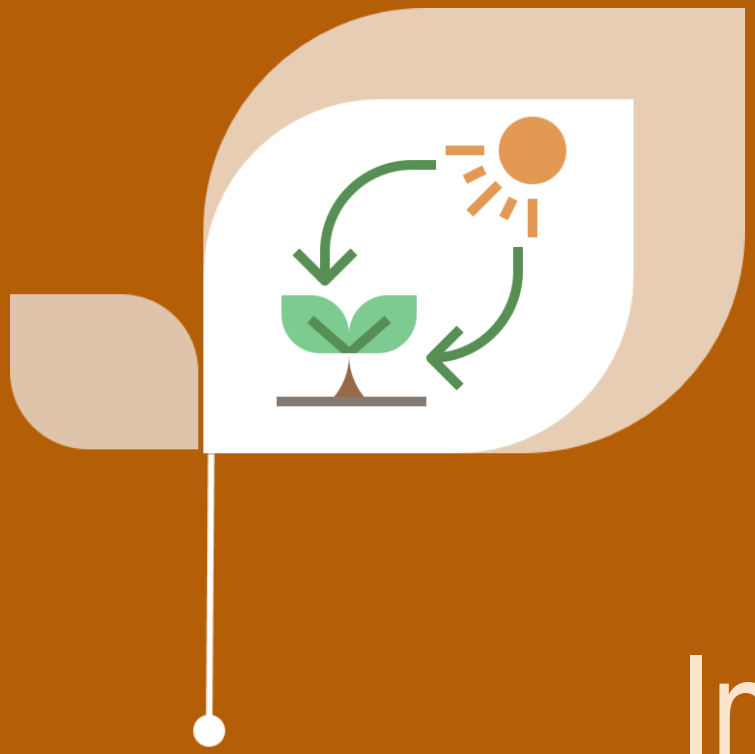


Chapter 1
Introduction to Ecology

Contents

1.1

Ecology as a discipline

Ecology

All organisms are intimately tied to their surroundings.

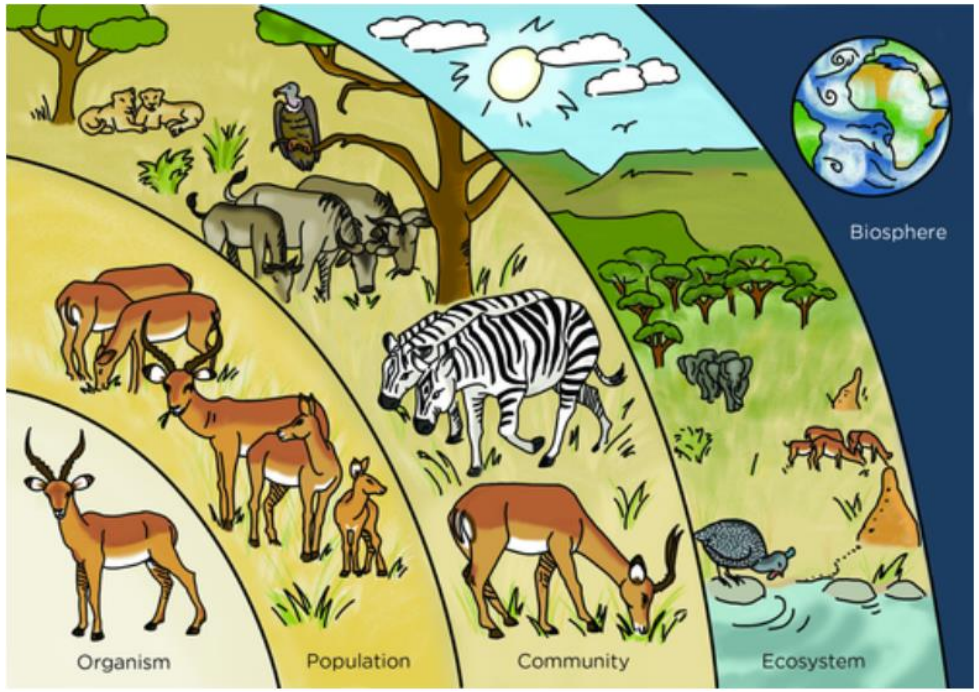
When an organism respires, it exchanges gases with the atmosphere. When it eats, it acquires second-hand energy that was originally harvested from the sun and atmosphere. Waste products of metabolism are returned to the surrounding environment where they are recycled. Organisms absorb and radiate heat from and to the surrounding environment. They compete with other for limited resources (such as food, water, space), and they consume each other.

Ecology

Ecology is the scientific study of all these kinds of interactions between organisms, to one another and their physical environment. Biologists tend to study things at different biological scales, from molecules to the biosphere. **Most** ecological research is concerned with questions from the **population** to **ecosystem** scale, although it is certainty not limited to this.

Different biological scales:

- Molecules
- Cells and Organs
- Organisms
- **Populations**
- **Species**
- **Communities**
- **Ecosystems**
- Landscapes
- Continents
- Biosphere



Ecology

The science of ecology is broad within itself and can be subdivided itself into many fields of research. Many of these are related to each other, overlap and complement each other.

Ecology

You may come across the following sub-disciplines : molecular ecology, organismal ecology, population ecology, community ecology, ecosystem ecology, behavioural ecology, landscape ecology, biosphere ecology, microbial ecology, functional ecology, evolutionary ecology, quantitative ecology, paleaoecology, chemical ecology, spatial ecology and physiological ecology.

None of them exist in isolation. For example, the **population ecology** of an organism is a consequence of its **behavioural ecology** and intimately tied to its **community ecology**.

Methods from **molecular ecology** are used to inform the **population ecology** of a species, and the **behavioural ecology** of a population.

All kinds of data are modelled and analyzed using **quantitative ecology** techniques.

1.2

History of Ecology

The roots of Ecology

Ecological thinking at some level has been around for a long time: in some sense, as long as human history.

In order to survive and forage effectively, humans have evolved with an intrinsic understanding of the natural environment around them, whether it be the seasonal patterns of fruit production, the anti-predator behaviour of prey species, knowledge of the specific habitats particular kinds of plant can be found in, or the reproductive behaviour of egg-laying animals.

However scholars have been formally writing about ecological relationships for over 2000 years: Aristotle and Hippocrates first wrote about the relationship between animals, humans and their environment in the 4th century BC. Aristotle's student,Theophrastus, studied plant types and forms in relation to altitude, moisture and light exposure, and is often credited as being the world's first 'real' ecologist.

Since then, the principles of ecology have developed gradually, closely intertwined with the development of other biological disciplines.

The age of exploration

Ecology as a modern academic discipline is a new science, having only become prominent in the late 20th Century. The term 'ecology' was first coined in 1869 by German zoologist Ernst Haeckel.

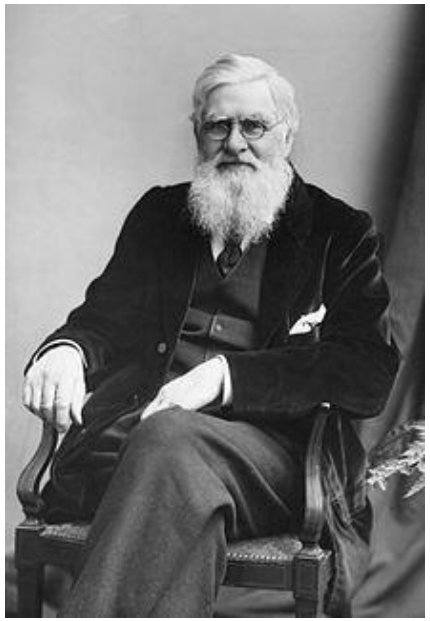
However, the roots of modern ecology lie earlier, in the 18th and 19th Century. At that time powerful maritime nations such as Britain, Spain and Portugal launched many world exploratory expeditions to develop commerce with other countries, and to discover new natural resources.

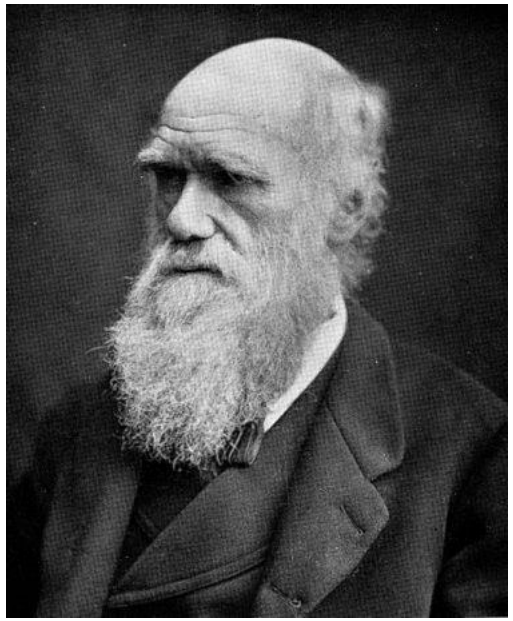
This was a fertile time for science: never before or since has so much of Earth been discovered in such a brief period of its history. New scientific disciplines were formed and a large number of explorers, naturalists, zoologists, botanists and geographers alike charted new territories and catalogued the weird and wonderful flora and fauna they discovered, often during extensive surveys and collecting expeditions.

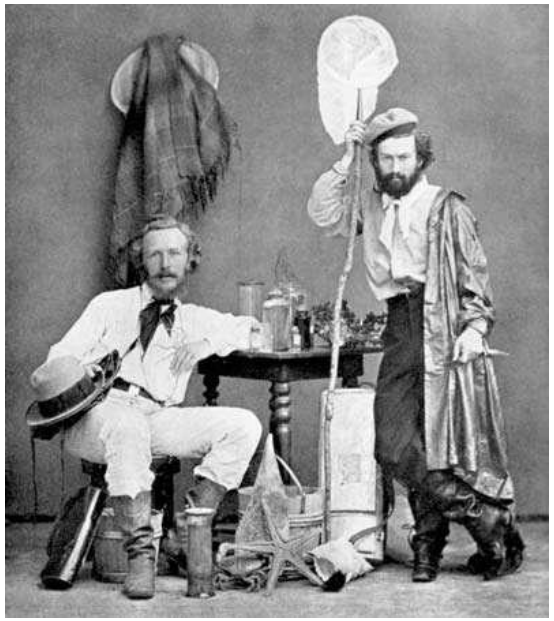
The collections they brought back for scientific study transformed our understanding of the natural world: in the name of science, millions of biological specimens were collected. An explosion of institutions dedicated to natural history were created: by 1900, the United States and the UK had 250 natural history museums each. Today the UK's Natural History Museum's alone houses 29 million animal specimens.

Key Scientists

While a large number of scientists have contributed to modern ecological thinking, a few stand out for key contributions and are presented in the following few slides.



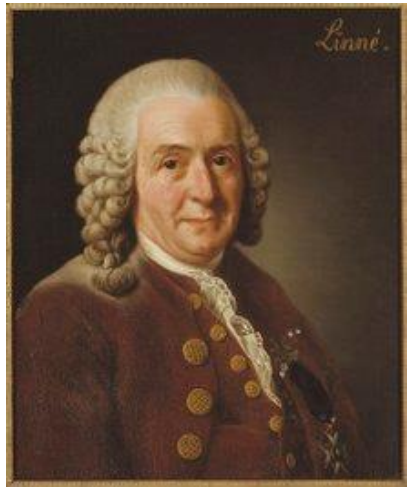


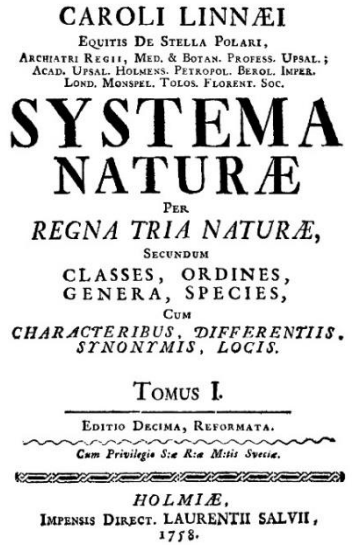


Carl Linnaeus (1707-1778)

Carl Linneaus was a Swedish zoologist and is known as the "father of modern taxonomy ". Aside from pioneering the science of identifying, classifying and naming organisms, he was also a pioneer in the study of ecology, being one of the first to describe relationships between living things and their environments.

Linneaus created **binomial nomenclature**, the modern system of naming organisms with a genus name followed by a species name. Linnaeus named over 12,000 species of plants and animals. His two most famous books, *Species plantarum* (1st edition, 1753) and *Systema naturae* (10th edition, 1758), are still used today as the basis for naming plants and animals.

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EQUITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.;
ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER.
LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA
NATURÆ
PER
REGNA TRIA NATURÆ,
SECUNDUM
CLASSES, ORDINES,
GENERA, SPECIES,
CUM
CHARACTERIBUS, DIFFERENTIIS,
SYNONYMIS, LOCIS.

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1758.

Jean-Baptiste Lamarck (1744-1829)

Jean-Baptiste Lamarck was a French naturalist and taxonomist and an early proponent of the idea that evolution occurred in accordance with natural laws.

He coined the term 'invertebrates' and published groundbreaking work on the classification of invertebrates called *Système des animaux sans vertèbres*. He was the first to separate arachnids from insects, classify molluscs, crustaceans and annelids and was one of the first to use the word 'biology' in its modern sense.

Lamarck however is generally remembered for his contributions to the theory of evolution. He proposed that organisms were driven from simple to increasingly more complex forms, and also theorized that individuals lose characteristics they do not require and develop characteristics that are useful. Most famously, he argued that acquired traits were heritable- that physical changes in organisms during their lifetime could be transmitted to their offspring.

This latter idea, the theory of **inheritance of acquired characteristics**, is commonly known as Lamarckism and is no longer accepted as a mechanism of evolution. However, it is innacurately named after him as it was an idea that had already been around for over a thousand years. Lamarck simply incorporated it into his wider theory of evolution.

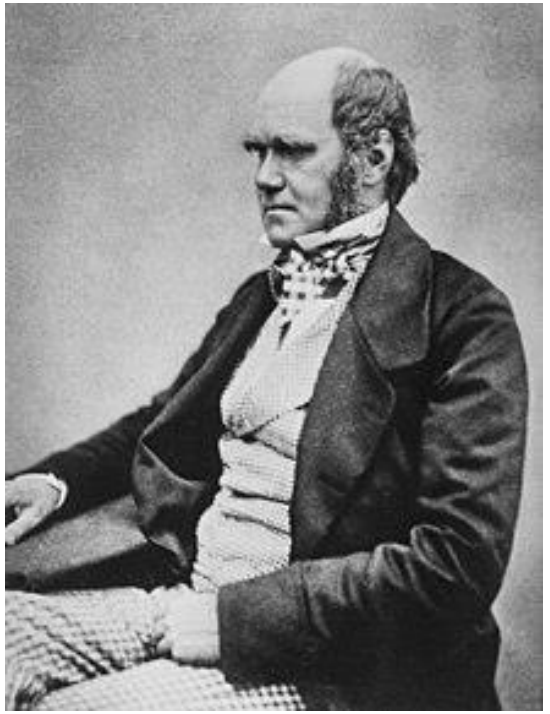
Charles Darwin (1809-1882)

History's most famous biologist, Darwin transformed the way we understand the natural world. His infamous 5 year expedition on HMS Beagle took him to South America, the Galapagos islands and New Zealand where he made extensive surveys, inspiring him to conceive the theory of evolution by a process of natural selection.

Considered one of the most important achievements in modern science, it is accepted by the scientific community as the best evidence-based explanation for the diversity and complexity of life on Earth.

Darwin continually emphasized the difference between establishing the fact of evolution, and proposing a theory—natural selection—to explain the mechanism of evolution.

Biologists consider it to be a scientific fact that evolution has occurred, and the theory of evolution by natural selection is supported by so many observations and confirming experiments that scientists are confident that the basic components of the theory will not be overturned by new evidence.



Alfred Russel Wallace (1823-1913)

Alfred Russel Wallace was a British naturalist, geographer and explorer. A contemporary of Charles Darwin, He independently conceived the theory of evolution by natural selection, publishing with Darwin and prompting him to publish The Origin of the Species.

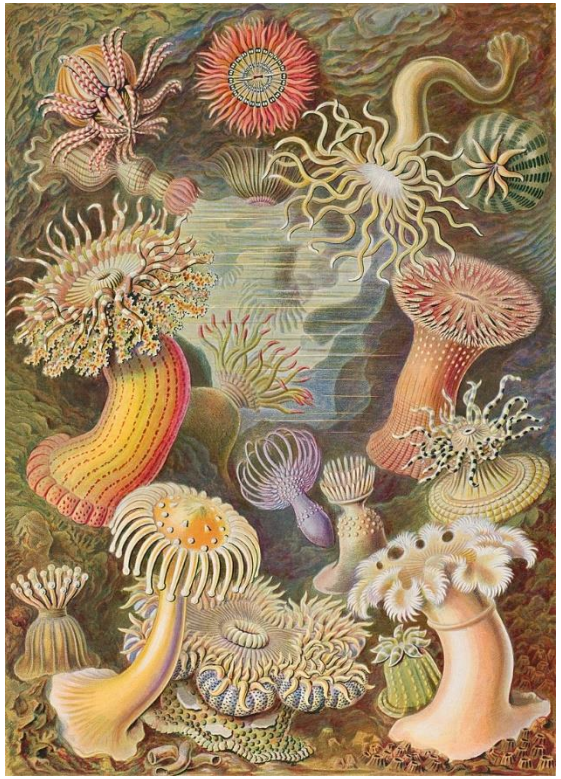
He was considered the 19th century's leading expert on the geographical distribution of animal species and is sometimes called the "father of biogeography".

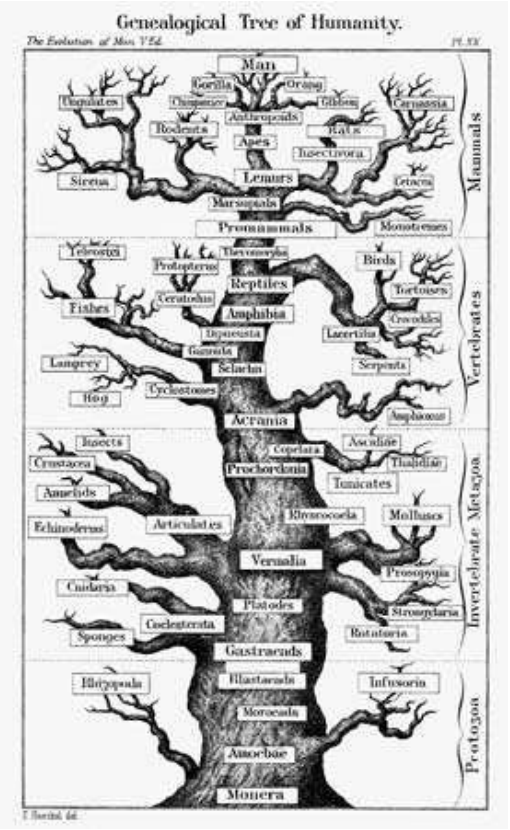
In 1876 he published " The Geographical Distribution of Animals", which divided the earth into six separate biogeographical regions for describing species distribution of mammals, reptiles and insects. This work formed the basis for the zoogeographic regions still in use today. He described factors that influence the current and past geographic distribution of animals within each geographical region, including land bridges, mountains, ocean depth, rivers and vegetation.

Ernst Haeckel (1834-1919)

Ernst Haeckel was a German zoologist, evolutionist and artist who was a proponent of Darwinian evolution, popularising it in widely read works. He discovered, described and named thousands of new species, mapped a genealogical tree relating all life forms, and coined many terms in biology, including ecology, phylum, phylogeny, stem cell, and Protista.

His artwork is published in Kunstformen der Natur ("Art Forms of Nature"), a collection of over 100 illustrations of animals and sea creatures .





Notable modern-day ecologists

You will probably come across some of the following big names in ecology- as well as many others. If you haven't done so already, it's a good idea to check out some of their publications and books.

Richard Dawkins is an evolutionary biologist. He first came to prominence with his 1976 book "The Selfish Gene", which popularised the gene-centred view of evolution and introduced the term "meme". With his book "The Extended Phenotype" (1982), he introduced into evolutionary biology the influential concept that the phenotypic effects of a gene are not necessarily limited to an organism's body, but can stretch far into the environment.

Tim Clutton-Brock is a well-known zoologist renowned for his studies of behavioural ecology in mammals, particularly red deer on the Isle of Rum, Soay sheep on the island of St Kilda and meerkats in the Kalahari. He is an authority on sexual selection and the evolution of reproductive strategies. "The Evolution of Parental Care" and "Mammal Societies" are two of his popular ecology textbooks.

Charles J. Krebs is renowned for his work on social behaviour, predation, and food supply constraints that act on population growth rates. His book "Ecology: The Experimental Analysis of Distribution and Abundance" is widely used, as is the classic ecology textbook "An Introduction to Behavioural Ecology" co-written with Nicolas Barry Davies.

Notable modern-day ecologists

John Terborgh is a renowned tropical ecologist and an authority on avian and mammalian ecology in Neotropical forests. He has directed a field station in Manu National Park since 1973 and published widely on tropical ecosystems and conservation planning. He is famous for his book "Requiem to Nature" where he examines current conservation strategies and considers the shortcomings of parks and protected areas both from ecological and institutional perspectives.

Georgina Mace is known for her research in measuring the trends and consequences of biodiversity loss and ecosystem change. She was instrumental in developing the criteria for listing species in the IUCN Red List and was actively involved in the Millenium Ecosystem Assessment.

Rachel Carson was a famous marine biologist and conservationist who challenged notions that humans could master nature with technology and was a champion of the environmental movement. A gifted writer, her 1962 book "Silent Spring" caused a sensation, warning of the dangers of chemical pesticides to natural systems.

Eugene P. Odum is sometimes referred to as the father of modern ecology. He co- wrote the pioneering textbook "Fundamentals of Ecology" in 1953, which was the discipline's only textbook for a decade. Considered a visionary, Odum's research and advocacy inspired the modern environmental movement and he pioneered the concept of the ecosystem. The world's first stand alone college of ecology in Georgia is named after him.

Relevance today

Importance of Ecology today

Ecology helps us understand how the world works. It provides useful evidence on the interdependence between people and the natural world, as well the consequences of human activity on the environment.

Never before in human history has the consequences of man's impact on nature been such a predominant concern for our societies. Our numbers are increasing exponentially, and we are depleting the earth's natural resources at an unsustainable rate. Governments and citizens around the world are increasingly aware of the consequences of pollution, climate change, over-hunting, over- fishing and habitat loss on ecosystem integrity and the earth's capacity to support life.

Ecology has never been more relevant than today, as human societies confront unprecedented global challenges in the coming century.

Over the past two decades, ecological science has undergone many significant shifts in emphasis and perspective, which have important implications for how we manage ecosystems and species.

Ecology, born originally from an academic interest in how the natural world works, is now a well-developed branch of science having increasing importance to human welfare and survival. Today's ecologist is increasingly called upon to shape policy, inform decision-making processes and contribute to action plans and strategies.

Importance of Ecology today

In order for governments and management agencies to make the best decisions possible to protect the worlds species and the ecosystem services that people need, it is imperative that current ecological knowledge fully informs societal decision making. Some of the ways it can contribute include:

- **Predicting the ecological effects of pollution and climate change**
- **Conserving a habitat and its biodiversity**
- **Designing protected areas and zoning activities**
- **Setting hunting and fishing quotas**
- **Managing invasive species**
- **Restoring degraded habitats, e.g. through reforestation or coral implants**
- **Restoring ecological connectivity to fragmented habitats**
- **Measuring and monitoring ecosystem health**

Classic ecology is no longer enough to respond to society's increasingly urgent needs. There is a particular need today for ecologists trained in integrating ecology, global change biology, spatially-explicit predictive modelling and conservation management.

1.4

Resources

Suggested Reading

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