HOW DOES IT ALL WORK TOGETHER?

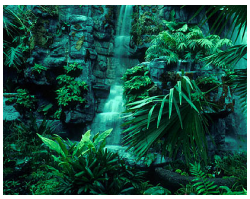
Eugen Warming, Eugene Odum, E.O. Wilson

From Natural History to Ecology

Natural history as a science dates back to the time of the ancient Greeks, who lavished rich descriptive prose on their observations of the natural world. Aristotle described many animal species, Theophrastus made detailed observations of plants, and other philosophers added to the store of knowledge about medicine and the human body.







While naturalists from ancient times through the 19th century slowly developed detailed knowledge about individual species and some information about how each organism interacted with its environment, it wasn't until the end of the 19th century that scientists began systematically studying the larger systems that were made up of many living things sharing the same geographic area, interacting with one another and with nonliving factors. In 1866, the German biologist Ernst Haeckel used the word "oekologie" to name a new science which studied the relationship between organisms and their environment. The word was later shortened to "ecology."

Haekel did little to develop the concept at the time. Later, in 1895, Danish botanist Eugen Warming wrote the first textbook on plant ecology and taught the first university course in ecology. Warming is generally considered the founder of the science of ecology.

Eugen Warming

Johannes Eugeneius Warming (1841-1924) began life on the tiny island of Mandø in the Wadden Sea off of Denmark. His father died while Eugen was young, and his mother moved the family to Jutland, the northernmost region of Denmark. Undoubtedly the harsh but lovely windblown landscape influenced young Warming, as he took an early interest in the natural world

around him. He studied natural history at the University of Copenhagen, but left before he finished his degree to work for a Danish paleontologist, digging up fossils in Brazil. Later he returned to Europe and studied under a number of well-known naturalists. By 1871, he had earned his Ph.D. at the University of Copenhagen. After several teaching positions at various universities, he became a professor of botany at the University of Copenhagen.

Warming was a dedicated teacher, enthusiastic about his subject and dedicated to his students. In 1878, he wrote his own textbook, the *Handbook of Systematic Botany,* followed in 1880 by *Handbook of General Botany*. In 1895, Warming wrote *Oecology of Plants*, the first ecology textbook ever published. This textbook, along with Warming's published papers on botany based on his worldwide field excursions, influenced many top botanists of the day to turn to ecological studies.

A Changing World View

Warming's *Oecology* was originally published in German so it would be well-received throughout Europe. The book only gained international acclaim after it was translated into English in 1909. English botanist Sir Arthur George Tansley (1871-1955) discovered *Oecology* and championed the science in England. Tansley was one of the first who used the simplified spelling, *ecology*, and may have coined the word *ecosystem* around 1935 (the word is also attributed to several other scientists). Tansley eventually founded the British Ecological Society and spread the science of ecology throughout the English-speaking world.

Tansley was working at a time when Western society's view of nature was changing. In the 19th century, nature was something to be "tamed." Nature was "red in tooth and claw," and represented wild and chaotic influences. "Taming" nature meant clearing forests and replacing them with farms, eradicating large predators such as wolves and bears, and killing any and all wild animals for food or just for fun. It also meant "taming" Native American people by confining them to reservations, taking their children away to boarding schools, or committing outright genocide.

By the end of the 19th century, most of the North American continent had been aggressively "tamed." The wild Passenger Pigeon and the California Golden Bear were extinct. Animals that we consider common, such as the wild turkey, the gray squirrel, beavers, deer, bison, and many songbirds had been hunted nearly to the brink of extinction, mostly for the fun of shooting things. The women's hat industry used bird skins, wings, and plumage to decorate the huge, extravagant hats that were the fashion. Naturalists began sounding an alarm as the seemingly boundless supply of American resources were

quickly coming to an end. Nature Study became a popular subject at schools. While often it consisted of little more than coloring in pictures of birds, at the very least it taught children that birds were worth knowing something about and weren't just moving targets for some recreational shooting.

In the early 20th century the first laws were passed to protect songbirds from hunting. Later other animals were added to the list. It wasn't until the 1970's that the Endangered Species Act went into effect to protect all endangered organisms from habitat loss and overuse could lead to extinction. Conservation laws passed in the early 20th century were aimed at conserving natural resources so that they could be used wisely, and resulted in federal and state systems of land management, such as the U.S. Forest Service. Preservation movements aimed to entirely preserve significant areas, and led to the development of National Parks, wilderness areas, and similar areas closed to exploitation.

It was in this period of change that Natural History grew into ecology, and ecology grew into a science. The spelling *ecology* was adopted officially at the Madison (Wisconsin) Botanical Congress in 1893. Zoologists at first protested, claiming that in changing the spelling, the botanists were changing the science. Zoologists went on to found the science of ethology, the scientific study of animal behavior in natural settings, and strongly separated themselves from the botanists in studying ecology. Botanists, in fact, seldom studied plant-animal interactions, which seriously limited the development of botanical ecology for several decades. By the 1930's, Arthur Tansley had developed his ecosystem concept, which required both plant and animal ecologists to recognize that another taxonomic kingdom existed other than the one they were most interested in. Only then did the science of ecology as we know it today take off.

While there were many scientists who developed the science of ecology in the early 20th century, two stand out in particular: Eugene Odum and E.O. Wilson.

Eugene Odum

While Tansley brought the science of ecology to England, Eugene Odum (1913-2002) was outstanding among those who promoted ecological study in the U.S. Odum grew up in Chapel Hill, North Carolina. His father encouraged him to wander the nearby forests, studying birds and other animals. Odum always credited his father with teaching him to study birds in a holistic way, looking not only at the individual birds themselves, but their surroundings and how the birds interacted

with the habitat around them. As junior high school students, Odum and a friend wrote a nature column for the local newspaper, often describing their own observations.

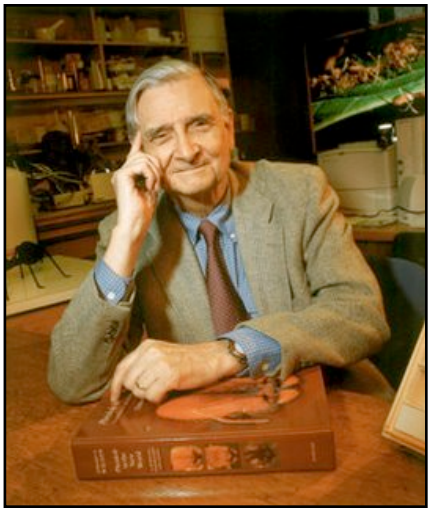
After graduating from high school, Odum studied Zoology at the University of Illinois, though his interests lay not in the narrow field of systematic zoology, but in the wider view of ecology. Odum took up a teaching post at the University of Georgia in the 1940's. There he discovered that most of his colleagues had not heard the term "ecology" before. Many of them studied the relationships between individual animals and their habitat, but had not discovered the broader system of studying many different and interacting populations of organisms. In fact, many biologists doubted that it was possible to conduct such broad studies. Odum soon developed the first ecology courses taught at his university, which were among the first taught in the U.S. He refined the term *ecosystem*, and wrote a new textbook on ecology. His textbook, titled *Fundamentals of Ecology*, was the first biology textbook to use a "top-down" approach: looking at the ecosystem first, then looking at the smaller and smaller components of the system. For ten years, it was the only ecology textbook available.

Odum's lasting contribution to ecological science was his persistent idea that ecological studies could go far beyond simply studying the ecology of a small pond or meadow in isolation as most ecologists thought. Odum insisted that ecologists needed to look at the larger picture: weather, watershed systems, geology, and more to understand why organisms lived where they did. Thanks to Odum's work, ecologists today look not just at individual ponds, but at the entire earth as an interactive ecosystem, and we have a much better understanding of human influence than would have been possible in the mid-20th century when Odum began his work.

After the publication of Rachel Carson's *Silent Spring*, an alarming book that showed how much effect human industrialism had on the ecosystem, Odum's work was used widely by environmentalists to demonstrate how every natural community on the Earth was linked together, and how humans could easily disrupt the system. Odum, however, did not consider himself an environmentalist, and kept his science out of politics.

E.O. Wilson

At the same time that Eugene Odum was studying Zoology at the University of Illinois, young Edward O. Wilson (1929-) was running through swamps and forests in the southern United States, learning everything he could about animals first hand. That child's sense of wonder at nature never left Wilson, who followed his interests straight into a long and illustrious career as a modern-day naturalist. Wilson lost his sight in one eye at the age of seven when a sharp fin of a fish he had just caught pierced his eye, and he developed a chronic hearing problem which was probably an inherited condition. Unable to hear bird



calls distinctly or spot animals from a long distance, Wilson turned his attention to animals that he could bring close to his good eye: insects. He joined the Boy Scouts, and one of the first badges he earned on his way to the Eagle Scout award was Insect Study. Eventually Wilson specialized in ants. By the time he finished high school and began college, he had already carried out several original studies that impressed his college professors, and before he graduated from college he discovered, named, and described several new species of ants.

As a graduate student and later a young faculty member at Harvard, Wilson traveled around the world in search of rare or unknown species of ants. He witnessed first-hand the effects of habitat destruction on species. He found and identified new tropical species of ants, then found on his return several years later that the forest he'd found them in no longer existed, or the mountainside that once held a thriving ant population had been devastated for human use.

Studies of ant behavior led Wilson to study how ants communicate using chemicals. By constructing artificial nests for fire ants, he noticed the ants seemed to follow invisible trails that others had laid as they explored the new nest. Wilson made minute observations of ant behavior to try to discern how they used touch and chemicals to communicate, and carried out micro-dissections to discover the organs that ants used to produce and distribute pheromones. Out of his work came the first detailed knowledge of insect pheromones, chemicals that many animal species use to communicate. Insect pheromones are now used in agriculture to make non-toxic insect control products, such as traps baited with pheromones that catch pests as they try to breed.

Besides studying and classifying insects, Wilson studied their ecology, behavior, and distribution from an evolutionary perspective: how did the natural communities that we see today come about?

One of Wilson's significant contributions to evolutionary ecology came out his work in the Florida Keys. By tracking the number of species on the Florida mainland and comparing it to the species of nearby islands, Wilson was able to work out a mathematical theory of biogeography which modeled how species immigrate to and become isolated on islands. The further from the mainland, the less diversity he found on the small islands. Also, the smaller the island, the less diversity of species he found there. This work became important in modeling how species can change genetically after isolation. The further from the mainland,

the less likely it is that other members of the same species might migrate to the island, and so the less mixing of genes there can be between the island and the mainland.

Less well-received was Wilson's work on the evolution of societal behavior in animals. While his conclusions about evolutionary origins of animal behavior were well-established in the scientific literature, Wilson carried his ideas into human society. This alarmed many people, including psychologists, sociologists, and naturalists. Regardless of what kingdom science places humans into, we still have a way of clinging to the idea that we're very different from other animals, and that belief can so strong that encountering ideas to the contrary raises strong emotions. Evolutionary biologist Stephen Jay Gould was especially critical of Wilson's conclusions, believing that Wilson had too little data. Sociologists insisted that human behavior was entirely based in culture, not inborn traits. Wilson found himself at the center of a storm of controversy, where he was accused of being racist and a misogynist. Some people even made unfounded accusations that he supported eugenics. Yet many recent studies on human and non-human primate behavior are showing that there may be truth to Wilson's ideas that at some aspects of human behaviors are at least in part inherited.

Throughout his years spent studying insects and other small invertebrates, Wilson was struck by the astonishing diversity of organisms in the ecosystem and how fragile the ecosystem could be, particularly under the onslaught of human exploitation in search of more and more resources to feed our growing desire for material things. His work led him into environmental activism of a practical kind. Wilson's most recent project is the Encyclopedia of Life (http://www.eol.org), an ambitious online project that is an information-age version of Buffon's *Histoire Naturelle*: a catalog of all living species on the planet, with information on where they are located, to assist current biologists as they work to describe living organisms and discover their ecological roles before undiscovered species disappear completely. Unlike Buffon, however, Wilson is far from working alone. Any expert on a particular species or larger group can become part of the project and contribute information. The Encyclopedia of Life is expected to be fully functional by the end of 2008.

In addition to being a scientist, Wilson is an accomplished author. His book, *On Human Nature*, won the Pulitzer Prize in 1979. *The Ants*, published in 1990, also won the Pulitzer Prize in 1991. His autobiography, *Naturalist* (1994) remains a popular favorite as does *The Diversity of Life* (1992). His latest book, *The Creation: An Appeal to Save Life on Earth* (2006) grew out of his concern for the loss of biodiversity that he has witnessed during his career.

Questions

After reading the text above, please answer these as fully as possible. Remember to write your answers your own words even if you work with others or use other resources.

1. The science of ecology grew out of the older science of natural history, but this did not happen until the early 20 century. How did changes in society relate to the development of this new approach to studying the natural world?

2. Compare the early lives of Warming, Odum, and Wilson. What factors do you think led these three people into careers as scientists?

3. What was different about the way that both Odum and Wilson went about studying the ecosystem compared with zoologists of the late 19th and early 20th centuries? Do you think their work has further changed the way that society views nature? In what ways?

4. Wilson developed a theory of biogeography. Briefly describe his theory, and explain why it is a theory rather than a law or hypothesis.

5. Wilson used scientific evidence to support his idea that sociobiology applies to humans. Stephen Jay Gould had access to the same evidence, yet came to a different conclusion. How is it possible for two highly-accomplished scientists to come to different conclusions from the same set of data? How does the scientific community decide who is right?