Natural microcosms as useful models in ecological and evolutionary research: tank bromeliads, pitcher plants and rock pools.

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Background

- A natural microcosm is a small ecosystem in nature that is used to test ecological theories in a contained system.
- Microcosms are useful models to test ecological theory as they are tractable to do manipulative experiments, can be easily replicated, and provide natural environmental variance and realistic species combinations with shared evolutionary histories (Srivastava, et al, 2004).
- Tank bromeliads, pitcher plants and rock pools are all examples of natural microcosms.

Question

Are natural microcosms increasing in importance as models to test general ecological and evolutionary theory?

Methods

Literature review to document how natural microcosms are used in ecological and evolutionary research, and their importance as model systems over time.

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Combine key words in Web of Science.

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Identify relevant scientific papers published from 1974-2020.

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Analyze qualifying papers and sort into categories based on scale of study and ecological theory.

Bromeliads
343 search results

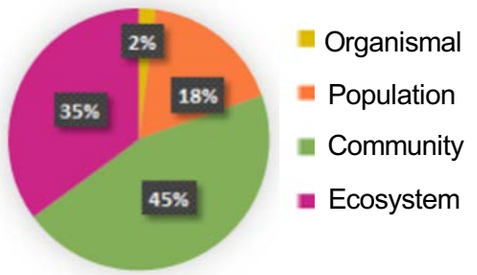


Figure 1: Ecological scales addressed in studies using tank bromeliads.

Pitcher Plants
281 search results

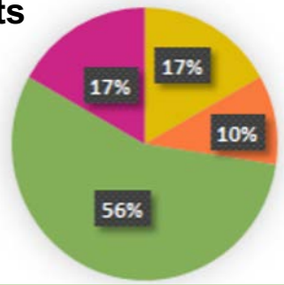


Figure 2: Ecological scales addressed in studies using pitcher plants.

Rock Pools
336 search results

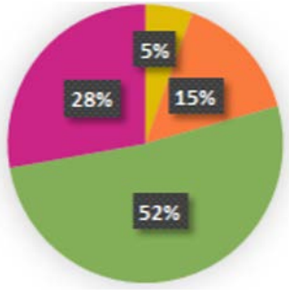
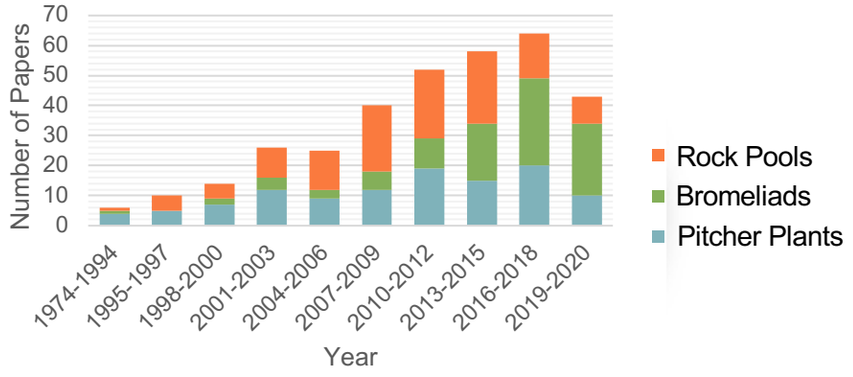


Figure 3: Ecological scales addressed in studies using rock pools.

Figure 4: Number of papers using natural microcosms to test ecological and evolutionary theory along time.



Results

Average of categorized microcosms (from Figures 1-3)
- Organismal (8%): Physiology, Thermoregulation, Evolution
- Population (14%): Species abundance, metapopulations, population growth.
- Community (51%): Species interactions, metacommunities, island biogeography.
- Ecosystem (27%): Nutrient cycling, organic matter decomposition.

Tank Bromeliads were used mainly to test community ecology hypotheses. Ecosystem ecology was a close second in relevance. Population studies were seen less in the search. The least common use was for organismal ecology research (Figure 1).

Pitcher plants had abundant results in community ecology hypotheses, the highest of all the microcosms. Pitcher plants saw equal results in organismal and ecosystem-level research. Both were seen more often than population-level. This is not seen in bromeliads or rock pools (Figure 2).

Rock pools were mainly utilized in testing community-level ecological hypotheses. Ecosystem studies were second in relevance. Population was slightly less seen utilized in experiments. Lastly, organismal-level studies were only found in a small percentage of papers (Figure 3).

Studies show a steady increase in use of these microcosms over the course of 46 years, from 1974 to date. Tank bromeliads were uncommon model systems until the 2000s but have become an important model used to test ecological theory (Figure 4).

Conclusions

- Tank bromeliads, pitcher plants and rock pools are valuable natural microcosms that benefit research in ecological theory.
- Ecological communities tend to be studied more using natural microcosms. This is likely because they represent simplified systems to study community structure, and yet are still complex.
- Natural microcosms represent useful systems that are increasing in importance over time as models to test general ecological theory along the ecological scale.

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