The Invisible Majority: Disciplinary Bias and the Systematic Neglect of Real Biodiversity

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ABSTRACT

Taxonomy underpins all biodiversity sciences, yet its essential role in measuring and managing life on Earth remains underrecognized in conservation and policy frameworks. Analyzing 360 articles from 12 leading ecology and taxonomy journals in 2024, we reveal that ecologists overwhelmingly focus on historically familiar vertebrates, while taxonomists emphasize recently described invertebrates—the overlooked majority of real biodiversity. These contrasting "Species Scapes" illustrate how disciplinary perspectives systematically shape what counts as biodiversity, with direct consequences for conservation and policy frameworks that depend on accurate taxonomic data. Integrating taxonomic expertise into biodiversity governance is essential for comprehensive policy implementation.

The structural threat to global biodiversity policy

Global efforts to halt biodiversity loss—from the Kunming-Montreal Framework to corporate disclosure under Taskforce on Nature-related Financial Disclosures (TNFD)—depend fundamentally on accurate taxonomic knowledge. Yet the scientific infrastructure providing this knowledge faces systematic undervaluation rooted in citation-based evaluation systems. Taxonomy, which builds biodiversity's foundational knowledge, remains structurally undervalued by citation-based evaluation metrics [1,2]. Unlike experimental research, taxonomic descriptions establish long-term knowledge infrastructure but generate citations slowly, particularly within the short two-year citation window used to calculate IF [2], contributing to a drastic decrease in the taxonomic profession [3].

Through an analysis of 360 open-access articles published in major peer-reviewed 12 journals in 2024 (Supplementary Information 1), we demonstrate that ecologists and taxonomists operate with fundamentally divergent perceptions of biodiversity. These divergent perceptions translate directly into biases and gaps in the data underlying conservation priorities and policy frameworks.

> *"Out of the millions of Umwelten, whose abundance would result in confusion, we shall pick out only those dedicated to the investigation of nature – the Umwelten of different scientists."*
>
> *— Jakob von Uexküll, A Stroll Through the Worlds of Animals and Men, in Instinctive Behavior, ed. C. H. Schiller, 1957 [originally published 1934]*

Two divergent Species Scape for biodiversity recognition

The concept of "Umwelt"—how organisms construct unique perceptual realities—applies to scientific communities. Ecologists and taxonomists operate within fundamentally different perceptual worlds. To visualize this gap, we adapted Wheeler's "Species Scape" concept [4]—which scales organism size to species richness—to reflect scientists' attention, scaling organisms to mention frequency across 360 articles from 9 ecological and 3 taxonomic journals (Fig. 1).

In the ecological Species Scape, charismatic megafauna dominate: mammals (26.75%) and birds (20.31%) take center stage, despite their relatively low global species richness [4]. By contrast, the taxonomic Species Scape presents a radically different picture: insects (27.55%) and other arthropods (19.56%) dominate, while mammals (3.79%) and birds (0.06%) are nearly absent. Organisms dominating ecological literature—often "Instagrammable" megafauna—are largely absent from taxonomy journals, where arthropods account for nearly half of all mentions.

This divergence is statistically significant (Supplementary Information 2), revealing systematic "taxonomic chauvinism" [5]: structural disadvantages faced by researchers studying less charismatic taxa. Although more than two million species have been formally described [6], the true extent of global biodiversity remains unknown [7], and many undescribed species face elevated extinction risks [8].

Previous studies have shown this taxonomic bias extends to conservation science [9, 10], where vertebrates receive disproportionate attention despite invertebrates facing comparable threats. Reliance on flagship and umbrella species may oversimplify ecological systems and fail to safeguard broader biodiversity [11]. Our analysis demonstrates this bias pervades ecological research beyond conservation. This spatial divergence in taxonomic attention has a temporal dimension that reveals its historical roots. This is not merely an academic issue: ecologists and taxonomists systematically focus on fundamentally different organisms, creating biases in the data that inform conservation and policy.

Temporal imbalance in focused species across disciplines

This temporal dimension is striking. The distribution of records across eleven 25-year intervals (1753–2024) reveals clear differences between ecological and taxonomic journals (Fig. 2). Ecological journals mentioned species described predominantly in the 18th century, with steep declines in later periods. In contrast, taxonomic journals showed substantial increases from the 20th century onward, with over 60% of mentioned species described after 1900. One possible explanation for this disparity lies in the difficulty non-taxonomists face in recognizing newly described species. Many of these organisms remained unnoticed even by taxonomists until recently, making it even more challenging for non-taxonomists to incorporate them into their research. This suggests that species recognition outside taxonomy has not substantially progressed since the Linnaean era (Fig. S1). This disconnect perpetuates a systemic neglect of newly described or morphologically inconspicuous species in broader ecological research. This finding reinforces the notion that ecologists and taxonomists operate with fundamentally different frames of reference. Ecologists tend to focus on vertebrates and conspicuous species in conservation and ecosystem service studies, while taxonomists shed light on species underrepresented in ecological studies and provide the foundation of biodiversity.

Policy Implications and the TNFD challenge

Taxonomy's foundational role becomes particularly evident in emerging global frameworks such as TNFD, where accurate species identification and occurrence records are prerequisites for evaluating nature-related risks and dependencies. As TNFD drives corporations to identify and manage their biodiversity dependencies and impacts, taxonomy—often dismissed as irrelevant in corporate settings—emerges as essential infrastructure. Despite biodiversity remaining largely overlooked in mainstream ESG assessments, emerging evidence suggests biodiversity-focused investment indices can deliver competitive financial returns [12]. The absence of taxonomic expertise within companies is not a reflection of its lack of value, but of the failure to recognize and measure that value. It is time for businesses to recruit and support taxonomists not only as scientists, but as enablers of sustainable decision-making, data credibility, and long-term stewardship of natural capital. For example, Li [13] argues that the education of financial professionals is key to addressing the underfunding of biodiversity conservation, which also indicates that the legitimate value of taxonomic findings is not being communicated. As calls for “biodiversity-informed policy” intensify, bridging this perceptual divide becomes ever more urgent. Without a taxonomic foundation, biodiversity disclosure frameworks risk measuring what is easy to count rather than what truly exists.

From academic value to socio-economic impact: the role of natural history and description

Despite being a cornerstone of biodiversity science, taxonomy continues to be undervalued. Taxonomic descriptions, regional checklists, and biodiversity atlases provide essential infrastructure but receive fewer citations than experimental studies. Broader reform movements—the San Francisco Declaration on Research Assessment [14], the Leiden Manifesto [15]—call for moving beyond journal-based metrics, yet citation counts continue dictating funding, hiring, and institutional rankings.

To align scientific incentives with societal goals, we propose the Discovery and Description (DD) Index (Appendix)—a novel evaluation framework designed to quantify the long-term contributions of taxonomic and descriptive research. Unlike citation metrics, the DD Index captures societal utility over decades, including adoption in policy frameworks like TNFD. Integrating it into biodiversity disclosure and funding mechanisms could realign incentives and strengthen global biodiversity governance.

The invisible majority—representing most of Earth's described species and facing elevated extinction risks—must become visible. Reforming evaluation systems to recognize taxonomy's foundational role is not optional; it is prerequisite for effective biodiversity governance. Specifically, we urge global financial bodies and conservation policymakers to adopt the DD Index as the standard metric for assessing and rewarding foundational taxonomic contributions, ensuring that TNFD and the 2050 targets are built on the reality of biodiversity, not the bias of Linnaean-era megafauna.

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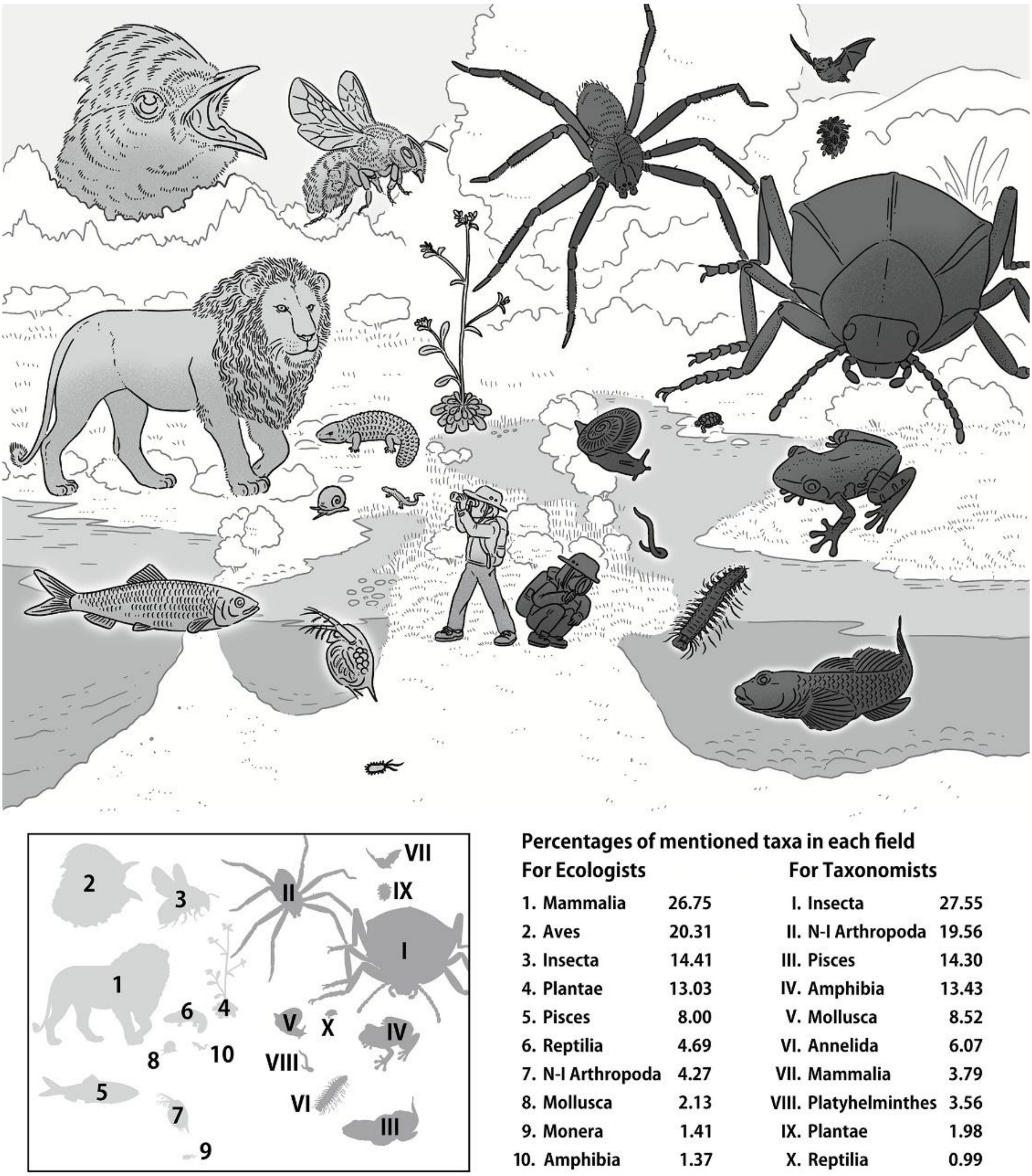

Percentages of mentioned taxa in each field

For Ecologists		For Taxonomists	
1. Mammalia	26.75	I. Insecta	27.55
2. Aves	20.31	II. N-I Arthropoda	19.56
3. Insecta	14.41	III. Pisces	14.30
4. Plantae	13.03	IV. Amphibia	13.43
5. Pisces	8.00	V. Mollusca	8.52
6. Reptilia	4.69	VI. Annelida	6.07
7. N-I Arthropoda	4.27	VII. Mammalia	3.79
8. Mollusca	2.13	VIII. Platyhelminthes	3.56
9. Monera	1.41	IX. Plantae	1.98
10. Amphibia	1.37	X. Reptilia	0.99

Figure 1. Divergent Species Scape reflecting the distinct 'Umwelt' of ecologists and taxonomists. Based on 360 articles (2024) from ecological (left) and taxonomic (right) journals. Organism size reflects mention frequency. Ecologists focus on charismatic vertebrates (mammals 26.75%, birds 20.31%); taxonomists highlight invertebrates (insects 27.55%, arthropods 19.56%). This statistically significant divergence (χ^2=1758.5, p<2.2e-16) demonstrates how disciplinary perspectives systematically shape biodiversity perception. Systematics follows Wheeler (1990); pie charts show taxonomic distribution across 18 major groups. Data in Tables S1-S4 and Fig. S3.

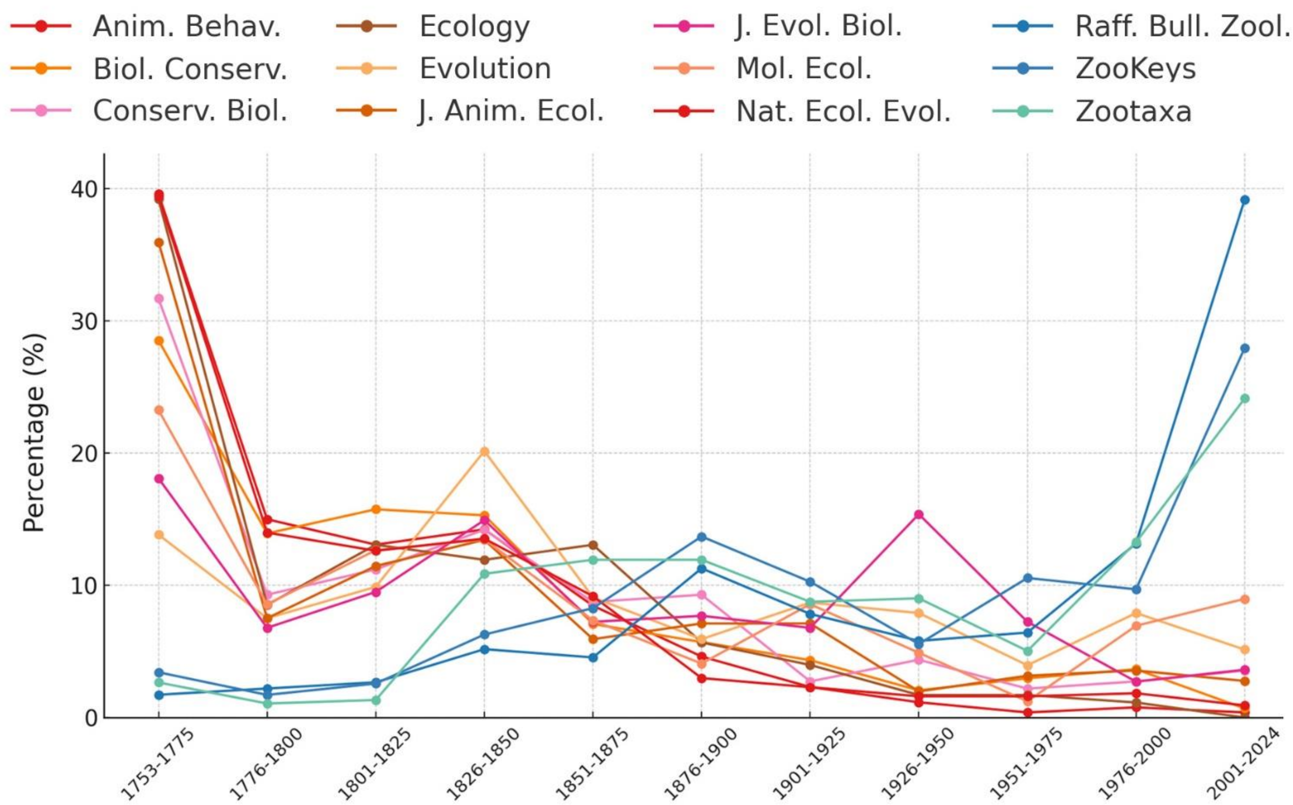

Figure 2. Temporal distribution of species description dates across ecological and taxonomic journals. Temporal distribution of species description dates across 12 journals shows relative proportion across 11 time intervals (1753–2024). Ecological journals (warm colors) predominantly mention species described in the 18th–19th centuries; taxonomic journals (cool colors) emphasize species described after 1950. This temporal divergence demonstrates that despite two centuries of taxonomic progress, ecological research remains anchored to Linnaean-era fauna.

Appendix: Discovery and Description (DD) Index

The DD Index evaluates taxonomic contributions using an h-index logic: a researcher has DD Index of h if h outputs each have Impact Score ≥h.

Impact Score components per output:

- Literature mentions: +1 each (peer-reviewed or not)
- Database inclusion (GBIF, WoRMS, etc.): +3
- Genetic data linkage (GenBank, BOLD): +3
- Conservation assessment (IUCN, national): +5
- Nomenclatural stability (valid ≥5 years): +10

This framework:

- Recognizes long-term infrastructure value
- Credits non-peer-reviewed but scientifically valuable outputs (regional checklists, museum bulletins, society reports)
- Employs additive authorship weighting (first author 100%, corresponding +50%, co-authors +30% each)
- Scales to institutional assessment
- Integrates with biodiversity disclosure frameworks (TNFD)

Implementation via automated text mining, database API integration, and community-driven calibration would align evaluation with taxonomy's societal relevance.

Supplementary Information 1

Materials and Methods

Data selection and journal sampling

We reviewed a total of 360 open-access articles in twelve major peer-reviewed journals published in 2024 (Table S1). From the list of open access articles published in 2024 from each journal, 30 were selected using random numbers (Table S2). Nine of the twelve journals are those in ecology, evolutionary biology, or conservation biology (*Animal Behaviour*, *Biological Conservation*, *Conservation Biology*, *Ecology*, *Evolution*, *Journal of Animal Ecology*, *Journal of Evolutionary Biology*, *Molecular Ecology*, and *Nature Ecology & Evolution*), and the remaining three were taxonomy journals (*Raffles Bulletin of Zoology*, *ZooKeys*, and *Zootaxa*). Purely theoretical papers and editorials that did not include any scientific names, as well as taxonomic monographs (e.g. checklists or distributional atlases) were excluded from analysis.

Species identification and classification

Scientific names of mentioned organisms in each article were systematically extracted and validated. The authorities and years of the original descriptions of the organisms were listed and synonyms were excluded following the taxonomy of databases (including GBIF, WoRMS, and original descriptive articles) where available, and manually verified otherwise (Table S3). For searching original description of scientific names, we used online databases (as listed above) when they were available. All organisms mentioned were identified as taxa according to Wheeler [4]. Although Wheeler's systematics does not correspond to the current systematics, we adopted the 1990 systematics for comparison with the Species Scape of that period.

Species Scape reconstruction

Distribution of mentioned taxa (Wheeler's group) across 12 journals are shown as pie charts (Figs. S2, S3), and we reconstructed the recent species scape in different disciplines (Fig. 1). Species Scape used the size of an organism on a landscape to indicate the relative number of species in that group [4]. To make an updated Species Scape for a split discipline, we constructed two parallel Species Scapes based on 360 published articles we reviewed (Tables S2 and S3): left side derived from species mentioned in nine ecological journals, and the right side from three taxonomic journals. We followed Wheeler's 18 major groups, and the symbolized organisms used are listed in Table S4. Taxa ranked eleventh or lower were omitted and not shown in Fig. 1.

Supplementary Information 2

Statistical Analysis of Species Scape Divergence

The statistical significance of the divergence in taxonomic focus between the ecological journals (N=9) and the taxonomic journals (N=3) was determined using a Chi-squared (χ^2) test of independence applied to the raw mention counts across the 18 major taxonomic groups defined by Wheeler (1990).

The analysis confirmed a highly significant difference in the distribution of attention between the two groups:

Chi-squared (χ^2) value: 1758.5

Degrees of Freedom (df): 17

P-value (p): $< 2.2e-16$ (The difference is highly significant)

Cramér’s V (Effect Size): 0.632 (Indicating a strong association between journal type and taxonomic focus)

These results confirm the observation from the Species Scape (Figure 1), demonstrating that the disciplinary bias towards certain taxa is systematic, not random, and represents a strong effect.

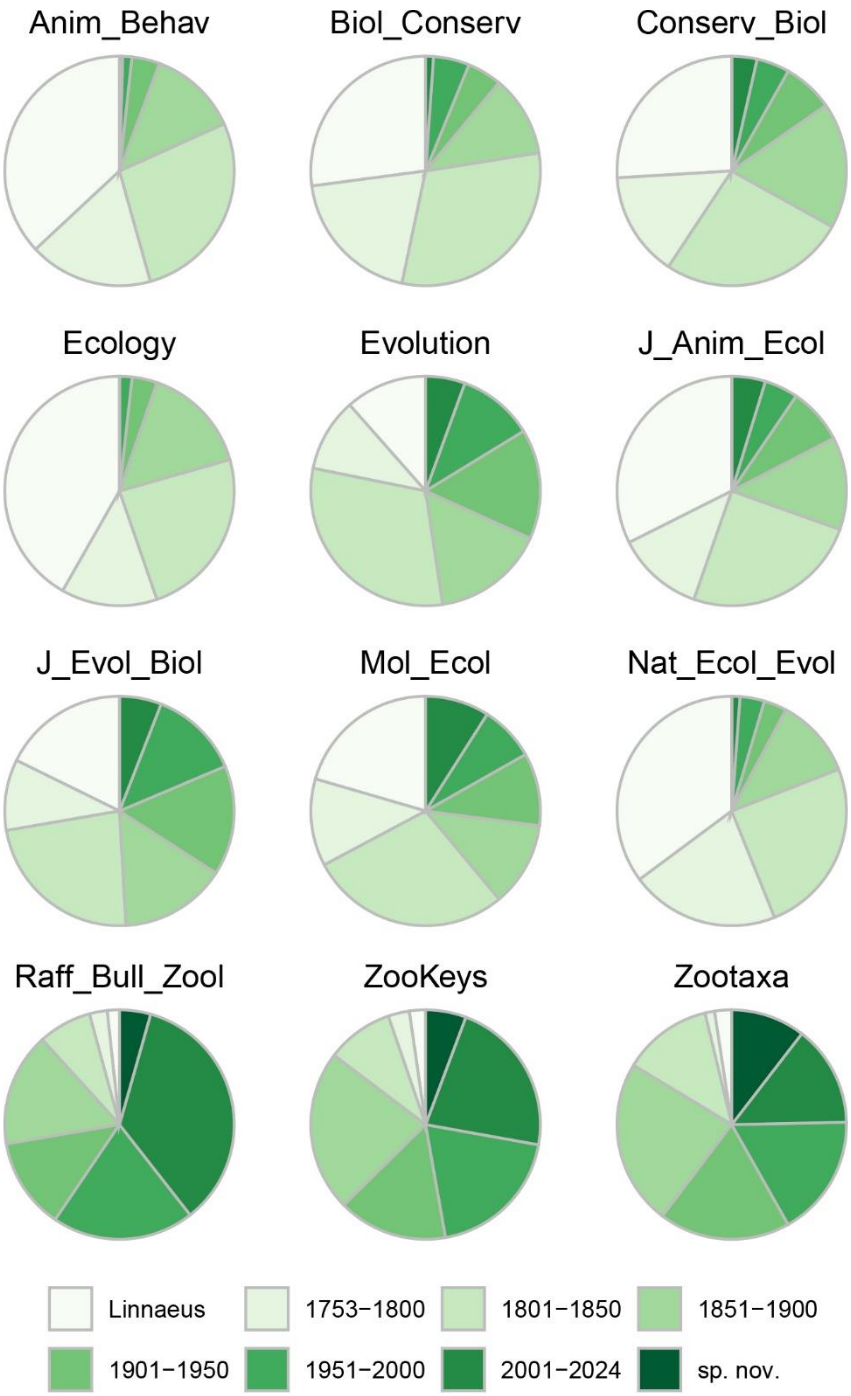

Figure S1. Temporal distribution of described taxa across 12 journals in historical categories. Each pie chart represents the proportion of described taxa across eight historical time categories: by Linnaeus (1753, 1758, and 1766), 1758–1800, 1801–1850, 1851–1900, 1901–1950, 1951–2000, 2001–2024, and as new species (sp. nov.). Linnaeus is positioned at the 12 o'clock mark in all charts, and slices progress counterclockwise. This panel further illustrates the stark contrast between ecological journals, which rely heavily on historically described taxa, and taxonomic journals, where newly described species dominate the recent decades. Both panels collectively demonstrate the significant temporal imbalance in species focus between ecological and taxonomic research.

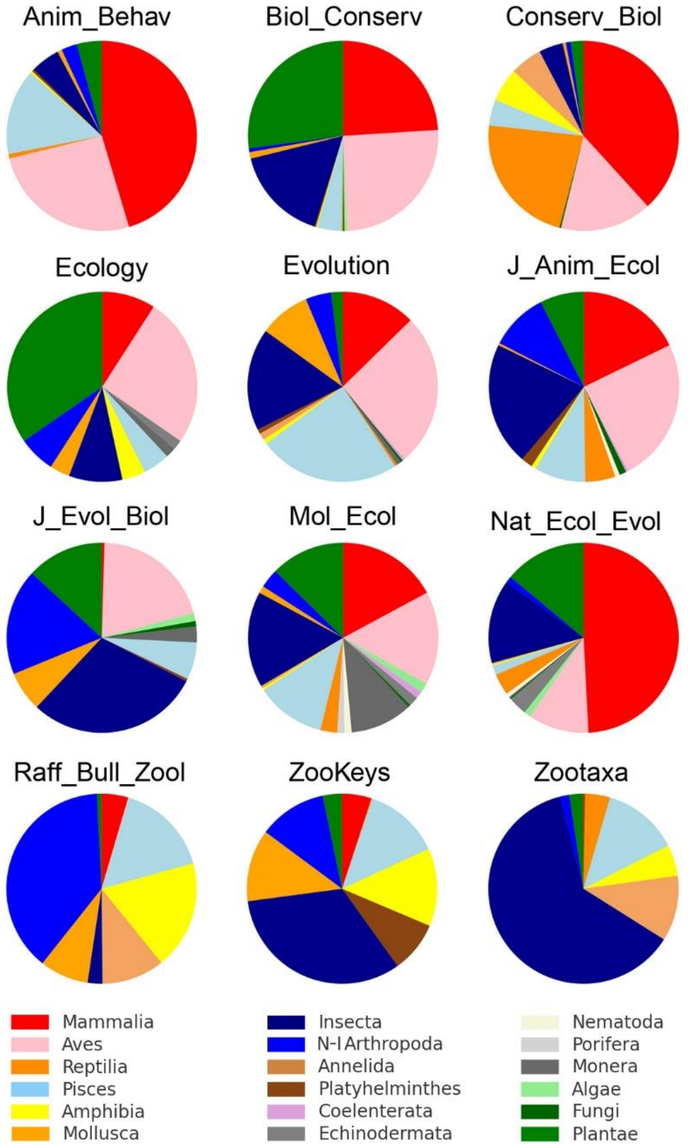

Fig. S2. Distribution of mentioned taxa across 12 journals.

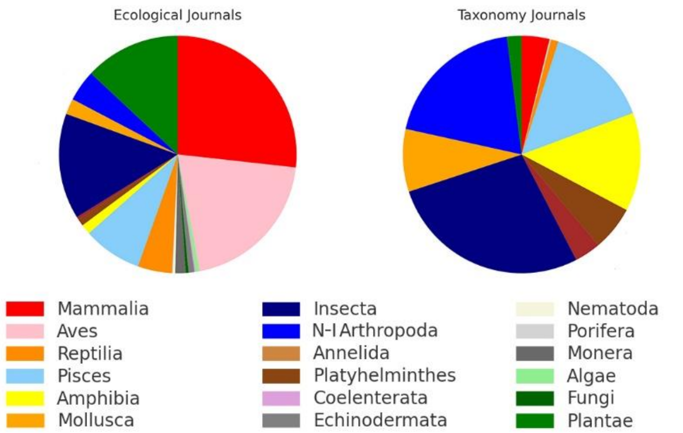

Fig. S3. Distribution of mentioned taxa in ecological and taxonomic journals.