Transcript Lecture 2

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In this session, I will discuss the meaning and levels of organization of ecology, followed by a brief look at taxonomy, which is naming and describing organizations.

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The learning outcomes for this lecture: by the end of the session, you should be able to define ecology, which is to state the meaning of the word.

You should also be able to list the five levels of ecology and the taxonomic levels of life. Finally, you should have an idea of why taxonomy is still very important today.

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Ecology is the study of how living things interact with each other and the environment: it considers interactions between animals, plants, microbes and the physical environment.

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Ecology comes from oikos, the Greek word for home, and -ology which means the study of. So we are literally studying our home when we study ecology.

We can divide this into biotic and abiotic variables. Biotic refers to living things, so bio means living, and abiotic refers to non-living things, the “a” refers to “non”. Abiotic could include temperature water pH and light, whereas biotic includes plants and animals and microbes.

We study the interactions between all of these things in ecology. It can be extremely complex to disentangle all that is happening.

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There are five main levels of ecology. The first is organisms such as this monkey.

This is one individual animal, plant or one microbe.

It can be difficult to know what one organism is- some organisms like corals group together and form modules.

Ecology considers how an organism is affected by the biotic or abiotic environment.

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Population is a group of organisms that live in an area and are the same species, which means they can breed and produce live young.

Examples include a rice field, a group of monkeys or a school of fish.

Ecologists are interested in presence or absence of species in an area, abundance or rarity of species and trends and fluctuations in numbers in geographical space or over time.

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A community refers to a group of populations and a given location. These may or may not interact with each other. A rock pool or a pond might be a community as they contain lots of different species in a small area.

Ecologists are interested in the composition or the structure of the community. So who was there. And how many of them.

The pathways of energy or nutrients through the system.

And interactions between and within populations.

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An ecosystem is basically a given area containing a community of organisms and interactions and energy and nutrients cycles. So this could be a forest or a marsh or a grassland.

The term ecosystem was first defined by Arthur Tansley in 1935 and his definition simply described the biological community so animals, plants and microbes with the physical environment.

The ecosystem concept was developed by Eugene Odum in 1971 and he further refined this idea of the ecosystem.

And his definition goes as follows.

Any unit that includes all of the organisms, for example, all the communities in a given area interacting with the physical environment. So that's a flow of energy leads to clearly defined trophic structure, biodiversity and material cycles. So this is exchange of materials between living and non-living parts within the system. This is an ecological system or an ecosystem.

So this definition encompasses the organisms that are present and the energy flows between them and the relationships between them. So it is quite a complex idea.

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The biosphere is the global ecosystem. It’s simply everywhere that life can live. So we're talking about the air, the land and the sea.

So the atmosphere, the terrestrial system or lithosphere and the sea, which is the hydrosphere.

It is the largest level of organization. And as far as we know it is the only one in our universe.

Life has been found up to 10 kilometers above sea level, birds flying extremely high in the sky and as deep into the sea as 8000 meters in the Marianas Trench in the Pacific Ocean.

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There is a sixth level of organization somewhere in between ecosystems and the biosphere. And this is called the biome. Now a biome is large area that has a certain climate and types of living things. And if we have this, then we can match these two different areas on the planet. And as you can see in this map, we can see that the rainforest is a biome. It occurs in South America in Africa and in Southeast Asia. It is characterized by similar climate and vegetation.

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In this map there are six major Biomes.

In the far north at high latitude there is the tundra in grey on this map. It is so cold all year round that soil, water is frozen and called permafrost. Vegetation tends to be very small, such as mosses lichens, grasses and very small trees which are called dwarf trees because actually there is very low rainfall or precipitation.

Also in high latitudes are boreal forests and you can see them in the pale green and yellow here. These are also known as taiga. This is characterized by coniferous trees that stay green all year. So evergreen, and they have needle leaves to retain temperature and moisture. These forests often consist of communities have only one or two species. So the biodiversity is relatively low.

In temperate latitudes, which are lower down the brighter green and the brighter yellow there is a large mixture of habitats including broadleaf forest, grasslands peatbogs and heathlands, there is high seasonality here. So everything works within the seasonal framework.

Grasses are major biomes on their own and they occur where rainfall is too low for continuous forest. Trees need a lot of water. And so this can be extremely limiting in these areas. Grasses maybe be named savanna, pampas, steppe, prairie or Veld, according to the location. But they are characterized by being dominated by grasses or Graminoid species.

Deserts are seen here in pink, red and brown. A very crucial biofilms the hot deserts, such as the Sahara Kalahari and the Australian deserts can be found along the lines of the Tropic of Cancer and the Tropic of Capricorn.

Cold deserts tend to be very far inland and have a continental climate where the ocean has little influence. What they have in common is not temperature but extremely low moisture, which means that the vegetation is very, very sparse and patchy and there are relatively few animals.

Finally, along the equator we have tropical forest. These are some of the most diverse communities on earth and comprise biodiversity hotspots, which are viewed as globally extremely precious. They are hot and wet and do not have clear seasons.

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In Myanmar there is a particularly precious rain forest. It is the largest tropical forest in Southeast Asia with that over 80 endemic species. Endemic species are species not found anywhere else on Earth. And we will talk about these later in the course.

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In this graph, we can see the biomes can be categorized by temperature on the x axis and precipitation or rainfall and snow and moisture on the Y axis, this is a simple way of being able to predict which biome is present as a geographic location if its annual climate is known. You can see that the desert is not defined by temperature, but by very low moisture.

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Habitat has two definitions in ecology, you can talk about a habitat, such as a certain type of environment like a forest or a pond or a lake. We can also talk about the habitat of an organism which means all the requirements of the organism to feed survive and reproduce.

These hydrothermal vents that you can see in this image are one such habitat. They are thought to be the only habitat that is not based on sunlight in terms of energy inputs. Instead, they are vents in the seabed. This allows water to be heated by the lava from the Earth's crust, a whole ecosystem of very specialized creatures has appeared, but are totally dependent on the hot mineral rich water that comes from vents, they would not be able to live anywhere else on Earth.

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The ecological niche is a slightly different concept from a habitat of an organism, it considers the functional role of the organism. The term niche encompasses the habitat, the activity times and distances, it could move. It includes the resources the organism needs and the interactions it has with other organisms which can include competition, predation mutualisms and parasitism.

It is thought that two species in the same place cannot have the exact same niche, because one more competitively out excludes the other. This is known as the competitive exclusion principle.

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 A classic example of niche differentiation and competitive exclusion is with barnacles on a rocky shore. Joseph Connell came up with this paradigm in 1961, looking at these two species. He showed two main concepts.

The first is the idea of the fundamental versus the realized niche. The fundamental niche of Chthamalus in this example can be seen on the left. The species can survive to the end of its life cycle and reproduce at any point on this rocky sure from very low tide to very high tide. Now, rocky shores are quite difficult areas to live in, because the tide and the salinity makes for very crucial specializations. You need to be able to survive when it becomes very dry when the tide is low, and very wet when the tide is in. So this is quite a complex set of specialisms.

*Chthamalus* is able to survive this wide range of specialisms and so it has a very large fundamental niche. However, this appears to only be true when there is no other barnacle species to compete with.

 On the right you can see the realized niche of *Chthamalus,* which is what you actually see in nature. This realized niche has occurred because the *Semibalanus* species has outcompeted the *Chthamalus* at low tide. So the *Chthalamus* is restricted to the high tide line.

The second principle that Connell has shown us in this example is competitive exclusion, we can see that the *Semibalanus* is very competitive and at low tide. There are no elements present the *Semibalanus* has taken up all the available space. However, it seems that the *Semibalanus* cannot live on the higher level where the tide is less frequent while the *Chthalamus* can.

This is an example of niche differentiation because *Semibalanus* has taken the lower wetter areas, while the *Chthalamus* is staying up high in the dry areas and therefore you have this differentiation.

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We’ll move on now to taxonomy as a concept. Now this is quite an exciting concept and I hope we'll have lots of interesting debate about this in the session after this lecture.

To study ecology and to conserve habitats, we must first know what is there and how organisms are related to each other. Until the early 20th century ecology was mostly descriptive. People observed the natural world and recorded what they found. While this is still a very valuable tool, ecology has generally moved towards manipulative studies where you change one variable to test the effect on others.

The Swedish scientist Carl Linnaeus is credited with beginning the naming system for species that we use today. It is known as binomial nomenclature, which means for every species is known by two names. The genus which encompasses many species and then the species name, which only talks about one type of organism.

For example, humans are known as *Homo sapiens*. The *Homo* part is the genus name and there are many other species within this that we have found over historical time such as *Homo erectus* and *Homo habilis*. However*, Homo sapiens* is purely for our species of humans that is alive today.

To write the genus and species name, on a computer you use italic font. As you can see here. And if you’re handwriting, then you need to underline the genus and species name.

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Taxonomy is the science of naming and classifying animals, plants and microbes, so they can be formally categorized. Taxonomists use morphological characteristics which are physical characteristics such as colour or the shape of various organs or components. They also use behavioural, genetic or even biochemical observations to help distinguish species unique qualities.

At present there are nearly 2 million species described, but there is a very long way to go. Taxonomists estimate that there could be as many as 90 million species on planet Earth. Most of these are still to be identified. And the main groups that need to be identified our invertebrates and microbes. For example, up to 95% of protozoans still need to be identified.

Many animals and plants have been identified, because they are usually easier to find and to classify and people like to study them they’re charismatic. However, we're still finding new species such as this wild banana that was found in Myanmar in 2019.

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Life is sorted into categories. Then split into subcategories. Here the examples are humans *Homo sapiens* and domestic cats *Felis catus*. So if we start at the top with domain the domain would then split into Animalia and various others. So then we go down to kingdom. And we have Eukarya. And we go to phylum. And both of these are still in Chordata. We go to class and we have Mammalia. And it's when we get to order that humans split from cats. And they become categorized in different orders.

One easy way to remember the order of these taxonomic levels is using a mnemonic. And here I've put one as an example. But you are welcome to make up your own if it helps. Dear King Philip Came Over For Good Soup. So domain Kingdom phylum class, order, family, genus and species.

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There are three main kingdoms in life.

Humans and Animals are in the Eukarya which also contains fungi and plants. These are all linked by having a nucleus in their cells. Bacteria are microorganisms, so single celled organisms and they play a crucial role in ecosystems, they cycle nutrients such as carbon, nitrogen and phosphorus. They help plants grow and sometimes they cause disease. They also break down dead material releasing nutrients to be cycled back into the system. They can have both positive and negative roles within the system.

Archaea, the third major kingdom, they have single celled organisms like bacteria. And they also do not have a nucleus. Archaea are believed to be an ancient group, but just intermediate between Eukarya and bacteria. There are many types of Archaea that are adapted to very extreme environmental conditions such as very hot or salty environment. Also, the hydrothermal vents that we looked at earlier.

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So why is taxonomy so important.

There are four main reasons in order to conserve the biodiversity of our planet. We need to know what is there. We are destroying pristine environments extremely rapidly and we will likely never know many of the organisms that have been driven to extinction. This has particular connotations for finding cures for new diseases and new food sources as we move into the future.

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We also need to be able to understand responses to climate change as the climate changes. Many species that require a narrow set of conditions or climate envelope will need to move in order to survive. Some will not be able to move and may be vulnerable to extinction. By knowing the spatial distributions of species we can predict risks of extinctions, pest outbreaks and disease and we may be able to reduce the impact of these

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Invasive species of pests like this locust outbreak in East Africa that is happening right now are a threat to food security and biodiversity. Taxonomists need to be able to provide species information and identification and rapidly in order to reduce the impact of these.

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Taxonomy is also needed to correctly diagnose diseases and predict spread of disease vectors. Another important factor is trade in medicinal plants which need regulation and quality control.

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In Myanmar taxonomy is a valuable skill. Here are two articles describing newly discovered plant species. The photograph is an example of the way the new species of a photographed and kept classified and as you can see you take many different photographs, at different scales and from different angles in order to help other people identify the same species, or will determine if they have found a new species.

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I've put a couple of links here to interesting websites on taxonomy and feel free to have a read through, see if you find anything interesting and then we can use it for our discussion later.

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So the topic for our breakout session today is that we're going to have a discussion on how could taxonomic study help conservation and manual what areas could benefit most.

Reading:

Chapter 1 Begon

Yang et al. Impatiens. – look at abstract and figures.

Biome paper– look at abstract and figures.