THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Popular Article
September 2024 Vol.4(9), 3743−3748

De-Extinction – Reviving the Vanished Animals

R. Selvam
Associate Professor, Department of Animal Genetics and Breeding, Veterinary College and Research Institute, Theni-625534, Tamil Nadu.
https://doi.org/10.5281/zenodo.13905202

Introduction

Extinction is the permanent disappearance of a species or group of species from the Earth's biosphere, it occurs when a species is no longer able to survive and reproduce and endangered species means individuals are in danger of extinction. When a species becomes extinct, all its genetic heritage is lost. It is believed that about 200 species of mammals and birds have become extinct during the last 2000 years. Rapid human population growth and urbanisation over the past few decades have led to massive deforestation and habitat loss, pushing wildlife to the brink of extinction. A 2020 analysis by the International Union for Conservation of Nature (IUCN) Red List indicated over 500 species of animals facing imminent extinction within the next two decades. India, known for its rich biodiversity, is now standing at the forefront of this crisis owing to its dense population and various factors like rapid land development, habitat loss, poaching, and climate change. According to the data given in the Indian parliament by the Ministry of Environment, Forest and Climate Change, four species of fauna have gone extinct in India in the past few centuries which includes Cheetah (*Acinonyx jubatus*), Sumatran rhinoceros (*Dicerorhinus sumatrensis*), Pink-headed duck (*Rhodonessa caryophyllacea*) and Himalayan quail (*Ophrysia superciliosa*).

Extinction is a natural process. Species have disappeared, and new ones have evolved to take their place over the long geological history of the Earth. During the past 3.5 billion years, an estimated 4 billion species have evolved, of which 99 percent have gone extinct. There are three types of extinction processes. Natural extinction occurs when environmental conditions change over time. Some species disappear, and others are ready to take the place of the disappeared ones, being more adapted to the changed conditions. This loss of species that occurred in the geological past at a very slow rate is called natural or background extinction. Mass extinctions are periodic rises in the

extinction rate above the background level. They are events that are not caused by changes in habitat or competition but are catastrophes. Anthropogenic Extinction is the increasing number of species disappearing from the face of the Earth due to human activities. The main causes of extinction are as follows, better adapted competition, climate change, destruction of habitat, diseases, introduction to foreign species, lack of genetic diversity, loss of habitat, over-hunting, unregulated, or illegal killings or poaching, pollution and sudden events

De-extinction

De-extinction, also known as resurrection biology, is the process of recreating extinct species. The IUCN defines de-extinction as the ecological replacement of an extinct species by adapting a living organism to serve the ecological function of the extinct species through various breeding techniques, including artificial selection, back-breeding, and precise hybridization facilitated by genome editing. The term de-extinction was coined in 2012 to denote the goals and the reversal of extinction. Along with de-extinction, terms like extinction reversal, re-creation, resurrection, reviving, and resuscitation are widely used. De-extinction aims to reverse animal extinctions by creating new versions of previously lost species with the goal of re-establishing dynamic processes that produce healthy ecosystems and restore biodiversity. De-extinction requires an in-depth study of the biophysical conditions where the species can live and reproduce in relation to other species, including humans, and adapt to environmental changes.

De-extinction aims to:

- Restore ecosystems: Reintroduce key species to maintain ecological balance.
- Preserve biodiversity: Revive unique genetic material and traits.
- Advance science: Study extinct species to gain insights into evolution, biology, and conservation.

Methods of De-extinction

The most promising strategies for achieving de-extinction are back-breeding, cloning, and genetic engineering.

1. Back-breeding

Back-breeding is the term used to describe the use of selective breeding to resurrect specific ancestral traits within populations of living organisms. The goal is to recreate the traits that were lost during extinction to create a species that is as close to the extinct one as feasible. Mating pairs that meet specific phenotypic requirements are chosen for back-breeding, just like in conventional selective breeding programs. This implies that the strategy might only be suitable in cases when the extinct species is closely linked to a current species. The genotype, phenotype, or behavior of an extinct species is carefully bred for in a close related, descendent, or hybrid form that still exists. Since traditional selective mating is the only method employed, no direct genetic material manipulation

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 30/9/2024

occurs, therefore it is difficult to predict which sets of features will be kept in each generation. The physical characteristics of the progeny, as well as genetic comparisons with the extinct species, may serve as the main guiding principles for these efforts. Selective back breeding may yield a functional counterpart of an extinct organism if its functional purpose has been fully determined. Although back-breeding could theoretically help save certain species from extinction, it is not a desirable choice because it would take many breeding generations to change the genetic makeup of most species. Backcrossing can potentially lead to undesirable gene combinations or increased levels of inbreeding within the population, both of which can lower the population's overall fitness.

The German brothers Lutz and Heinz Heck, who planned to bring back to life two extinct species the tarpan (*Equus ferus ferus*) and the aurochs (*Bos primigenius*), the wild relatives of the horse and cow in the 1920s and 1930s. All things considered, these creatures are merely doppelgängers of their vanished "ancestors," even though the population they produced which continues to exist differs from "ordinary" cows and horses. To closely resemble the now-extinct quagga (*E. quagga quagga*), plains zebra (*Equus quagga*) has undergone selective breeding for pelage coloration and patterning. The research began in 1987, and by 2005, animals of the fifth generation possessed distinguishable quagga traits.

2. Cloning

Cloning could be used to create genotypically authentic live animals from well-preserved cellular subsamples that have been either naturally frozen extinct species or purposefully obtained from species that have already gone extinct. This technique is known as "de-extinction." Cloning is a desirable method of de-extinction because, in contrast to back-breeding, the resultant organism will be genetically identical to the extinct donor of the somatic cell, at least about the nuclear genome. Cloning is the process of creating a precise genetic duplicate of a living organism using somatic cell nuclear transfer, or SCNT. In SCNT, an enucleated egg cell receives the nucleus of an adult somatic cell, which is subsequently reprogrammed by the host egg cell. Through this process of reprogramming, the somatic cell is transformed back into an undifferentiated pluripotent stem cell, which can subsequently develop in a manner like to that of an embryo created when a sperm cell fertilizes an egg cell. The donor of the somatic cell will have the same nuclear genome sequence as the organism that is born following SCNT. However, most extinct species do not have live cells, which are necessary for cloning. Over time, the genomes of extinct animals must have been conserved.

The first successful de-extinction of bucardo, a species of mountain goat located solely in the Pyrenees region, was achieved in 2003. Regretfully, the animal's lung abnormality caused it to pass away 7 minutes after birth. Nuclei from the only surviving bucardo were implanted into 57 substitute goats. Only one of those bucardos was able to be born out of the seven that became pregnant. But as this example demonstrates, cloning might be a viable de-extinction strategy.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 30/9/2024

3. Genetic engineering – Ancient DNA Extraction and Sequencing

The ability to rebuild entire genome sequences from extinct species is becoming more and more possible thanks to developments in ancient DNA extraction and sequencing methods. These genomes can be compared to the genomic sequences of the extinct species' closest extant relative. Once the primary sequence variations in the genomes of extinct and extant species are identified, living species' genomes can be edited in vitro using genome engineering techniques to create living cells that express extinct genes. Then, SCNT can be made from these live cells.

4. Genome editing

By utilizing the genome of an extinct species to alter the genome of a closely related species, genome editing can be used to recreate extinct species. Cutting edge biotechnology, like CRISPR/Cas9, uses an adjacent RNA sequence to direct DNA cleavage at nucleotide sequences. Custom-built guide RNAs can be used to cut DNA at specific locations on a genome, and then the DNA sequence of your choice can be inserted into the complex. The restoration of the woolly mammoth through genome editing in Asian elephants is the perfect illustration of this technique in action. The majority of the genes in Asian elephants and mammoths work in exactly the same way.

Challenges of De-extinction

The techniques of de-extinction may not be sufficiently developed to ensure successful recreation of organisms with at least partial genomic similarity to their extinct relatives in the future. Several challenges arise regarding the recreation of species, such as potential adverse effects on ecosystems and unsuitability of the current environment. The challenges of de-extinction are as follows:

- The susceptibility and resistance of de-extinct animals to modern diseases and parasites, as well as the potential for de-extinct forms to act as disease vectors.
- Producing a stable, self-sustaining population of the de-extinct species, which requires de-extinction of many genetically diverse individuals to ensure adequate genetic diversity.
- Providing a suitable habitat for a de-extinct individual.
- Behavioural evolution and transfer, potentially including the loss of social information in social animals, such as hunting techniques, migration routes, and communication methods.

Benefits of De-extinction

- Restoring biodiversity, which may increase ecosystem stability, promote network diversity, and reduce the loss of other species.
- Enhancing ecosystem function and resilience.
- Positive socio-economic impacts through tourism, ecosystem services, and cultural values.
- Enables to apply technological advances to the conservation of present species.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 30/9/2024

Disadvantages

- High financial and opportunity costs and human resources.
- Animal welfare concerns, such as gestational surrogates, animal husbandry, and post-release management.
- Uncertainty about de-extinct species behavior and performance.
- Risks of disease spread and hybridization with closely related forms.
- Vulnerability to diseases and unforeseen impacts on ecosystem functions.
- Socio-economic impacts, including human-wildlife conflict and
- Negative effects on ecosystem services and cultural values.

Ethical Issues

De-extinction could inadvertently condone extinction and threaten biodiversity. Concerns include unknowns about the health and adaptability of resurrected animals, as well as potential impacts on genetic, population, and ecological properties. The motivation behind de-extinction projects has also been questioned.

Conclusion

De-extinction, or species revivalism, involves bringing back extinct species through selective breeding, cloning, or genetic engineering. It aims to restore ecosystems, revive genetic material, and study extinct species. However, it raises concerns about ecosystem disruption, conservation priorities, ethics, and feasibility. Back-breeding involves the use of selective breeding to resurrect specific ancestral traits within populations of living organisms. The aim is to bring back the qualities lost in extinction and produce species as similar as possible to the extinct one. Mating pairs are selected based on their phenotype, and this approach may be appropriate when the extinct species is closely related to a living species. Cloning, on the other hand, refers to the technique known as somatic cell nuclear transfer to create an exact genetic copy of a living organism. Cloning requires living cells, which may not be available for most extinct species. Genetic engineering involves ancient DNA extraction and sequencing to reconstruct full genome sequences from extinct species. Genome editing can be used to edit the genome of a closely-related species, using the extinct species' genome. De-extinction is a complex and potentially costly process that requires careful consideration of its consequences.

References.

Ben Jacob Novak. De-Extinction. Genes 2018, 9, 548; doi:10.3390/genes9110548.

Beth Shapiro. THE ECOLOGY OF DE-EXTINCTION. Pathways to de-extinction: how close can we get to resurrection of an extinct species?. Functional Ecology 2017, 31, 996–1002.

Bolton, Rhiannon & Mooney, Andrew & Pettit, Matt & Bolton, Anthony & Morgan, Lucy & Drake, Gabby & Appeltant, Ruth & Walker, Susan & Gillis, James & Hvilsom, Christina. (2022). Resurrecting biodiversity: Advanced assisted reproductive technologies and biobanking. Reproduction and Fertility. 3. 10.1530/RAF-22-0005.

IUCN SSC (2016). IUCN SSC Guiding principles on Creating Proxies of Extinct Species for

Conservation Benefit. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.
Richmond, Douglas & Sinding, Mikkel-Holger & Gilbert, Thomas. (2016). The potential and pitfalls of de-extinction. Zoologica Scripta. 45. 22-36. 10.1111/zsc.12212.