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BIOLOGY NEWSLETTER

Hi everyone!

It's been a while, but nevertheless, here is the most recent edition of the Biology newsletter, packed with the exciting science behind some of the Natural Wonders of the World! Hopefully you'll be able to appreciate how striking our planet's fantastic displays are, and if you have any queries, suggestions or articles that you'd like to share, please email me at:

16jaina177@kechg.org.uk

Enjoy,

Aahana

Northern Lights

'The Northern Lights'- or the Aurora Borealis - is the first of the 'Wonders of the World' we're going to explore. In the trilogy by Phillip Pullman (of which the BBC series adaptation 'His Dark Materials' I definitely recommend), he vividly describes the beauty of this natural phenomenon:

> The sight filled the northern sky; the immensity of it was scarcely conceivable. As if from Heaven itself, great curtains of delicate light hung and trembled. Pale green and rose-pink, and as transparent as the most fragile fabric, and at the bottom edge a profound and fiery crimson like the fires of Hell, they swung and shimmered loosely with more grace than the most skilful dancer. Lyra thought she could even hear them: a vast distant whispering swish.
>
> **— Phillip Pullman, His Dark Materials**

But what is the science behind this?

The Aurora Borealis, as well as the Aurora Australis (The Southern Lights), occur due to their location at the poles of the Earth. Here, the Earth's magnetic fields converge and are the strongest. When the highly charged particles[1] emitted from our star - the Sun - collide with the molecules in our atmosphere, energy is released as light in the iconic waves and oval shape.

An array of colours seen in this phenomenon is caused by the different gases in the Earth's atmosphere[2] which emit different colours when they are excited. Green, caused by oxygen, and blue/violet, caused by nitrogen are the two most prominent colours in these displays, and as we have learned from the history of the Earth, these are also the two most abundant gases in today's atmosphere[3]. Scarlet is also present for high altitude oxygen, due to the lower energy levels producing lower energy wavelength, however, this is only occasionally seen as our eyes are 5 times less sensitive to red light rather than green light[4].

This difference in our view of the aurora is due to our eye structure. Colours are perceived due to the proportion of how much each type of cone receptor is stimulated. There are 3 kinds of cones, dependent on light wavelength: long, medium and short. Green light stimulates 2 of the 3 kinds of cones almost equally, hence our eyes are the most sensitive to this colour. This structure also explains colour-blindness, as these wavelengths mostly pertain to red, green and blue (RGB), hence someone can be red-green colourblind, which means the **photopigments** in the red or green cones are faulty.

Whilst our eyes may deceive the real colour of this spectacle, the Aurora Borealis and Australis are still sublime experiences of which mankind has had little impact on - simply the innate formation of the Earth and our galaxy allows us to behold this natural wonder.

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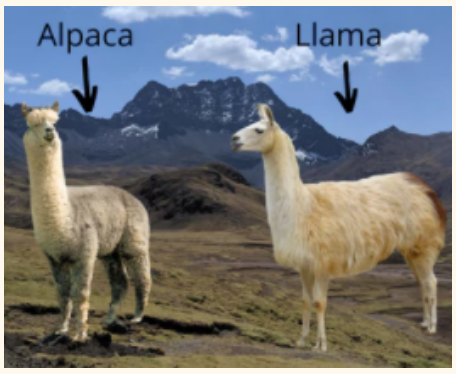
[1] https://www.discover-the-world.com/northern-lights/
[2] https://earthsky.org/earth/what-causes-the-aurora-borealis-or-northern-lights/
[3] https://www.rmg.co.uk/stories/topics/what-causes-northern-lights-aurora-borealis-explained
[4] https://www.hurtigruten.co.uk/inspiration/experiences/northern-lights/what-causes-the-northern-lights/

Rainbow Mountains

Whilst Las Montaña de 7 Colores is technically not a natural wonder of the world, it really is an organic, awe-inspiring sight. Based in the Andes of Peru, this geological wonder does show off all of its spectacular shades in the blue skies of July and August. Standing at 5,200m tall[5] - nearly at Kilimanjaro's 5, 895m height - its multicoloured layers have formed over millions of years by different types of rock sediments[6].

Despite arid conditions, quite a few flora and fauna thrive in the rocky, high altitude conditions of the mountains. Lichens are one of the plants that can survive in this desert-like environment. Whilst a subtype of lichens are **vagrant lichens** which can grow on sand, most lichens need to grow attached to some kind of substrate. Due to its unique existence being a product of symbiosis between a fungus and an algae, lichen can grow on the smallest of rocks. As lichens can do nothing to produce water necessary for photosynthesis and growth, these organisms tend to grow in rock crevices and other confined spaces, in order to get some protection from drying winds and the full force of the sun[7]. As they photosynthesise only when externally hydrated, when lichens come into contact with water, they absorb the water for a little while, using up energy stores whilst filling up on water, before eventually using the H_2O to replenish the depleted energy store as well as grow due to photosynthesis.



Ever wondered what the difference between alpacas and llamas is? Whilst they can successfully **crossbreed**, suggesting that they are very closely related, alpacas tend to be noticeably smaller than their **camelid** counterparts. Llamas have both a soft overcoat and coarse undercoat, whereas alpacas only have one, faster-growing coat of soft hair[8].

Alpacas and llamas herded in the surrounding Peruvian villages, as well as the respective wild guanaco and vicuñas, all have thick coats - an adaptation to protect against the harsh climate of the sometimes snow-capped mountains!

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5 https://www.skratch.world/post/how-to-visit-rainbow-mountain-in-peru-and-what-to-expect#:~:text=To%20experience%20the%20mountain%20in,with%20the%20most%20blue%20skies.

6 https://www.earthstartsbeating.com/2017/10/02/rainbow-mountains/

7 https://www.anbg.gov.au/lichen/ecology-habitats-arid.html

8 https://campoalpaca.com/blogs/news/10-differences-between-llamas-and-alpacas

Great Barrier Reef

One of the prime tourist attractions in Australia, the Great Barrier Reef is the largest coral reef in the world[9]. It is a complex of more than 2,100 individual reefs and around 800 **fringing reefs**[10], many barely underwater at low tide. As the name suggests, the natural wonder is made out of barrier reefs, a kind of reef which runs parallel to the shore but is separated by water. Although there is much variety between the reefs, they all share a common origin as the result of the accumulation of large marine organisms' skeletons over millions of years.

The reefs consist of **'hard' corals**, which are made up of **calcareous** remains binded by coralline algae. These reefs form through the survival of a **coral polyp** that add their own exoskeleton onto an existing coral structure[11]. Most corals form a symbiotic relationship with the algae, especially a kind called zooxanthellae, so whilst the corals provide the algae with a protected environment, the algae photosynthesise to produce energy for the coral, which can be used for growth.

Many animals thrive in the Great Barrier Reef, from microscopic plankton to sharks, whales[12] and even crocodiles! The abundance of fish present at the coral reefs, themselves drawn by the microscopic nutrient particles, entices predators to spend time at the barrier reef. Due to the steady diet of krill and other fish, humpback whales (named after the 'humping' motion they make when diving back down from the surface) give birth and allow their calves to feed and build up body fat for insulation to survive the journey back to the Antarctic[13].

However, these beautiful, biodiverse corals are now being bleached due to climate change. Warmer water temperatures lead to the corals expelling the zooxanthellae living in the tissues, causing the corals to bleach[14]. This means that the corals are more susceptible to disease, due to the lack of energy production from the algae photosynthesis. Protected by agencies such as the EPA, hopefully the destruction of this natural wonder is reduced, and eventually, stopped.

[9] https://greatbarrierreef.org/
[10] https://www.britannica.com/place/Great-Barrier-Reef
[11] https://www.livescience.com/40276-coral-reefs.html
[12] https://www.gbrmpa.gov.au/the-reef/animals
[13] https://greatbarrierreef.com.au/dolphins-and-whales/
[14] https://oceanservice.noaa.gov/facts/coral_bleach.html

Harbour of Rio de Janeiro

Another one of the seven natural wonders in the world is Guanabara Bay - a harbour in Rio de Janeiro, Brazil. It is famed for being the world's largest bay, with mountains that almost come down to the water's edge. It has more than 130 islands in it as well as a 13.3km bridge. This is also the location of the famous Christ the Redeemer statue that overlooks the whole city. Its ecosystem is rich and diverse, and it is known especially for its mangrove population.

Mangroves are trees/shrubs that grow in saline coastal water. As these plants can tolerate salt water, they are known as halophytes, and they have adapted to absorb enough oxygen from the water-logged mud. Red mangroves do this by propping themselves up above the water level to absorb air through lenticels (porous tissue) in the bark. Black mangroves on the other hand have straw-like projections, called pneumatophores or aerial roots, that stick out of the soil to act as breathing tubes (think snorkel) to absorb gases such as nitrogen and oxygen.

To absorb nutrients, mangroves have symbiotic relationships with bacteria and fungi by relying on them to solubilise phosphide and nitride ions in the soil to allow for plant uptake.[1] In return, these bacteria and fungi get the organic matter from dead mangroves. Although the decomposition occurs slowly, this mangrove litter is still an important form of nutrient recycling in mangroves.

Mangroves also have complex root systems to cope with the waves and salt-immersion of their harsh habitat, such as roots made impermeable by suberin. This excludes 90-97% of the sodium salts in the soil from the rest of the plants. They also have methods of salt filtration and storage to avoid any toxic element of the high concentrations of salt. The three layers of the epidermis allow only a certain volume of Na^+ ions to enter through the pores, and any excess salt can be lost through pneumatophores or sequestered in the leaves and bark.

However, pollution is causing population decline of mangroves and marine life. After three major oil spills, mangrove areas were destroyed and the bay, once rich in marine life with lots of dolphins and whales, now only Byrde's whales can be spotted at the entrance of the bay.

[1] https://academic.oup.com/treephys/article/30/9/1148/1641261

- Sahana Jain 12C

Glossary

Photopigments - pigments (colourings) that absorb light and change chemically, e.g. photosynthetic pigments

Vagrant Lichens - Lichens that can grow without ever being attached to a substrate

Crossbreed (successfully) - Through mating 2 animals of different species, create (fertile) offspring

Camelid - A family of animals including camels

Fringing reefs - One of the three kinds of coral reefs: it grows from a land mass towards water

Hard corals - Hermatypic corals that have a hard exoskeleton unlike soft corals that do not build reefs

Calcareous - Partly composed of calcium carbonate

Coral Polyps - Individual coral: short-lived microscopic organisms, which live in colonies

Glossary References:

1. https://www.webmd.com/eye-health/color-blindness
2. https://www.anbg.gov.au/lichen/ecology-vagrants.html
3. https://www.collinsdictionary.com/dictionary/english/crossbreed
4. N/A
5. https://oceanservice.noaa.gov/facts/threecorals.html
6. https://www.livescience.com/40276-coral-reefs.html
7. N/A
8. https://www.toppr.com/ask/question/what-are-coral-polyps-write-in-brief/