Science Unit: ***Meet Me at the Beach!***

Lesson # 5 ***The Water is Alive with Plankton!***

Summary:	Students observed live plankton using microscopes. They then used craft supplies to build model plankton with the goal of creating a body shape that sinks, but very slowly. Students timed their plankton model sinking rates in buckets of water and experimented with different ways to improve their design.
School Year:	2014/2015
Developed for:	Elsie Roy Elementary School, Vancouver School District
Developed by:	Jonathan Kellogg (scientist); Saira Devji and Carolyn Fanning (teachers)
Grade level:	Presented to grade K; appropriate for grades K – 5 with age appropriate modifications
Duration of lesson:	1 hour
Notes:	Requires a plankton net (purchased or homemade) and a seawater sample. Also requires microscopes (multiple scopes if possible to allow more students to participate. If collecting sample with students, additional safety concerns may be necessary.

Objectives

1. Expose students to the microscopic world and help them understand that there are living things smaller than they can see with the naked eye.
2. Students will learn that there are two types of plankton, phytoplankton and zooplankton that are plants and animals, respectively.
3. Students will learn that phytoplankton are the base of the marine foodweb and contribute ½ of all the oxygen that is in the atmosphere.
4. Students will observe different shapes of both phytoplankton and zooplankton.
5. Students should understand the basics of buoyancy and that phytoplankton have near neutral buoyancy.

Background Information

Plankton are ubiquitous throughout the marine environment and there are ~10^6 phytoplankton per litre and ~10^3 zooplankton per litre. Plankton, from the Greek word for drifter, are any plant or animal that are unable to swim against the current. The life on this scale is quite diverse and surprises many.

Phytoplankton may be individuals or chain forming. They have interesting life histories. For example, diatoms have silicate, or glass like, shells that form a nested pill box shape. Typically they undergo division with two smaller shells forming within the larger exterior shells. However, after many generations, the diatoms become small enough that they enter a sexual reproduction phase, the product of which is progeny that are again full sized. Phytoplankton are largely harmless, but some species can be environmentally triggered to begin producing toxins that, when bioconcentrated in shellfish, can prove harmful, or even deadly, to humans during periods of abundant growth, called blooms. These blooms are often in the spring or mid-fall in the BC area as the nutrients and sunlight are most abundant at that time of year.

Zooplankton are made up of two different groups, holoplankton are plankton that spend their entire life as plankton, like copepods or arrow worms, while meroplankton spend only a portion of their life in their planktonic form before growing to a size where they either settle to the seabed or can otherwise swim against the current.

Vocabulary

Microalgae	Algae that are not visible to the eye. Phytoplankton.
Plankton	Microscopic plants and animals that are unable to swim against a current and are drifters
Phytoplankton	Microscopic plants that are ubiquitous in the marine environment.
Zooplankton	Microscopic animals. May be the immature stages of larger animals.
Meroplankton	Microscopic animals that are only planktonic for only part of their life cycle, usually the larval stage. Examples: urchins, crabs, sea stars, most fish, marine worms.
Holoplankton	Microscopic plants and animals that are planktonic for the entirety of their life cycle. Examples: copepods, krill, salps, diatoms, and some dinoflagellates.
Buoyancy	The ability or tendency to float in water or air.
Diatom	A common single-celled alga that has a cell wall of silica. May be either planktonic or benthic (growing on the seabed). Some diatoms are chain forming.

Materials

- Plankton net. Zooplankton net mesh size: 150 µm Phytoplankton net mesh size: <60 µm
- Weight for your plankton net
- Eye dropper and clear bottomed reservoir (like a petridish)
- Line to tow plankton net through the water column with marked 1 m increments
- Microscope (at least 40x magnification) (the more microscopes, the more students can be engaged in the experience, digital scope that can be projected may be useful)
- Containers for the samples that are collected from the seawater.
- For the Great Plankton Race you will need a mixture of craft items that both float and sink. Toothpicks, clay, washers, cork, pipe cleaners, popsicle sticks, etc.
- Clear sided basin to hold 8-12” of water for a timing basin. Additional basins for water are useful for students to conduct testing of their plankton.
- Stopwatch for timing student trials towards achieving the slowest sinking plankton

In the Classroom

Introductory Discussion

1. Short description of 'hook' to capture student's attention.
   - Show the students a glass of unfiltered seawater and ask them if they think anything is living in it. Why or why not? Show them a picture of a wave and ask them if there is anything living in it. Why or why not? How do they know if something is living there? Is it possible for something to be living that we cannot see?
2. Short description of other items to discuss or review.
   - Review an introduction to plankton showing examples of both phyto- and zooplankton.
   - Discuss how plankton are collected and show students a plankton net (homemade: e.g., nylon and plastic bottle; or commercial)
   - Discuss the importance of both phytoplankton and zooplankton to the marine food web.
   - Introduce students to *meroplankton* and *holoplankton* through examples of both (sea stars, urchins, crabs, octopus, and copepods, arrow worms, amphipods, respectively). Discuss why both forms of zooplankton are important.
3. Briefly describe science experiment/activity.
   - Students will be looking through microscopes with adult assistance to examine plankton samples from a previously completed net tow. Videos of net tows are available on YouTube or you may have create a video when collecting your sample. If feasibly possible, students may also do the collection if access to the water is possible. For a phytoplankton sample, surface water will work nicely. For a zooplankton sample, best results are achieved with a vertical tow from the seafloor to the surface.
   - With as many microscopes as you can find, allow students to explore the plankton samples. For small numbers of microscopes in large classes, best results may be attained with a digital microscope that is controlled by the teacher. Examine the different shapes and discuss the life histories of the animals observed. Use identification guides if available to identify major species. (See references)
   - Provide students with the opportunity to draw the plankton and ask questions about the different shapes that they see.
   - Discuss that an important aspect of phytoplankton is the need to stay neutral in the water column also known as neutral buoyancy. Then introduce the Great Plankton Race where students will create their own plankton and test it and modify it to see whose plankton can sink the slowest.
4. Briefly describe the processes of science that the students will focus on
   - This lesson focuses on scientific observations and asks students to notice details about plankton. Students may not have been exposed to microscopes before so it may be important to talk about how a microscope magnifies an object. They will make observations of real plankton sampled from the environment, then apply what they have learned through observations to their creations for the Great Plankton Race.
5. Briefly describe safety guidelines.
   - Microscope safety should be discussed so students are not too rough with the instruments. Care for the plankton net should be introduced if students will be engaged in the collection process.

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Science Activity

1. Plankton Observation

Have students put drops from the plankton sample onto petri-dishes and take them back to their microscopes. Assist in the focus of the different scopes where possible. Life is abundant in even a small water drop so allow students to explore the plankton sample and to examine the diversity of shapes that are present in the plankton environment.

During the exploration remind students that phytoplankton are responsible for ½ of all the air we breathe and that they are the base of the marine food web (e.g. phytoplankton -> zooplankton -> small fish (herring) -> larger fish (salmon) -> marine mammals (seals and dolphins/whales). Identify meroplankton, if present, and discuss the life histories of those present. Touch on broadcast spawning as a reproductive strategy, if appropriate, and how some species release millions of egg and sperm so that hundreds of thousands of babies are made, but then only 10's-1000's will make it to adulthood.

When examining phytoplankton, draw student attention to the shapes of the organisms and discuss the strategies that are used with shape to help the phytoplankton sink slowly. Buoyancy control is important for phytoplankton since it determines their proximity to nutrients and sunlight needed for growth and reproduction. However, the surface is often nutrient limited and not a productive environment for the plankton. For this reason they often need to sink slower in the water column. However, if the plankton sink too quickly, they leave the lit zone of the ocean and cannot grow. Therefore, many plankton use different strategies to sink slowly. Use this discussion as an introduction to the next phase where students will be constructing their own plankton in the Great Plankton Race.

2. Great Plankton Race

Allow students to build their own plankton using the craft supplies that are available. For this activity it is often helpful to have test basins where students can determine if their plankton will float or sink. The object is for the students to build the plankton that sinks the slowest using the materials provided. With one master timing tank, have students come one at a time for the official testing of their plankton. Use a stopwatch to determine whose plankton sinks the slowest.

Closure Discussion

1. Wrap up the lesson by revisiting the opening questions. Is there life in the ocean that we can't see? Is it important? What do zooplankton eat? What eats zooplankton?
2. Why are phytoplankton important? How do they sink slowly? Why do they need to sink slowly?

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References (examples of the format to use for different types of references are below)

Pierson, J., A. Barba, C. Smith, L. Goggins et al. "Plankton – aquatic drifters," *Teach Ocean Science.* n.d. Web 30 May 2015. http://www.teachoceanscience.net/teaching_resources/education_modules/plankton_-_aquatic_drifters/get_started/

Strickland, R.M., *The Fertile Fjord*. Washington Sea Grant, University of Washington. Seattle, WA. 1983. https://wsg.washington.edu/wordpress/wp-content/uploads/Fertile-Fjord-Chapters-One-Two.pdf and http://www.cev.washington.edu/lc/CLFISH497/bio.html

Washington Sea Grant. *Marine Zooplankton of Puget Sound Identification Card*. University of Washington 2013. http://wsg.washington.edu/wordpress/wp-content/uploads/publications/Marine-Zooplankton-Identification-Card.pdf (a phytoplankton ID card is available upon request to Washington Sea Grant.)

Extension of Lesson Plan

The microscope portion of this activity can be expanded by having students identify the phyto- and zooplankton that are present in their sample and, given enough lesson time, students may be able to quantify the relative abundance of the different species in the sample (high school level). The Great Plankton Race will take as much time as is available to the class since many students are competitive and will tweak their plankton until they achieve near neutral buoyancy.