SPECIES: THE CORNERSTONE OF BIODIVERSITY

AN EXAMINATION OF HOW SPECIES DIVERSITY IS THE KEY TO A HEALTHY PLANET, AND A CLOSER LOOK AT A MAJOR TOOL USED IN BIODIVERSITY CONSERVATION

4

Kathryn Pintus, IUCN

So far, we've had a look at genetic diversity, and we've learned that genes are responsible for the wide variety of species that exist on Earth. But what exactly is a species?

A species is a basic biological unit, describing organisms which are able to breed together and produce fertile offspring (offspring that are able to produce young). The above statement is a fairly widely accepted definition, and in some cases it is easy enough to determine whether two organisms are separate species simply by looking at them; the mighty blue whale is clearly not the same species as the fly agaric mushroom.

A BANANA SLUG EATING A RASPBERRY AT A CAMPSITE IN REDWOOD NATIONAL PARK, CALIFORNIA, USA.

However, the situation is not always quite so straightforward. The science of describing and classifying organisms is called **taxonomy**, and this provides us with a common language that we can all use to communicate about species, but it can get rather complicated! Biology is split into several fields, including botany, zoology, ecology, genetics and behavioural science, and scientists from each of these branches of biology will have slightly differing definitions for what constitutes a species, depending on the focus of their specialty. For instance, some definitions will be based on **morphology** (what it looks like), others on **ecology** (how and where it lives), and others still on **phylogenetics** (using molecular genetics to look at evolutionary relatedness). For this reason, when considering two **organisms** which on the surface may look almost identical, scientists sometimes disagree as to how to classify them. Are they individuals of the same species or are they two completely separate species? Or are they perhaps **subspecies**? Having said that, taxonomy can be very useful (see the box: "How Does Taxonomy Help Biodiversity?" for more details).

BLUE WHALE.
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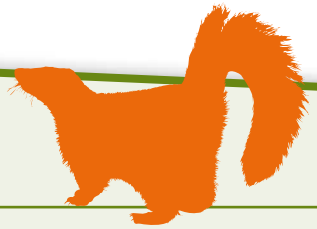
To complicate matters further, some individuals of the *same* species may look considerably different from one another, perhaps due to their sex or as a result of their geographical distribution. The trait whereby males and females look different from one another is known as **sexual dimorphism**, and can be seen in many species, particularly in birds.

Scientific disagreements aside, there are about 1.78 million described species on Earth, with millions more out there that we don't even know about yet. That's an incredible amount of biodiversity, but unfortunately much of it is being lost, and it is possible that we are losing some species before we even have the chance to discover them.

FLY AGARIC MUSHROOMS AT LOCKERBROOK FARM IN DERBYSHIRE, UK.
© Roger Butterfield

HOW DOES TAXONOMY **HELP BIODIVERSITY?**

Junko Shimura, CBD



Biodiversity, or life on Earth, is disappearing at an unprecedented rate as a result of human activities. Decisions must be taken now to reverse this trend. But how do decision-makers decide where to establish **protected areas**, places that receive special protection because of their environmental or cultural value, if they don't know what needs protecting? How can regulators identify and combat harmful **invasive alien species** if they cannot distinguish them from native species? How can countries use their biodiversity if they don't know what biodiversity exists within their borders?

The field of taxonomy answers these questions and more!

Taxonomy is the science of naming, describing and classifying organisms and includes all plants, animals and **micro-organisms** of the world. Using morphological, behavioural, genetic and biochemical observations, taxonomists uncover evolutionary processes and study relationships among species.

Unfortunately, taxonomic knowledge is far from complete. In the past 250 years of research, taxonomists have named about 1.78 million species of animals, plants, fungi and micro-organisms. Though the total number of species is unknown, it is probably between five and 30 million, which means only six to 35 percent of the Earth's species have been scientifically identified. Without thorough taxonomic knowledge, it's very difficult to have effective **conservation** and management of biodiversity.

Governments, through the Convention on Biological Diversity, noted this "taxonomic impediment" to the sound management of biodiversity. In 1998, they launched the Global Taxonomic Initiative (GTI) to fill the knowledge gaps in our taxonomic system, to fix the shortage of trained taxonomists and curators, and to address the impact these deficiencies have on our ability to conserve, use and share the benefits of biodiversity.

For more information about scientific naming see Annex B.

THE IMPORTANCE OF SPECIES

Now that you have a better idea of what a species is, you might be asking yourself the following question: why are species important?

Species play a vital role as building blocks of biodiversity, interacting to form the ecosystems upon which we all depend for survival, and providing us with what are known as ecosystem goods and services (discussed extensively in the next chapter).

Goods are things that we can physically use or sell, including food, fuel, clothes and medicine, whilst services include the purification of water and air, crop pollination and cultural values.

HEN AND CHICKS FROM NICARAGUA.
© FAO/Saul Palma

GOAT HERDING IN LEBANON.
© FAO/Kai Wiedenhoefer

SPECIES ARE A SOURCE OF FOOD, FOR EXAMPLE THESE GROUND NUTS (PEANUTS) GROWN IN CHINA.
© FAO/Florita Botts

THE DOMESTIC COW AND ITS ANCIENT RELATIVE, THE AUROCH. THE LAST AUROCH DIED IN 1627 IN THE JAKTORÓW FOREST, POLAND; PREHISTORIC CAVE PAINTINGS, SUCH AS THOSE IN THE LASCAUX CAVES OF FRANCE, ARE THE ONLY IMAGES OF AUROCHS THAT EXIST TODAY.

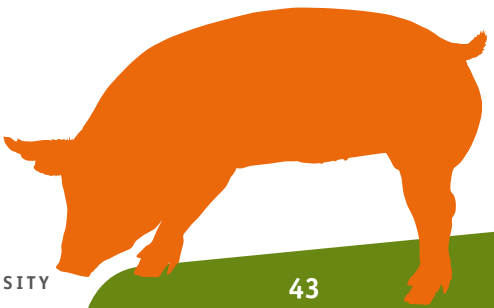
SPECIES BIODIVERSITY AND GOODS

Many of the goods we obtain come from domesticated species, including cows, pigs and sheep, and various agricultural crops such as wheat, rice and corn. All of these domesticated species originally descended from wild ones, which were selected and bred for specific purposes. The food produced from domesticated species sustains the lives of billions of people around the world, by forming the essential components of our daily diets. Despite there being thousands of species that we could potentially eat, we routinely consume only a small handful of these!

Wild species are just as important as domesticated species; people across the globe rely on marine, freshwater and terrestrial **ecosystems** for food and materials they need to survive. The oceans, for instance, cover more than 70 percent of the Earth's surface, and house an astonishing array of biodiversity, some of which provides essential food and income for millions of people. Freshwater ecosystems are just as valuable to humans; an estimated 126 000 described species including fish, molluscs, reptiles, insects and plants rely on freshwater habitats, many of which are an extremely important component of the **livelihoods** of local people. Rainforests such as those found in South America contain thousands upon thousands of species, some of which are extremely important in both modern and traditional medicine. As such, healthy biodiversity is essential to human well-being.

DID YOU KNOW?
Since agriculture began about 12 000 years ago, roughly 7 000 plant species have been used for human consumption.

DID YOU KNOW?
More than 70 000 different plant species are used in traditional and modern medicine.



SPECIES BIODIVERSITY AND SERVICES

Services provided by species include water purification, which is carried out by molluscs such as clams and mussels. These molluscs are very common in river systems, and purify the water by filtration, making it safer to drink. Dragonflies also play an important role in freshwater ecosystems, by acting as indicators of water quality. If pollution becomes a problem in an area, dragonflies will be the first to be affected, and so a reduction in their numbers could indicate a reduction in water quality. This early warning mechanism could prove vital, as action can then be taken to resolve the problem before other species (including humans) become affected.

Wild species also provide valuable services such as pollination, the process of transferring pollen to enable reproduction in plants. Pollination is needed by most of the world's land-based plant life. The "Animal Pollination" box discusses some of the adaptations various plant species have evolved to attract different species of animal **pollinators**.

DID YOU KNOW?
The global value of wetlands is US$ 17 trillion!

DRAGONFLY.
© raymondbPhotos

ANIMAL **POLLINATION**

Nadine Azzu, FAO

Pollination is a very important ecosystem service, without which many of the plants that we use for food could not grow. Pollination can occur in three main ways: self-pollination, wind pollination and pollination by animals. But let's talk about pollination by *animals*. There are many types of animal pollinators, including: insects (e.g. bees, wasps, flies, beetles, moths and butterflies), birds (e.g. hummingbirds), and mammals (e.g. bats and the Australian honey possum). Insects are the most common pollinator, especially because they are small and can easily fly from flower to flower.

Pollination by animals is a very particular and wondrous event. For a plant to be pollinated, the habits and physical characteristics of the animal (e.g. its mouth shape, its ability to see and smell, and even the way it moves around) must be well-matched with the habits and physical characteristics of the flower (e.g. colour, scent and structure). The need for a "perfect match" is one of the reasons why different types of pollinators pollinate different plants. For example:

- Bees are attracted by a flower's colour, scent and especially nectar (the bees' food).
- Beetles, who do not see well, are generally attracted to flowers with a strong scent.
- Butterflies, who pollinate during the day, rely mainly on the visual stimulus provided by the plant (in other words, colour).
- Moths tend to pollinate at night and may rely less on visual cues than on olfactory cues (smell). To catch the attention of their moth pollinators, some plant species emit varying scent intensities throughout the day, with a stronger scent during the evening when moths are active. An example of such a flower is the night blooming jasmine.

NIGHT BLOOMING JASMINE PRODUCES A STRONGER SCENT AT NIGHT TO ATTRACT MOTHS.
© Asit K. Ghosh/Wikimedia Commons

Some red flowers do not have a strong scent at all – for these flowers, hummingbirds are an ideal pollinator. Why is that? Because the vision of hummingbirds is particularly good at seeing red in the colour spectrum, and they also have an underdeveloped sense of smell so, a flower does not need to have such a strong scent for hummingbirds to find it.

Other plant species have very strongly scented flowers that are very dark in colour. Their dark colour would not attract bees or hummingbirds. In this case, a pollinator with poor vision and a very highly developed sense of smell is ideal. Bats possess these characteristics, and, not surprisingly, are the main pollinators of such plants, doing most of the pollen transfer at night.

THE COLOUR OF THIS FLOWER ATTRACTS ITS PREFERRED POLLINATOR, THE HUMMINGBIRD IN ARCADIA, CALIFORNIA, USA. THE FLOWER'S LONG TUBULAR SHAPE, PERFECT FOR A HUMMINGBIRD BILL, SUGGESTS THAT THE BIRD AND PLANT SPECIES EVOLVED TO RELY ON EACH OTHER FOR FOOD AND FOR POLLINATION.

So far, we have looked at how the colour and scent of plants attract specific pollinator species. Another factor to consider is the *structure* and shape of both the flower and the pollinator. Let's look at two examples of pollinators: butterflies and flies. Butterflies have long mouth parts that can reach nectar stored at the bottom of long tubular-shaped flowers. These "butterfly" flowers often have a convenient place for butterflies to land, so they can slurp the nectar with ease. Some flies, on the other hand, have the capacity to hover above a flower as if they were helicopters (hummingbirds have this capacity, too), and do not always need a landing pad. So flowers pollinated by these flies tend not to have landing pads.

These examples show how the habits and physical characteristics of *both* the flower and the pollinator must be well-suited to each other for pollination to occur. Based on these characteristics, which types of animal pollinators visit which types of flowers in your neighbourhood?

THE WORLD'S LARGEST POLLINATOR

The ruffed lemur, a mammal found on the island of Madagascar, is the main pollinator of the traveller's tree (also called traveller's palm). These banana tree lookalikes are very tall, and can reach a height of 12 m. The lemur climbs the tree and, thanks to its nimble hands, opens the flower bracts and puts its long snout into the flower. In doing so its fur becomes covered in pollen. The pollen is transferred to the next traveller's tree flower that the lemur visits.

BLACK AND WHITE RUFFED LEMUR.
© Vision holder/Wikimedia Commons

TRAVELLER'S TREE.
© Nolege

CONSERVATION EFFORTS

Species are also important units in terms of conservation efforts. We often identify, prioritise and monitor biodiversity in terms of species, as we tend to understand them better than genes or ecosystems. As a result of the strong public interest in species, they also play a key role in engaging people in biodiversity conservation.

SEA OTTER
© Mike Baird/Wikimedia Commons

Let's take a look at a few terms used to describe different types of species that you might come across when learning more about conservation:

FLAGSHIP SPECIES: these are usually very charismatic, well-known species such as the giant panda or the tiger. Flagship species are used to help raise awareness of the need for conservation, by acting as mascots for all sorts of other species in need of our help.

UMBRELLA SPECIES: as a result of targeting conservation efforts towards one particular species, a whole host of other species might end up being protected. The target species is then often referred to as an umbrella species, as it provides cover for many others! For instance, by protecting an area of rainforest in order to conserve the beautiful jaguar, all other species that live within that habitat will also be protected.

KEYSTONE SPECIES: a keystone species is one which makes a disproportionately large contribution to the ecosystem it inhabits, given its **biomass**. Sea otters are keystone species; in terms of numbers, they do not form a massive part of the coastal area in which they live, yet, they make a huge contribution to their habitat. By eating sea urchins which, if left unchecked, can cause massive amounts of damage to their kelp forest **habitat**, sea otters help to maintain a balanced ecosystem for the other species living in the kelp forests.

THE STATUS OF SPECIES

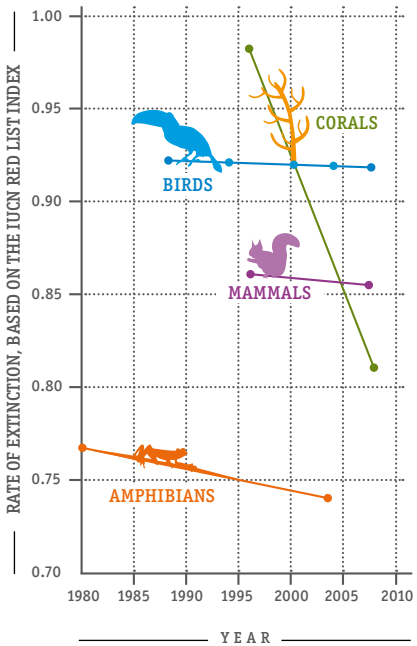
Just as genes make up species, species make up ecosystems, which we will learn more about in the next chapter. Whether directly or indirectly, the survival of a species within an ecosystem often depends on the presence of several other species, and as such, the conservation of biodiversity is of utmost importance.

In Chapter 2 we had a look at some of the main causes of biodiversity loss, including **habitat loss** and **fragmentation**, **overexploitation**, **climate change**, invasive alien species and **pollution**. Each of these can place enormous pressure on species, leading to many being driven to **extinction** (see adjacent figure).

Extinction is a natural process which has been occurring since life on Earth began. There is a natural balance to life with the cycle of births and deaths of individuals. Over time some species thrive and **evolution** creates fascinating new species whilst others, unable to adapt to changing circumstances, become extinct.

Due to human activities the current rates of extinction are estimated to be 100 to 1 000 times higher than the normal background rate.

The problem we face today is not that extinction is occurring, but rather the *rate* at which it is happening. As outlined in Chapter 2, current rates of extinction are estimated to be 100 to 1 000 times higher than the normal **background rate**, due to human activities that are having a devastating effect on plant and animal life.



THE PROPORTION OF WARM-WATER CORAL, BIRD, MAMMAL AND AMPHIBIAN SPECIES EXPECTED TO SURVIVE WITHOUT ADDITIONAL CONSERVATION ACTIONS HAS DROPPED SINCE 1980.

CORAL SPECIES ARE MOVING MOST RAPIDLY TOWARDS GREATER EXTINCTION RISK. AMPHIBIANS ARE THE MOST THREATENED GROUP. THE IUCN RED LIST INDEX RANGES FROM 0 TO 1. A VALUE OF 0 MEANS ALL SPECIES IN A GROUP HAVE GONE EXTINCT. A VALUE OF 1 MEANS THAT ALL SPECIES IN A GROUP ARE NOT EXPECTED TO BECOME EXTINCT IN THE NEAR FUTURE.

Adapted from: Global Biodiversity Outlook 3, 2010

RED FOR DANGER...

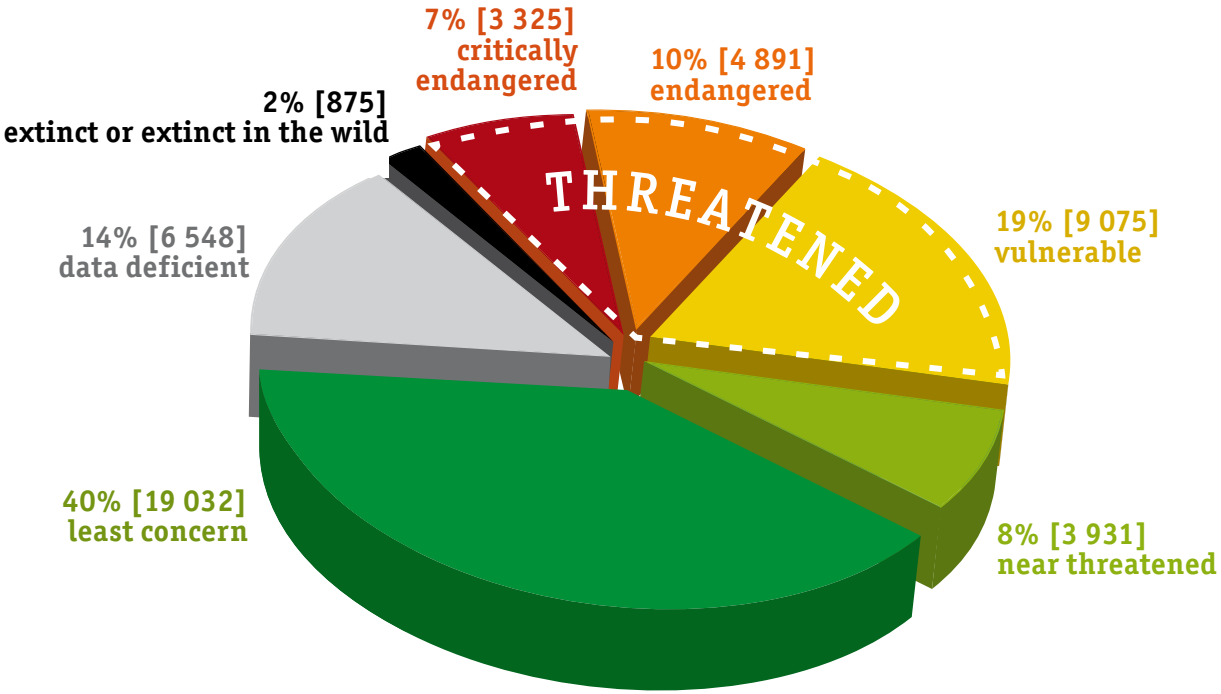
Species already driven to extinction include the famous dodo, as well as the lesser-known hula painted frog, woolly-stalked begonia and pig-footed bandicoot. Unfortunately, there are thousands of species set to follow in their footsteps, all of which are in danger of being wiped out completely as a result of habitat destruction, pollution, overexploitation, climate change, invasive alien species or any combination of these.

A RECREATION OF THE EXTINCT DODO AND A SKELETON AT THE NATIONAL WATERFRONT MUSEUM IN WALES.

IUCN RED LIST
THE IUCN RED LIST OF THREATENED SPECIES™

With so many species in need of conservation action, and with limited resources to help them, how do we know which are most at risk and most in need of our help? This is where the IUCN Red List of Threatened Species™ (also called the IUCN Red List) comes in.

The IUCN Red List is the world's most comprehensive information source on the global conservation status of species; it currently holds information about more than 48 000 different species, covering species taxonomy, geographic ranges, population numbers and threats. These data are collected by thousands of experts worldwide, and are an extremely useful tool in influencing conservation decisions, in informing species-based conservation actions, and in monitoring species' progress.



THIS FIGURE SHOWS THE PROPORTION OF SPECIES IN DIFFERENT THREAT CATEGORIES, WHICH REFLECT THE LIKELIHOOD THAT A SPECIES MAY BECOME EXTINCT IF CURRENT CONDITIONS PERSIST. THE RISK STATUS IS BASED ON THE RESEARCH OF THOUSANDS OF SPECIES DONE BY SCIENTISTS FROM AROUND THE WORLD. AS OF 2009, 47 677 SPECIES HAD BEEN ASSESSED. OF THESE, 36 PERCENT ARE CONSIDERED THREATENED WITH EXTINCTION.

Source: IUCN data in Global Biodiversity Outlook 3, 2010

Just as most hospitals have a triage system in place, whereby the ill and injured are assigned a category depending on how bad their condition is and therefore how quickly they need to be seen by a doctor, the IUCN Red List assigns species to special categories depending on how threatened they are.

There are eight categories for assessed species on the IUCN Red List, which can be seen on the scale accompanying the green turtle on the next page. A species is assigned a Red List category once its data have been assessed against very strict and carefully formulated criteria. These are based on factors such as geographic range, population size and rates of decline. Species that have been classified as Vulnerable, Endangered or Critically Endangered are referred to collectively as “threatened species”.

NOT EVALUATED	DATA DEFICIENT	LEAST CONCERN	NEAR THREATENED	VULNERABLE	ENDANGERED	CRITICALLY ENDANGERED	EXTINCT IN THE WILD	EXTINCT
NE	DD	LC	NT	VU	EN	CR	EW	EX

By having this classification system and all the accompanying data, the IUCN Red List can help to answer several important questions, including:

- At what rate is biodiversity being lost?
- Where is biodiversity the highest?
- Where is it being lost most rapidly?
- What are the main reasons for these losses?
- How successful are conservation actions?

With these answers, conservationists and decision-makers are able to make more informed choices when developing and implementing conservation actions, therefore increasing their chances of success. With this success comes the preservation of biodiversity, which is so vital for our planet and all who live on it.

GREEN TURTLE.
© Kathryn Pintus

ALPINE IBEX:
A CONSERVATION SUCCESS STORY!

The alpine ibex is endemic to Europe, and this once-abundant species used to roam freely across the Alps of France, Switzerland, Austria, Germany and northern Italy. However, as a result of intensive hunting practices, the alpine ibex was nearly driven to extinction in the early nineteenth century, with just a few hundred individuals remaining, all of which were found in the Gran Paradiso massif in Italy. Thanks to targeted conservation efforts, which included reintroductions to parts of its native range as well as introductions to Slovenia and Bulgaria, the alpine ibex is now listed as a species of Least Concern on the IUCN Red List, with a population of about 30 000 individuals recorded in the 1990s.

This species is not completely out of harm's way yet, though, as without continued efforts to protect its habitat, prevent poaching and reduce the impacts of human disturbance, it is likely to fall into a decline once again. The alpine ibex is thankfully not the only species that has been brought back from the brink of extinction, but it is a great example of what can be done to save species when we have the necessary knowledge and means.

ALPINE IBEX.
© Cash4Alex from Wikimedia Commons

CONCLUSION

In this chapter we looked at the importance of species diversity, particularly in relation to human livelihoods, and at the current status of the world's species. Despite the fact that the outlook seems less than bright, with many species currently at risk of extinction, there is still hope. There have been several success stories to date, with species being brought back from the brink of extinction through the careful application of conservation strategies. By implementing conservation tools such as the IUCN Red List, and using them to their full capacity to influence decisions and to inform action, biodiversity loss can be halted, if not reversed.

Most of the decisions that can be taken to instigate conservation efforts will be made by country leaders and officials, but they are not the only ones that can make a difference. We are all responsible for the well-being of our planet, and even the smallest of actions can have a positive effect.

There are plenty of things that each of us can do to help fight the extinction crisis:

- **Make informed decisions when considering what species of fish we eat, to help maintain wild fish stocks.**
- **Be respectful towards wildlife, and only take part in ecotourism opportunities that are responsibly and ethically run, in order to prevent wildlife disturbance.**
- **Recycle paper to reduce deforestation.**
- **Spend a minute or two less in the shower each day to save water.**
- **Use public transport to decre ase pollution levels, which may be contributing to global climate change.**

The above are just examples of simple actions which you can implement in your daily lives. Think what specific actions you can undertake to contribute to the survival of species diversity.

LEARN MORE

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- Vié, J.-C., Hilton-Taylor, C. And Stuart, S.N. (eds.) 2009. *Wildlife in a Changing World – An Analysis of the 2008 IUCN Red List of Threatened Species*. Gland, Switzerland: IUCN. 180 pp.
- The International Union for Conservation of Nature (IUCN): www.iucn.org
- The IUCN Red List of Threatened Species: www.iucnredlist.org
- ARKive: www.arkive.org