Spat, What's That?

Subject
Oyster Life Cycle

Objective
Students will:

- Obtain and combine information about multiple intertidal life cycles and seasonal growth patterns
- Use a model to understand natural and human caused pressures that impact life cycle stages

Materials

- Printed life cycle graphics
- Sized shells
- Hand lens
- Birdseeed
- "Spat Spots" (can be paper, rubber discs, or oyster shells)
- H+ T-shirts or stickers
- Salish Sea Challenge

Size/setting/duration
Entire class/ Outdoor/ 1 hour

Activity	Time
Part 1: Life Cycle Overview	20 minutes
Part 2: Oyster Growth Rings	15 minutes
Part 3: Spat Tag	15 minutes
Part 4: Wrap Up	10 minutes

Background
Student prior knowledge: NGSS 3rd grade standards (Heredity: inheritance and variation of traits)

Teacher Background: Oysters are bivalve molluscs that live in marine or brackish waters and filter

phytoplankton out of the water. Adult oysters can filter up to 50 gallons of water per day. Oysters are capable of spawning within their first year of life. Larger oysters produce more gametes than smaller oysters. Some oysters (Eastern oyster) can change their sex based on environmental pressures and over time can create both sperm and eggs, but since they are only one sex at a given time they can't self- fertilize. Other oysters (Olympia oysters) can produce both eggs and sperm at the same time, making self-fertilization possible. Environmental cues such as temperature and salinity trigger the spawning process (commonly 68 degrees Fahrenheit, depending on the species). Oysters are broadcast-spawners, releasing their eggs and sperm into the water column where they encounter each other in the water, begin the fertilization process, and drift away from the spawning grounds by the current. It is estimated that females produce between 2 and 115 million eggs each year. Once the larvae are approximately two weeks old and in the pediveliger stage (larva with a foot), they begin to settle from the water column to search for a hard substrate to attach to using their foot. Once they have successfully located a suitable location, usually an oyster shell, they begin to attach to the shell by secreting a glue. Once attached, the larvae metamorphose their internal anatomy to become spat and begin putting all of their energy into shell growth by sequestering calcium carbonate from the water column. At one year oysters become a juvenile, capable of reproducing, and at three years they are considered adult. Oysters have been observed to live up to 20 years in captivity. Oysters reefs provide ecosystem services by filter the water column, provide habitat, and reproducing.

Procedure

Part 1: Life Cycle Overview

- Begin this lesson by asking students for examples of life cycles they know about. Most students were taught about frog or butterfly life cycles in 3rd grade.
- Show students examples of shells with barnacles or spat. Ask students for observations. Ask students for ideas of why the barnacles or spat attach to the shells. What might cause difficulty for the organisms during attachment?
- Have students rotate through stations about multiple different life cycles and fill in the worksheet for each one. Stations cover clam, oyster, and barnacle life cycle. Stations should be set up with an image of the life cycle and at least one physical example of that organism. (Graphics provided, physical examples of each can be collected locally)
- As a whole class, have students discuss how these life cycles are the same and how they differ. One key similarity is that all of the life cycles include planktonic larval stages where they float through the water column. One key difference is once both oysters and barnacles settle from the water column they attach to rocks or shells, whereas clams settle to become juvenile clams that bury themselves.

Part 2: Oyster Growth Rings

- As oysters settle down and attach to a solid surface to grow (such as rocks or old shells) they accumulate and create an oyster reef. Oyster reefs create important habitat for forage fish, invertebrates, and other shellfish. They also provide a safe nursery for commercially valuable species. Oyster reefs also provide important barriers to storms and tides, preventing erosion and protecting productive estuary waters.
- Depending on the species, oysters are capable of spawning within their first year of life. Larger oysters produce more gametes than smaller oysters. Similar to trees, shellfish have annual seasons of rapid shell growth. This process creates rings which can be counted to estimate the age of the shellfish, just like growth rings are used to estimate the age of trees.
- Inside the shell of the oyster, the animal is covered in flesh the called the mantle which builds the shell. Shell growth rate depends on water temperature, season, available nutrients, and dissolved minerals. In warm weather, when food is abundant, growth is faster than in cold weather with a less algae to eat. The shell growth is visible as concentric growth lines on the exterior of the shell. The growth lines tend to be narrower in winter and wider in summer indicating season of growth.
- The appearance of the growth lines is different for two halves of the shell. In oysters, where there is normally a flat and a cupped shell, it is easier to determine age based on the flat side since it is smoother, making the lines clearly visible instead of the cupped half which has growth shoots that give it a “frilled” appearance.
- Have each student observe multiple oyster shells and make hypotheses about the ages of the shells. Each group should get one shell that has the age estimate written on it as an example to compare to.
- As a class compare results of the ages of the shells to see who had the oldest shell. (Samples range from seed to 5 years). Were the oldest shells always the largest?

Part 3: Spat Tag

- The goal of this game is to better understand the pressures that an oyster might face during its life cycle each round of the game you will be modelling a different pressure. In this game, part of the class will be acting as oyster spat whose goal is to attach, become spat, and survive to reproduce. The other part of the class will act as some of the pressures that oyster larvae face during their life cycle that make it difficult for oysters to become spat and reproduce.
- Round 1: Predation
    - Students divide approximately into half. Team 1 is oyster larvae. Team 2 is

predators. Arrange students so that the oyster larvae team is in a line on one end, the predator team is in another line in the middle of the field and the 'spat spots" are in a line on the opposite end of the field. Larvae attempt to reach the 'spat spots' before being tagged. If tagged, they must freeze. If they reach a spat spot, they may throw rice to 'reproduce'. Each larva must have his/her own spat spot.

- Round 2: Ocean Acidification
    - Divide students in thirds and give the third group t shirts to signify that they are H+. H+ makes the ocean acidic, which makes it harder for oyster larvae build their shells. Repeat game.
- Round 3: Habitat Loss
    - Repeat the game again, but remove some of the 'Spat Spots". This represents what happens when there is less suitable habitat for larvae to attach and grow into adult oysters.

Part 4: Wrap Up

- Ask students what some of the things they learned about intertidal life cycles today. What were some of the pressures that the different organisms faced? What are some of the pressures that humans can impact?
- Ocean acidification, a chemical imbalance due to air and water pollution, can impact shell formation. By choosing to change our habits, like riding a bike or walking instead of driving we can help reduce the effects of ocean acidification.
- Hand out the Salish Sea Challenge
- This is a list of ideas for ways that you can have a positive impact on the health of your watershed and decrease the amount of CO2 you are releasing. Take these home and make a commitment with your families to be stewards of the Salish Sea and practice watershed healthy habits.

Extension

Have students play the other life cycle games included in the GSSC Games Kit which include:

- Oyster Life Cycle Game: This is a board game meant for four players. Players move through the board game and learn about the struggles oysters face as they grow into adults.
- Clam Life Cycle Game: Students try to assemble the clam life cycle cards in the correct order. This game can be done alone or in groups of up to 4 students. There are two sets included in this kit, so two groups could do this at once and try to see which group can assemble the clam life cycle correctly the fastest.

- Anemone Life Activity: Students learn about the two different ways sea anemones can reproduce through constructing the anemone life cycle stages with play dough. This activity can be done alone or in groups of up to 4-6 students. For more details on the games please see the Games Kit Guide and the 5th Grade Games Worksheets.

Have students organize a way to be advocates for their environment. Ideas include:

- Write letters to legislators.
- Hold a stakeholder forum.
- Reach out to or learn about their local shellfish protection district.

Next Generation Science Standards

Performance Expectations		
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.		
Scientific and Engineering Practices	Disciplinary Core Ideas	Cross-cutting Concepts
Developing and Using Models Obtaining, Evaluating, and Communicating Information	ESS2.A: Earth Materials and Systems ESS3.C: Human Impacts on Earth Systems	Systems and System Models Science Addresses Questions About the Natural and Material World

Worksheet

Life Cycle Worksheet

Oyster Life Cycle What is a baby oyster called when it has just attached to a substrate (rock or shells)?

_____

Clam Life Cycle Does the clam attach to anything?

_____

What does this tell you about where it lives (habitat and substrate)?

_____

Barnacle Life Cycle Is a barnacle a mollusk?

_____

Do barnacles attach? What might be a benefit of attaching?

_____

_____

_____

Summary

What is something that these life cycles had in common?

_____

What is something that was different?

_____

_____

Life Cycle Answer Key

Oyster Life Cycle

What is a baby oyster called when it has just attached to a substrate (rock or shells)?

Spat

Clam Life Cycle

Does the clam attach to anything?

No, it has a foot to dig.

What does this tell you about where it lives (habitat and substrate)?

The substrate is different where clams live compared to oysters. Oysters need hard substrate to attach to, but clams need soft substrate like mud or sand to bury themselves underground for protection.

Barnacle Life Cycle

Is a barnacle a mollusk?

No, since it has appendages it is an arthropod related to a lobsters, crabs, and insects.

Do barnacles attach? What might be a benefit of attaching?

Yes, it helps them survive the strong wave action of the intertidal zone.

Summary

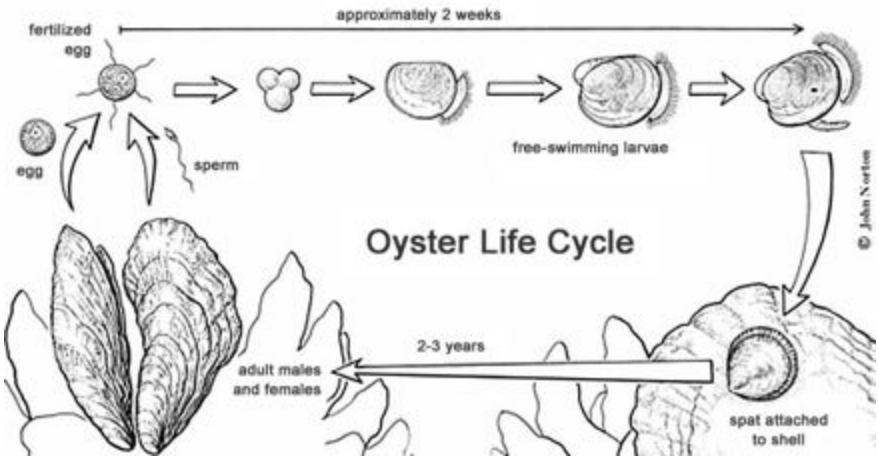
What is something that these life cycles had in common?

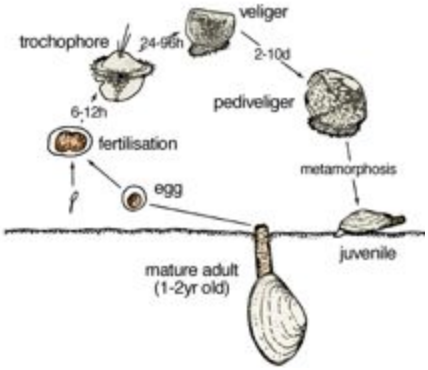
- *All species have a planktonic stage where they float in the water column*
- *All species have a settlement stage*
- *All species metamorphose*

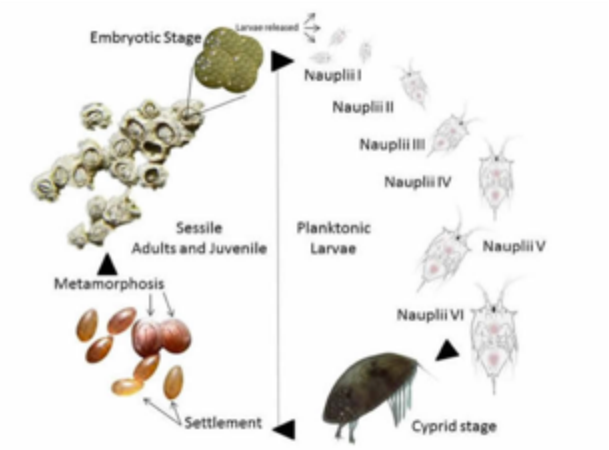
What is something that was different?

- *Clams develop a foot*
- *Barnacles are not mollusks, they are arthropods.*
- *Clams do not attach, but barnacles and oysters do.*

Graphics

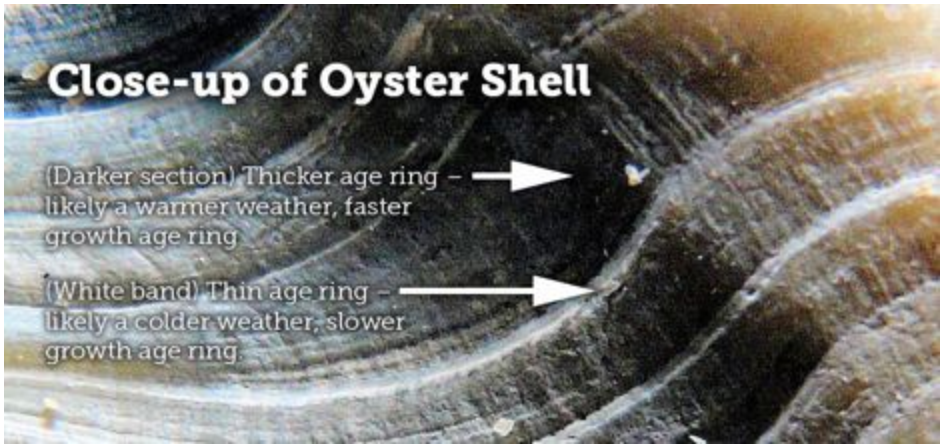


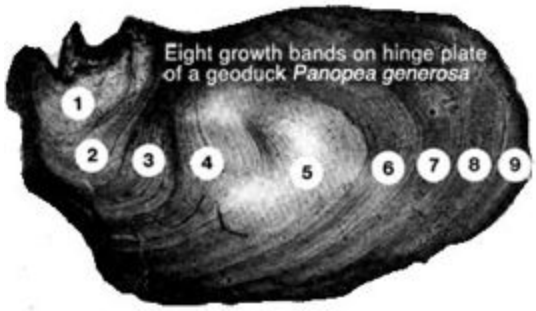




Barnacle Life Cycle

Barnacles are not shellfish, they are arthropods which makes them related to lobsters, crabs, and insects! However, during attachment they compete for the same habitat (lower intertidal rocks and shells) as oysters.





Possible other graphics:

http://www.barnegatshellfish.org/clam_lifecycle_01.htm
http://www.nio.org/userfiles/image/images/naupliarcycle.jpg
https://en.wikipedia.org/wiki/Barnacle