Importance Of Species Definitions In Conservation: Taxonomy

Abstract

Taxonomy is complex and has many different criteria for distinguishing between species. The different definitions of a species can create problems in research, as a clearly defined group is important in experiments and field studies. Additionally, distinguishing between species is important for the conservation of threatened organisms, as accurate population counts can only be obtained with a clear group of concern. Furthermore, defining a specific population is important in receiving funding and targeting management efforts for conservation. In North America, the definition of a species has been a big concern in looking at the carnivorous family of Canidae that inhabit the continent. Specifically, this paper explores the taxonomic status of eastern wolves (Canis lycaon) and red wolves (Canis rufus), and their relations to gray wolves (Canis lupus) and coyotes (Canis latrans). Different interpretations of which populations constitute species have conservation impacts, as C. lycaon's status as a separate species is being reconsidered, and the status of C. rufus is controversial. If their status as threatened species is revoked, then efforts to protect these groups will decrease.

Defining a Species

Every discovered species has a name, and this is essential for communication in the scientific community. From looking at predator-prey relationships, migratory patterns, or the effect of pollution on a certain species, scientists need to be confident that the group of individuals they are studying are one and the same— that they have the same anatomy and physiology, exhibit the same behavior, and are able to reproduce. Species are differentiated through the combination of several different species concepts: evolutionary, phenetic, biological, and phylogenetic. Some species may meet the requirements of one or several different species concepts, and require taxonomists to use combinations of these concepts. Looking through the scope of one definition may define species differently than others, such as in the case of classifying polymorphic or cryptic species in the phenetic species concept, as it looks at phenotypes of individuals. Consequently, defining a species is often not clear, as there are various approaches with multiple interpretations, which can cause confusion, disagreement, and discrepancy.

In addition, hybridization, or mating between two species, can further complicate the definition of a species, as gene flow between two groups makes them more difficult to distinguish with genetic analyses. Furthermore, parapatric speciation, or speciation that buds from a particular population, can create hybrid zones, or areas where different species reproduce to form hybrid offspring with complicated gene flow. Consequently, taxonomic assignment is intricate, and this can create problems not only in studying different organismas, but also in the conservation of different species.

Importance of Species Definitions

Defining species is especially important in looking at conservation management, and the complications presented can obscure strategies and the possibility of funding for conservation efforts. To assess population sizes, a vital aspect of conservation, scientists need to know which organisms to count. This allows proper estimates of different group sizes, and also allows researchers to measure vital rates of population growth such as birth rates, death rates, and fecundity and other demographics such as the age structure of a population and the ratio of males to females. This produces targets in which to focus efforts (Mace, 2004). Lists such as the International Union for Conservation of Nature (IUCN) Red List or Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provide a place for policymakers to determine which organisms are worth allocating resources to, on the national and international level (Mace, 2004). However, lists such as these are subject to change due to changing definition of species and further genetic research (Mace, 2004). If a species is taken off the list, the value of conserving the group decreases, and policy makers may believe that the species no longer needs human intervention (Mace, 2004).

In the United States, an important policy regarding conservation is the Endangered Species Act, or ESA. The ESA has a broader definition of a species, where a species is not only the classically defined species, but also unique populations in a defined geographic area or subspecies of any species that can reproduce once it is mature (National Academies of Sciences, Engineering, and Medicine, 2019). This expansive view of species of the ESA promotes preservation of biodiversity, and it provides more flexibility if a distinct population's status as a species is changed, which can happen with increased amounts of research (National Academies of Sciences, Engineering, and Medicine, 2019).

The canids of North America are impacted by the ESA of the United States, and their status as different species has important conservation implications. Presently, the gray wolf, Canis lupus, and the endemic coyote, Canis latrans are two canids that roam North America as accepted species, while two more large predatory canids are not as well defined. The red wolf (Canis rufus) inhabits southeastern United States, and the eastern wolf (Canis lycaon) occupies the eastern Great Lakes Region, primarily in Algonquin Provincial Park and adjacent parts of Ontario (vonHoldt et al., 2016). However, these wolves' position as species are often questioned, as there are many interactions between the other canids of North America. This ambiguity challenges the status of the eastern wolf as a threatened species and is being reconsidered by the Committee on the Status of Endangered Wildlife in Canada, while C. lupus have been removed from the US endangered species list (Rutledge et al., 2015). C. rufus were listed in 1967 under the Endangered Species Preservation Act as endangered, however, their listing and recovery efforts are controversial because of discrepancies about their evolutionary history and current status (Waples et al., 2018). If removed from important conservations lists such as the Endangered Species Preservation acts, then these important Canid groups can lose important funding, research, and management efforts for their survival. In order to examine whether these populations are separate species, researchers use genetic analyses of modern wolves and old samples of wolves, along with comparing physiology and morphology of the different groups.

Species status of the Eastern Wolf (Canis lycaon)

There are three main hypotheses in examining the distinction of Canis lycaon species. The first is the C. lupus subspecies hypothesis, stating that the eastern wolf (C. lycaon) is a subspecies

of C. lupus (Kyle et al., 2006). Nowak (2002) looked at sizes of canid skulls in North America and suggests that this is the case. He found that C. lycaon is an intermediate size between C. rufus and C. lupus, arguing that this resulted from hybridization of these two species (Nowak, 2002). However, this hypothesis is unsupported by much modern molecular data, where Wilson et al. (2003) looked at 8 microsatellite loci of C. lycaon wolves in Algonquin Provincial Park from 1960-1965 and found that none of these wolves shared mtDNA sequences with the gray wolf (C. lupus).

The second hypothesis is that C. lupus and C. latrans have mated to create a distinct hybrid, deeming it as not a separate species (Kyle et al., 2006). In captivity, wolves and coyotes have produced healthy hybrids that have produced healthy offspring, proving it possible, but has it happened in nature (Mech et al., 2017)? If so, a hybrid is not considered a distinct species, unless it is able to reproduce. In looking at mitochondrial DNA from twenty-six populations of gray wolves, Wayne et al. (1992) found that out of eighteen populations of mitochondrial DNA, seven are derived from hybridization with coyotes. They argue that this is due to high amounts of habitat fragmentation, where coyote populations thrived and wolf populations diminished (Wayne et al., 1992). Additionally, the eastern wolf phenotype is a continuum of sizes, and this variation has been attributed to interspecific hybridization between C. lupus and C. latrans or a phenotypic plastic response in prey size (Wilson, 2012). However, there is conflicting molecular data: principal components analyses contain no evidence to support that eastern wolves are hybridized products of gray wolf and coyote (Rutledge et al., 2015). Additionally, in looking at genetic sequences of haplotypes, sequence divergence and eastern-specificity of Zfy-4 haplotypes point towards a long evolutionary history of C. lycaon in North America, where the analyzed genetic markers suggest a closer relationship between C. lycaon and C. latrans than to C. lupus, suggesting it is not a product of C. lupus evolution (Wilson et al., 2012).

However, this does not mean coyotes are not hybridizing with wolves. Kays and Kirchman (2010) found Northeastern coyote skulls are larger than Western coyote relatives with craniodental characteristics similar to wolves with greater areas for masticatory musculature, and they are proportionally broader. These larger coyotes can become hunters for larger prey, as they have wolf-like jaw adaptations that are associated with strong bites and resistance to movements such as fighting, larger prey (Kays and Kirchman, 2010). In studying C. lycaon, it has been shown that these hybrids fill an intermediate niche, including better success in human-altered landscape, in comparison to the parental groups of C. latrans and C. lupus (Otis, 2017). If these hybrids are able to reproduce, then they can be considered a new species, with a new role to fill in the ecosystem. However, in Algonquin Provincial Park, although genetic structuring analyses of mitochondrial, Y chromosomal, and autosomal microsatellite genetic data suggest gene flow between the three canis species of C. lupus, C. lycaon, and C. latrans in a hybrid zone, they are maintained to be separate species (Rutledge et al., 2010).

The third hypothesis examining the distinction of Canis lycaon species suggests that it is a distinct species originating in North America, where it shares a recent common ancestor with C. latrans (Kyle et al., 2006). Evidence shows that Canadian populations of C. lycaon have a group of mtDNA sequences more closely related to that of C. latrans than those of C. lupus (Wilson, 2000). Further support for this hypothesis is found in the absence of C. lupus mtDNA from sampled wolf skins from the 1800s (Wilson et al., 2003). Eastern wolves in Algonquin Provincial Park are a genetically differentiated group of C. lycaon, with a common evolutionary lineage with C. latrans and C. rufus, so since there is no relation to C. lupus, this refutes the hypothesis that C. lycaon are a subspecies of C. lupus (Rutledge et al., 2011).

Species status of the Red Wolf (Canis rufus)

The red wolf, Canis rufus, is a small wolf-like canid that was driven to extinction by the middle of the 20th century, and now only exists as a captive population and small experimental population in the wild (Gese et al., 2015). Although historical C. rufus constituted a taxonomically valid species, much like Canis lycaon, the contemporary red wolf's status as a distinct species is questioned, with several hypotheses explaining its evolutionary origin (National Academies of Sciences, Engineering, and Medicine, 2019). One hypothesis is that C. rufus is a distinct lineage that evolved in North America from C. latrans (Waples et al., 2018). This is supported in genetic analyses, where evidence shows that C. rufus has a group of mtDNA control region sequences more closely related to that of C. latrans than those of C. lupus (Wilson et al., 2000). Further support for this hypothesis is found in the absence of C. lupus mtDNA of 19th century wolf skin samples (Wilson et al., 2003). This hypothesis has the most support, in which there is evidence from morphology, behavior, ecology, and genetics (National Academies of Sciences, Engineering, and Medicine, 2019).

Another hypothesis is that C. rufus are a specialized subspecies of C. lupus for eastern forests (Waples et al., 2018). This hypothesis suggests that eastern forests were populated with smaller forms of C. lupus that specialized on predating deer after hybridizing with C. latrans (Waples et al., 2018). It is pointed out that changing environmental conditions during the Pleistocene and Holocene had the ability to promote hybridization between species, however there is little empirical evidence to support this (Waples et al. 2018, Mech et al., 2011). Leading researchers all agree that there is hybridization in southeastern United States C. latrans and C. rufus in the 20th century, however, there are possible prezygotic isolation mechanisms differences between C. latrans and C. rufus in the form of behavioral and morphological differences (National Academies of Sciences, Engineering, and Medicine, 2019).

Causes for Interbreeding between Canids

There are many factors that have influenced the interbreeding between canids and the confusion this has created, including genetic muddling due to hybridization between species. One of the primary drivers of hybridization is decline in wolf populations due to humans. In the early 1900s, people eliminated the wolves east of the Mississippi river, and they disappeared from the wild by 1980 (Nowak, 2002). With lack of individuals to mate with, wolves may have resorted to mating with coyotes. Studies have shown that eastern wolf culls lead to a loss of genetic diversity and may intensify hybridization with coyotes (Rutledge et al., 2011). Additionally, the closely related species may have been brought together by landscape changes and expansion of foreign species (Rutledge et al., 2011). With changes in the environment and expansion, different species of canids may come into contact with other species they previously did not have access to, promoting reproduction. Along the hybrid zone near Algonquin Provincial Park, there was evidence to suggest that variable environmental conditions explain the genotype variation in wolves and coyotes, where body size increases on a gradient, and hybrid progeny exhibit morphology intermediate to parental types (Benson et al., 2012). Gene flow due to hybridization may entangle the different species in a manner that makes genetic analysis less concrete.

Implications

The status of these different canids is a complicated issue, with no clear answer about which species can be distinguished as its own. This has potentially serious ramifications. Definitive definitions of the canids in North America is vital in ensuring their conservation, especially in a time where conservation laws are being weakened. In August of 2019, President Donald Trump's administration made drastic changes in the Endangered Species Act (Lambert, 2019). Species that are considered threatened and not endangered now will receive protections only if the case has been studied and deemed worthy of protection (Lambert, 2019). Additionally, they removed language prohibiting the consideration of economic impact of species, putting a monetary value on biodiversity (Lambert, 2019). Because of the weakening of this vital protection act and a movement towards ignoring the economic value of species, knowing the conditions of the United States' fauna is essential in protecting different species.

Conclusion

Taxonomy is essential in science, and serves particular importance in conservation with implications for management, funding, and research. However, defining a species is difficult, as can be seen in looking at the canids of North America, particularly the status of C. rufus and C. lycaons. As more research comes out, different hypotheses are supported and rejected, but it is imperative to define these groups. More research in combining both historical samples and more recent advancements in genetics may be looked at in order to secure the status of these different canids. Furthermore, stronger definitions of what constitutes a species may clear the complicated nature of taxonomy. Nevertheless, coming to a strongly supported status on the North American canids is crucial for their protection and proliferation.