

# Lost species, neglected taxonomy, and the role of natural history collections and synonymization in the identification of the World's forgotten biodiversity

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## Abstract

A recent paper highlighted the need for increased attention towards species that have vanished from scientific literature and proposed a new nomenclature in view of needed conservation actions, based on the time interval since their disappearance. Here, we propose to implement this concept by showcasing a taxonomic perspective that is often overlooked in conservation studies. In recent decades, research on vertebrates showed that, in several cases, species considered as undescribed were, in fact, first discovered and already named a long time ago. Quite often they fell into oblivion while being considered synonyms of other taxa until they were re-evaluated in subsequent taxonomic revisions. In this context, we are proposing the concept of “long-lost synonymized” species, asking for greater attention to the discipline of taxonomy, the relevance of specimen-based taxonomy and the value of natural history collections within conservation and academic communities.

**Key words:** Conservation, long-lost synonymized species, natural history museums, taxonomy, vertebrates



Academic editor: Klaus Henle

Received: 13 July 2024

Accepted: 7 September 2024

Published: 2 October 2024

ZooBank: <https://zoobank.org/4DB6682A-635D-49C0-BF9C-80E9B13E07BC>

**Citation:** Gippoliti S, Farina S, Andreone F (2024) Lost species, neglected taxonomy, and the role of natural history collections and synonymization in the identification of the World's forgotten biodiversity. *Nature Conservation* 56: 119–126. <https://doi.org/10.3897/natureconservation.56.132036>

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In a recent paper, Long and Rodriguez (2023) highlighted the cases of species that have dropped off science's radar and proposed a new nomenclature to guide conservation actions. They stated that species absent for at least 50 years should be termed “long-lost” species, those missing for more than 10 years as “lost species”, and those not found for 5–10 years as “missing species”. However, the authors omitted to address taxonomy in their contribution, a fundamental scientific discipline that itself can also be considered missing, threatened or lost. It is a well-known fact that the ranks of taxonomists are shrinking all around the world, and natural history museums (NHMs), where many of them usually work, are suffering a parallel decline in support (Pearson et al. 2011; Engel et al. 2021; Löbl et al. 2023).

In our opinion, unambiguously identified taxa are crucial to many biological disciplines, especially conservation biology, as they represent the first compulsory steps to enable the confirmation or rejection of any scientific study that

refers to them (Gippoliti and Amori 2002; Dubois 2003). More properly, Long and Rodriguez (2023) focused on distinct and poorly known vertebrate taxa. Obviously, no one can highlight and conserve species that are not yet known to science and/or that are not formally described, and for this taxonomy, once more, plays a crucial role. As a well-known fact, species must be formally described prior to being subjected to red list assessments, as undescribed and/or candidate species simply do not exist in terms of conservation priorities. This is why taxonomic actions are often, albeit informally, encouraged (i.e., Zachos et al. 2014).

We here report some cases regarding vertebrates, as they are better known and easier to deal with in terms of nomenclature and taxonomy. As a remarkable example we may cite amphibians, recently confirmed as the most threatened terrestrial vertebrates, with more than 41% of described species reported on IUCN Red Lists (8761 according to AmphibiaWeb 2024), but, at the same time, with many new species discovered and constantly being described (Luedtke et al. 2023). In fact, we believe that there is another category of “long-lost” species that are often overlooked by conservation literature: the synonymized (and often forgotten) taxa. Indeed, the 20<sup>th</sup> century was dominated by an overly synthetic and “lumping” approach to the study of biological diversity that resulted in a significant decrease in the number of recognized species, especially in vertebrates. Several nominal species were forgotten because they were synonymized or because they were moved to the sometimes-neglected sub-specific rank (Burgin et al. 2018). Such an approach concerns mainly the relatively well-known vertebrates, for which red lists are already available. For invertebrates the situation is quite different, with species often known from just a single specimen, the so-called “singletons” (Wells et al. 2019), and with red lists, with just a few exceptions (Neubert et al. 2019), missing.

As a consequence, the “taxonomic inertia”, a term used to describe the persistence of incomplete knowledge of biodiversity due to a lack of taxonomic interest during most of the 20<sup>th</sup> Century (Gippoliti et al. 2017), propagated the remarkable prevalence and persistence of taxonomic errors. So far, the subspecies category has lost much of its scientific credibility and therefore many subspecies were *de facto* forgotten by conservation biology (Gippoliti et al. 2018). Subspecies are often not even considered worthy of conservation attention except in a few cases, mostly involving charismatic animals such as the mountain gorilla *Gorilla beringei beringei* Matschie 1903 (Gippoliti and Amori 2007). Among mammals, other than the well-known example of primates (Rylands and Mittermeier 2014), even among supposedly well-known groups, such as felids, there are overlooked species and resurrection of old synonyms, such as in the case of the Neotropical genus *Leopardus* (Carnivora, Felidae) with the recent re-validation of *L. guttulus* Hensel 1872 (do Nascimento and Feijo 2017). African canids are also little known from a taxonomic perspective. For example, the newly identified lineage of the African wolf *Canis anthus* F. Cuvier 1820 (Rueness et al. 2011) probably includes several distinct species (Allen 1939) that were later considered subspecies of a phylogenetically distinct species, the golden jackal *C. aureus* Linnaeus 1758 (Ellerman and Morrison-Scott 1951) and that consequently disappeared from science’s radar for more than half a century. This seems to be the case for the recently observed wolf in Danakil that has been preliminarily assigned to *C. mensesi* Noack 1897 (Gippoliti and

Lupi 2020), a long-lost synonymized taxon. New World deer of the tribe Odocoileini offer a clear example of the effect of taxonomic inertia. At the end of the 20<sup>th</sup> century most authors recognized a total of 12 species in six genera (Corbet and Hill 1986). Nowadays, after a revival of interest in their taxonomy and the contribution of molecular techniques, the number of accepted genera is 10 with around 20 species (Gutiérrez et al. 2017; Morales-Donoso et al. 2023; Barrio et al. 2024). Interestingly, the 40% increase in recognized species in about forty years is almost completely due re-evaluation of synonyms (the only exception being the newly discovered *Pudella carlae* Barrio et al. 2024). *Bisbalus citus* Osgood 1912 (Artiodactyla; Cervidae) is another good example of a “long-lost synonymized” species. In fact, the genus *Bisbalus* is based on *Mazama americana cita*, a taxon that has been overlooked, as most other subspecies, for almost a century (Sandoval et al. 2024).

The importance of a revisionary and taxonomic working activity is even more evident in other speciose vertebrate groups, like amphibians and reptiles. In these cases, the intensification of field surveys and the use of integrative tools (i.e., biomolecular, acoustics, etc.) often leads to the reevaluation of the fauna of understudied geographic areas. Of course, the list of these works would become almost endless and is one reason for the continued description of new herpetological species (i.e., Köhler et al. 2005). As an example, in a recent work that described 24 new species in the genus *Mantidactylus* (Anura; Mantellidae) from Madagascar, a detailed comparison of historical museum types allowed the re-validation of four old taxonomic names that were formerly synonymized (and forgotten) for more than one century (Scherz et al. 2022). The availability of new techniques to extract genetic and genomic data from historical museum vouchers also led to the development of the exciting field of “museomics” that offers a further hope for filling a gap between natural history museums and biodiversity researchers (Fong et al. 2023). Furthermore, incorporating available names by generating molecular data for types of synonymized species is definitely feasible meanwhile and should be a standard protocol when describing new species using proper taxonomy. This would help in bringing these names back into scientific process and helping to avoid nomenclatorial chaos.

It is also well-known that the historical vouchers may be the only evidence for distinct and probably already extinct species, as is the case with the reptile *Lygodactylus neglectus* Ceríaco and Passos 2023 found in the herpetological collections of the Museu Nacional, Rio de Janeiro (Brazil) (Ceríaco and Passos 2023). First evidence for new species may originate directly from museum-based revisions, as in the case of the Somalian mole-rat *Fukomys ilariae* Gippoliti and Amori 2011 in the collection of the Museo Civico di Zoologia in Rome (Gippoliti and Amori 2011) or, more recently, the two new species of Neotropical small-eared *Cryptotis* shrews discovered at the Smithsonian National Museum of Natural History (Woodman 2023). In other cases, museum specimens offer definitive evidence regarding the former distributions of species and open new taxonomic questions, as is the case of the recently verified Mediterranean occurrence in historical times of the small-eye hammerhead *Sphyrna tudes* (Valenciennes 1822) (Carcharhiniformes; Sphyrnidae) confirmed by the (re)description of the specimen preserved in the NHM of Pisa University (Collareta and Farina 2023). This species is today reported only from the Atlantic coast of South America, from Venezuela to Uruguay (Pollom et al. 2020).

Hammerhead sharks have declined in the Mediterranean Sea by more than 99.99% since the late 19<sup>th</sup> century (Ferretti et al. 2008) and the reappraisal of historical sphyrid specimens from natural history collections could help to clarify the taxonomic identity and the true extent of species diversity, and its decline, in the Mediterranean Basin.

Finally, as reported by Wheeler (2024), we underline here the central role of natural history collections in systematics, and the pivotal role of NHMs as centers for taxonomic research and preservation of voucher specimens, thus reflecting species diversity as fully as possible, even of the most obscure taxonomic groups on Earth (Suarez and Tsutsui 2004; Fisher 2019). It is therefore crucial that taxonomists and museum communities persist, and are fully integrated, into worldwide efforts to map the biodiversity of the planet, including the specific mission to rediscover and conserve lost and long-forgotten species. Only with this in mind is it possible to re-align historical collections with the new role of biodiversity assessment. And, obviously, taxonomy plays an important role in resurrecting lost species, most of which are lost in museums. It is time that international bodies, such as IUCN, recognize that biodiversity conservation needs to be fully embedded in a wider vision that is fully aware of the crucial role of botanical and zoological collections and of the people that care for them and study them. Success relies on a future with a stronger collaboration between the conservation and taxonomy communities. This will certainly help in developing conservation actions that are urgently needed.

## Acknowledgements

We are greatly indebted to George Beccaloni and Quentin D. Wheeler for having read and improved this paper through their comments on an earlier draft. We also greatly thank Babu Saddam, Cristian Pertegal, Arni Sholihah, two anonymous reviewers, and Klaus Henle for having provided useful comments and integrations to our contribution.

## Additional information

### Conflict of interest

The authors have declared that no competing interests exist.

### Ethical statement

No ethical statement was reported.

### Funding

No funding was reported.

### Author contributions

Conceptualization: FA, SF.

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## Data availability

All of the data that support the findings of this study are available in the main text.

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