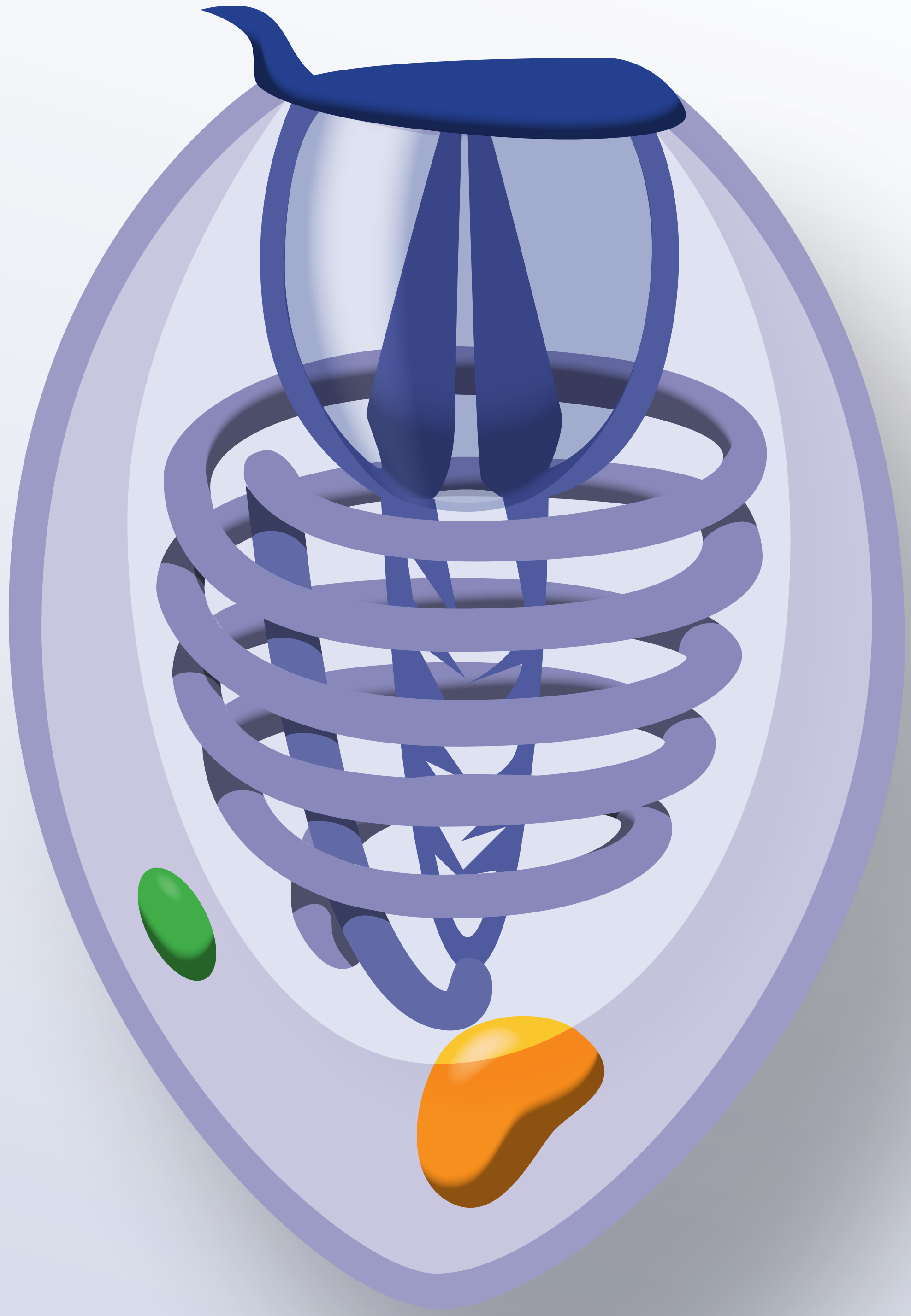


Specialised Stinging Cells

YEAR EIGHT STUDENTS

Introduction

Cells are studied by researchers from many different institutions, including the Queensland Museum. Museum scientists may examine cells as a part of the process of discovering new species. For example, in the following activity you will read about marine biologists who studied stinging cells in a new species of box jellyfish. Other Queensland Museum researchers (like parasitologists) study organisms that are unicellular, so their work requires a detailed knowledge of cells. And finally, some Queensland Museum scientists (like geneticists) extract DNA from the cells of organisms of interest, and then collect and analyse these DNA sequences.

Whatever their use, cells play an important role in current biological research.

As this resource has been designed to complement classroom-based teaching and learning experiences, students are assumed to have developed knowledge about the following concepts:

- all living things are made of cells.
- cells are the basic units of structure and function of living things.
- there are different structures within cells.

Australian Curriculum Links for this Resource

Year 8

Science Understanding

Biological sciences

Cells are the basic units of living things and have specialised structures and functions

(ACSSU149)

Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce

(ACSSU150)

Science as a Human Endeavour

Nature and development of science

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available

(ACSHE134)

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC project aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Specialised Stinging Cells

Have you ever been stung by a jellyfish? Ouch! Jellyfish (and other organisms like coral and sea anemones) have special stinging cells called cnidocytes (pronounced "NYE-dough-sites").

It is these cells that define the phylum Cnidaria (pronounced "nye-DARE-ee-uh"), meaning that every organism in this phylum has these cells.

Phylum Cnidaria includes jellyfish (top), corals (left), anemones (middle) and soft corals (right). All cnidarians have stinging cells called cnidocytes. All images: Queensland Museum, Gary Cranitch.

In this activity we will learn more about the specialised cells that give jellyfish (and other cnidarians) a powerful sting.

First have a look at the jellyfish below.

Though they are very simple animals, jellyfish are multicellular and have different "body parts."

In the picture you can see the bell, tentacles and mouth of a Morbakka jellyfish.

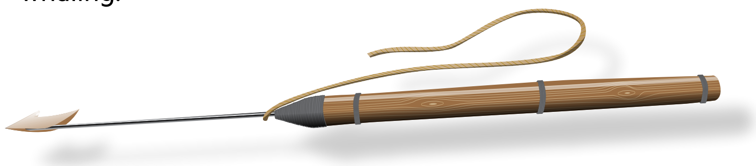
The bell contains the stomach and mouth of the jellyfish, while the tentacles are covered in stinging cells that help the jellyfish capture a meal.

It is important to note that stinging cells can be found on all parts of a jellyfish, not just the tentacles!

Stinging cells help jellyfish catch prey because they contain organelles called nematocysts.

When something brushes against a jellyfish, the nematocysts shoot out, pierce whatever they encounter, and release venom, causing what we experience as a sting. Other organisms experience it as something worse... then they become dinner!

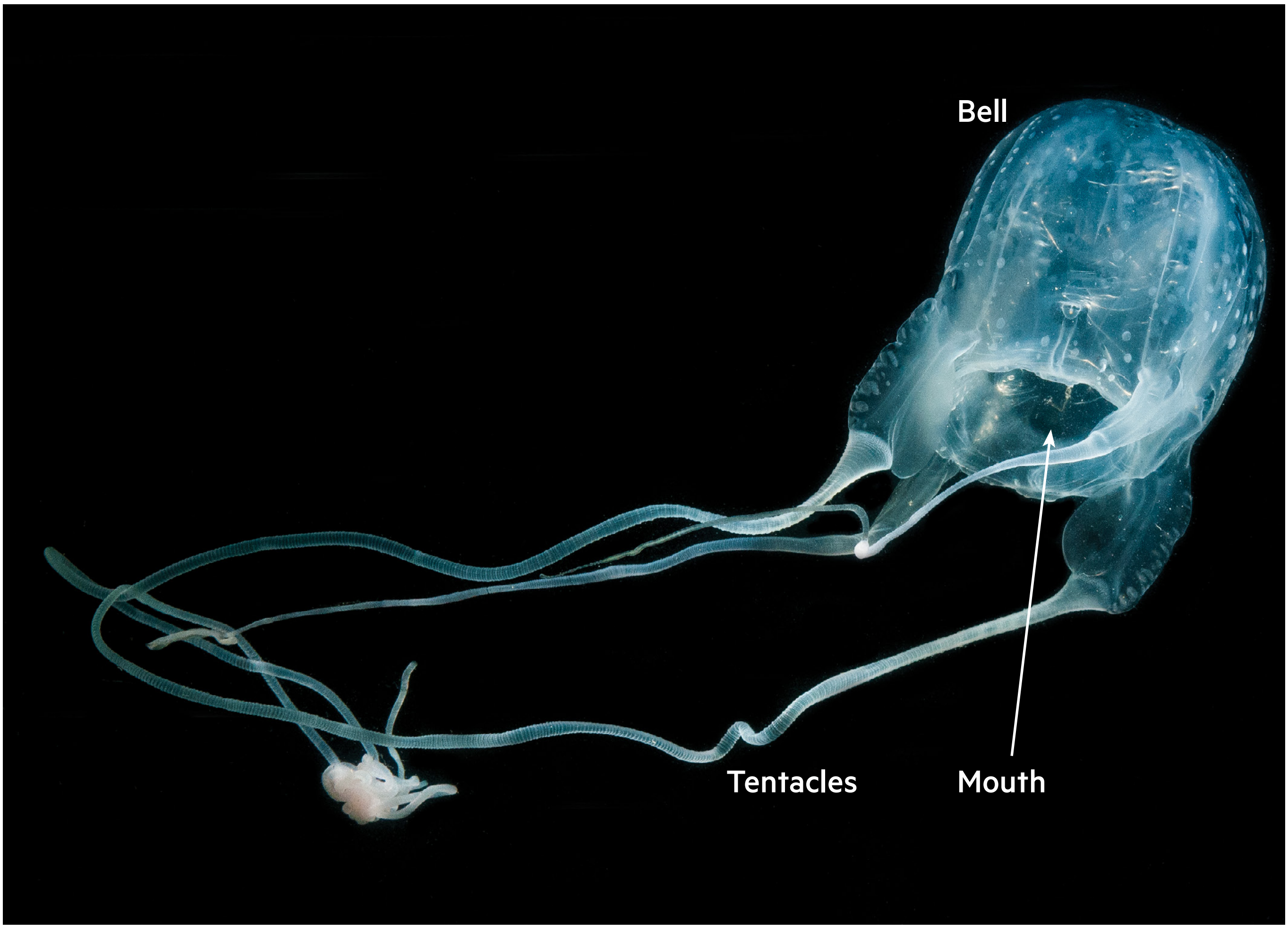
You can compare the nematocyst to a harpoon, a weapon that was historically used in fishing and whaling.



Attached to rope, a harpoon was thrown at animals like whales, where its barb would stick into skin and allow the animal to be captured.

Similarly, nematocysts have a coiled tube that shoots out and attaches to prey. This tube may be covered in spines that help it stick to whatever it touches.

Jellyfish don't want to waste nematocysts, as they cannot "reload" or reuse them; new nematocysts have to be produced to replace the ones that have discharged.

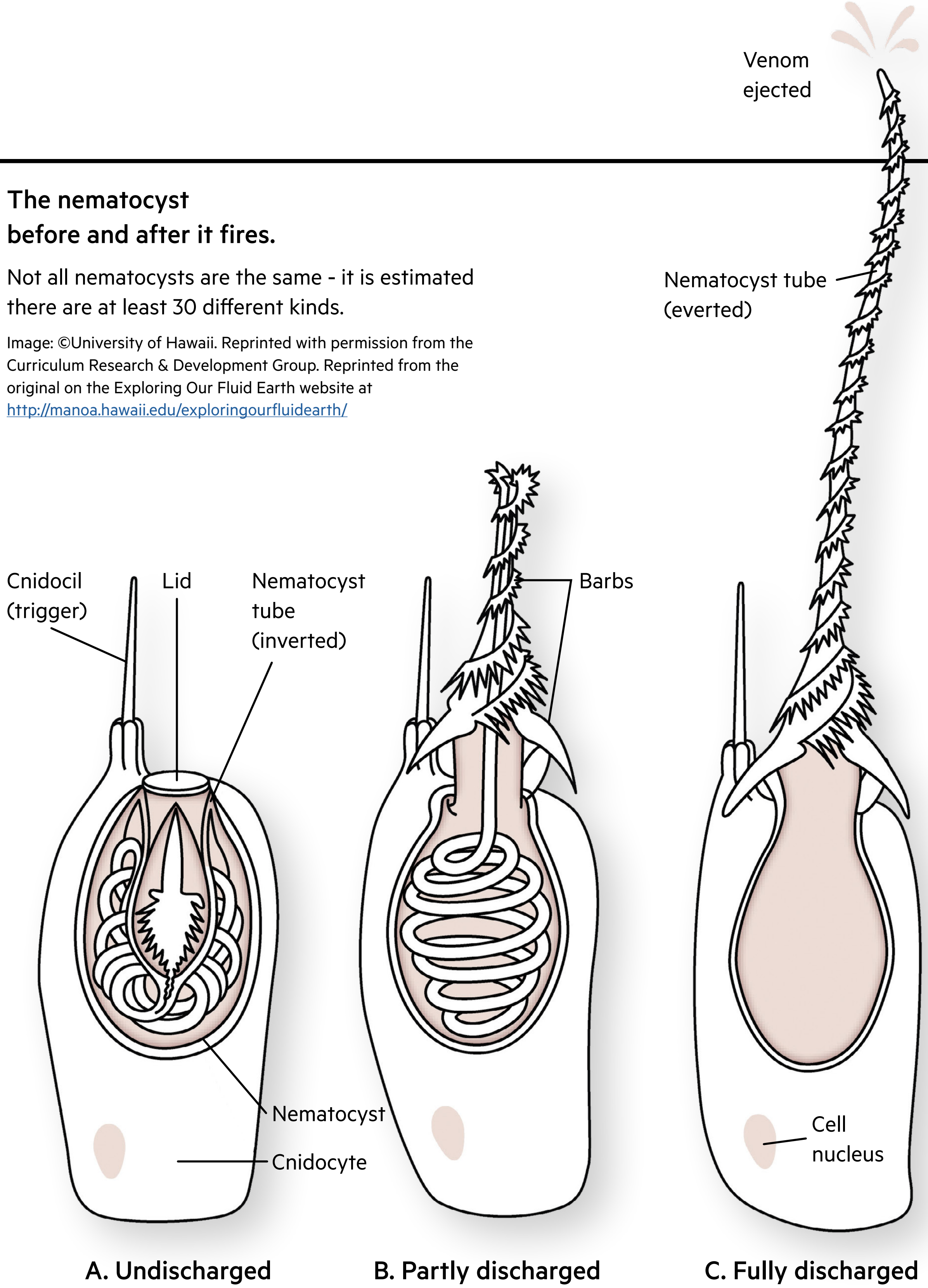


Morbakka fenneri, a type of Irukandji jellyfish from the Gold Coast, Queensland. Image: Queensland Museum, Gary Cranitch.

The nematocyst before and after it fires.

Not all nematocysts are the same - it is estimated there are at least 30 different kinds.

Image: ©University of Hawaii. Reprinted with permission from the Curriculum Research & Development Group. Reprinted from the original on the Exploring Our Fluid Earth website at http://manoa.hawaii.edu/exploringourfluidearth/



How big?

Nematocysts (the organelles within stinging cells) vary in size from about 4–90 microns (also known as micrometres) in length, but on average are 20–30 microns long. Cnidocytes (stinging cells) also vary in size, but as the nematocyst takes up much of the cell (see figure above), cnidocytes are only slightly bigger than the nematocyst inside them.

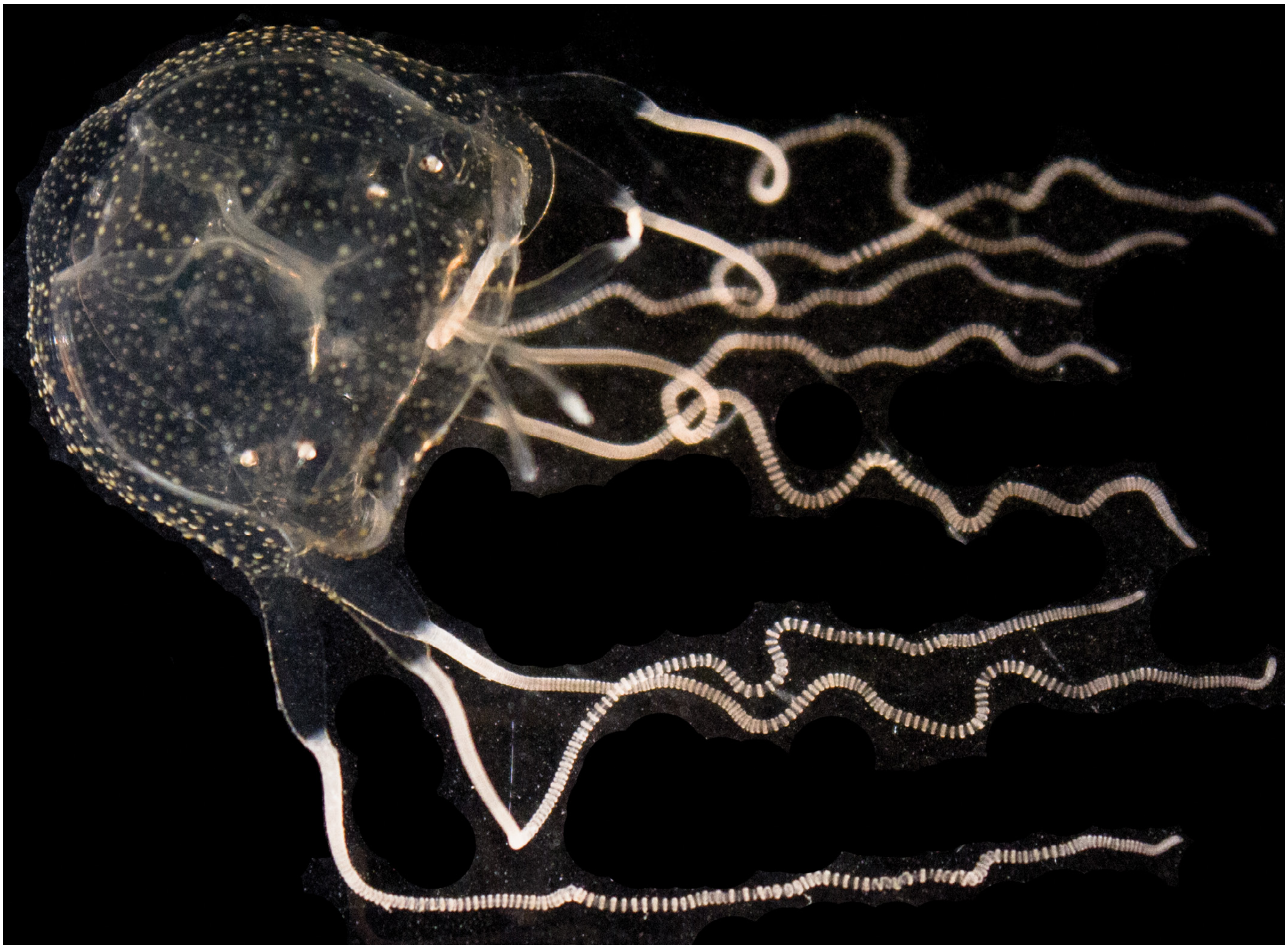
From this we can see that nematocysts are much bigger than mitochondria (~1–2 microns in length), and are more similar to the size of a mammalian cell nucleus (~10 microns in diameter).

Nematocysts have been described as the cnidarian's secret weapon. One scientific study[1] found that they only take about 3 milliseconds to fire, travelling at an average speed of 2 m/s and accelerating more than 40,000 g (astronauts experience 3 g during shuttle launch). This is one of the fastest reaction times in the animal world!

Given their variety, nematocysts can be useful in jellyfish identification. Scientists at the Queensland Museum and CSIRO recently discovered a new species of pygmy box jellyfish from southeast Queensland (unlike its more venomous tropical cousin, it is not considered dangerous). In their scientific paper[2] describing this new species, the authors identified three different types of nematocysts they found in the jellyfish specimens.

What's the deal with vinegar?

Some scientists and health authorities recommend pouring vinegar onto box jellyfish stings. This is because vinegar prevents any additional nematocysts from firing. Unfortunately, vinegar cannot stop the pain caused by the nematocysts that have already been discharged into the skin. **If stung, seek medical attention immediately or call 000.**



Caribbean box jellyfish (*Tripedalia cystophora*), first recorded in Australia by scientists from Queensland Museum and CSIRO.

Photo: Queensland Museum, Merrick Ekins. More details in: Ekins, M. and Gershwin, L. (2014) 'First record of the Caribbean box jellyfish *Tripedalia cystophora* in Australian waters', Marine Biodiversity Records, 7.

[1] Paper: Holstein, T, and Tardent, P. (1984). The ultrahigh-speed analysis of exocytosis: nematocyst discharge. Science 223: 830-834.

[2] Paper: Gershwin, L. and Ekins, M. (2015). A new pygmy species of box jellyfish (Cubozoa: Chirodropida) from sub-tropical Australia. Marine Biodiversity Records 8. doi: 10.1017/S175526721500086X.

Activity

Have a look at the images on pages 8 and 9. These images show what you would see if you were looking down a microscope at slides of jellyfish nematocysts. Images are shown from three objective lenses: the 10x, 20x and 40x. The eyepiece of the microscope has a magnification of 10x. Can you figure out the total magnification of each image?

Pick one image, and make a scientific illustration of what you see. Be sure to label if the nematocysts are “fired” or “not fired.” Measure the length of one nematocyst (fired or not fired). Approximately how long is it in microns? Can you convert that to meters?

The nematocysts on the following pages are from *Pelagia noctiluca* (above), the mauve stinger. This jellyfish was collected at Point Lookout on North Stradbroke Island, Queensland. The species name *noctiluca* means "night light," and this animal has the ability to flash bioluminescently at night.

Image above: © Queensland Museum, Merrick Ekins.

The following images: © Queensland Museum, Marissa McNamara.

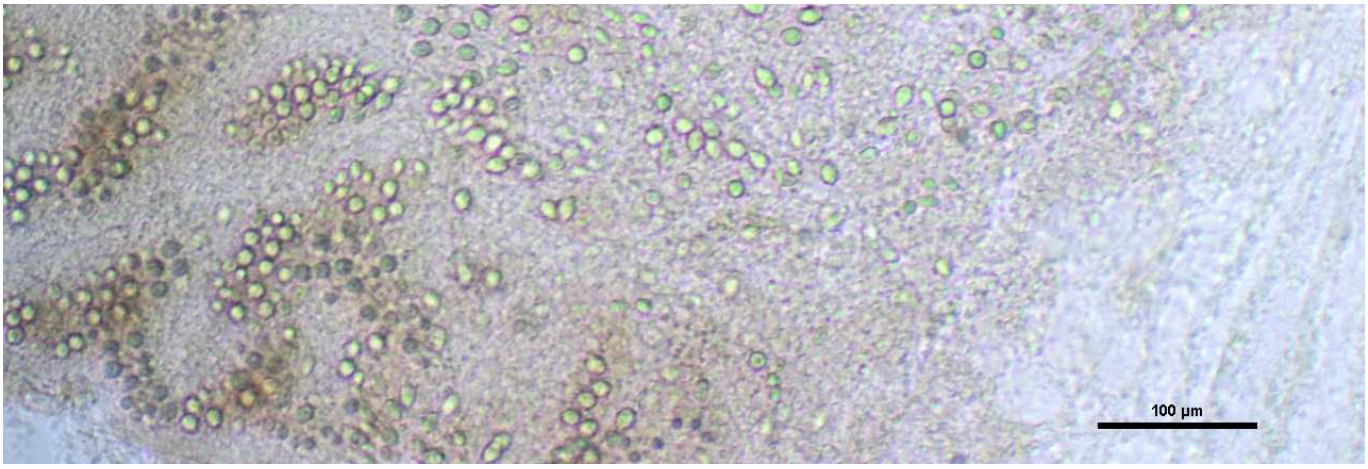


Image 1. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 10x objective. Scale bar: 100 microns.

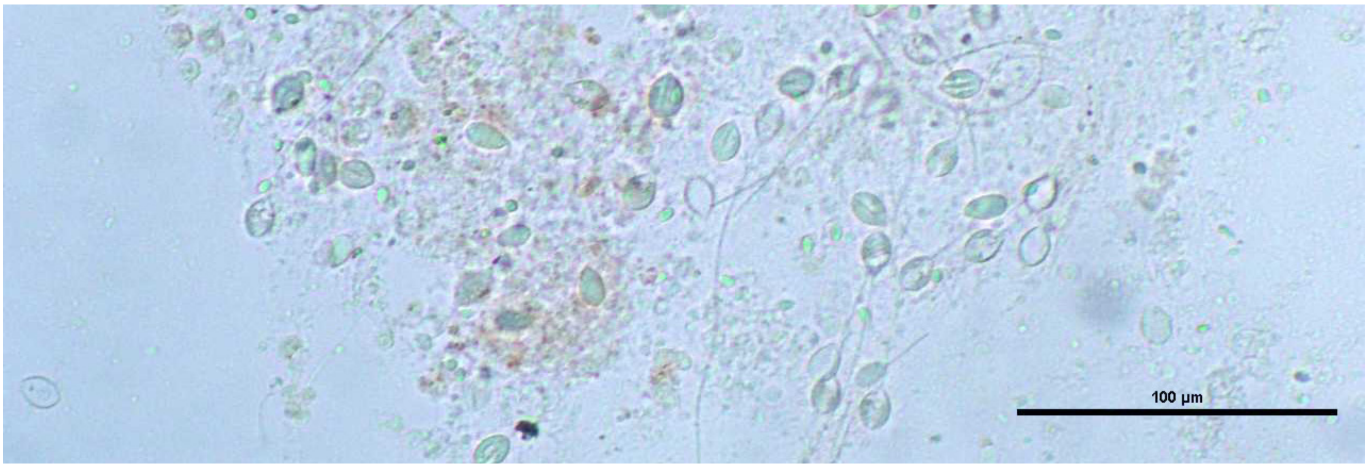


Image 2. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 20x objective. Scale bar: 100 microns.

Image 3. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 20x objective. Scale bar: 100 microns.

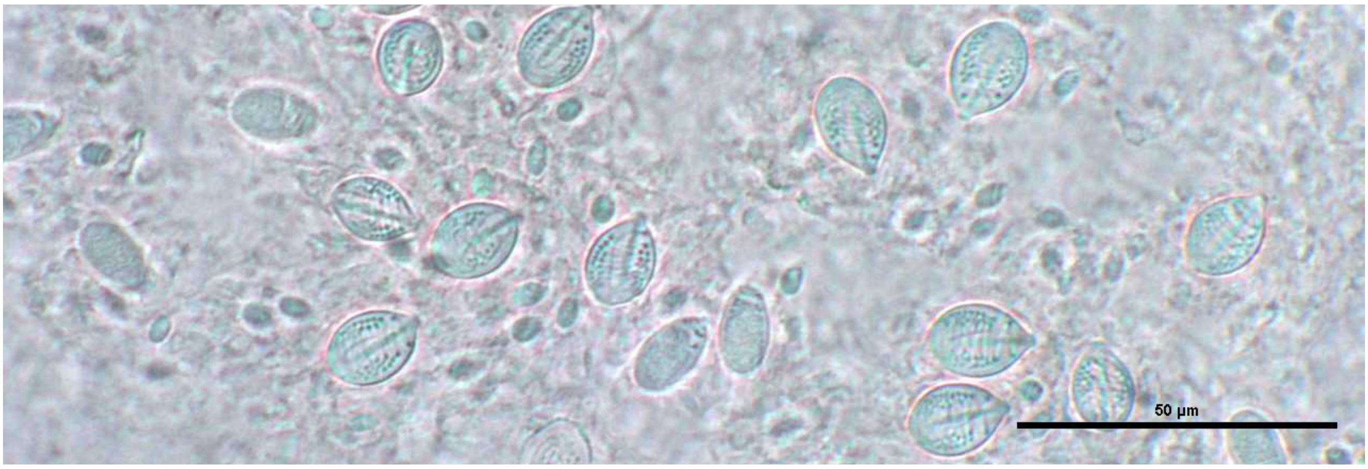


Image 4. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 40x objective. Scale bar: 50 microns.

Image 5. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 40x objective. Scale bar: 50 microns.

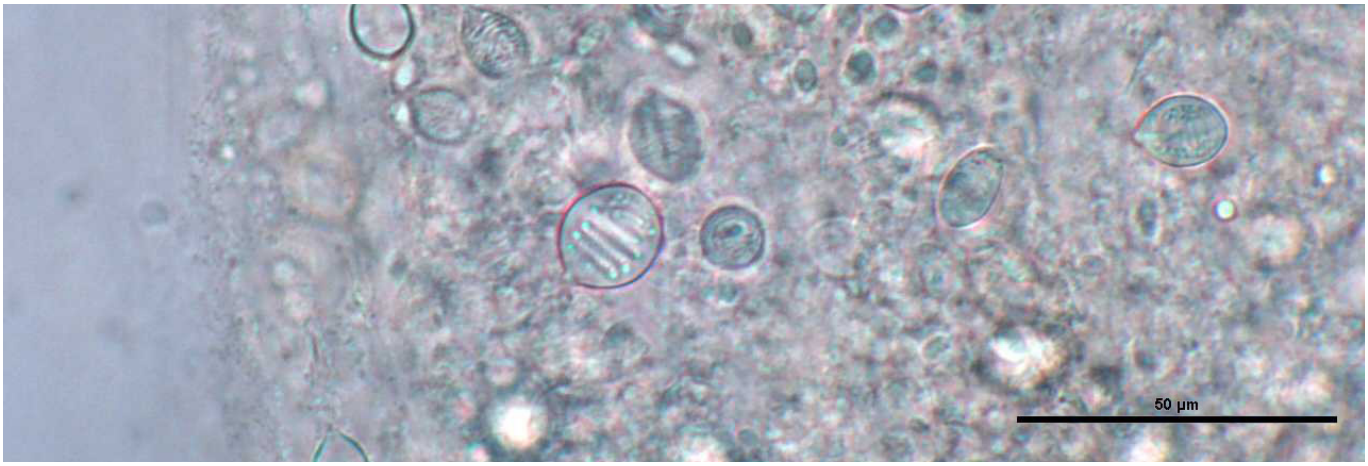


Image 6. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 40x objective. Scale bar: 50 microns.

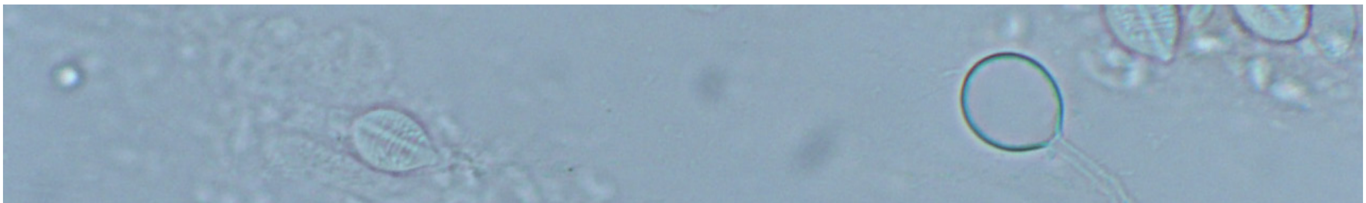


Image 7. Nematocysts from *Pelagia noctiluca* (mauve stinger) tentacles. 40x objective. Scale bar: 50 microns.

There are at least 30 different types of nematocysts, with varying shapes and arrangements of spines. Why do you think there are so many different kinds of nematocysts?

Hint: think about how different kinds of cnidarians might use nematocysts in different ways.

Does viewing nematocysts up close change how you think about jellyfish or jellyfish stings? Why or why not?

This resource was developed by the the Queensland Museum, with an illustration from the Exploring Our Fluid Earth program. The Exploring Our Fluid Earth program is a product of the Curriculum Research & Development Group (CRDG) of the University of Hawaii.