PARASITES CREATE ZOMBIE SNAILS

(1) Imagine if you were a little snail minding your own business, then all of a sudden, some other creature takes over your mind and body and forces you to give up all your survival instincts making you more likely to be seen by your predators. This is what happens to the amber snail when it is infected by a parasite called *Leucochloridium paradoxum* which is a type of parasitic flatworm. This parasite requires both the snail and a bird to be its hosts to complete its life cycle and create offspring. When *L. paradoxum* infects the bird, it has no negative effect on the bird but the amber snail undergoes a horrific experience.

(2) The reason *L. paradoxum* infects amber snails is because the flatworm actually wants to infect a bird and it needs to use the snail as bait for getting to the bird. The parasite does this in two ways. First, it gets inside the snail and transforms the snail into an attractive meal for the bird. Many birds do not normally eat snails otherwise. Second, it makes the snail give up its instinct to hide in the daytime so that a bird, who hunts by vision, will be able to detect the amber snail easily. How does it accomplish these two things? The story is both a gruesome and interesting one.

(3) When *L. paradoxum* eggs are accidentally ingested by an amber snail, the eggs develop into sporocytes within the snail's body. These sporocytes have no mouths and simply absorb food through their skin. This food comes from the snail's own supply of nutrients. To make sure that there's enough food, the parasite makes the snail infertile by inhibiting its production of sperm and eggs. Since snails are hermaphrodites, each contains both male and female sex organs. When the snail cannot put any energy into reproduction, more energy is available to put towards feeding and this greatly benefits the hungry sporocytes. When the sporocytes are well fed, they will tunnel through the snail's body to eyestalks (tentacles). Here they will form long brood sacs which are tube-shaped containers that hold tens of thousands of *L. paradoxum* larvae.

Uninfected Amber Snail, Credit: Charles J. Sharp

Amber Snail with Brood Sacs in Eyestalks, Credit: Gilles San Martin

The brood sacs are green, red and brown in color and are visible under the thin stretched skin of the eyestalks. When the brood sacs pulse, the swollen eyestalks look like two moving caterpillars. Invading of the snail's eyestalks accomplishes the parasite's first task; It makes the snail, or at least its eyestalks, look like an attractive meal for the birds.

(4) The parasite does not stop at just taking over the body of the snail, it now needs to take over the mind of the snail as well so that the snail gives up its usual self-protective behaviors. This turns the snail in to a mind controlled zombie! Snails don't like being out in the bright open spaces. Open spaces make them more vulnerable to their predators, and being out in the daytime desiccates them, meaning that it dries out their soft moist bodies. *L. paradoxum* controls the snail's mind to reverse the snail's instincts to be less active in the day and out of sight. The brood sacs within the eyestalks impair the snail's vision and prevents it from being able to tell the difference between light and dark. This causes the snail to go out in daylight and seek out the upper leaf of a plant making it much easier to be spotted by a bird. The bird mistakes the snail's pulsing eyestalks for caterpillars and bites them off the snail's head. The parasites are now within the bird.

(5) Though injured, the snail can survive the bird attack and can regenerate its eyestalks. It can even regain its ability to make sperm and eggs. Though *L. paradoxum* harms the snail, the parasite benefits if the snail survives and can reproduce. More snails will always be needed to help the parasites get to the birds.

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(6) When one organism pretends to be the food source for another organism in order to trick the second organism into eating it, this is called aggressive mimicry. Mimicry means to copy or imitate. In this case, *L. paradoxum* is using the snail to imitate a caterpillar.

(7) When the brood sac has been ingested by the bird, the larvae can break free and begin to grow into sexually mature adults. At this point they can reproduce and lay eggs within the bird's rectum. These eggs will be excreted by the bird in its poop. Another unsuspecting amber snail will eat the poop and unknowingly ingest the parasite eggs. The snail now becomes the new host for the start of the next generation of *L. paradoxum* parasites.

(8) *L. paradoxum* is not the only parasite that uses mind control to turns its hosts into zombies. Many other parasites also use this effective survival strategy. For example, some parasitic wasps lay eggs within the bodies of some spiders. The eggs hatch into larvae which begin mind controlling the spider so that it starts spinning webs that will be perfect cocoons for the wasps. Though many parasites use mind control, very few use it in combination with aggressive mimicry, making *L. paradoxum* quite unique.

Article Questions

1) What two hosts are needed for the *L. paradoxum* parasite to complete its life cycle?

2) Number the following events in order from 1 to 9 to represent the life cycle of *L. paradoxum*. Step 1 has already been provided to guide you.

____ Amber snail seeks out an open space during the day.
____ Bird spots amber snail eyestalks and eats them.
____ *L. paradoxum* eggs hatch and form sporocytes.
____ Bird poops out the eggs.
____ Sporocytes grow as they absorb food from the snail.
____ *L. paradoxum* larvae grow into sexually mature adults and lays eggs in bird's rectum.
1 An amber snail eats bird poop containing *L. paradoxum* eggs.
____ Brood sacs, containing *L. paradoxum* larvae, grow in the snail eyestalks and pulsate.
____ Sporocytes tunnel through the snail's body to the eyestalks.

3) Why does the *L. paradoxum* parasite cause the snail to stop producing eggs and sperm?

4) What is aggressive mimicry in the case of the *L. paradoxum* parasite?

5) How does the *L. paradoxum* parasite change the snail's typical survival behavior?

6) What two things happen to the amber snail after it has its infected eyestalks removed by a bird?