



**Ecology** is generally spoken of as a new science, having only become prominent in the second half of the 20th Century. More precisely, there is agreement that ecology emerged as a distinct discipline at the turn of the 20th Century, and that it gained public prominence in the 1960s, due to widespread concern for the state of the environment [\[1\]](#). Nonetheless, ecological thinking at some level has been around for a long time, and the principles of ecology have developed gradually, closely intertwined with the development of other biological disciplines. Thus, one of the first ecologists may have been Aristotle or perhaps his student, Theophrastus, both of whom had interest in many species of animals. Theophrastus described interrelationships between animals and between animals and their environment as early as the 4th century BC (Ramalay, 1940).

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### // **18th and 19th century ~ Ecological murmurs** **The botanical geography and Alexander von Humboldt**

Throughout the 18th and the beginning of the 19th century, the great maritime powers such as Britain, Spain, and Portugal launched many world exploratory expeditions to develop maritime commerce with other countries, and to discover new natural resources, as well as to catalog them. At the beginning of the 18th century, about twenty thousand plant species were known, versus forty thousand at the beginning of the 19th century, and almost 400,000 today.

These expeditions were joined by many scientists, including botanists, such as the German explorer Alexander von Humboldt. Humboldt is often considered a father of ecology. He was the first to take on the study of the relationship between organisms and their environment. He exposed the existing relationships between observed plant species and climate, and described vegetation zones using latitude and altitude, a discipline now known as geobotany.

In 1804, for example, he reported an impressive number of species, particularly plants, for which he sought to explain their geographic distribution with respect to geological data. One of

#### **Humboldt**

's famous works was

#### **"Idea for a Plant Geography"**

(1805).

Other important botanists of the time included Aimé Bonpland.

In 1856, the Park Grass Experiment was established at the Rothamsted Experimental Station to test the effect of fertilizers and manures on hay yields. [\[2\]](#)

### The notion of biocoenosis: Wallace and Möbius

**Alfred Russel Wallace**, contemporary and competitor to Darwin, was first to propose a "geography" of animal species. Several authors recognized at the time that species were not independent of each other, and grouped them into plant species, animal species, and later into communities of living beings or biocoenosis. The first use of this term is usually attributed to

**Karl Möbius**

in 1877, but already in 1825, the French naturalist

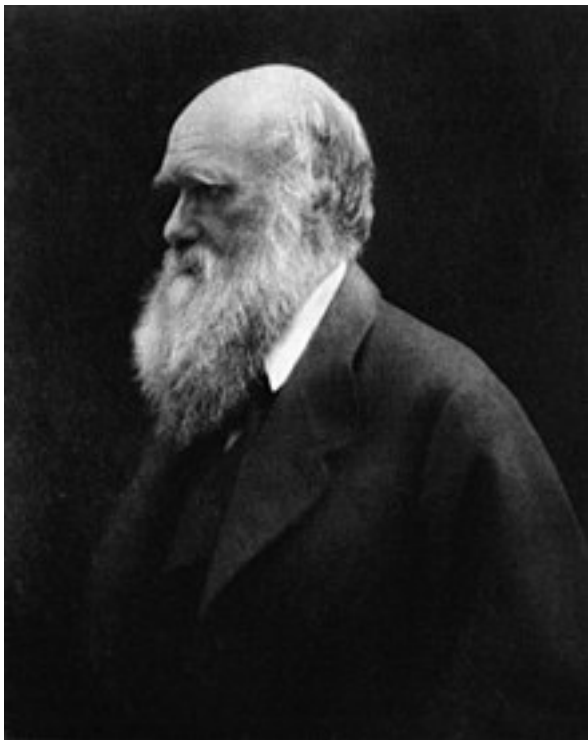
**Adolphe Dureau de la Malle**

used the term

*société*

about an assemblage of plant individuals of different species.

### Warming and the foundation of ecology as discipline



While **Darwin** focused exclusively on competition as a selective force, **Eugen Warming** devised a new discipline that took abiotic factors, that is drought, fire, salt, cold etc., as seriously as biotic factors in the assembly of biotic communities. Biogeography before Warming was largely of descriptive nature - faunistic or floristic. Warming's aim was, through the study of organism (plant) morphology and anatomy, i.e. adaptation, to explain why a species occurred under a certain set of environmental conditions. Moreover, the goal of the new discipline was to explain why species occupying similar habitats, experiencing similar hazards, would solve

problems in similar ways, despite often being of widely different phylogenetic descent. Based on his personal observations in Brazilian cerrado, in Denmark, Norwegian Finnmark and Greenland, Warming gave the first university course in ecological plant geography. Based on his lectures, he wrote the book 'Plantesamfund', which was immediately translated to German, Polish and Russian, later to English as

### **'Oecology of Plants'**

. Through its German edition, the book had immense effect on British and North American scientist like Arthur Tansley, Henry Chandler Cowles and Frederic Clements.

[\[3\]](#)

## **Darwinism and the science of ecology**

It is often held that the roots of scientific ecology may be traced back to Darwin. [\[4\]](#) This contention may look convincing at first glance inasmuch as

### ***On the Origin of Species***

is full of observations and proposed mechanisms that clearly fit within the boundaries of modern ecology (e.g. the cat-to-clover chain – an ecological cascade) and because the term ecology was coined in 1866 by a strong proponent of Darwinism,

### **Ernst Haeckel**

. However, Darwin never used the word in his writings after this year, not even in his most "ecological" writings such as the foreword to the English edition of Hermann Müller's

### *The Fertilization of Flowers*

(1883) or in his own treatise of earthworms and mull formation in forest soils (The formation of vegetable mould through the action of worms, 1881). Moreover, the pioneers founding ecology as a scientific discipline, such as

### **Eugen Warming, A. F. W. Schimper, Gaston Bonnier, F.A. Forel, S.A. Forbes**

and

### **Karl Möbius**

, made almost no reference to Darwin's ideas in their works.

[\[5\]](#)

This was clearly not out of ignorance or because the works of Darwin were not widespread, but because ecology from the beginning was concerned with the relationship between organism morphology and physiology on one side and environment on the other, mainly abiotic environment, hence environmental selection. Darwin's concept of natural selection on the other hand focused primarily on competition.

[\[6\]](#)

The mechanisms other than competition that he described, primarily the divergence of character which can reduce competition and his statement that "struggle" as he used it was metaphorical and thus included environmental selection, were given less emphasis in the Origin than competition.

[\[7\]](#)

Despite most portrayals of Darwin conveying him as a non-aggressive recluse who let others fight his battles, Darwin remained all his life a man nearly obsessed with the ideas of competition, struggle and conquest – with all forms of human contact as confrontation.

[\[7\]](#)

[8]

### **Early 20th century ~ Expansion of ecological thought** **The biosphere - Eduard Suess, Henry Chandler Cowles, and Vladimir Vernadsky**

By the 19th century, ecology blossomed due to new discoveries in chemistry by **Lavoisier** and de **Saussure**

, notably the nitrogen cycle. After observing the fact that life developed only within strict limits of each compartment that makes up the atmosphere, hydrosphere, and lithosphere, the Austrian geologist Eduard Suess proposed the term biosphere in 1875. Suess proposed the name biosphere for the conditions promoting life, such as those found on Earth, which includes flora, fauna, minerals, matter cycles, et cetera.

In the 1920s **Vladimir I. Vernadsky**, a Russian geologist who had defected to France, detailed the idea of the biosphere in his work **"The biosphere"** (1926), and described the fundamental principles of the biogeochemical cycles. He thus redefined the biosphere as the sum of all ecosystems.

First ecological damages were reported in the 18th century, as the multiplication of colonies caused deforestation. Since the 19th century, with the industrial revolution, more and more pressing concerns have grown about the impact of human activity on the environment. The term ecologist has been in use since the end of the 19th century.

### **The ecosystem: Arthur Tansley**

Over the 19th century, botanical geography and zoogeography combined to form the basis of biogeography. This science, which deals with habitats of species, seeks to explain the reasons for the presence of certain species in a given location.

It was in 1935 that **Arthur Tansley**, the British ecologist, coined the term ecosystem, the interactive system established between the biocoenosis (the group of living creatures), and their biotope, the environment in which they live. Ecology thus became the science of ecosystems.

Tansley's concept of the ecosystem was adopted by the energetic and influential biology educator Eugene Odum. Along with his brother, Howard Odum, Eugene P. Odum wrote a textbook which (starting in 1953) educated more than one generation of biologists and ecologists in North America.

### Ecological Succession - Henry Chandler Cowles

At the turn of the 20th century, **Henry Chandler Cowles** was one of the founders of the emerging study of **"dynamic ecology"**, through his study of ecological succession at the Indiana Dunes, sand dunes at the southern end of Lake Michigan. Here Cowles found evidence of ecological succession in the vegetation and the soil with relation to age. Cowles was very much aware of the roots of the concept and of his (primordial) predecessors.

[\[9\]](#)

Thus, he attributes the first use of the word to the French naturalist

#### **Adolphe Dureau de la Malle**

, who had described the vegetation development after forest clear-felling, and the first comprehensive study of successional processes to the Finnish botanist

#### **Ragnar Hult**

(1885).

## Timeline of ecologists

### A list of founders, innovators and their significant contributions to ecology, from Romanticism onward.

Notable figure	Lifespan	Major contribution & citation
Antoni van Leeuwenhoek	1632-1723	First to develop concept of food chains
Carl Linnaeus	1707–1778	Influential naturalist, inventor of science on the ecology <a href="#">[10]</a> <a href="#">[11]</a>
Alexander Humboldt	1769–1859	First to describe ecological gradient of latitudinal biogeography <a href="#">[4]</a> <a href="#">[12]</a>
Charles Darwin	1809-1882	Founder of evolution by means of natural selection <a href="#">[13]</a>
Herbert Spencer	1820–1903	Early founder of social ecology, coined the phrase <a href="#">[11]</a> <a href="#">[13]</a>
Karl Möbius	1825-1908	First to develop concept of ecological community, <a href="#">[14]</a> <a href="#">[15]</a> <a href="#">[16]</a>
Ernst Haeckel	1834-1919	Invented the term ecology, popularized research in ecology
Victor Hensen	1835-1924	Invented term plankton, developed quantitative analysis in ecology
Eugenius Warming	1841-1924	Early founder of Ecological Plant Geography <a href="#">[17]</a>
Ellen Swallow Richards	1842–1911	Pioneer and educator who linked urban ecology to ecology <a href="#">[18]</a>
Stephen Forbes	1844–1930	Early founder of entomology and ecological concepts <a href="#">[5]</a> <a href="#">[19]</a> <a href="#">[20]</a>
Vito Volterra	1860-1940	Independently pioneered mathematical population ecology <a href="#">[21]</a> <a href="#">[22]</a>
Vladimir Vernadsky	1869-1939	Founded the biosphere concept
Henry C. Cowles	1869-1939	Pioneering studies and conceptual development in ecology <a href="#">[23]</a>
Jan Christian Smuts	1870-1950	Coined the term holism <a href="#">[24]</a> <a href="#">[25]</a> <a href="#">[26]</a> <a href="#">[27]</a>
Arthur G. Tansley	1871–1955	First to coin the term ecosystem in 1936 and notable ecologist <a href="#">[15]</a> <a href="#">[24]</a> <a href="#">[25]</a>
Charles Christopher Adams	1873-1955	Animal ecologist, biogeographer, author of first American textbook on ecology <a href="#">[28]</a> <a href="#">[27]</a>

[\[6\]](#)

Friedrich Ratzel	1844-1904	German geographer who first coined the term biogeography.
Frederic Clements	1874-1945	Authored the first influential American ecology book, <i>Plant Communities</i> .
Victor Ernest Shelford	1877-1968	Founded physiological ecology, pioneered food-web ecology.
Alfred J. Lotka	1880-1949	First to pioneer mathematical populations models.
Henry Gleason	1882-1975	Early ecology pioneer, quantitative theorist, author of <i>Individualism in Geography</i> .
Charles S. Elton	1900-1991	'Father' of animal ecology, <i>Animal Ecology</i> , food-web & community ecology.

[29]

[33]

G. Evelyn Hutchinson	1903-1991	Limnologist and conceptualist who advanced the niche concept.
Eugene P. Odum	1913-2002	Co-founder of ecosystem ecology and ecological energetics.
Howard T. Odum	1924–2002	Co-founder of ecosystem ecology and ecological energetics.

[40]

Robert MacArthur	1930–1972	Co-founder on Theory of Island Biogeography and Ecological Niche Theory.
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## Ecology's influence in the social sciences and humanities

### Human ecology

**Human ecology** began in the 1920s, through the study of changes in vegetation succession in the city of Chicago. It became a distinct field of study in the 1970s. This marked the first recognition that humans, who had colonized all of the Earth's continents, were a major ecological factor. Humans greatly modify the environment through the development of the habitat (in particular urban planning), by intensive exploitation activities such as logging and fishing, and as side effects of agriculture, mining, and industry. Besides ecology and biology, this discipline involved many other natural and social sciences, such as anthropology and ethnology, economics, demography, architecture and urban planning, medicine and psychology, and many more. The development of human ecology led to the increasing role of ecological science in the design and management of cities.

In recent years human ecology has been a topic that has interested organizational researchers.

### Hannan and Freeman

(

#### ***Population Ecology of Organizations (1977)***

, *American Journal of Sociology*) argue that organizations do not only adapt to an environment. Instead it is also the environment that selects or rejects populations of organizations. In any given environment (in equilibrium) there will only be one form of organization (isomorphism). Organizational ecology has been a prominent theory in accounting for diversities of organizations and their changing composition over time.

### James Lovelock and the Gaia hypothesis

Main article: [Gaia hypothesis](#)

The **Gaia theory**, proposed by **James Lovelock**, in his work ***Gaia: A New Look at Life on Earth***, advanced the view that the Earth should be regarded as a single living macro-organism. In particular, it argued that the ensemble of living organisms has jointly evolved an ability to control the global environment —

by influencing major physical parameters as the composition of the atmosphere, the evaporation rate, the chemistry of soils and oceans — so as to maintain conditions favorable to life.

This vision was largely a sign of the times, in particular the growing perception after the Second World War that human activities such as nuclear energy, industrialization, pollution, and overexploitation of natural resources, fueled by exponential population growth, were threatening to create catastrophes on a planetary scale. Thus Lovelock's Gaia hypothesis, while controversial among scientists, was embraced by many environmental movements as an inspiring view: their *Earth-mother*, Gaia, was "becoming sick from humans and their activities".

### Conservation and environmental movements

Environmentalists and other conservationists have used ecology and other sciences (e.g., climatology) to support their advocacy positions. Environmentalist views are often controversial for political or economic reasons. As a result, some scientific work in ecology directly influences policy and political debate; these in turn often direct ecological research.

The history of ecology, however, should not be conflated with that of environmental thought. Ecology as a modern science traces only from Darwin's publication of *Origin of Species* and Haeckel's subsequent naming of the science needed to study Darwin's theory. Awareness of humankind's effect on its environment has been traced to Gilbert White in 18th-century Selborne, England. <sup>[42]</sup> Awareness of nature and its interactions can be traced back even farther in time. <sup>[43]</sup> <sup>[44]</sup> Ecology before Darwin, however, is analogous to medicine prior to Pasteur's discovery of the infectious nature of disease. The history is there, but it is not particularly relevant.

Neither Darwin nor Haeckel, it is true, did self-avowed ecological studies. The same can be said for researchers in a number of fields who contributed to ecological thought well into the 1940s without avowedly being ecologists. <sup>[45]</sup> <sup>[46]</sup> Raymond Pearl's population studies are a case in point. <sup>[47]</sup> Ecology in subject matter and techniques grew out of studies by botanists and plant geographers in the late 19th and early 20th centuries that paradoxically lacked Darwinian evolutionary perspectives. Until Mendel's studies with peas were rediscovered and melded into the Modern Synthesis <sup>[48]</sup>

, Darwinism suffered in credibility. Many early plant ecologists had a Lamarckian view of inheritance, as did Darwin, at times. Ecological studies of animals and plants, preferably live and in the field, continued apace however. <sup>[49]</sup>



When the Ecological Society of America (ESA) was chartered in 1915, it already had a conservation perspective. <sup>[50]</sup> Victor E. Shelford, a leader in the society's formation, had as one of its goals the preservation of the natural areas that were then the objects of study by ecologists, but were in danger of being degraded by human incursion.

<sup>[51]</sup>

Human ecology had also been a visible part of the ESA at its inception, as evident by publications such as: "The Control of Pneumonia and Influenza by the Weather," "An Overlook of the Relations of Dust to Humanity," "The Ecological Relations of the Polar Eskimo," and "City Street Dust and Infectious Diseases," in early pages of *Ecology and Ecological Monographs*. The ESA's second president, Ellsworth Huntington, was a human ecologist. Stephen Forbes, another early president, called for "humanizing" ecology in 1921, since man was clearly the dominant species on the Earth.

<sup>[52]</sup>

This auspicious start actually was the first of a series of fitful progressions and reversions by the new science with regard to conservation. Human ecology necessarily focused on man-influenced environments and their practical problems. Ecologists in general, however, were trying to establish ecology as a basic science, one with enough prestige to make inroads into Ivy League faculties. Disturbed environments, it was thought, would not reveal nature's secrets.

Interest in the environment created by the American Dust Bowl produced a flurry of calls in 1935 for ecology to take a look at practical issues. Pioneering ecologist C. C. Adams wanted to return human ecology to the science. <sup>[53]</sup> Frederic E. Clements, the dominant plant ecologist of the day, reviewed land use issues leading to the Dust Bowl in terms of his ideas on plant succession and climax.

<sup>[54]</sup> Paul Sears reached a wide audience with his book, *Deserts on the March*.

<sup>[55]</sup>

World War II, perhaps, caused the issue to be put aside.

The tension between pure ecology, seeking to understand and explain, and applied ecology, seeking to describe and repair, came to a head after World War II. Adams again tried to push the ESA into applied areas by having it raise an endowment to promote ecology. He predicted that "a great expansion of ecology" was imminent "because of its integrating tendency." <sup>[56]</sup> Ecologists, however, were sensitive to the perception that ecology was still not considered a rigorous, quantitative science. Those who pushed for applied studies and active involvement in

conservation were once more discretely rebuffed. Human ecology became subsumed by sociology. It was sociologist Lewis Mumford who brought the ideas of George Perkins Marsh to modern attention in the 1955 conference, "Man's Role in Changing the Face of the Earth." That prestigious conclave was dominated by social scientists. At it, ecology was accused of "lacking experimental methods" and neglecting "man as an ecological agent." One participant dismissed ecology as "archaic and sterile."

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Within the ESA, a frustrated Shelford started the Ecologists' Union when his Committee on Preservation of Natural Conditions ceased to function due to the political infighting over the ESA stance on conservation.

[\[50\]](#)

In 1950, the fledgling organization was renamed and incorporated as the Nature Conservancy, a name borrowed from the British government agency for the same purpose.

Two events, however, led to changes in ecology's course away from applied problems. One was the Manhattan Project. It had become the Nuclear Energy Commission after the war. It is now the Department of Energy (DOE). Its ample budget included studies of the impacts of nuclear weapon use and production. That brought ecology to the issue, and it made a "Big Science" of it. [\[58\]](#) [\[59\]](#) Ecosystem science, both basic and applied, began to compete with theoretical ecology (then called evolutionary ecology and also mathematical ecology).

### **Eugene Odum**

, who published a very popular ecology textbook in 1953, became the champion of the ecosystem. In his publications, Odum called for ecology to have an ecosystem and applied focus.

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The second event was the publication of **Silent Spring**. **Rachel Carson's** book brought ecology as a word and concept to the public. Her influence was instant. A study committee, prodded by the publication of the book, reported to the ESA that their science was not ready to take on the responsibility being given to it.

[\[61\]](#)

Carson's concept of ecology was very much that of **Gene Odum**. [\[62\]](#) As a result, ecosystem science dominated the International Biological Program of the 1960s and 1970s, bringing both money and prestige to ecology.

[\[63\]](#)

[\[64\]](#)

Silent Spring was also the impetus for the environmental protection programs that were started in the Kennedy and Johnson administrations and passed into law just before the first Earth Day. Ecologists' input was welcomed. Former ESA President Stanley Cain, for example, was

appointed an Assistant Secretary in the Department of the Interior.

The environmental assessment requirement of the 1970 **National Environmental Protection Act** (NEPA), “legitimized ecology,” in the words of one environmental lawyer.

[\[65\]](#)

An ESA President called it “an ecological ‘Magna Carta.’”

[\[66\]](#)

A prominent Canadian ecologist declared it a “boondoggle.”

[\[67\]](#)

NEPA and similar state statutes, if nothing else, provided much employment for ecologists. Therein was the issue. Neither ecology nor ecologists were ready for the task. Not enough ecologists were available to work on impact assessment, outside of the DOE laboratories, leading to the rise of “instant ecologists,”

[\[7\]](#)

having dubious credentials and capabilities. Calls began to arise for the professionalization of ecology. Maverick scientist Frank Egler, in particular, devoted his sharp prose to the task.

[\[8\]](#)

Again, a schism arose between basic and applied scientists in the ESA, this time exacerbated by the question of environmental advocacy. The controversy, whose history has yet to receive adequate treatment, lasted through the 1970s and 1980s, ending with a voluntary certification process by the ESA, along with lobbying arm in Washington.

[\[68\]](#)

Post-Earth Day, besides questions of advocacy and professionalism, ecology also had to deal with questions having to do with its basic principles. Many of the theoretical principles and methods of both ecosystem science and evolutionary ecology began to show little value in environmental analysis and assessment. [\[69\]](#) Ecologist, in general, started to question the methods and logic of their science under the pressure of its new notoriety.

[\[70\]](#)

[\[71\]](#)

[\[72\]](#)

Meanwhile, personnel with government agencies and environmental advocacy groups were accused of religiously applying dubious principles in their conservation work.

[\[73\]](#)

Management of endangered Spotted Owl populations brought the controversy to a head.

[\[74\]](#)

Conservation for ecologists created travails paralleling those nuclear power gave former Manhattan Project scientists. In each case, science had to be reconciled with individual politics,

religious beliefs, and worldviews, a difficult process. Some ecologists managed to keep their science separate from their advocacy; others unrepentantly became avowed environmentalists. [\[75\]](#)

### Ecology and global policy

Ecology became a central part of the World's politics as early as 1971, UNESCO launched a research program called *Man and Biosphere*, with the objective of increasing knowledge about the mutual relationship between humans and nature. A few years later it defined the concept of Biosphere Reserve.

In 1972, the United Nations held the first international Conference on the Human Environment in Stockholm, prepared by Rene Dubos and other experts. This conference was the origin of the phrase "**Think Globally, Act Locally**". The next major events in ecology were the development of the concept of biosphere and the appearance of terms "biological diversity"—or now more commonly biodiversity—in the 1980s. These terms were developed during the Earth Summit in Rio de Janeiro in 1992, where the concept of the biosphere was recognized by the major international organizations, and risks associated with reductions in biodiversity were publicly acknowledged.

Then, in 1997, the dangers the biosphere was facing were recognized from an international point of view at the conference leading to the Kyoto Protocol. In particular, this conference highlighted the increasing dangers of the greenhouse effect -- related to the increasing concentration of greenhouse gases in the atmosphere, leading to global changes in climate. In Kyoto, most of the world's nations recognized the importance of looking at ecology from a global point of view, on a worldwide scale, and to take into account the impact of humans on the Earth's environment.

### See also

- [Humboldtian science](#)

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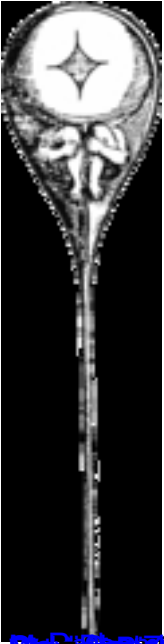
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