Science Unit: ***Biology Inquiry***

Lesson 3: *Brine Shrimp Attraction to Light*

Lesson Summary

Students observe that juvenile brine shrimp are attracted to light and then investigate whether or not they are attracted to different colours of light.

School Year:	2016/2017
Developed for:	Britannia Elementary School, Vancouver School District
Developed by:	Ingrid Sulston (scientist); Kevin Dwyer and Pascal Spino (teachers)
Grade level:	Presented to grades 4-6; appropriate for K-7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes

Objectives

a) Observe a behavioural change in response to a stimulus in an animal.
b) Learn to gauge statistical (rather than absolute) results.
c) From knowledge of what animals need for survival, learn to speculate on why an animal might have a particular adaptation.

Background Information

Brine shrimp (*Artemia salina*) are found in high-salt bodies of water, such as the Great Salt Lake in Utah, the Caspian Sea, inland salt swamps, as well as in coastal waters near San Fransisco. They are readily available in aquarium stores, where they are sold as fish food. Brine shrimp are an easy animal to grow in the classroom to the juvenile stage (on into adulthood is more challenging without more equipment).

Brine shrimp, along with many other aquatic animals, move towards light (“phototaxis”) (Ref. 1), although adults can move away from bright light (Ref. 2). Juvenile brine shrimp are particularly attracted to certain light colours, including blue and green light (Refs. 3, 4, 5 and results of this activity). One possibility for this adaptation might be that algae, the food source of brine shrimp, give water a green-blue tinge, so with an attraction to green and blue light, shrimp might swim towards greater concentrations of algae (Ref. 5).

Although the reasons for light attraction by ocean animals is complex and still a little understood area of research, (for example adult brine shrimp will move towards or away from light depending on how hungry they are, see Ref. 2), the clear response of brine shrimp to blue and red light in the classroom makes this a worthwhile experiment to conduct and to promote speculative discussions around adaptations and evolution.

www.scientistinresidence.ca
info@scientistinresidence.ca

Vocabulary

brine shrimp — *Artemia salina*, along with other species, are shrimp that live in high-salt bodies of water. They are crustaceans, growing from cysts that are resistant to drought and other extreme environments.

phototaxis — Movement in response to light, either towards or away from the light.

adaptation — Also called an adaptive trait. A feature of an organism that benefits its survival, and is maintained by natural selection as long as it provides an evolutionary advantage.

Materials for growing up brine shrimp

- brine shrimp eggs (aquarium stores carry them)
- sea salt
- pipette to transfer brine shrimp
- clear plastic box
- tap water, left to stand overnight to release the chlorine
- small glass jar or other transparent container, to transfer shrimp

Materials for Light attraction of brine shrimp activity

- petri dishes (or other shallow dish with lid), completely covered in black paper and black tape, except for one corner of the lid (see photo), one per student pair
- coloured filters - red, yellow and blue ideal (e.g. scrap acetate sheets left over from industrial colour printing, available from Urban Source in Vancouver)
- optional: 20X - 40X microscope(s), ideally with an adapter to view image on a classroom screen. e.g. microscope attachment for smartphone (Carson HookUpZ) with image connection to classroom screen e.g. Apple Airplay
- brine shrimp, about 100 per dish. Juveniles worked well for me, 1 or 2 days after hatching
- flashlights, one per petri dish
- if microscope is available: pipette and microscope slide

Materials for Animal colour for Camouflage activity

- coloured markers
- white paper

Petri dish covered in black paper and tape

www.scientistinresidence.ca
info@scientistinresidence.ca

Before the lesson: growing brine shrimp

Start growing the shrimp two or three days before the lesson.

1. Prepare 2% sea salt in dechlorinated tap water (i.e. 2g salt in 100ml water or equivalent), enough to fill the plastic box to a depth of 3-5cm.
2. Sprinkle brine shrimp eggs over the surface, to form a sparse coating.
3. Leave in a space with natural light, undisturbed. (Some sources say to add a bubbler to the water, to provide more oxygen, but for my use I have found that this is not necessary, though my hatch rate is likely lower.)

The shrimp should hatch after a day, and can be left another day or maybe two before using for the activity. After this, without food or water replacement to remove ammonia and other toxins, the shrimp will start to die.

To harvest the shrimp for the lesson, place near a bright window, with one corner of the box facing the window. If a window is not bright enough, point a flashlight at the corner of the box. Raise up the end of the box facing the light with a book.

The shrimp will move towards the light, so wait a few minutes, then use the pipette to suck up a concentration of shrimp in the shallower water nearest to the window. Transfer to a small jar or other container. Avoid the empty egg cases floating on the surface of the water.

In the Classroom

Processes of science that the students will focus on: exploration, curiosity, mechanical manipulation, close observation, collecting data, classifying and comparing data, recording results, graphing data, interpreting graphs, inferring, concluding, hypothesizing.

Science Activities

A. Close observation of brine shrimp

1. At the start of the lesson transfer about 100 shrimp to each blacked-out petri dish. Ideally have one dish per pair of students.

2. Hand out one flashlight for each dish, and ask the students to keep the lid off, and use the flashlight to find the shrimp in their dish. Show them by scanning the flashlight over the dish at an angle, the shrimp can be found more easily. Ask students to watch the movement of the shrimp - they will move along in a jerky way, following a zig-zag path.

3. If available, use a higher power microscope to look at a shrimp closely. One shrimp can be added to a slide using a microscope. Ideally project the image on a screen so that the parts of the shrimp can be discussed together more easily.

   The juvenile shrimp use their antennae as paddles to push (or "row") through the water, hence the jerky movement. As they get older they will grow legs and swim with a smoother motion. The juvenile has one eye at the front of the head. They will later grow an additional pair of eyes, located on the sides of the head (to total three eyes!). The juveniles initially eat the yolk remaining from the egg, then start to feed on tiny algae in the water.

B. Light attraction of brine shrimp activity

1. While looking closely at the shrimp, some students may have noticed that they are attracted to the light. This observation introduces this activity.

2. Ask all students to observe the attraction of shrimp to (white) light using these steps:
   i. Gently swirl the dish to distribute the shrimp evenly, then carefully place the lid on.
   ii. Hold or rest the flashlight over the open corner of the lid, and wait one minute, without disturbing the dish
   iii. Carefully lift the lid, without jostling the dish, and immediately look to see where the shrimp are distributed. Quickly scan the flashlight over the dish to find the location of all the shrimp.

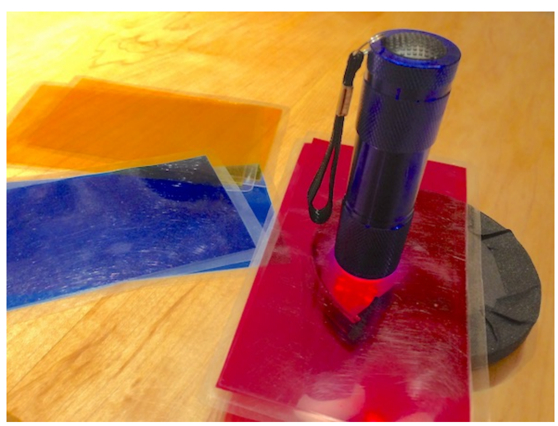
3. Students should find that most of the shrimp will be gathered under the location of the light. Not all of the shrimp will have moved there though - there will be a few in other areas of the dish. Discuss with students that it is statistically likely that shrimp will be under the light, but there is no absolute distribution of the shrimp.

   Tell students that they will be looking at more distributions with this kind of variation and that we will call this distribution (with most of the shrimp in one location) a "strong attraction" to light. Draw the shrimp distribution for a "weak attraction" (a distinct concentration in one spot, but more shrimp scattered elsewhere) or "no attraction" (an even distribution of shrimp).

4. Explain that different colours of light attract shrimp differently, and that the students will find out which colours shrimp are more attracted to. Hand out the filters. Ask students to repeat the steps as for the white light (i. swirl dish, ii. light over dish, iii. look at distribution), but with filters between the dish and the light, so that the shrimp are exposed to different colours.

   (We used two of each filter colour, which I had previously determined to give best results i.e. for blue light, use two blue filters, for red light use two red filters, for green light use one blue and one yellow filter etc.) Make sure that all students try blue, red and green light, then they can mix pairs of filters to try any other light combinations they wish. Students use a worksheet to record whether the shrimp are "strongly attracted", "weakly attracted" or "not attracted" to each light colour.

5. Graph the class results, making a bar chart of the number of times the shrimp were strongly attracted to each light colour that all the groups recorded. Other colours can be added to the chart that several groups recorded by converting to a fraction of the total groups present (if there are enough data points). Although not every student will get the same result, the class results should show that the shrimp are strongly attracted to blue light, and not attracted (or weakly attracted) to red light.



www.scientistinresidence.ca
info@scientistinresidence.ca

6. Allow students to speculate as to why brine shrimp might be more attracted to certain colours. Encourage thought around what might help these animals survive (e.g. food, habitat etc). Encourage them to come up with other experiments to try (and a hypothesis to test) to find out.

7. During discussion, inject some ideas:
    i. The food source of brine shrimp is blue-green algae - it might be advantageous to be sensitive to the colour of a food source, and to swim towards it.
    ii. The attraction to certain light colours correlates with how deep different colours penetrate into water (Ref. 6). Could shrimp have an adaptation that allows them to follow blue light to the surface of the water (where their food lives?) Make it clear that scientific research is still in progress as to why ocean animals are attracted to different light colours, and any ideas are worth discussion.

(C) <u>Animal colour for camouflage activity</u>

1. Show students an image of how far different wavelengths of light penetrate water (Ref. 6), and explain that this results in the ocean deeper than 50 metres looks blue.

2. Tell students that this activity explores animal adaptations for the blue-tinged undersea world.

3. Ask students to draw an undersea scene with coloured markers on paper, making sure that they draw some brown or black seaweed or rocks, some red and black ocean animals, and some light blue and light-coloured ocean animals.

4. Ask them to look through a blue filter at their scene, which mimics the lighting in ocean water. In the blue light, which fish colours appear dark, and which fish show up lighter? Red-coloured fish will look dark, and look the same shade as black objects. Blue and lighter coloured animals show up more brightly and are easier to see.

5. Explain that ocean animals exploit this phenomenon to hide from predators: in the mid-water regions of the ocean, where only blue light penetrates, many ocean animals are coloured red or black, so that they can camouflage against dark algae and rocks or just appear dark in the water.

Closure Discussion

Encourage other discussion around animal adaptations for their environment that would help them to find food, or to escape from predators.

References

1. <http://animaldiversity.org/accounts/Artemia_salina/> University of Michigan Museum of Zoology article on brine shrimp characteristics and behaviour (including light attraction). Accessed May 29, 2017

2. <http://sicb.org/meetings/2012/schedule/abstractdetails.php?id=764> Society for Integrative and Comparative Biology Meeting abstract (2012). Adult brine shrimp are attracted to light when they are hungry. Accessed May 29, 2017.
3. <http://www.caltech.edu/news/swimming-sea-monkeys-reveal-how-zooplankton-may-help-drive-ocean-circulation-43843> Caltech research study that exploits the attraction of brine shrimp to blue light. Accessed May 29, 2017.

4. <http://cssf.usc.edu/History/2009/Projects/S2410.pdf> California State Science Fair project on light attraction by brine shrimp (2009). Accessed May 29, 2017.

5. <http://www.britishecologicalsociety.org/wp-content/uploads/Brine-Shrimp-Ecology.pdf> British Ecology Society classroom lesson on Brine Shrimp Ecology p.64-65. Accessed May 29, 2017.

6. <https://disc.gsfc.nasa.gov/education-and-outreach/additional/science-focus/ocean-color/images/spectral_light_absorption.gif> and <http://oceanexplorer.noaa.gov/explorations/04deepscope/background/deeplight/media/diagram3_600.jpg>. NASA and NOAA images of how far different light colours penetrate into water. Accessed May 29, 2017.

Extension of Lesson Plan

Study the white light attraction of other aquatic organisms. For example, cyclops collected from a freshwater pond, was attracted to the flashlight using the same materials as the above brine shrimp experiment.