MEGA:BITESS Lesson Plan

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Lesson plan title: A lesson plan investigating ecological niches and resource partitioning by studying the oviposition (egg-laying) habitat of *Aedes triseriatus* (Eastern Treehole Mosquito) and *Aedes albopictus* (Asian Tiger Mosquito).

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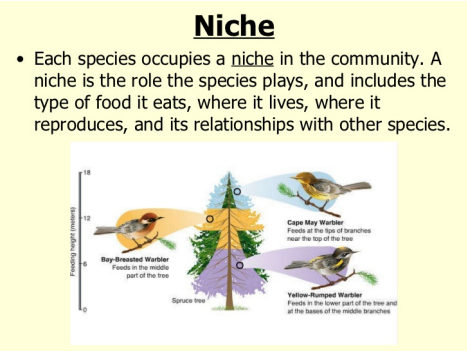
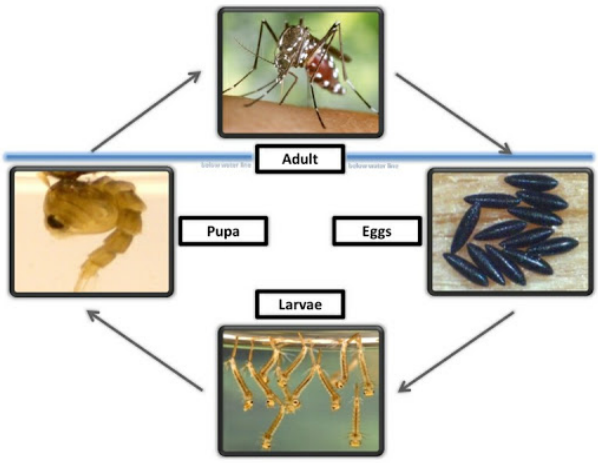


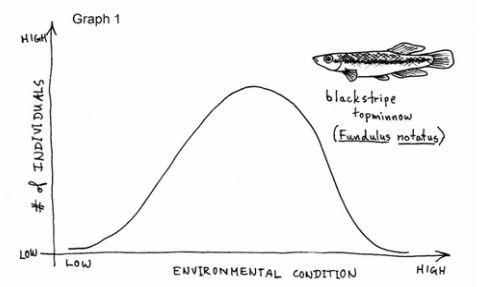
Required background:



Ecological Niche: the role and position a species has in its environment; how it meets its needs for food and shelter, how it survives, and how it reproduces. A species' niche includes all of its interactions with the biotic and abiotic factors of its environment (Study.com). As a component of their ecological niche, mosquitoes require standing water for egg, larvae, and pupa development, as indicated in the diagram on the left. The niche of a mosquito also includes sipping flower nectar, their primary food source. Another aspect of their niche involves female mosquitoes using their proboscis (feeding tube) to collect nutritious host blood, which facilitates proper egg development. The type of host from which blood is collected depends on the species of mosquito. The link for that information is found here. It is during this collection of host blood that viruses can be transmitted to other organisms, including humans. Different species of mosquitoes tend to carry their own unique pathogens. Pathogens are defined as disease causing particles/organisms, which can include viruses, bacteria, or protists (single-celled eukaryotic organisms). This lesson involves two species of mosquitoes, *Aedes triseriatus* (Eastern treehole mosquito) and *Aedes albopictus* (Asian Tiger Mosquito).

Aedes triseriatus (Eastern treehole mosquito) and *Aedes albopictus* (Asian Tiger Mosquito) mosquitoes both feed on mammalian hosts (such as squirrels and humans), and if infected with pathogens, may lead to the mosquito transmitting the pathogen to the squirrel or human host, as it feeds on the individual's blood. Both species of mosquitoes tend to lay their eggs in small volumes of standing water found in tree cavities, old tires, childrens' toys, garbage such as bottlecaps, and gutters. Due to the small volume required for larval development, and the fact that many of these water collecting items are often found in residential areas, these mosquitoes can be quite prevalent near human dwellings. Both species of mosquitoes are considered to be vectors of the La Crosse Encephalitis virus; however, *Aedes triseriatus* is considered the primary vector of this virus (Dr. Becky).

Range of Tolerance graph, showing a greater number of individuals occurring/reproducing within a certain range of conditions, as seen on right.



Although both species of mosquito share many similarities in their feeding and egg-laying locations (this is part of their niche), *Aedes triseriatus* seem to prefer densely shaded water for laying their eggs, while *Aedes albopictus*, a non-native species, is more generalist in their choice of oviposition (egg-laying) water. In general, non-native species tend to have a broader niche than native species, leading to a greater flexibility in the non-native species' range of tolerance for environmental variables, such as the amount of shade for ovipositing. If we were to use the graph on the right as our example in this study, the "environmental condition" variable could be replaced with the amount of shade/sun provided by the overstory of a forest.

Objectives:

One objective of this citizen (student) science project to preferentially collect the *A. triseriatus* eggs/larvae, since this species is considered to be the primary vector of the LaCrosse virus, and all eggs collected in the 2019 study season were *A. albopictus.* A second objective of this lesson is to expose students to as many of the aspects of the scientific method as possible, thereby facilitating their understanding of how this occurs in a real-world situation. A third objective of this lesson is to enhance student understanding of the following vocabulary terms and concepts: vector, pathogen, host, niche, range of tolerance, and resource partitioning. Other vocabulary terms are found here in this Quizlet.

Standards addressed:

1. AP Environmental Science Practice 4: Identify a testable hypothesis or scientific question for an investigation. Students will apply these concepts to this mosquito study, in how to target the A. triseriatus species.
2. Practice 1: Describe niche specialist and niche generalist. (Using mosquito species as examples, students could be assigned different mosquito species to research, and then come back together as a group to share information, and classify as generalists or specialists. Niche aspects to research might include host type, type of oviposition water preferred, degree of shade preferred, etc…).
3. Practice 1: Describe how resource partitioning helps species avoid competition, and aids in species survival/reproduction. Students will apply these concepts to mosquito species.
4. Practice 1: Describe how a range of tolerance graph is interpreted, and how this relates to a species' niche. Students will apply these concepts to mosquito species.

Primary tasks:

1. Students will complete this online interactive card activity with this link, to demonstrate knowledge of the terms pathogen, virus, disease, and host.
2. Students and teacher will discuss a testable hypothesis (about where more A. triseriatus mosquito eggs will be collected), and plan trap placement which will focus on attracting the *Aedes triseriatus* mosquitoes. An example design may be 3 locations (with 2 replicates each), each at forest edge, 5 meters into forest, and 10 meters into forest.
3. Students will complete 6 week mosquito trapping study, as described in this 2020 Megabitess Trapping protocol document.

Other activities:

1. To become more familiar with the mosquito life cycle, Students may complete the following HHMI activity, "The Mosquito Life Cycle", prior to this lesson.
2. To have more practice with the scientific method, students can design their own controlled experiment, testing which factors may affect mosquito development (examples may include temperature or humidity) as specified in this HHMI student handout. Great caution must be exercised with this activity, so as to not release any mosquitoes!
3. As a virtual school alternative, students could navigate through the following HHMI Click and Learn activity about the mosquito life cycle.

Assessment:

1. Initially, students may be assessed with the correct placement of the cards on the "host, pathogen, vector, and disease" diagram.
2. Students will write up a lab report about the mosquito trapping study, which has the components in this lab report template (title, initial observation, question, one paragraph introductory information, hypothesis in correct form, experimental design (materials & methods), data, data analysis, and discussion/conclusions).
3. Students may practice and/or be quizzed on the vocabulary terms in this Quizlet game.

Materials/links:

Host blood info.:
https://natureecoevocommunity.nature.com/posts/36640-at-the-river-styx-mosquitoes-feed-on-worm-blood

My story map: https://storymaps.arcgis.com/stories/9012848a57604d9fb23f44d06fc9ee24
https://study.com/academy/lesson/ecological-niche-definition-lesson-quiz.html#:~:text=An%20ecological%20niche%20is%20the,abiotic%20factors%20of%20its%20environment
Species specific info.: https://animaldiversity.org/accounts/Aedes_triseriatus/ &
https://animaldiversity.org/accounts/Aedes_albopictus/
HHMI Mosquito Resources link:
https://www.biointeractive.org/classroom-resources/stopping-mosquitoborne-disease

Potential limitations/issues to anticipate:

***If mosquitoes are reared to study the mosquito life cycle (as discussed in the HHMI activity), great care must be taken (with adult supervision), so that no mosquitoes are released. Mosquitoes raised in these containers may be placed in the freezer, which will anesthetize the mosquitoes, resulting in their death.**

***It is imperative that the teacher communicate clear and concise safety precautions to be taken by the students, while collecting the egg papers from the outdoor environment. Ideally, these would include wearing closed-toe shoes and pants.**

***It should be noted that students should be attentive to the details of correct labelling and data collection. This attention to detail will facilitate the collection of reliable data.**