The Plant Community

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What is a Community?

A community is a group of populations that coexist in space and time and interact directly or indirectly.

By "interact", we mean affect each others' population dynamics.

The definition as presented, is inclusive, and pertains to all plants, animals, fungi, bacteria, etc.

What is a Plant Community?

A plant community is the vegetative subset of the community (excluding herbivores, decomposers, pollinators, etc.).

The plant community is simply all of the plants occupying an area which an ecologist has circumscribed for study.

In many ways, the plant community is an abstraction.

Previous Terminology

Association: a particular community type (e.g., oak-hickory), found in many places and with a specific species composition and physiognomy.

Formation: originally used to refer to a large regional climax community.

Boundaries

The operational definition of a plant community immediately forces the question of boundaries. Where should a boundary be drawn to delimit a community?

In practice, the boundaries of plant communities are usually defined operationally (i.e., based upon the abundance of the most common species). Sampling is then confined within those boundaries.

A stand is a local area, treated as a unit for the purpose of describing vegetation. The community is usually described based upon data from a number of stands.

Nature of the Plant Community

Ecologists based in different countries, educated in different traditions, tend to view communities differently.

Europeans tend to see communities as distinct and discrete entities. North Americans tend to see communities as entities that blend together continuously.

Josias Braun-Blanquet (1884 - 1980)
A History of Controversy

The nature of the plant community remains today as one of the biggest controversies to ever occur in ecology.

Our current view of plant communities "evolved" over almost 100 years and can be discretely categorized in three historical eras or paradigms:

- Clementsian Paradigm
- Gleasonian Challenge
- Modern Synthesis

The Clementsian Paradigm

In 1899, William Morris Davis (a geologist) put forth the notion of a Geographical Cycle; i.e., that landforms were created through a very orderly set of processes.

This cycle was likened to the orderly development of a human being (i.e., birth, childhood, adolescence, etc.).

This concept spread throughout the scientific community in the post-Darwinian era and became known as the organismal metaphor.

The Clementsian Paradigm

At around the same time frame, Henry C. Cowles, a geology student at the University of Chicago, shifted his interest to botany.

Cowles extended the concept of geographical cycle to a vegetational cycle (what we now call succession) and produced the pioneering work on vegetation succession on the Lake Michigan sand dunes (1899).

The Clementsian Paradigm

Clements (1904) picked up on the work of Cowles and crystallized it in to a broader theory of vegetation dynamics.

Clements used the Organismal Metaphor (communities are "superorganisms") to demonstrate that communities changed over time in very discrete ways (like human development) ultimately culminating in a predictable endpoint or "climax".

In this view, the climax community was a static developmental endpoint of great stability.

Two themes are prevalent in this viewpoint:

1. there are very tight linkages among species
2. there is cooperation among species for the benefit of the community.
Frederick E. Clements (1874-1945)

Clements' view of the community was intransigent: communities were distinct spatial entities and developed with one superorganism complex giving way to another (either in space or time).

Clements did acknowledge the role of competition, mutualism, and predation in influencing community structure; and he did recognize the role of environment, soils, and history.

BUT, his focus was on the idealized nature of communities.

**The Clementsian Paradigm**

Clement's view of the community dominated the science of ecology well into the early 1960s. His perception of the community was simple, palatable, and easy to relate to (*human metaphor*).

However, some ecologists of the day were less accepting of this neatly packaged, developmentally predictable, view of the plant community.

**But, the key to happiness is...moderation**

Henry Allen Gleason, in a series of papers (1917, 1926, 1939), argued that communities were the result of interactions between individual species and the environment (biotic and abiotic) in combination with chance historical events.

Each species has its own environmental tolerance and responds *individually* to the environment.

**Ecotones**

Ecotones are boundary areas between adjacent communities and often share a mix of species.

Henry Allen Gleason (1882-1975)
Gleasonian Challenge

Gleason's view of the plant community became known as the Individualistic Concept (aka Continuum View) and opposed Clement's Organismic View in virtually all aspects.

The implication of Gleason's view was that species were distributed along environmental gradients, with their boundaries determined by their tolerances to the environment.

Communities were not tightly linked superorganisms, but rather arbitrarily circumscribed by humans.

An Uphill Battle

Despite the evidence, Clement's view of the nature of the community dominated ecology for many years. His notion of the climax community can still be found in many textbooks despite the lack of evidence for its existence.

Subsequent work by Curtis & McIntosh (1951) and Whittaker (1956) helped solidify the Continuum View of the community.

Further evidence for support of the Continuum View comes from the apparent lack of integration of plant communities...

Non-integration of Communities

The chestnut blight represents one of the largest natural experiments to ever take place to test the hypothesis of community integration.

If the community was fully integrated unit, the loss of the dominant tree species should have resulted in complete system collapse, or at least major modification.

The gaps created by dead chestnut trees were immediately filled by adjacent trees and sapling in-growth of associated species.

Further Evidence

The lack of integration in plant communities was further confirmed by a series of pollen studies done in 1970s by Margaret Davis and her colleagues.

She showed (1981) that many species that co-occur today did not always do so during glacial periods; rather species were distributed among communities in the past in very different combinations than they are found today.

For example: white pine, hemlock, chestnut, and maple were often in association the last 500 yrs, but rarely before that.

Paleovegetation (18k - 500 YBP)

(Delcourt & Delcourt 1981)
Paleodistribution of Acer spp. (18k - 500 YBP) (Delcourt & Delcourt 1981)

Where Are We Now?

Today most plant ecologists take a middle ground position between Clement's and Gleason's views, and in many ways have diverged from both.

There is wide agreement that species are distributed individually, and that community composition typically changes along environmental gradients.

Abrupt changes can be found, but are often associated with abrupt changes in the environment, or historical effects (e.g., fire or agriculture).

The Modern Synthesis

The primary issues surrounding the nature of plant communities divide roughly into those of pattern and process.

The issues of pattern focus on how species and communities are distributed over the landscape. Are boundaries abrupt or gradual? How predictable are the patterns?

The issues of process focus on what processes (e.g., competition, herbivory, history) actually function in natural communities and which of these are most important in determining the observed patterns. Do some processes predominate? Do processes vary among communities? Are communities static or dynamic?
The Modern Synthesis

An overarching issue in the modern view of communities is the problem of scale.

Ecologists have realized that varying spatial and temporal scales will influence both pattern and process.


The Modern Synthesis
- Major Elements -

1. Communities structure is a population process
2. Communities are sections of continuous gradients
3. Communities show some directionality & predictability
4. Communities are strongly influenced by historical effects
5. Communities do not develop to a stable climax
6. Communities are dynamic & influenced by disturbance

Are Communities Real?

The extent to which communities are "real" has been the central part of debate amongst plant ecologists in the 20th century.

The issue is really philosophical: What types of entities are real and what types are just mental constructs?

Populations and species are real entities, but are communities, and are they just convenient arbitrary human inventions?

Since many studies have shown that, except where there are abrupt physical discontinuities, plant communities tend not to have discrete boundaries. This might suggest that there are no community-level processes worth studying.

Wrong--the debate is really miscast. Instead of focusing on pattern, we should focus on process and ask which processes are responsible for structuring the living world.

If processes are significant in structuring particular systems, we can then regard the community as an entity with unique properties.

Describing Communities

Determining which processes are most important in shaping community pattern (composition and structure) requires that we be able to describe the communities.

There are basically two sets of community properties that we will develop in the next few lectures:

1. Number & relative abundance of species
2. Physical structure of the community