

ENTM 4040 – Insect Ecology – Ecological Theory Assignment

Background.

Ecologists seek to explain observed **patterns** in the abundance, distribution, and diversity of organisms in the environment. To achieve their goal, ecologists conduct manipulative experiments in the field or laboratory to understand how abiotic and biotic **processes** shape the natural world. This understanding is formalized into ecological theories that generate predictions and test hypotheses regarding the abundance, distribution, and diversity of organisms, based upon evidence collected in scientific studies. Insect ecologists develop and test theories to build fundamental and applied knowledge about insects.

Scientific theories are not developed overnight. Often, overwhelming evidence needs to be collected and scrutinized by scientists in order for scientific theory to be accepted by the scientific community as generally true. With respect to ecology, theories may undergo extensive changes as more evidence is collected from different ecosystems, conditions, and taxa. Some ideas may catalyze the development of a rich set of hypotheses to explain observations under varying conditions (e.g., Stamp et al. 2003), others, abandoned (or at least suggested to be, see Fox 2013). For the most comprehensive understanding of theory, scientists should study the history of the idea (i.e., intellectual history), which includes but is not limited to, the individual(s) that first proposed it, the institutions they were affiliated with, conferences they attended, other scientists they conferred with, and the greater cultural, political and social context that existed while it was developed. Herein insect ecology, we will use the primary scientific literature as the lens through which we understand the development of ecological theories. While our scope is limited, it will allow a strong understanding how ecologists formally propose and develop ecological theories in scientific literature over time.

Objective.

The objectives of this assignment are to highlight:

- 1) The importance of observation in generating data used to propose ecological theories
- 2) How careful experimental manipulation can identify mechanisms driving observed patterns
- 3) How mathematical modeling can support predictions, or generate new predictions regarding the role of proposed mechanisms governing ecological theories.

Assignment information.

While there are no hard and fast page expectations (and this may vary), but I imagine that your paper should be between 10-15 single-spaced pages in length, excluding references and figures.

Your paper should:

- o Identify the individual and their professional affiliation that first proposed the ecological theory, as well as the evidence that they collected (and where the evidence was collected, i.e., type of habitat, region of the country/world) that led them to their conclusion.
- o Identify and discuss the related hypotheses (see limited examples at the end of this document) tested to generate support (or lack thereof) for the ecological theory.
- o Elaborate how and if tests of the previously identified hypotheses over time lead to modifications of the ecological theory and how that has changed from inception to modern day.
- o Indicate the breadth of your ecological theory – has this theory been tested empirically, theoretically, or both? In how many different types of ecosystems, regions, with many different types of taxa (insect or otherwise)? Speculate (with evidence if possible) why or why not and indicate how this may have influenced the development and our understanding of the ecological theory. Are there still open questions or gaps in knowledge? How generalizable is the theory? What should future ecologists do to close these gaps or further expand our understanding of your ecological theory?
- o Indicate how and why your ecological theory is relevant to our fundamental and applied understanding of insects and how this impacts our relationship with them (e.g., conservation, pest management)
- o Include a conceptual figure that shows the ecological theory as first proposed, and its modern-day understanding
- o Include proper citations and be formatted according to the Entomological Society of America style guide: <https://www.entsoc.org/pubs/publish/style>

Be creative! If you feel that you can effectively convey the same information in another medium (e.g., comic/illustrations, documentary video, podcast, series of Tik Toks, poetry?), I may be open to this, but I may require some convincing and demonstration of the ability of your proposed medium to meet the above requirements with the same level of depth as a written paper.

Student outcomes.

After completing this assignment, students will have:

1. Used scientific search engines such as Google Scholar to locate peer-reviewed literature
2. Evaluated evidence in peer-reviewed literature and determined whether it supported or failed to support ecological hypotheses and theories
3. Synthesized evidence from multiple authors into a coherent narrative, which provides the baseline for mini- or larger reviews that could be submitted to scientific journals
4. Provided and received feedback
5. Translated details from a written paper into a presentation

Assignment milestones

Prior to Sept. 15th Schedule a 30 minute meeting with me to propose an ecological theory you want to write about for your paper. Bring one manuscript that formalizes the theory (i.e., its first mention in the peer-reviewed literature), and a second paper that provides a modern

understanding of the theory. Be prepared to explain how the theory is relevant to insect ecology and why you personally find it to be interesting.

Oct. 13th Construct an annotated bibliography of at least 15-20 papers that test your proposed ecological theory from its inception to modern day. Your annotated bibliography should include 3-4 sentences describing the main contribution of the paper and why you are including it as paper of your assignment.

Nov. 10th Submit an outline of your paper to me

Nov. 20th Submit your first draft to two classmates and me for peer-review

Nov. 29th Deadline to submit peer-review comments to classmates

Dec. 7th (Final) Submit your final draft of your theory paper

Required reading

Fox, J.W. 2013. The intermediate disturbance hypothesis should be abandoned. *TREE* 28: 86-92.
Stamp, N. 2003a. Out of the quagmire of plant defense hypotheses. *Q. Rev. Biol.* 78: 23-55.
Stamp, N. 2003b. Theory of plant defensive level: examples of process and pitfalls in development of ecological theory. *Oikos*. 102: 672-678

Further reading

LoPresti, E.F., R. Karban, M. Robinson, P. Grof-Tisza, W. Wetzel. 2016. The natural history supplement: furthering natural history amongst ecologists. *Bull. Ecol. Soc. Am.* 97: 305-310.
Hanley, W. 1977. *Natural history in America: from Mark Catesby to Rachel Carson*. Quadrangle/New York Times Book Co., New York.
Kingsland, S. E. 2005. *The evolution of American ecology*. John Hopkins Press, Baltimore.
Mayr, E. 2003. *The growth of biological thought: diversity, evolution, and inheritance*. Belknap, Cambridge.
Worster, D. 1994. *Nature's economy: a history of ecological ideas*. 2nd edition, University of Cambridge Press, New York.

Assistance with searching literature

If you need assistance with searching the literature for your ecological theory paper, LSU has an agricultural librarian (Randa Lopez Morgan - rlope12@lsu.edu) that can assist with the development of your paper. Appointments can be scheduled here:

https://guides.lib.lsu.edu/prf.php?account_id=28892 Here are some examples of things Randa can assist with:

Evidence Synthesis Resources

Randa can assist with Evidence Synthesis projects such as Systematic Reviews, Scoping Reviews, and even Literature Reviews. Randa has a research guide on selecting the [Right Review for You](#).

Research Workshops

Randa gives a number of research workshops on resources such as a specific database, concepts like searching for original research articles vs review articles or even resources like citation management.

Research Guides

Resource pages that have specified resources for your class or on a specific topic. We have a research guide for every department in the [College of Agriculture](#). These pages can be of assistance when students are overwhelmed with library resources and not sure where to start their research for their papers.

Tips for peer-review

- Be constructive.
- Does the author address the assignment information bullet points?
- Identify areas of the paper that could be strengthened. This can include:

o The introduction of the paper

- Is it clear what the objective or the goal of the paper you are reading is?
- Has the author convinced you as to why it is important to our basic or applied understanding of ecology to synthesize and discuss the ecological theory they have chosen?
- Does the author introduce their ecological theory in a way that is engaging and logically lead into the next section of the paper?

o Discussion of the development of the selected ecological theory over time

- Are an adequate number of references (15-20) included in this section and cited properly both in the text and at the references section at the end of the paper?
- Does the author present the papers relevant to their ecological theory in an order that is chronological?
- Does the authors demonstrate how the selected references contributed to an improved understanding of their ecological theory over time?
- Does the author include evidence from observational, experimental, and modeling papers?
- Does the author attempt to provide context or discuss these findings with respect to individual or groups of scientists, institutions, regions of the country, or particular taxa studied?

o The conclusion of the paper

- Does the author conclude the paper with a synthesis of all the evidence presented in their paper?
- Does the author indicate how their findings contribute to a better understanding of their selected ecological theory?
- Does the author suggest future areas of research that could expand our understanding of their ecological theory?

o The conceptual figure

- Does the figure accurately show predictions of the ecological theory?
- Could the figure be improved graphically?

o Writing

- Use of acronyms only when needed; acronyms are defined at first usage.
- Is writing clear- are there sections where the author could improve language to make it less vague?

Examples of ecological theory and some related hypotheses

Behavioral Ecology

- Optimal Foraging Theory:
 - Optimal Diet Hypothesis: Insects will select food items that maximize their net energy gain per unit handling time.
 - Giving-up Density Hypothesis: Insects will leave a food patch when the energy gain decreases and handling time increases beyond a certain threshold.
- Life History Theory:
 - Trade-Off Hypothesis: Insects face trade-offs between investment in reproduction, growth, and survival due to limited resources.
 - Fast-Slow Continuum Hypothesis: Insects will adopt fast or slow life history strategies based on environmental conditions and predation risk.
- Parent-Offspring Conflict:
 - Parental Investment Hypothesis: Insects will allocate resources to their offspring to maximize their own reproductive success.
 - Parent-Offspring Communication Hypothesis: Insects may employ chemical or acoustic signals to manipulate parental investment.
- Sexual Selection Theory:
 - Female Choice Hypothesis: Females will preferentially mate with males displaying specific traits, leading to the evolution of exaggerated male traits.
 - Male-Male Competition Hypothesis: Males will compete with each other for access to mates, resulting in the evolution of elaborate mating displays and weapons.

Community ecology

- Ecological Succession:
 - Facilitation Hypothesis: Early successional insect species create conditions that favor the establishment of later successional species.
 - Tolerance Hypothesis: Later successional insect species can persist and tolerate the presence of early successional species.
- Species Interactions:
 - Competition Exclusion Hypothesis: Two insect species with identical resource requirements cannot coexist in the same habitat indefinitely.
 - Predator-Mediated Coexistence Hypothesis: The presence of predators can prevent competitive exclusion among insect prey species.
- Assembly Rules:
 - Environmental Filtering Hypothesis: Insect communities are structured by the environmental conditions present in a habitat.

- o Dispersal Limitation Hypothesis: The composition of insect communities is influenced by the limited dispersal abilities of certain species.
- Food Web Theory:
 - o Trophic Level Hypothesis: Insect species at higher trophic levels will have a larger impact on community dynamics than those at lower trophic levels.
 - o Indirect Effects Hypothesis: Changes in insect populations can lead to cascading effects on other trophic levels within the food web.
- Theory of Island Biogeography:
 - o Species-Area Relationship Hypothesis: The larger the area of an island or habitat, the greater the number of species it can support.
 - o Equilibrium Theory of Island Biogeography: The number of species on an island is a balance between immigration and extinction rates, influenced by island size and isolation.
- Biodiversity-Ecosystem Functioning (BEF) Theory:
 - o Biodiversity-Productivity Hypothesis: Ecosystem productivity increases with species richness, as more diverse communities can better utilize available resources.
 - o Complementarity Hypothesis: Different species perform unique roles, increasing ecosystem functioning and stability.

Population Ecology

- Logistic Growth Model:
 - o Carrying Capacity Hypothesis: The insect population will stabilize at a level determined by the availability of resources in the environment.
 - o Density-Dependent Mortality Hypothesis: Mortality rates in the insect population will increase as population density exceeds the carrying capacity.
- Metapopulation Theory:
 - o Rescue Effect Hypothesis: Extinction-prone local populations can be recolonized by individuals from nearby source populations.
 - o Habitat Patch Size Hypothesis: Larger habitat patches can support larger and more stable insect metapopulations.
- Source-Sink Dynamics:
 - o Subpopulation Connectivity Hypothesis: High rates of dispersal between source and sink populations are necessary for overall metapopulation persistence.
 - o Habitat Quality Hypothesis: The quality of sink habitats influences the survival and reproductive success of individuals residing there.
- Allee Effect:
 - o Mate-Finding Allee Effect Hypothesis: Insects may struggle to find mates in low-density populations, reducing reproductive success.

Ecosystem Ecology

- Trophic Cascades:
 - Top-Down Control Hypothesis: Predators exert strong effects on insect prey populations, indirectly influencing lower trophic levels.
 - Bottom-Up Control Hypothesis: Resource availability (e.g., plant abundance) drives insect population dynamics and influences higher trophic levels.
- Nutrient Cycling:
 - Litter Quality Hypothesis: The chemical composition of plant litter influences the rate at which insects decompose organic matter.
 - Detritivore Abundance Hypothesis: The abundance of detritivorous insects directly affects the rate of nutrient cycling in ecosystems.
- Plant-Insect Interactions:
 - Plant Defense Hypothesis: Insects will selectively feed on plants with lower levels of defensive compounds.
 - Pollination Efficiency Hypothesis: Different insect pollinators will vary in their effectiveness at transferring pollen among plant species.
- Bottom-Up and Top-Down Control:
 - Trophic Cascade Hypothesis: Changes in top predators will lead to cascading effects on lower trophic levels through changes in prey abundance.
 - Nutrient Availability Hypothesis: Changes in resource availability (bottom-up) can influence the abundance and distribution of higher trophic levels (top-down).