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Neglected Biodiversity and the Current Extinction Crisis

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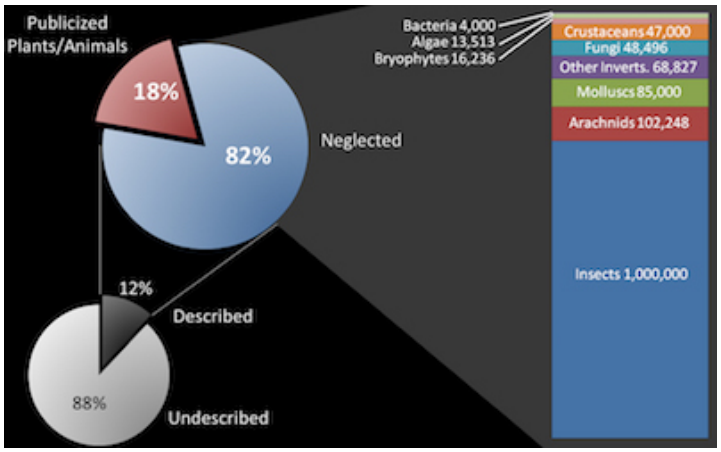
article highlights

- The majority of the world's estimated 12 million species have yet to be discovered.
- Neglected biodiversity spans the globe and has enormous unappreciated ecological value.
- Neglected biodiversity is often threatened but is rarely protected by regulations.

What is neglected biodiversity?



More than 14 million species are estimated to exist worldwide, of which approximately 1.7 million, or 12 percent, have been documented by scientists over the last three centuries. Well-studied and iconic groups of organisms such as plants, mammals and birds account for only about 18 percent of the total documented life on Earth. The other 82 percent, more than 1 million species, collectively constitute what we here call "neglected biodiversity," or species that are not recognized, understood, or appreciated by most people. Considering that scientists agree that the majority of the 12 million or so species remaining to be discovered also belong to the Earth's "neglected biodiversity," it is evident that much more than 82 percent of global diversity is "neglected."

Neglected biodiversity may be overlooked and underappreciated, but it covers an immense array of life forms, including many that are beautiful and eye catching (for example, striped land snails, elaborate stick insects, giant earthworms, and mushrooms that glow in the dark). Even those that may not stand out to the naked eye are hidden treasures of the natural world (such as tiny diatoms made of natural glass, delicate green algae, microbial communities that color the hot springs of Yellowstone, or tardigrades, the bear-like creatures that live inside moss and lichen cushions and carpets). Indeed, the

neglected 82 percent are some of the most remarkable and improbable products of millions of years of evolution.

Why is neglected diversity important?

Just because humans have neglected and overlooked a large percentage of global biodiversity does not mean that it lacks ecological value. Rather, the millions of species that are invisible to most of us perform a multitude of functions essential to the daily operation of ecosystems. Perhaps the most prolific and familiar groups of neglected biodiversity are fungi and invertebrates.

Fungi: More than 37,000 species of fungi likely occur in the United States[1], and estimates of the total number of species worldwide range from 700,000 to more than 5 million. Their networks of cells weave an invisible web of support in both natural and human-influenced ecosystems. Beyond just edible mushrooms and annoying molds, fungi are important as decomposers in land-based ecosystems. They also form intimate relationships with the vast majority of plants. These relationships are termed symbiotic, meaning that both partners benefit. Among the plants that benefit are crops crucial to human food supplies. Generally, the fungus facilitates water and nutrient uptake as well as pathogen resistance in the plant. Certain fungi form symbioses with algae and cyanobacteria, called lichens[2]. These collectively form structures that prevent soil erosion in arid regions and contribute essential services regulating humidity in forests.

Invertebrates: Of the estimated 1.2 million known species of invertebrates, 143,000 occur in the United States1. Invertebrates are not just beautiful butterflies, stinging jelly fish, and pests that plague apartments and crops, but also critical players in ecosystems. Their functions span a vast range. For example, they pollinate billions of individual plants—including vegetables and fruits such as apples that humans consume—and filter freshwater in rivers and lakes that provide water for multiple uses, including recreation. Invertebrates also constitute food for birds and other animals, including humans, who delight in consuming mussels, oysters, and scallops.

If even a fraction of neglected biodiversity went on strike—say, if insects stopped pollinating and fungi gave up decomposing—everyone would demand immediate action.

Neglected biodiversity is threatened but not acknowledged and rarely protected

Large scale extinctions are not a new challenge for life on Earth. Such events occurred repeatedly in the past, generally around periods of major global change. It is now widely accepted that the planet is in the midst of such a period. The era we live in has been termed the Anthropocene, because it is characterized by human-caused impacts so broad reaching that they are the most important force influencing environmental and geological processes. Across the planet, large numbers of species have gone extinct over the past 150 years, and many more are threatened by the compounding effects of habitat loss, invasive species, pollution, overexploitation, and climate change. Two of these phenomena in combination are particularly threatening to biodiversity. Irreversible habitat loss due to human activities has reduced the areas species that can occupy, in some cases dramatically isolating them to islands of suitable habitat surrounded by densely modified landscapes of cities, farms, and industry. Species surviving in these islands, already compromised by the fragmentation of the landscape, are increasingly threatened by the rapidly changing climate[3].

Human actions, direct and indirect, threaten vast numbers of species.

When we discuss the threats that habitat loss and global climate change pose, we typically think either about humans and human infrastructure or charismatic plants and animals that live in remote places. As a result, we tend to focus on just a small category of possible harms. For instance, when sea-level rise is discussed in the United States, people usually think about low-lying military infrastructure or cities along the Atlantic Coast, rather than threats to the diverse and important coastal ecosystems in the same region[4]. These ecosystems have already been affected by centuries of change caused by humans. Similarly, vast resources and attention focus on threatened iconic plants and animals[5], while untold numbers of less conspicuous or charismatic organisms, such as insects and fungi that perform vital ecosystem functions, face extinction in our own backyards[6].

Conservation resources are focused on iconic animals and not neglected biodiversity.

- The majority of conservation efforts worldwide focus on a tiny fraction of global biodiversity, although many more species, including much neglected biodiversity, are known to be under threat.
- Conservation strategies that highlight iconic plants and animals are based on the outdated assumption that patterns of biodiversity are the same for different organismal groups and that protecting one iconic species will benefit the neglected biodiversity that occurs with it[7].

- In the United States, the Endangered Species Act provides legal protection for 5 percent of plants and 8 percent of vertebrates, but only 0.01 percent of fungi and 0.17 percent of invertebrates.

The emphasis on very visible organisms in current conservation strategies is not because species other than plants, mammals and birds are faring well. Nor is it because we know too little about why fungi and insects are threatened to be able to do anything to reverse their declines. The stories of three fungi illustrate this point. We choose these examples because we know fungi best. These species are well known and easily identified by scientists, yet they are neglected by policymakers and largely ignored in discussions of conservation—even though we know what is threatening them and could reverse the threats by changes in management and policy.

- **Hot dots (*Arthonia kermesina*)** is a small fungus that lives only on the bark of large old red spruce trees in old growth forests at the highest peaks of the southern Appalachian Mountains of North Carolina and Tennessee. Historical logging reduced by 90 to 99 percent the habitat available for this species to occupy. Acid deposition from air pollution, coupled with large-scale tree die-off from an invasive insect, further reduced and degraded hot dots's habitat. Now, the few populations that remain are likely to disappear by 2070 as a result of climate change.
- **Dey's moon lichen (*Sticta deyana*)** is a fungus that forms brown rosettes that have tiny orange holes on their lower surfaces. It lives only on the bark of trees in old-growth forests, and 99 percent of the known living individuals occur within a tiny area of coastal North Carolina that is predicted to be inundated by rising seas within the century. The species is sensitive to air pollution, and the same populations are within a short distance of a proposed highway expansion that would reduce and degrade their only remaining habitat.
- **Fisherman's dream (*Usnea angulata*)** is a large, beard-like fungus that once hung from trees from Maine to Florida, forming greenish masses that resembled Spanish moss. Since the Industrial Revolution, it has disappeared from over 90 percent of its range and now occurs in only a few old-growth forests in the southern Appalachians and the Ozarks. Most of the remaining populations occur on American hemlock (*Tsuga canadensis*), a tree that in recent years has been decimated by an invasive insect. Many large old hemlocks in the Great Smoky Mountains, viewed by millions of tourists annually, were festooned with the species. Now the forest floor in some areas is littered with fallen trees covered in dying fisherman's dream.

Interpreting the loss of neglected biodiversity

Many people find it hard to understand the decline and loss of neglected biodiversity, because it involves large numbers of species distributed throughout all ecosystems. Further, the losses are so common, particularly in densely populated areas, that in the twenty-first century the majority of the public perceives a degraded and altered natural landscape as normal. Lichens, for example, are in widespread decline.

The loss of neglected biodiversity is readily visible if you know what to look for.

- **Lichens** perform vital ecosystem services from nitrogen cycling to soil formation. More than 25,000 species are known, of which more than 4500 occur in the United States and Canada. In ecosystems from deserts to rainforests and even the arctic tundra, lichens should be abundant and diverse, covering every surface from leaves to rocks with dense mosaics of color. However, since the Industrial Revolution (approximately after 1850) sharp declines in the abundance and diversity of lichens have been documented. These declines occurred because, although their symbiotic lifestyle allows them to thrive in harsh environments, it leaves them sensitive to air pollution and disturbance. Regions such as the eastern United States now have vast areas where lichen diversity has been greatly reduced or nearly eradicated. Reductions in sulfur dioxide and other air pollutants following the Clean Air Act of 1973 have allowed some lichens to recolonize their former ranges, including even urban centers such as New York City and Washington, DC. Recolonization remains incomplete, however, and most species are still impaired.

The downstream impacts to the environment and human health and wellbeing that result from the loss of neglected biodiversity remain little studied. Nonetheless, because most US landscapes are now deficient or even devoid of lichens, few Americans have experienced the striking colors and textures that lichens provide in a healthy ecosystem.

What can be done?

Current projections of the future of global biodiversity under business-as-usual scenarios are worrying. More than half (about 52 percent) of vertebrate biodiversity on earth will likely be extinct by 2104. Trends and projections for millions of species of neglected biodiversity are far from certain. However, it is clear that they have already been greatly affected and will continue to be. Rather than allowing neglected biodiversity to disappear in silence, concerned members of the public can follow numerous avenues to bring about immediate action aimed at the situation.

- **Establish and increase targeted funds to study neglected biodiversity.** Currently, in the United States and Canada, no targeted state or federal programs are aimed specifically at improving and expanding scientific knowledge of neglected biodiversity. Such programs are essential so that scientific knowledge can catch up with that on groups such as vertebrates and plants, which have traditionally garnered the majority of research funds
- **(Re-)Build scientific capacity.** The need for a diverse and highly trained body of scientists to address the knowledge gaps and conservation needs of neglected biodiversity has never been greater, yet basic research on biodiversity has been in decline for decades. Research programs and positions at local institutions such as city and state museums, major research universities, and even national institutions such as the Smithsonian have been cut. This has had disproportionate impacts on the study of neglected biodiversity. Recognition and support of research focused on generating high-quality data on neglected groups must become a priority for governmental and non-governmental organizations to reverse historical trends.
- **Enhance communication and collaboration between those that study neglected biodiversity and those responsible for conservation.** Along with building scientific capacity for neglected biodiversity is the need to foster collaboration and communication among the biologists, nonbiological scientists, and policymakers responsible for conservation and natural resource management. Improving knowledge of neglected biodiversity can reverse the threats only when it is effectively shared and interpreted for a variety of experts and professionals.
- **Inform society.** One of the overarching issues that plague neglected biodiversity is a lack of recognition, or worse, negative public perceptions of, the problem. Creating curricula, training educators and students, and reaching out to the public are essential to fostering an informed society that values all of biodiversity.
- **Advance conservation efforts for neglected biodiversity.** There are many examples of insects, fungi, and other types of neglected biodiversity that are known to be threatened but are not protected by state, federal, or international laws. Moving to formally protect such species, developing recovery plans, and implementing such efforts in tandem with public outreach could be undertaken immediately. The same actions should be taken to formally recognize, protect, and manage regions that harbor hotspots of neglected biodiversity, which have been overlooked as conservation priorities because they do not host more visible organisms. An example of such an area is the Albemarle–Pamlico Peninsula of coastal North Carolina, which hosts important and unique lichen communities that are threatened by diverse forces, including sea-level rise.

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