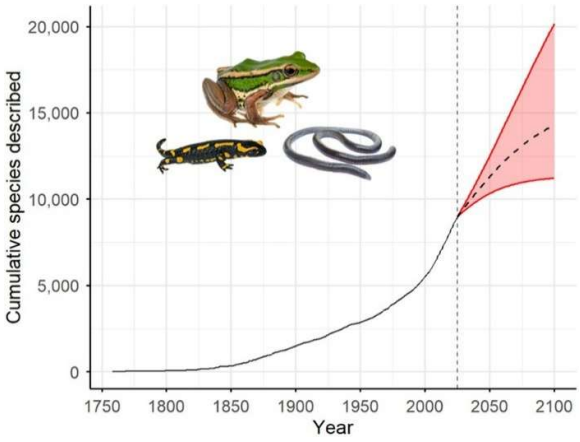

Figure 1: The cumulative number of described amphibian species by past year (solid line) until present (thin, vertical dashed line), plus a model-based estimate of future totals (thick dashed line) and 95% confidence interval (red shading). A logistic model was fit to past species description data while assuming a 2020 inflection point in the overall annual species description rate (see Figure 2). Data: Frost, 2025. Photos: Didier Descouens and Brian Gratwicke.

sigmoidal curve shapes, e.g., Gompertz) supports a similar conclusion, predicting 15,372 amphibian species overall, with a 95% confidence interval of ~12,000–20,000 species described by 2100 (Figure 1). A substantial number of amphibian species (potentially ~6,000–7,000, although perhaps far greater or fewer) thus likely remain undescribed, although cumulative knowledge of 9,000 species is nonetheless highly significant and may plausibly represent more than half of all species. Below, we summarise major trends in species descriptions across amphibian orders and continents and suggest potential implications for future research and conservation efforts.

Species description trends by order

Frogs, salamanders, and caecilians all continue to be described at rapid rates (Figure 3), albeit with large differences in absolute numbers. Anurans have been consistently observed as the most speciose amphibian group over hundreds of years and currently comprise ~88% of all known amphibians, with their dominance unlikely to change. Further, both anurans and salamanders (the latter representing ~9% of all amphibians) have followed the same general trend in descriptions as for amphibians overall, with a long, historical period of relatively slow species descriptions transitioning to a rapid spike in description rate near the end of the 20th century, possibly peaking in 2017–

2020, although subsequent higher peaks cannot yet be ruled out. Notably, although the description rate for both groups has slowed slightly in the past four years, it is not yet possible to disentangle SAC-based explanations for this decline from impacts of the COVID-19 pandemic, which slowed overall scientific research immensely (Riccaboni and Verginer, 2022). Compared to anurans and salamanders, however, even greater uncertainty exists for caecilians, as the relatively small number of species in this group (n = 231, as of mid-December 2025; only ~3% of amphibians) and onerous nature of studying them (Gower and Wilkinson, 2005; Wilkinson and Nussbaum, 2006)—often via manual excavation (Measey, 2004)—mean that the increases in known caecilian richness have been strongly influenced by individual flurries in new research, following a less stable long-term pattern than for anurans or salamanders. Therefore, while logistic model-based estimates predict a modest future attenuation in the number of new caecilian descriptions over time, predictions for this group should be viewed as exceptionally speculative.

Species description trends by continent

Amphibian biodiversity varies considerably between continents, but overall trends in species descriptions also appear driven—to an equal or perhaps greater degree—by historical sampling effort and regional development. Amongst amphibian species with geographic range data, the largest proportion (~37%) occur in South America, followed by Asia (~23%), North America (~17%), Africa (~15%), Oceania (~9%), and Europe (~1%; Frost 2025). However, these raw percentages do not provide a complete picture, considering that continents differ substantially in their size and current stage of biodiscovery. After correcting (crudely) for area by dividing each continent's proportion of globally known amphibians by its proportion of global (excluding Antarctica) land area (Briggs and Smithson, 1986), South America has by far the highest ratio (proportion of global amphibians ~2.8x higher than proportion of global land area), followed by Oceania (~1.6), North America (~0.9), Asia (~0.7), Africa (~0.7), and Europe (~0.2). Notably, Europe is by far the least amphibian-biodiverse continent (regardless of metric) yet has received arguably the most research attention and shows an approximate inflection point in its SAC in ~1895 (Figure 4), more than 100 years earlier than any other continent. In contrast, SACs appear to have reached an inflection point in ~2016 for Africa and Oceania, and ~2020 (or possibly later, depending on continental-scale COVID-19 impacts and exact ranges of newly-described species) for Asia, North America, and South America. Correspondingly, Europe, despite being the least consequential continent for amphibian conservation, is also the only continent poised to reach an asymptote in new species descriptions (i.e., describe nearly all species) by 2100. This trend not only reflects Europe's low overall biodiversity, but also an ongoing fundamental misallocation of research funds, in favour of economically privileged regions (Peterson and Bode, 2021; Zhang et al., 2023). Notably, this phenomenon also favours disproportionate research within large portions of North America and Oceania (specifically the United States, Canada, Australia, and New Zealand), but comparatively inadequate research funding in other portions of these continents (e.g., within Central America and Papua New Guinea) has ensured that SACs for amphibians in these continents are not yet nearing their plateaus. Only ~2% of known species occur on more than one continent, highlighting the exceptional endemism of amphibians in comparison to other major groups of vertebrates.

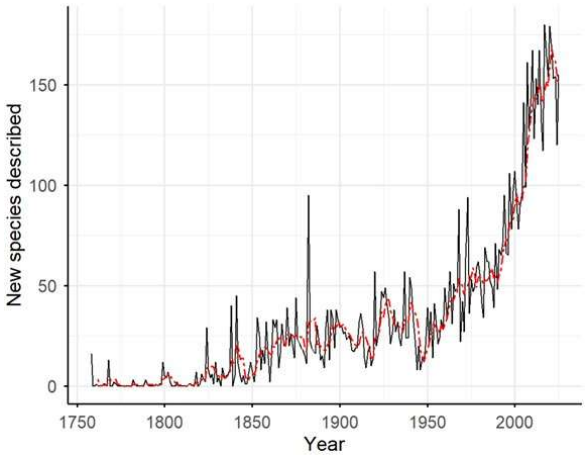

Figure 2: Trends in the description rate of new amphibians, showing actual annual trends (solid black line) and five-year running averages (dashed red line). Data: Frost, 2025.

Impacts of broader trends in taxonomy

Across all orders and continents, long-term trends in new amphibian species descriptions have been affected both by overall scientific interest and technological progress. For example, increased species description rates during the past several decades have coincided with increases in amphibian research overall (Womack et al., 2022). During the latter half of this period, modern, integrative taxonomy tools have also become rapidly more widespread and are now frequently used to describe new species (Streicher et al., 2020). However, the tendency for most new species

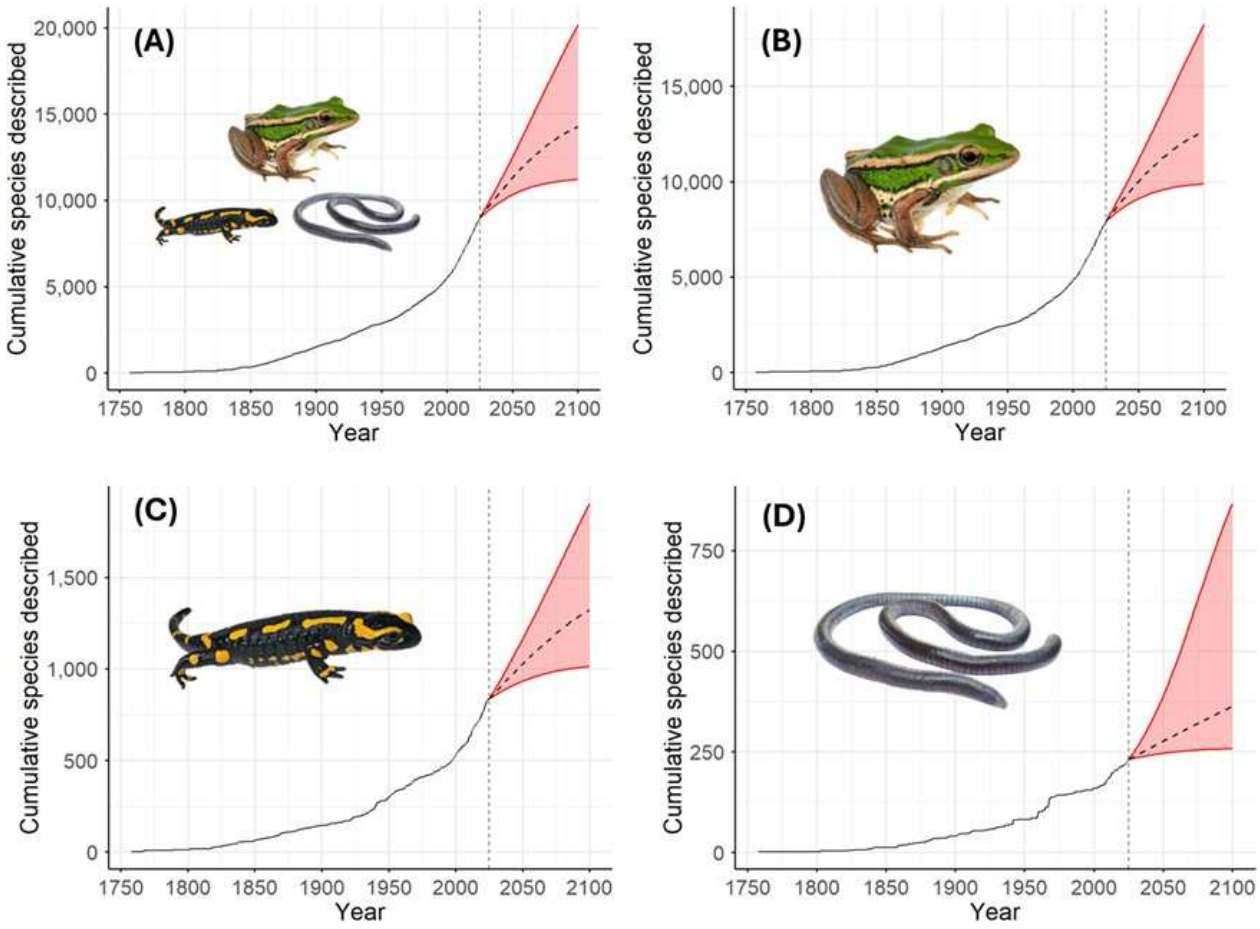

Figure 3: The cumulative number—grouped by taxonomic order—of described amphibian species by past year (solid line) until present (thin, vertical dashed line), plus a model-based estimate of future totals (thick dashed line) and 95% confidence interval (red shading). Plots represent all species (A), anurans (B), salamanders (C), and caecilians (D). A logistic model was fit to past species description data while assuming a 2020 inflection point in the overall annual species description rate (see Figure 2). Data: Frost 2025. Photos: Didier Descouens and Brian Gratwicke

to be described by taxonomists means that a shortage of these specialists can seriously limit description rates, even when access to relevant technology is high (Engel et al., 2021). As a result, the underappreciation of taxonomists by institutions and funding bodies — particularly in recent decades (Löbl et al., 2023)—has been implicated in "taxonomic impediment", wherein species are not described quickly enough to identify and address relevant threats to their conservation (Raposo et al., 2021). Relatedly, ongoing institutional pressures on taxonomy could ultimately decrease future rates of species descriptions beyond those projected by SACs, in turn limiting conservation assessment tools wherein species serve as fundamental units (Mace, 2004). If taxonomy remains undervalued, resulting threats to undescribed species may be severe overall: while nearly half of all described amphibians are threatened or declining (Luedtke et al., 2023), undescribed species are even more likely to be threatened (Liu et al., 2022) and may have extinction risks amplified by taxonomic uncertainty (Angulo and Icochea, 2010). Nevertheless, improved data-sharing between taxonomists and non-taxonomists may partially improve certain conservation outcomes, as this practice ensures that conservation assessments and management plans can be more rapidly formulated as new species are eventually described (Tapley et al., 2018).

Conclusion

The description of 9,000 amphibian species is nothing short of remarkable considering the ongoing taxonomy funding crisis (Al-Asif and Nerurkar, 2024). However, while overall species description rates have potentially peaked in the past decade (Figure 1), subsequent declines should nonetheless be considered modest and inconclusive given additional research challenges

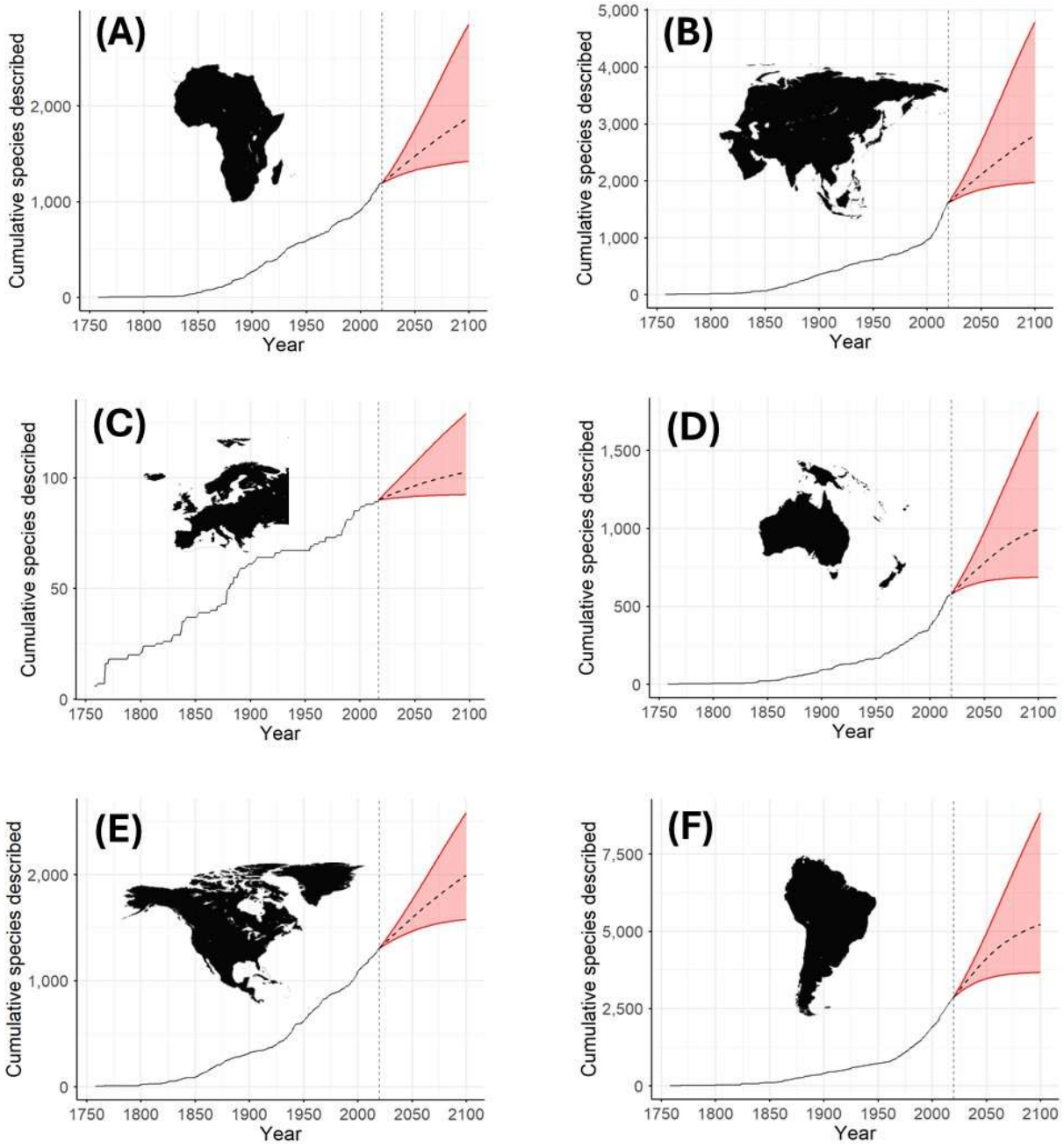

Figure 4: The cumulative number—grouped by continent—of described amphibian species by past year (solid line) until 2020 (thin, vertical dashed line), plus a model-based estimate of more contemporary and future totals (thick dashed line) and 95% confidence interval (red shading). Plots represent Africa (A), Asia (B), Europe (C), Oceania (D), North America (E), and South America (F). A logistic model was fit to past species description data while assuming an inflection point year of 2020 for Asia, North America, and South America, 2016 for Africa and Oceania, and 1895 for Europe. Threshold years were chosen for each continent based on its estimated peak in the rate of new species descriptions. Species described after 2020 were excluded from continent-specific models, due to a lack of available geographic range polygons for the majority. Data: Frost 2025.

posed by COVID-19 in these same years (D. Frost, pers. comm.). Regardless of the precise peak year for new species descriptions, any future plateau appears distant; 2025 has—as of mid-December—yielded >95% of the peak number of annual descriptions. Based on this continually high species description rate, it appears unlikely that fewer than ~3,000 additional amphibians will be described by 2100, with ~15,000–16,000 species

appearing as a reasonable "best guess" (based both on empirical models and rule-of-thumb heuristics) for the total number of extant species.

Based on a combination of the trends described herein and in previous studies, a simple but alarming thought experiment is possible. Assume that (a) a few thousand amphibian species (~2,000–8,000) remain undescribed by 2050 (Figure 1), (b) ~30–50% of these species are at risk of extinction without new conservation interventions (Luedtke et al., 2023), and (c) ~10–70% (unknown in practice; thus assigned a wide range) of these threatened, undescribed species will not incidentally benefit from other future conservation developments at a sufficient level to avoid extinction by 2050. The product of these three ranges of possibilities—which are intentionally cautiously broad—is that insufficient biodiscovery is on track to be implicated in 60–2,800 amphibian extinction events by 2050. These extinctions are likely—based on ongoing knowledge gaps (Figures 3–4)—to span all three amphibian orders, yet be particularly pervasive within South America, Africa, Asia, and underfunded portions of North America and Oceania. Therefore, augmentation and better allocation of taxonomy funding to these regions is urgently needed and may help prevent dozens (at minimum), hundreds, or even thousands of future extinction events, considering that describing new species is often an important first step towards conserving them (Costello et al., 2015). These steps will undoubtedly require rapid institutional overhaul in a manner that reprioritises taxonomy, while simultaneously deprioritising geographically misallocated (e.g., Eurocentric) research with roots in geopolitical inequality.

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