the science of | conservation

Companion Guide for:

Giraffes… 4 Species or 1?

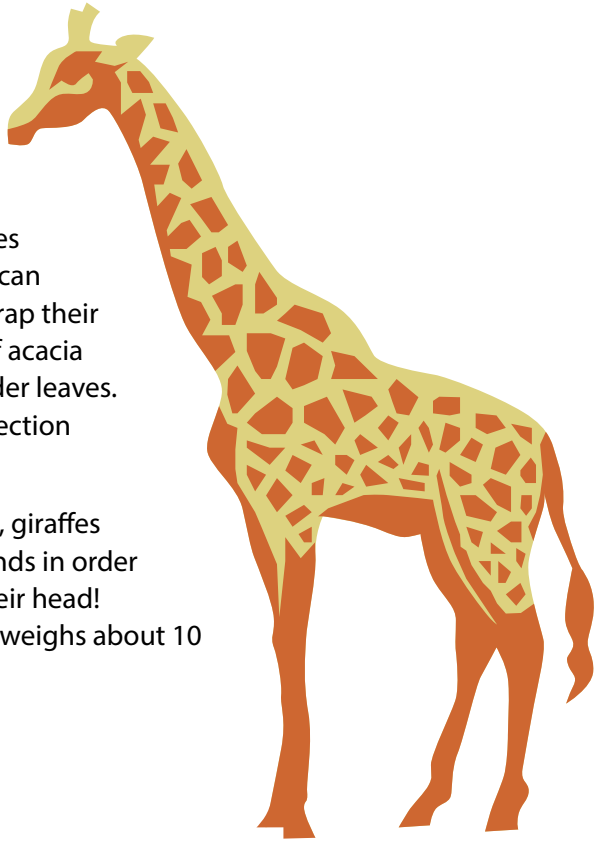
HORNS vs. OSSICONES vs. ANTLERS

Horns: Usually sharp, bony projections on the head of an animal, covered in a keratin sheath. The core of the horn is made of bone and the covering is keratin—the same protein that your fingernails and hair are made of.

Ossicones as found on a giraffe's head.

Ossicones: Projections that are part of the skull, but covered in skin and fur. Ossicones are found on male and female giraffes and on male okapi. The ossicones begin as cartilage when a giraffe is born, but develop into bone as the giraffe ages.

Antlers: Extensions branching from the skull and only found in the deer family. They are bone structures that grow in symmetrical pairs, and in temperate regions, are typically shed year after year.



SPECIALIZED TONGUES, NECKS, AND HEARTS

Giraffe tongues can grow to be 20 inches long and are prehensile, meaning they can grasp. This is beneficial for giraffes to wrap their tongues around the thorny branches of acacia trees in order to strip them of their tender leaves. Their tough lips also provide extra protection against the thorns.

Having the longest necks of any animal, giraffes also have hearts weighing over 25 pounds in order to provide blood carrying oxygen to their head! Compare that to a human heart, which weighs about 10 ounces—less than 1 pound.

TAXONOMIC CLASSIFICATION

Linnaeus was the original classifier of the giraffe, over 250 years ago, even without ever seeing one, and his classification became accepted by scientists. In the past, scientists looked at coat patterns and number of ossicones to assign different subspecies of giraffes. Currently the accepted classification is one species with 9 subspecies as shown here:

People who have lived among giraffes have recognized subtle differences between populations, and now that genetic analysis is available, scientists are learning more about giraffe genotypes and suggesting other classifications, such as is listed below.

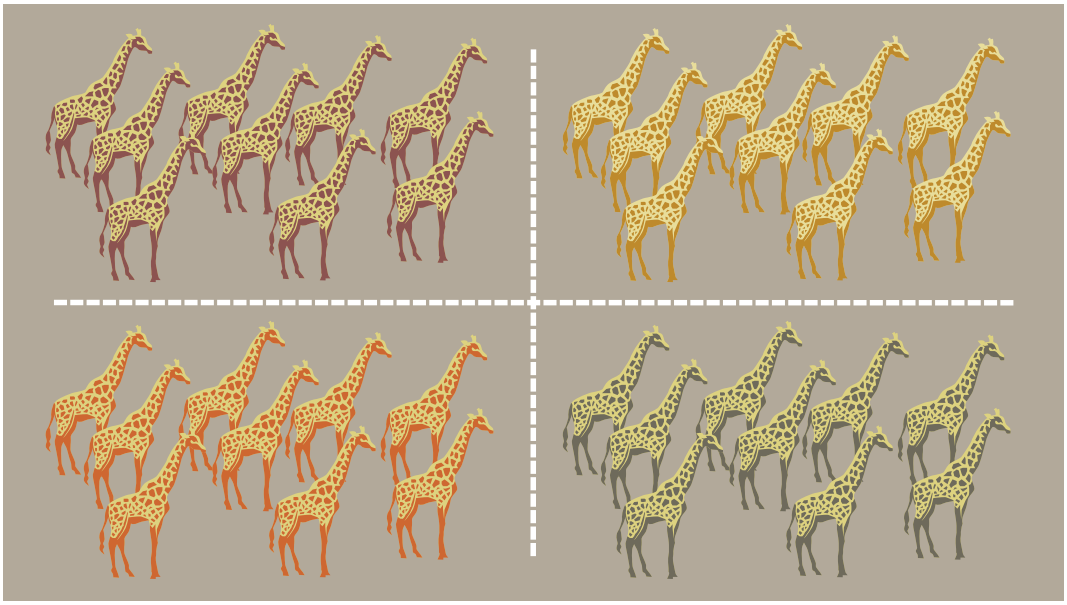
These are the recommended classifications of giraffe species and subspecies in the most recent *genetics paper* involving the Giraffe Conservation Foundation.

- Northern Giraffe (*Giraffa camelopardalis*)
  - Kordofan Giraffe (*Giraffa camelopardalis antiquorum*)
  - Nubian Giraffe (*Giraffa camelopardalis camelopardalis*)
  - West African Giraffe (*Giraffa camelopardalis peralta*)
- Southern Giraffe (*Giraffa giraffa*)
  - Angolan Giraffe (*Giraffa giraffa angolensis*)
  - South African Giraffe (*Giraffa giraffe giraffa*)
- Masai Giraffe (*Giraffa tippelskirchi*)
- Reticulated Giraffe (*Giraffa reticulata*)

SPECIES, POPULATIONS, AND GENE FLOW

There are multiple definitions for what a species is. The *biological species concept* is the most common way to think about a species, and can be defined as a group of organisms that can interbreed in nature, producing viable, fertile offspring. A population is a group of the same species that live in the same area and interbreed, and this interbreeding keeps the genetics of the population similar.

When members of different populations mate, gene flow (also called gene migration), occurs. When this happens, different variations of genes (alleles) are transferred between the populations, changing the composition of the gene pools of the receiving populations. The introduction of new alleles through gene flow increases variability within the population and makes possible new combinations of traits.

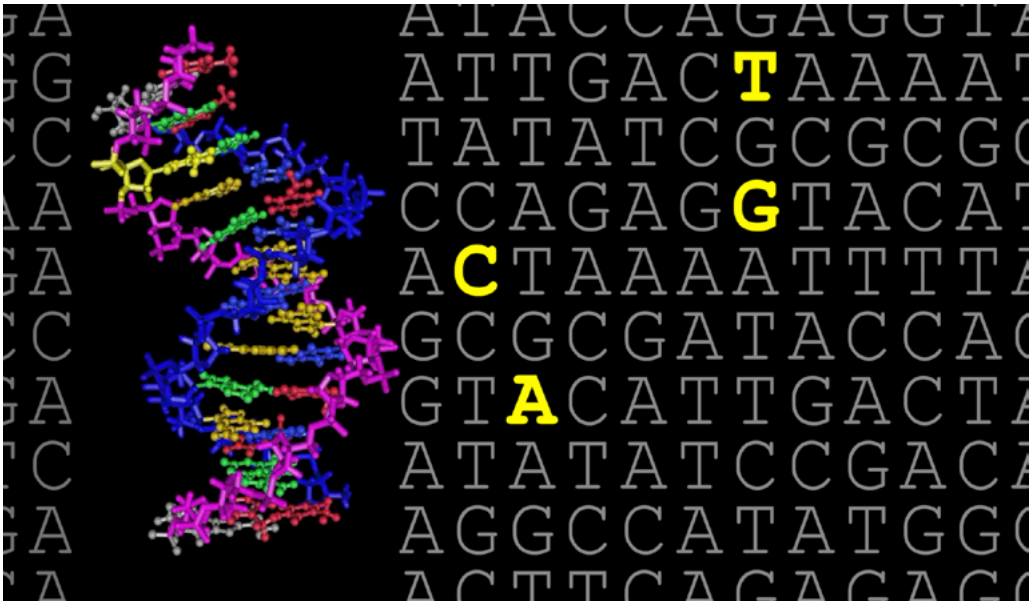


The continual transferring of genes between giraffe populations shares the genetic material between each population, keeping the different populations the same species. However, when a barrier prevents animals of different populations from sharing their genes through mating, the individuals from each population only breed amongst themselves, and eventually, over long periods of time, they can form new species. Barriers can be physical—rivers, mountains, valleys, or behavioral—the animals simply do not mate with each other. In this way, the reduction or stopping of gene flow can contribute to speciation over very long periods of time.

Speciation is the formation of a new and distinct species during the course of evolution, and often, barriers contribute. A physical barrier is the easiest way to understand how it works. If there are two populations separated by a river, and neither population crosses the river, gene flow is restricted. There is no exchanging of genes between the two populations. Over time, as mutations in the DNA occur, some favorable and some not, the overall genetic makeup of each population can change, and can contribute to forming new species. It should be noted that this topic is much more complex, with many facets, than is described here.

DNA … GENOTYPE AND PHENOTYPE

DNA (deoxyribonucleic acid) is made up of individual building blocks called nucleotides—Adenosine (A), Thymine (T), Cytosine (C), and Guanine (G). You may have heard of DNA referred to as a set of instructions, or blueprints of life. These concepts reflect a fundamental aspect of DNA—that genes and other regions of a genome contain instructions and capabilities in the form of messages and encoded molecules. It is the different variations of these As, Ts, Cs, and Gs, that lead to different features of organisms. As a couple of giraffe examples of different physical characteristics, we can look at ossicones, extremely long necks, and the patterns and colors of their fur. All of these features exist in giraffes because the instructions for them are in giraffe genomes, and illustrate the link between genotype (the DNA sequences) and phenotype (how they look and other observable characteristics).

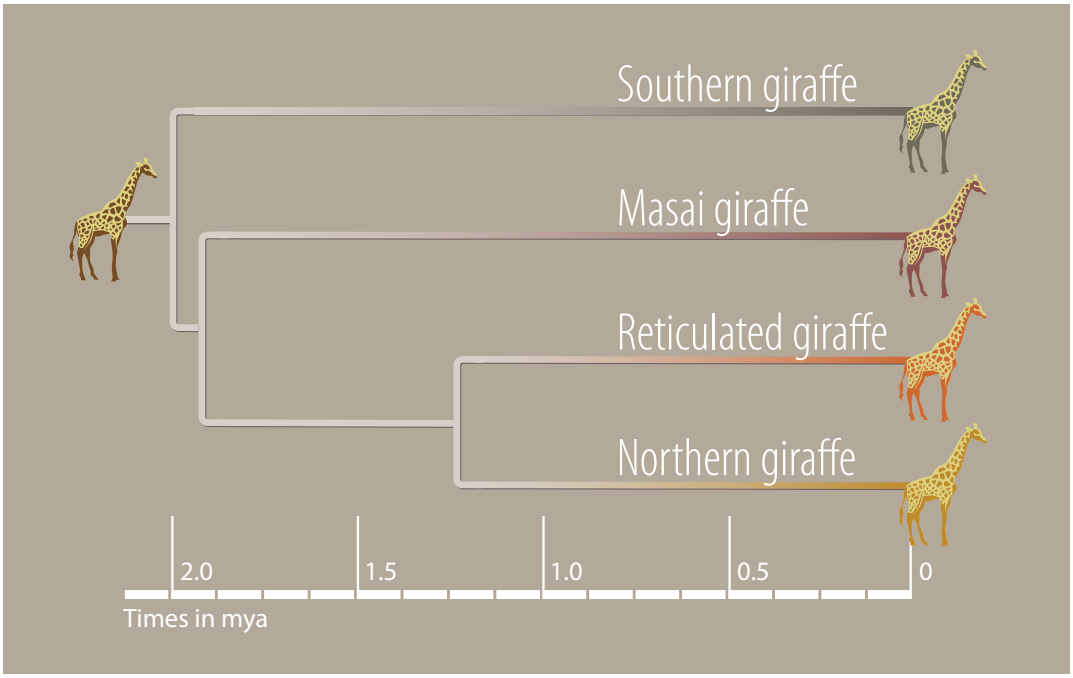


USING DNA TO IDENTIFY A SPECIES

DNA analysis can yield many types of information, depending on the types of techniques used and the question that the scientists are trying to answer. For example, DNA analysis at a crime scene is used for identifying individuals that have a DNA match, as well as rule out everyone else, who do not have a DNA match. This idea of 'matching' can be applied to determining the 'sameness' and 'differences' of organisms, ultimately determining whether an organism is the same species or not. Assigning a species using genomic information is an example of the phylogenetic species concept (compare this to the biological species concept explained above).

USING DNA TO SHOW RELATEDNESS OF SPECIES AND ESTIMATE HOW LONG AGO A SPECIES EVOLVED.

The following images are called trees, and represent how long ago each species of giraffe evolved away from the other species. The first image is from the video, and is based on the second image, which comes from *Fennessy et al. (2016)*. Each 'branch' of the tree represents the time range when a giraffe population separated away from the rest of the giraffes. The divergence times for each branch point were estimated by analyzing the DNA sequences using an analysis technique called *BEAST* (for Bayesian Evolutionary Analysis Sampling Trees). "Times in mya" represents how many millions of years ago (mya) the event happened. The DNA BEAST analysis in *Fennessy et al. (2016)* estimates that the three branching events occurred 1.99, 1.89, and 1.25 million years ago, as shown in the video, as well as the figure below.



'SILENT EXTINCTION'

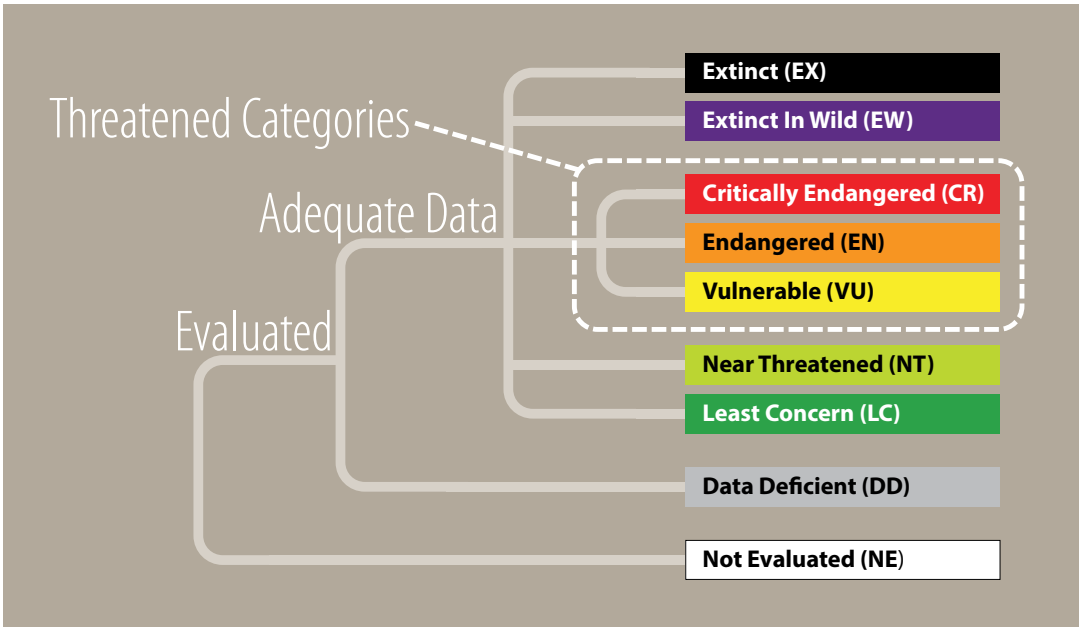
The earliest known extensive giraffe population survey was conducted in the 1980s. Prior to that, no one knew how many giraffes there were. Their numbers have fallen by 40% since that initial survey, 3 decades ago.

The term 'silent extinction' is used to describe the rapid decrease in giraffe populations because most people do not know it is happening. Giraffes are widely recognized, charismatic animals, and children and adults alike are instantly captivated by their uniqueness. However, because they are so familiar, and people can see them in almost any zoo, as stuffed toys, and in cartoons, the general public doesn't realize their numbers have drastically decreased in the wild. They are silently becoming extinct, making organizations such as the Giraffe Conservation Foundation all the more important.

Giraffes have gone extinct in 7 countries—Burkina Faso, Eritrea, Guinea, Mali, Mauritania, Nigeria and Senegal. This is mainly due to hunting by poachers, habitat loss as wild lands are converted to farming, human population expansion and the general warfare and civil unrest throughout Africa.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)

The *IUCN* is the global authority on the status of the natural world and the measures needed to safeguard it. They provide knowledge and tools to enable human progress, economic development and nature conservation to take place together. To protect nature, IUCN developed the *Red List of Threatened Species* that categorizes species on the state of their population. Every known species is given a classification from one of the following categories:



In order to receive one of the colored classifications, a species must have 'adequate data,' meaning an extensive population study needed to be conducted in order for the IUCN to decide the level of threat a species has to becoming extinct. An animal is 'threatened' when it is classified as vulnerable, endangered or critically endangered. 'Extinct in Wild' means the animals are only found in human care—examples are Scimitar-horned Oryx, Hawaiian crow, and Wyoming toad.

Examples of animals at the Jacksonville Zoo and Gardens that are in the 'threatened' categories:

Reticulated giraffe (vulnerable)

African Elephant (vulnerable)

Okapi (endangered)

Whooping Crane (endangered)

Puerto Rican Crested toad (critically endangered)

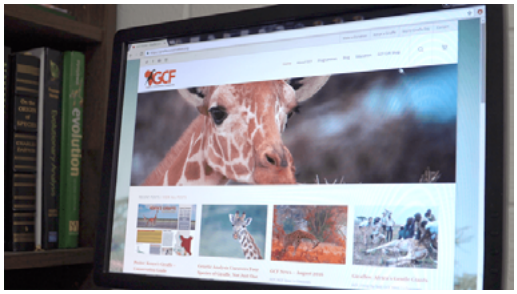
Western Lowland Gorilla (critically endangered)

Sumatran Tiger (critically endangered)

Visayan warty pig (critically endangered)

GIRAFFE CONSERVATION FOUNDATION

- *Giraffe Conservation Foundation* is the only organization dedicated solely to protecting giraffes throughout the continent of Africa, ensuring a sustainable future for all giraffe populations in the wild. This is done by:
    - Supporting the conservation of viable and existing habitat for giraffe;
    - Identifying key threats to giraffe in Africa and developing innovative ways to mitigate them;
    - Collaborating with local, national and international partners on giraffe conservation efforts in the interests of giraffe conservation in African Range States;
    - Raising funds for giraffe conservation and management across Africa; and
    - Maintaining a close-working relationship with the IUCN SSC Giraffe and Okapi Specialist Group (GOSG) to provide comprehensive awareness and technical support.
- Early conservation efforts were involved in translocations—the moving of animals from one area to another, and because of these recent population studies, conservationists are involved in it again. In 2015, Giraffe Conservation Foundation, along with Ugandan Wildlife Authority and Uganda Wildlife Education Centre conducted a translocation of 18 Rothschild's giraffe from the northern park of Murchison Falls National Park across the Nile River to the southern part of the park. This translocation was called *Operation Twiga* (Twiga means giraffe in Swahili), and the field report is *here*.



- Additional Resources from Giraffe Conservation Foundation:

- Giraffe species and subspecies
- Donate to GCF
- Adopt-a-Giraffe
- Africa's Giraffe Poster
- Giraffe Conservation Status Poster
- Giraffe Coat Pattern Poster

SCIENTIFIC RESEARCH ARTICLES HIGHLIGHTED IN THE VIDEO THAT USE DNA ANALYSIS TO UNDERSTAND GIRAFFES

- *Multi-locus analyses reveal four giraffe species instead of one*
- *Extensive population genetic structure in the giraffe*
- *Giraffe genome sequence reveals clues to its unique morphology and physiology*
- *Mitochondrial sequences reveal a clear separation between Angolan and South African giraffe along a cryptic rift valley*
- *Mitochondrial DNA analyses show that Zambia's South Luangwa Valley giraffe* (Giraffa camelopardalis thornicrofti) *are genetically isolated*
- *Development of 11 microsatellite markers for* Giraffa camelopardalis *through 454 pyrosequencing, with primer options for an additional 458 microsatellites*