Creatures of the Hydrothermal Vents

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Hydrothermal Vents

- Hydrothermal vents are fissures in a planet's surface from which geothermally heated water issues.
- First discovered in 1977 at the Galapagos Rift. Apparently, life thrives well in the region.
- They are the result of the seawater percolating down through fissures in the ocean crust in the vicinity of spreading centers or subduction zones. The cold seawater is heated by hot magma and re-emerges to form the vents.
- The seawater in these hydrothermal vents may reach temperatures of over 300 °C.
- Water from these vents are full of hydrogen sulfide. As such, waters from these parts smell like rotten eggs, and are toxic, at least to human beings. Don't worry. Your ex is probably much more toxic. They may also have sulfur.
- Animals living here have special biochemical adaptations that protect them from hydrogen sulfide.

FUN FACT! During the discovery of the hydrothermal vents, some of the specimens gathered from the vents were preserved using some strong Russian vodka the scientists bought in Panama. This is one reason why you should bring vodka to trips.

Bacteria in the Vents

- Prevalent in these waters. They are so thick that form a crust over the entire vent region.
- They take in hydrogen sulfide and converts them to food.
- Some creatures have bacterial growth to form a bacto-blanket that protects the creatures from the heat.

Pyrolobus ("fire lobe") and Pyrodictium ("fire network")

- Scientists isolated species of *Pyrolobus* and *Pyrodictium* from chimney walls. These microbes (which grow optimally at 100 degrees Celsius) get their energy from hydrogen gas and produce hydrogen sulfide from sulfur compounds from vents.

Pyrolobus fumarii

- One hydrogen-sulfide-making species is *Pyrolobus fumarii*.
- It was first isolated from a vent at the Mid-Atlantic RIdge. It grows at 90-113 degrees Celsius, optimally at 106 degrees Celsius.

Pyrodictium abyssi

- Disc-shaped cells that grow attached to networks of hollow tubes that resemble tree roots.
- These microbes grow best at 105 degrees Celsius but can reproduce at 80 and 110 degrees Celsius.

Methanopyrus kandleri

- *Methanopyrus kandleri* is a heat- and salt-loving of Archaea that makes its home on the chimney walls of smokers.
- It harvests hydrogen gas and releases methane, a process called methanogenesis.
- Has been isolated from hydrothermal sediments at Kolbeinsey Ridge off coast of Iceland and the Guaymas Basin in the Gulf of California.
- In the lab, this bacteria can still divide at 122 °C, the highest temperature known to be compatible with microbial growth, though it grows best at 98 °C.

Green Sulfur Bacteria

- Unique among hydrothermal vent bacteria because they require both chemical energy and light energy to survive.
- They contain chlorosomes, organelles that are so efficient at harvesting light that green sulfur bacteria can grow at much lower light intensities than other light-requiring bacteria.
- There is no sunlight in the vents. Instead, they capture energy from the weak radioactive glow emitted from geothermally heated rock.

Tube Worms

- Resembles worms, but they live in fleshy tubes and have no mouth, no stomach, and no intestines.
- Grows to nearly 8 feet (2.5 m).
- Lives close to the hydrothermal vents, and live together in large clusters.

- Each worm has red head, or plume. The red colour indicates a specialized chemical, similar to hemoglobin in human blood, but it transports hydrogen sulfide instead of oxygen.
- The hydrogen sulfide is deposited in a cavity in the worm's body, called the trophosome. This large, stomach-like space is filled with trillions of bacteria that eat the hydrogen sulfide. In return for the shelter, the bacteria provide food for the worm. Talk about paying rent!
- The worm has no mouth and no digestive system. Seems not like fun. But, the worm never gets indigestion and never needs to use the bathroom.
- The worm's system is a very efficient system, with minimal "working parts" in a very dangerous environment. Stealing a quote from Software Engineering by Christian Cantrell, "*The fewer moving parts, the better.*" "*Exactly. No truer words were ever spoken in the context of engineering.*" .

Scaly Foot Snails

- Builds a shell out of iron sulfide. IT BUILDS A SHELL WITH IRON!
- The squishy part of the snail, known as the foot, that protrudes out of the shell is covered with iron plates.
- Bacteria living in the shell builds the iron armour.
- Its mortal enemies are crabs and other snails.
- The shell isn't as rigid like plate armor. They're more like chain mail – pliable, yet strong.
- The shell has three layers: an iron-plated top, and a calcified bottom, with squishy organic layer in between. The iron plate provides the strength, while the middle squishy layer acts a shock absorber.
- The scales on the foot serve a rather more righteous purpose.
- Some predatory snails shoot a harpoon at the flesh of fish and other snails. So, the iron-plating of the scaly-foot snail is thought to deflect such missiles.
- There are two varieties: one black, and one white. The white one lacks a shell unlike the black variety. The lack of a shell is probably due to the white variety's lack of bacteria on the outside the facilities the production of iron sulfide. That's the hypothesis, however.
- The snail's digestive system is practically non-existent. It does have a gland (which is 1,000 times bigger than other snails) that hosts bacteria. The snail depends on the bacteria in its gland for sustenance in a process called chemosynthesis, a process which means that food is produced by bacteria using chemicals as the energy source, instead of sunlight.

Pompeii Worm

- Can be up to 13 centimeters long
- Pale grey with hairy backs. These "hairs" are formed by bacteria which are thought to afford the creature with some degree of insulation. Glands on the worm's back secrete a mucus which the bacteria feed on.
- They form large aggregate colonies in delicate, paper-thin tubes.
- They attach themselves to black smokers.
- They are found to thrive in temperatures of up to 80 degrees Celsius.
- The worm pokes its feather-like head out of its tube home to feed and breathe.
- The plume of tentacle-like structures on the head are gills, coloured by haemoglobin.
- Its posterior end is exposed to extreme temperatures, and the anterior end stays at a much more comfortable 22 degrees Celsius.

Squat Lobster

- Can grow from 0.7-3.5 inches
- They are scavengers. They scoop up muddy or sandy deposits and sort out edible bits with their mouth parts. They also feed on larger food items.
- They may be called lobsters but they are more closely related to hermit crabs.
- Unlike their relatives, squat lobsters don't carry shells on their backs. Rather, they squeeze into crevices and keep their large sharp claws exposed to keep neighbouring lobsters away.
- They also hide under rocks to protect their bodies and stay away from hungry fishes. They wait for snacks to settle nearby. Their claws are perfect for reaching out and picking up food.
- Their arms can grow to be several times larger than their body.
- They also sometimes steal food from sea anemones.

Deep Sea Vent Octopus

- Has unusual traits for an octopus. It has no ink sac. Its dorsal arms are longer than the ventral arms. They include biserial suckers. Overall, it has a mean total length of 184 mm.
- Its primary defense is to freeze in place. Yeah, it freezes like how you freeze when you see someone you like. Its secondary defense involves pushing away from the bottom then drifting back down.

- The front (dorsal) arms are used to feel its way around and detecting and catching prey. Its back arms (ventral) support its weight and move the octopus forward.
- This species of octopus has not been observed to utilize jet propulsion.
- It is confirmed to feed on *Halice hesmonectes*, and crabs.

Hydrothermal Vent Crab

- Living among the tube worms and on mussel beds.
- Both a predator and a scavenger.
- Adult carapace is traversely elliptical, depressed, and nearly smooth, cornea is unpigmented.
- Its width can be up to 59 mm.

Japanese Deep Sea Crab

- Marine crab that lives around the waters of Japan.
- SCARY AF!!! IT'S LIKE STRAIGHT OUT OF RESIDENT EVIL OR SOMETHING.
- It is the subject of fishery and is a delicacy (yum yum yum!) in Japan.
- Has the greatest leg span of any arthropod (wow legs), and can reach up to 5.5 meters from claw to claw.
- The crab is orange with white spots along the legs.
- It has a gentle disposition, despite its ferocious appearance.
- Their armoured exoskeletons help protect them from predators such as octopuses. They also use camouflage, which includes adorning themselves with sponges and other animals.
- They can stay in cold waters (about 10 degrees Celsius). But in deeper waters, they prefer to inhabit vents and holes.
- It is an omnivore. Sometimes acts as a scavenger, consuming dead animals. Some have been known to scrape the ocean floor for algae and plants, while others pry open the shells of mollusks.
- During breeding season, they can migrate up to a depth of 50 meters.

Hydrothermal Vent Clams

- Usually lives on hot vents.
- The two valves of these clams are oval or kidney-shaped and are about two times as long as they are high. The shell material is thick and the exterior is white and usually chalky in appearance. The gills are large and thick and the visceral mass is red due to the presence of haemoglobin in the blood.

- Assumed to burrow and it is thought the divided foot may be specially adapted for insertion into cracks in hard substrates or among mussels.
- Can move around on the seafloor with its muscular foot and usually takes up a vertical position rather than lying flat.
- Little is known about their reproduction and life cycle of these clams but examination of specimen brought up from the deep showed oocytes with yolks in various stages of development. Research thought that this means that the clams have poor dispersal abilities. However, a study using rDNA analysis showed that larvae did in fact disperse to other vents throughout its range. Hydrothermal vents may stop flowing and the communities around it die. To ensure the continued existence of their species, there is a need for the larvae for these vents to be dispersed to other existing vents and for them to exploit new vents when they open up.

Sea Spiders

- Actually, they're not spiders though they're common in hydrothermal vents.
- Rather, they're spider-like marine arthropods.
- They have four pairs of walking legs, which make up most of their bodies.
- Their bodies are so thin that they don't need a respiratory system. They exchange gases through their bodies.
- Their muscles are only a single cell, due to their size, surrounded by connective tissue.
- They use a tubular proboscis to scavenge for food or feed on microbes.
- They reproduce by clustering together and males locate eggs and fertilizing them. The fathers care for the egg and the young.
- The length of these guys are merely 1 cm.

Sea Anemones

- Wait, there are sea anemones at these depths???
- Yep, they're wooping big with unusual tentacle features.
- Called the flowers of the ocean.
- They are actually predators of smaller fish and shrimp.
- They live on the ocean floor, latched to rocks or coral.
- Fish unlucky enough to get enmeshed in their tentacles are shot with venom and a trip into the anemone's mouth, at the center of the disc.
- One sea anemone is found off a sea mountain near Wake Island, a coral atoll in the Western Pacific Ocean.

Rattail Fish

- Also known as Grenadiers.
- Has a distinctive whip-like tapering form.
- Its size may range from 25 centimeters to greater than 1.5 meters.
- They are long-lived. They can live up to 70 years in the Pacific Ocean, and 58 years in the Atlantic Ocean, with 23 years needed to mature.
- As larvae, they feed on small invertebrates. As they reach adulthood, they take on larger species, including lanternfish, cephalopods, and larger benthic crustaceans. They have been observed feeding on chunks of decomposing whalebone extracting nutrition from the Osedax worms and their eggs that have bored within.
- They are closely related to cod. As such, they have been a target of commercial fishing.

References

- https://divediscover.whoi.edu/archives/ventcd/vent_discovery/index.html
- https://answersingenesis.org/biology/microbiology/deep-sea-vents-lifes-toxic-sanctuary/
- https://en.wikipedia.org/wiki/Hydrothermal_vent
- http://ocean.si.edu/ocean-news/microbes-keep-hydrothermal-vents-pumping
- https://answersingenesis.org/biology/microbiology/deep-sea-vents-lifes-toxic-sanctuary/
- https://teara.govt.nz/en/diagram/8960/photosynthesis-and-chemosynthesis
- http://eol.org/pages/2912652/overview
- https://pangea.stanford.edu/projects/marve/bio_gallery/
- https://www.montereybayaquarium.org/animal-guide/invertebrates/squat-lobster
- http://eol.org/pages/3100246/details
- http://eol.org/pages/4270790/details
- https://en.wikipedia.org/wiki/Japanese_spider_crab
- http://eol.org/pages/4771184/overview
- https://en.wikipedia.org/wiki/Calyptogena_magnifica
- http://eol.org/pages/4771184/details
- http://novae.ocean.washington.edu/story/Sea_Spiders_at_Axial.html
- https://www.seeker.com/giant-deep-sea-anemone-has-mysterious-tentacles-1964151377.html
- http://extrememarine.org.uk/2017/12/a-great-tail-of-the-deep-rattail-fish/