

# Cryptic species as a window on diversity and conservation

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**The taxonomic challenge posed by cryptic species (two or more distinct species classified as a single species) has been recognized for nearly 300 years, but the advent of relatively inexpensive and rapid DNA sequencing has given biologists a new tool for detecting and differentiating morphologically similar species. Here, we synthesize the literature on cryptic and sibling species and discuss trends in their discovery. However, a lack of systematic studies leaves many questions open, such as whether cryptic species are more common in particular habitats, latitudes or taxonomic groups. The discovery of cryptic species is likely to be non-random with regard to taxon and biome and, hence, could have profound implications for evolutionary theory, biogeography and conservation planning.**

## Cryptic species: the biodiversity wildcard

Increasing worldwide destruction and disturbance of natural ecosystems are precipitating catastrophic extinctions of species [1]. Given that most species remain undescribed, efforts to catalogue and explain biodiversity need to be prioritized. Research on cryptic species has increased exponentially over the past two decades (Figure 1), fuelled in large part by the increasing availability of DNA sequences. Identifying cryptic species (Box 1; see Glossary) challenged biologists and naturalists even before the Linnaean classification system was adopted [2]. Most species descriptions conform with what can be regarded as the morphological or typological species concept (Box 1) [3], because they predate Mayr's classic *Animal Species and Evolution* [4], which articulated the first incarnation of his 'biological species concept' now adopted by many biologists. Because speciation is not always accompanied by morphological change, the true number of biological species is likely to be greater than the current tally of nominal species, most of which are delineated on purely morphological grounds.

Unexpected genetic diversity within species throughout the tree of life prompts several questions about possible regional and taxonomic biases in our estimates of diversity. For example, are tropical biomes home to more cryptic

species than are temperate biomes? Do large, varied groups such as insects and fungi hide unknown numbers of new species? Genetic diversity within a 'species' also implicates underappreciated mechanisms of morphologically static cladogenesis (i.e. diversification of new species without morphological change). Moreover, misidentification of medically and economically important species in cryptic complexes [5–11] can have serious negative consequences (e.g. in fisheries management and pest control), and implications of cryptic species complexes for conservation [12,13] are sobering.

Here, we summarize the burgeoning literature on cryptic and sibling species (Figure 1) and describes its salient trends. Our emphasis on metazoan animals reflects the intended focus of this review and the existing bias in the literature, although we suspect that our conclusions apply more broadly across the tree of life.

## Glossary

- Allopatric:** populations or species with geographically separated ranges.
- Alpha taxonomy:** the description and naming of organisms.
- Clade:** a monophyletic group of organisms.
- Cladogenesis:** the evolutionary splitting of groups of organisms or, literally, the generation of a clade.
- Cryptic species:** two or more distinct species that are erroneously classified (and hidden) under one species name.
- Karst:** irregular (often limestone) formations often including structures such as caves, sink holes, underground water ways and abrupt outcroppings.
- Koinobiont:** parasitoids that allow their hosts to develop normally, often not killing the host for a relatively long time period, and therefore coexisting with the host.
- Monophyly:** the grouping together of an organism and all of its descendants in a clade.
- Morphological stasis:** lack of change in characteristics of gross external anatomy
- Parapatric:** populations or species with contiguous, nonoverlapping geographical ranges.
- Sister taxa or species:** two taxa that are derived from the same immediate common ancestor and are therefore.
- Sibling species:** a cryptic sister species; two species that are the closest relative of each other and have not been distinguished from one another taxonomically.
- Species flock:** a monophyletic group of closely related species all living in the same ecosystem; sometimes called a 'species swarm'.
- Sympatric:** populations or species with the same or overlapping geographical ranges.

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