

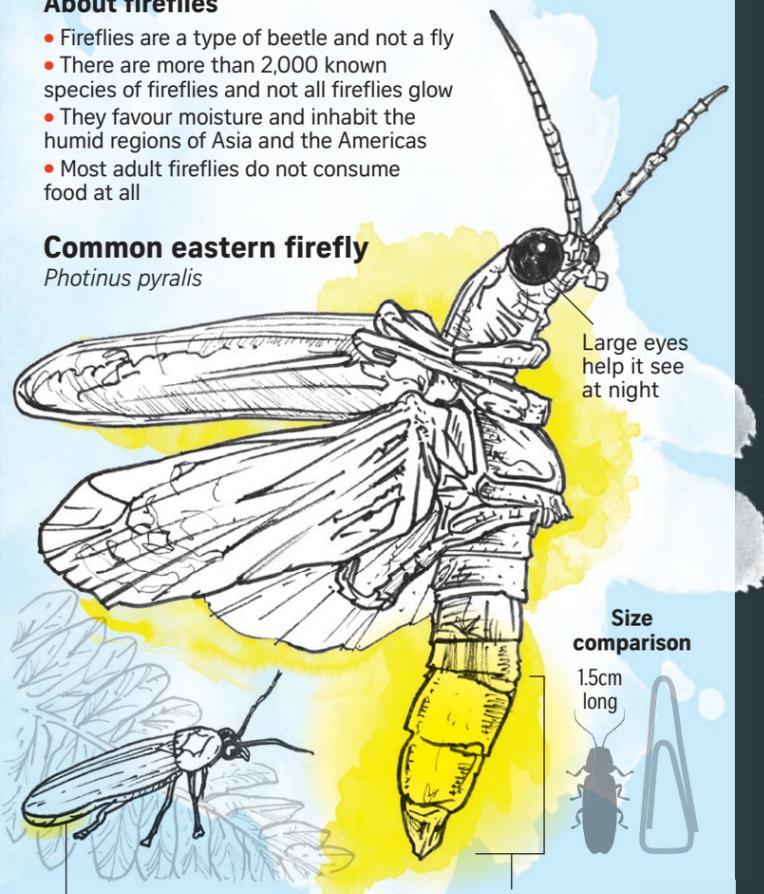
TERRESTRIAL ORGANISMS

About fireflies

- Fireflies are a type of beetle and not a fly
- There are more than 2,000 known species of fireflies and not all fireflies glow
- They favour moisture and inhabit the humid regions of Asia and the Americas
- Most adult fireflies do not consume food at all

Common eastern firefly

Photinus pyralis



Large eyes help it see at night

Size comparison

1.5cm long

- Each firefly species has its unique flash patterns that help the fireflies identify their own kind
- The glowing light, coupled with the beetle's slow, predictable flight, also warns predators such as bats that it is noxious

Luminescence is produced in an **organ of light cells** located at the abdomen

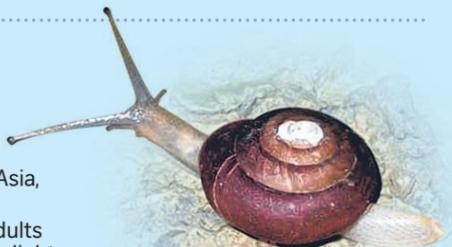
A layer of **reflector cells** focuses the light and directs the beam outward

Light shines through the **translucent exoskeleton**

Brown land snail

Quantula striata

- The only known land snail to bioluminesce
- Native to South-east Asia, including Singapore
- Juveniles and most adults give off flashes of green light while its eggs glow in the dark



Ghost fungus

Omphalotus nidiformis

The naked eye sees the light emitted as dim blueish-white. Photos taken using long-exposure results in a luminous green glow

Up to 13cm in diameter



- One of more than 100 bioluminescent fungi – a mere 0.1 per cent of 100,000 described species of fungi
- Unlike some mushrooms that glow to attract insects that then disperse spores, the Ghost mushroom's glow could be just a by-product of metabolism

Living lights

Captivating blue glows in the waters off the beaches of Changi and Pasir Ris last week attracted throngs of people. A phenomenon like this may seem rare but in reality, bioluminescence in the natural world is more widespread than we think. **The Straits Times** shines a light on the magical and mysterious things that glow.

WHAT IS BIOLUMINESCENCE

Bioluminescence occurs when an organism produces light energy **inside its body through a chemical reaction**

Chemical reaction between two unique chemicals – **Luciferin and Luciferase (or photoprotein)** – and oxygen, creates light. This is **"cold light"**, where less than 20 per cent of the light generates heat.

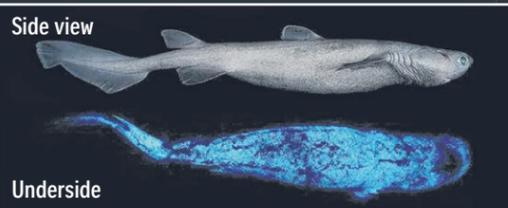
DID YOU KNOW

3 in 4 ocean creatures are bioluminescent

About 1,500 known fish species exhibit luminescence

Kitefin shark

Largest known bioluminescent vertebrate at up to 1.8m long

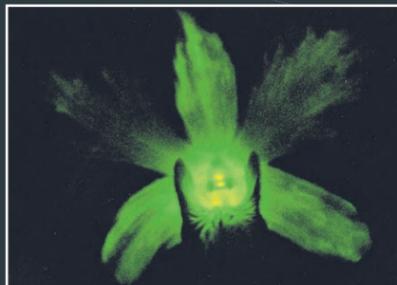


Most of the bioluminescence produced in the ocean is **blue-green light***

NOTE: *They have shorter wavelengths, travel further and thus are visible to most marine lifeforms in both shallow and deep waters.

Milky seas are rare bioluminescence events out in the open ocean where innumerable bacteria light up all at once to form 'glowing mats' – the smallest of which is about **8 times the size of Singapore**

In December 1999, Professor Chia Tet Fatt of National Institute of Education unveiled the **world's first bioluminescent flower**. The white orchid plant's petals, leaves, stem and roots glowed for **up to 5 hours at a stretch**.



A GLOWING RESUME – WHY ORGANISMS LIGHT UP

- **Hide from predators**
In counter-illumination, an animal produces the right amount of light to match their surroundings (far right), thus hiding their silhouette (right) from predators lurking below
- **Warn and defend against predators**
Many squid species give off flashes to startle predators, giving them time to escape



• **Attract or find prey**

• **Communication or for courtship**

MARINE ORGANISMS

About anglerfish

- Anglerfish are named for their method of predation
- Glowing bacteria called Photobacterium resides in the fish's lure – a fleshy enlargement at the tip of a rod-like protrusion from its head
- The fish relies on this "borrowed" bioluminescence to attract and capture prey. In exchange, the bacteria receives nutrients from its host
- Each species of anglerfish pairs with its specific species of bacterium

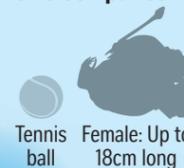
Humpback anglerfish

Melanocetus johnsonii

- The first time this species was filmed alive and in its natural habitat was in November 2014

- An ambush predator with a slow, ponderous swim
- One of the most rarely seen of all deep-sea fishes

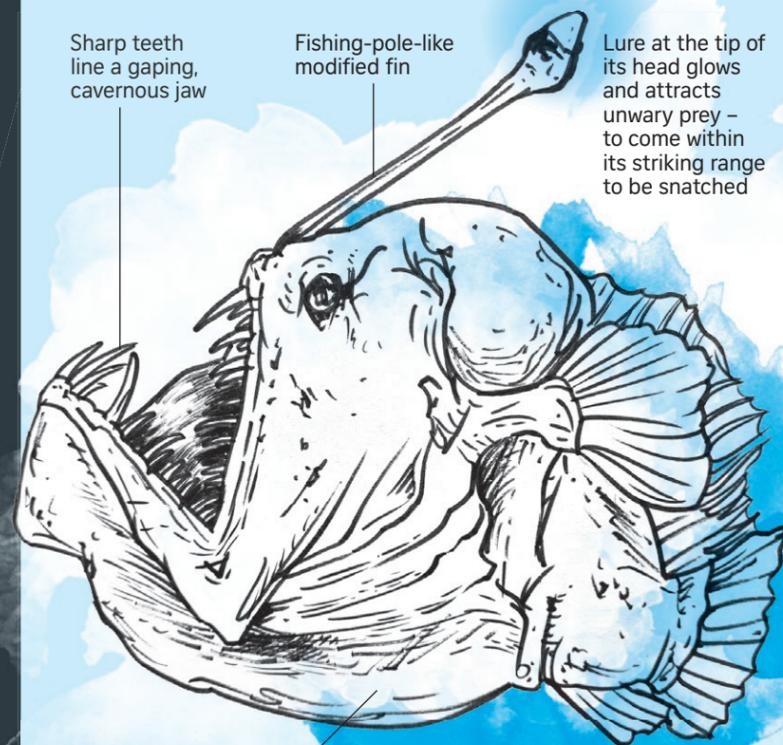
Size comparison



Sharp teeth line a gaping, cavernous jaw

Fishing-pole-like modified fin

Lure at the tip of its head glows and attracts unwary prey – to come within its striking range to be snatched



An expandable stomach allows it to swallow prey up to twice its own size

Dinoflagellates

Melanocetus johnsonii

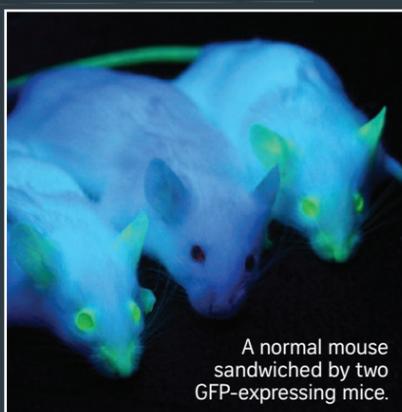
- These single-cell microorganisms, dating back 1.2 billion years, emit a bright, blue glow when disturbed
- This phenomenon is not cyclical locally and the recent event is likely an anomaly



BRIGHT IDEAS

"Reporter gene"

- Scientists use Green fluorescent protein (GFP) to tag to other genes being studied because its fluorescent presence can be readily measured.
- This eases the task of monitoring the activity of the studied gene.
- One example is in using it to track the human immunodeficiency virus and cancer. It is a safer and far less costly technique than using radioactive materials.



A normal mouse sandwiched by two GFP-expressing mice.

Plant-based lighting

- In 2017, Massachusetts Institute of Technology engineers embedded specialised luciferin- and luciferase-carrying nanoparticles into the leaves of a watercress plant. They gave off dim light for nearly four hours.
- In 2021, they created plants that produce light 10 times brighter than the first batch.
- Scientists are also working on creating responsive plants that stop emitting light when there is sunlight.



Challenges

- Current bioluminescence technology does not yield enough light.
- It can be challenging to maintain the living organism and not cost-effective to compete with existing options such as LED lighting.

Sources: NATIONAL GEOGRAPHIC, MIT, SMITHSONIAN INSTITUTE, MONTEREY BAY AQUARIUM RESEARCH INSTITUTE, PHYS.ORG
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