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Species colonisation, not competitive exclusion, drives community overdispersion over long-term succession

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Abstract

Ecological communities often transition from phylogenetic and functional clustering to overdispersion over succession as judged by space-for-time substitution studies. Such a pattern has been generally attributed to the increase in competitive exclusion of closely related species with similar traits through time, although colonisation and extinction have rarely been examined. Using 44 years of uninterrupted old-field succession in New Jersey, USA, we confirmed that phylogenetic and functional clustering decreased as succession unfolded, but the transition was largely driven by colonisation. Early colonists were closely related and functionally similar to residents, while later colonists became less similar to the species present. Extirpated species were generally more distantly related to residents than by chance, or exhibited random phylogenetic/functional patterns, and their relatedness to residents was not associated with time. These results provide direct evidence that the colonisation of distant relatives, rather than extinction of close relatives, drives phylogenetic and functional overdispersion over succession.

Keywords

Buell–Small Successional Study, colonisation, community assembly, extinction, phylogenetic community ecology.

Ecology Letters (2015)

INTRODUCTION

The assembly and maintenance of ecological communities reflect the net sum of many ecological processes that often act on species similarities and differences. One of the most accepted ideas in community ecology is that communities are the results of species sorting processes through environmental filtering and competitive exclusion (Silvertown 2004). With the advent of phylogenetic and trait-based community ecology, the co-occurrence of phylogenetically and functionally similar species (phylogenetic or functional clustering) is often interpreted as evidence for environmental filtering, while the coexistence of dissimilar organisms (overdispersion) has been generally attributed to competitive exclusion (Webb *et al.* 2002; Cavender-Bares *et al.* 2009). Recently, this phylogenetic-patterns-as-proxy approach has been criticised as simplistic in the way it links mechanisms to observed patterns. In fact, there are a number of fundamental assumptions that are either unrealistic or not adequately assessed (see Goebena *et al.* 2014; Gerhold *et al.* 2015). Importantly, competitive exclusion could also drive phylogenetic and functional clustering, by excluding groups of ecologically similar species with low competitive abilities (Mayfield & Levine 2010), and the competition-overdispersion linkage in natural systems currently lacks evidence (see Bennett *et al.* 2013), though more tests are required.

However, phylogenetic and functional overdispersion are widespread patterns in natural communities across numerous taxa and ecosystems (reviewed in Swenson 2013), and the causes of such patterns remain elusive.

Succession has been a central theme in ecology for nearly a century, and has served as a lens to understand how ecological communities are assembled (Clements 1916; Meiners *et al.* 2015). With few exceptions, ecophylogenetic studies using space-for-time substitutions, which compared communities that differ in time since disturbance, often found that older, late-successional communities consist of more distantly related species (Letcher 2010; Letcher *et al.* 2012; Whitfield *et al.* 2012; Purschke *et al.* 2013; see Table S1 in Supporting Information for a summary). Such an overdispersion pattern has been generally attributed to the extinction of closely related and functionally similar species caused by the competitive exclusion (Purschke *et al.* 2013), but the actual effects of colonisation and local extinction on functional and phylogenetic patterns have never been actually observed. While ecophylogenetic analyses of static communities offer little insight to the dynamic mechanisms generating successional patterns, these mechanisms could be better understood with the availability of long-term data on successional dynamics.

Temporal phylogenetic and functional patterns could reflect several different ecological processes acting on colonisation and

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Name _____ Class _____ Date _____

SKILL BUILDER Reading Strategy

Fill in the table to preview the lesson. Then, in the space that follows the table, write one sentence to explain what you think this lesson will be about.

What is the title of this lesson?	Community Stability
What are the vocabulary terms for this lesson?	Succession, primary succession, pioneer species, secondary succession, invasive species
What are the key concepts for the two main sections of this lesson?	Following a disturbance, communities may undergo succession. Without limiting factors, species introduced to a new area can become invasive.
What do the photos depict?	Images of a variety of nature scenes
What do the diagrams seem to show?	It looks like the diagrams show something related to the way forest communities are built.

Answers will vary. Sample answer: I think this lesson details the way forest communities grow from just a few plants to many different kinds of plants.

EXTENSION On a separate sheet of paper, write five questions that come to mind while previewing this lesson. Answer your questions after you have completed the lesson. Answers will vary.

Ecological Succession

For Questions 1–3, write True if the statement is true, if the statement is false, replace the underlined word or words to make the statement true. Write your changes on the line.

- Primary 1. Secondary succession begins with bare rock.
- pioneer species 2. The first species to colonize newly exposed land are called primary species.
- True 3. Over the course of ecological succession, species diversity increases over time.

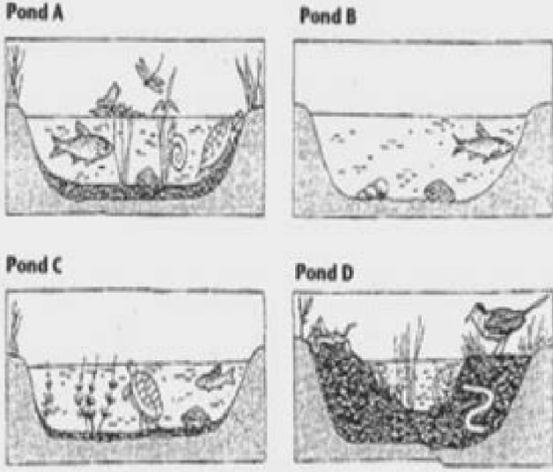
Examining the Stages in Ecological Succession

Name _____

Succession, a series of environmental changes, occurs in all ecosystems. The stages that any ecosystem passes through are predictable. In this activity, you will place the stages of succession of two ecosystems into sequence. You will also describe changes in an ecosystem and make predictions about changes that will take place from one stage of succession to another.

The evolution of a body of water from a lake to a marsh can last for thousands of years. The process cannot be observed directly. Instead, a method can be used to find the links of stages and then to put them together to develop a complete story.

The water level of Lake Michigan was once 18 meters higher than it is today. As the water level fell, land was exposed. Many small lakes or ponds were left behind where there were depressions in the land. Below are illustrations and descriptions of four ponds as they exist today. Use the illustrations and descriptions to answer the questions about the ponds.



Pond A: Cattails, bulrushes, and water lilies grow in the pond. These plants have their roots in the bottom of the pond, but they can reach above the surface of the water. This pond is an ideal habitat for the animals that must climb to the surface for oxygen. Aquatic insect larvae are abundant. They serve as food for larger insects, which in turn are food for crayfish, frogs, salamanders, and turtles.



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This can happen, for example, when the washing cools and creates new rocks, or when a glacier retreats and rocks without any soil. The university's ecological field of Warren Woods at Berrien County, Michigan, offers students, teachers and employees the opportunity to study and observe the ecosystem dynamics in a landscape that includes remaining forests (not disturbed), restored prairies and old fields. This restarts the succession cycle, but not back to the inno - the soil and the nutrients are still present. The study of succession was a pioneer at the University of Chicago by Henry Chandler Cowles, which was also one of the founders of ecology as a discipline, while studying the plants of the Indiana dunes. Ecological succession can occur in many contexts and in many times. Consistent distance distances and variation in factors such as the availability of water and nutrients throughout themselves, therefore, allow many plant and animal communities to prosper within a certain clumpy and geographical niche - no Only those adapted to the absence of distances observed in the clan communities. In addition, Victor Ernest Shelford, a cowles student, became an influential ecologist himself, and a dialer in the foundation of Nature Conservancy, a large non-profit organization of conservation. The. As the native sprains are extinguished or become rare, new ecosystems and clumpy base lines change, communities that previously dominated an ecosystem may be less likely to return ap. distance. Eventually, sufficient forms of soil and sufficient nutrients are available, so that a clan community, such as a forest, is formed. These are known as pioneering sciences. Another work examined the impact of biodiversity loss, invasive sciences, climatic changes and others anthropogian in the change in the way ecosystems ecosystems change. For example, in an area prone to forest incidence such as the west of the US, ripe forests may exist near pounds with fewer scattered around. Each plant community creates conditions that subsequently allow different communities of plants to prosper. This is measured that new nuances have been added the original theory, insights that are valuable to interested humans to manage natural resources. The even more dunes had pines and finally, there were ripe oak forests that didn't resemble grassy dunes near the lake. If you are through a web filter, make sure the domains *.kastatic.org and *.kasandbox.org are unlocked. For example, when a former agrıacola field in the middle- the US is abandoned and left alone for many years, it gradually becomes a meadow, then some shrubs grow and eventually the leasures completely fill the field, producing a forest. In the central US US, for example, this community can be a wooden forest with oaks and hickories such as dominant spirit. Prıntial succession happens when a new earthenwork is created or exposed for the first time. The ecological succession is the process by which natural communities replace (or e ă Antem "centate) to each other over time. Ecological succession is a fundamental concept in ecology, which as a field examines the structure and dynamic of biological communities. There are two main types of ecological succession: Succession and Secondary Succession. The dunes ă edge of the lake had only beach grass, while those who were farther from the coast had other plants, such as a cotton that could grow on sandy soil. From this, he inferred that plant communities tended to oak forests in northern Indiana along the way That each community created the soil and microclimate conditions required for their successor community to prosper: as big and cotton stabilized added dunes and nutrients, they were replaced later late late communities. A clan community is the "endpoint" of succession in the context of a specific climate and geography. (If you visit the dunes, you can walk through the succession trail of dunes, which highlights the different successes of succession in a real world context.) In the 1890 University of Chicago, Henry Chandler Cowles, noticed that the dunes that were farther from Lake Michigan had different plants growing in them than the dunes closest to the lake. First, the wool that can cling to rocks, and some small plants capable of living without much solo can appear. In the early twentieth, the University of Chicago also housed other notable ones, marine ecologists and bi. animals and an important figure in the development of ecology. The succession to temporarily when a community of "Climax" forms of the community. Such communities remain in relative equilibrium until a distance restarts the succession process. Henry Chandler Cowles, Ecological Success and University of Chicago The University of Chicago played a fundamental role in the pioneer in scientific study of ecologic succession and ecology as a broader discipline. Succession of plants in the Indiana dunes, the Indiana dunes, 40 kilometers southeast of Chicago and today the site of a state and a national park, served as an original field for research on ecological success plant communities and continues to serve as an ideal case study. For example, the first colonizers like big guys can add nutrients to the ground, while posterior shrubs and rods can create coverage and shadow. A CLANMAX community will persist in a particular place that a distance occurs. He taught student generations on the ecology of the Through field trips through the continent of Maine to Alaska, Califom and Texas. For example, many natural natural. In the northern rich, they have adapted to dangerous distance from forest in incidence: this can help maintain prairie or savanna communities that depend on open habitat and nutrient cycling that can occur as a result of fire. Domance science environment if you are seeing this message, it means that we are having trouble carrying external resources on our site. The ecological succession is the process by which the mixture of spirit and habitat in a change changes over time. However, the study of succession can also provide valuable information for interested ecologists and wildlife managers to restore these natural systems: through careful management, such as controlled burns or Control of invasive spirit, people can help ecological communities to remain strong. For example, after a forest fire that kills all mature leisure in an specific landscape, big guys can grow, followed by shrubs and a variety of spray, which eventually the community that existed before of the fire is present again. However, in many ecosystems, disturbance occurs with sufficient frequency so that a matrix of community types can be consistently present in the landscape. In many records, secondary succession occurs where forest incoming sponsor forests, or where former pesticides are reversing to Meadow or Scranland. In Hawaiı and Islam, the attachment occurs in the lava flows where new lands have formed; In the dunes of Canadian Athabasca, it happens when the new sand is deposited along a margin of the lake; In the Andes, it occurs when the glaciers withdraw. For example, recent studies show that even in the "Climax" communities, the changes in which features are disposable can change the equilibrium of the composition of the expinations over time, without a formal distance. What is ecological succession? In this video of the National Park Service, Tim Watkins and Robert Boyd exploit the Indian dunes, learning about their history as an important case study for the development of ecological success. The farthest dunes of the lake were the oldest and were strictly stated for longer, the sand often changes in the wind without the plants to keep it in place. Cowles newspapers are also housed at the Special Hanna Holborn Gray Special Collection Research Center and can be found here. Understanding how succession happens in a variety of ecosystems - and what types of distance and time of time lead to formation of different plant and animal communities - it is important for scientists who want to understand the Dinat ecosystem mica and protect or effectively restore natural communities. Ecological succession is a fundamental concept in ecology. Secondary succession happens when a clan community or intermediate community is impacted by a distance. Today, the University of Chicago remains a wool in research on ecology and evolutionary biology. What these examples are in common is that the Clanmax community is not the first gift in the landscape of the succession of success: first, intermediate communities occupy the space, sometimes for many years creating ideal conditions for the following communities. If the site is disturbed after this point, a secondary succession occurs. During the attachment, organisms must begin from scratch. Through careful observation and comparisons, cowles determined that the linear succession of these communities in the space also represented a linear progressive in time. After his fundamental dissertation work in the Dunes of Indiana as a doctoral student in Uchicago, Henry Chandler Cowles has become a teacher, remaining in Uchicago for more than trees, at the end of the 1930s. Today, the concept of ecological succession continues to be studied in new ones, as humans change the global environment more than ever. Trips and cowles field work is documented in the special collection of American environmental ones, which show cowles, students, students, American landscapes of a summary in wide variety and details. Gradually, these communities replace themselves that a "climax community" ", like a mature forest", be reached, or that a distance occurs, like a fire. occurs.

05.10.2021 · Ecological succession are the third stage in ecological succession. (Foto: Source: CC0 / Pixabay / jplenio) You can think of a climax community as a stable biological environment, due in part to the diversity of the species and the unchanging nature of the landscape. An example of a climax community is a forest whose tall trees have created a canopy, the physical ... 05.10.2021 · Ecological succession are the third stage in ecological succession. (Foto: Source: CC0 / Pixabay / jplenio) You can think of a climax community as a stable biological environment, due in part to the diversity of the species and the unchanging nature of the landscape. An example of a climax community is a forest whose tall trees have created a canopy, the physical ... 05.10.2021 · Ecological succession are the third stage in ecological succession. (Foto: Source: CC0 / Pixabay / jplenio) You can think of a climax community as a stable biological environment, due in part to the diversity of the species and the unchanging nature of the landscape. An example of a climax community is a forest whose tall trees have created a canopy, the physical ... Ecology (from Ancient Greek οἶκος (oikos) 'house', and -λογία (l) 'study of') is the study of the relationships between living organisms, including humans, and their physical environment. Ecology considers organisms at the individual, population, community, ecosystem, and biosphere level. Ecology overlaps with the closely related sciences of biogeography, ... Ecology (from Ancient Greek οἶκος (oikos) 'house', and -λογία (l) 'study of') is the study of the relationships between living organisms, including humans, and their physical environment. Ecology considers organisms at the individual, population, community, ecosystem, and biosphere level. Ecology overlaps with the closely related sciences of biogeography, ... Ecology (from Ancient Greek οἶκος (oikos) 'house', and -λογία (l) 'study of') is the study of the relationships between living organisms, including humans, and their physical environment. Ecology considers organisms at the individual, population, community, ecosystem, and biosphere level. Ecology overlaps with the closely related sciences of biogeography, ...

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