WHAT'S THE BIOBUZZ?

A journal for students by students

How do Cuttlefish Use Camouflage to Trick Predators?

Key Terms

Cephalopod:
A group of marine invertebrates that include octopus, cuttlefish, and squids; Can camouflage themselves against virtually any background

Invertebrate:
Animals that do not have a backbone/spine

Camouflage:
The ability to blend into their surroundings; Often used to hide from predators

Chromatophore:
Cells that contain pigment (color) and can reflect light.

Motor neuron:
A brain cell that helps control muscle movement

Uniform (pattern): Not a lot of variation

Mottle (pattern): Light and dark patches; some pattern repetition

Disruptive (pattern): Different shaped light and dark patches; high contrast

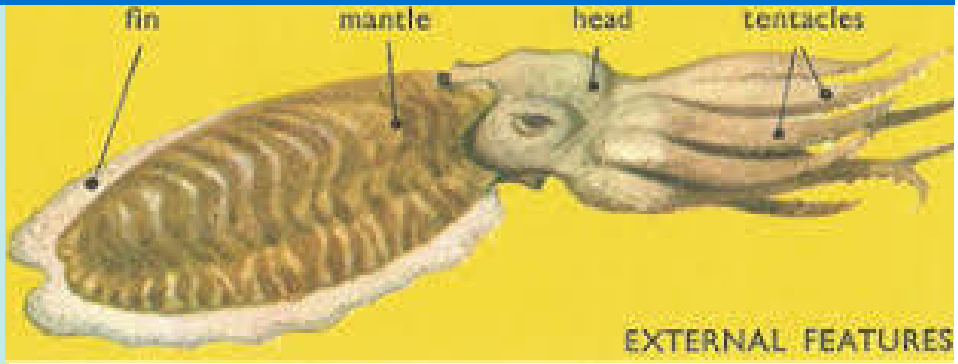


Figure 1: A diagram showing the external features of a cuttlefish including the fin, mantle, head, and tentacles.

ABSTRACT

Do you think that chameleons are the the masters of camouflage? Well, think again. **Cephalopods**, a group of marine **invertebrates** that include octopus, cuttlefish, and squids, can **camouflage** themselves against virtually any background. This ability to camouflage is possible because of complex visual systems that allow Cephalopods to quickly assess their environment and produce the correct motor response that leads to camouflage.

In this study, researchers categorized camouflage patterns into three broad categories after years of study using Cephalopods. They used European cuttlefish, a good model organism, to test their hypothesis that all camouflage patterns in animals would fall into these three categories. After multiple experiments using their own virtual backgrounds, the researchers found evidence for their hypothesis, showing how a complex trick like camouflage can come from three simple patterns.

WHAT MAKES CEPHALOPODS DIFFERENT?

- Cephalopods have good vision and special skin with a nervous system that allows for quick change and adaptation.
- They don't need to depend on timing, right lighting, or hormones like other animals with camouflage abilities such as the more common chameleons.

Why European Cuttlefish?

They are good model organisms because they are well-adapted to lab environments. They are also already predisposed to camouflage themselves against any background because they are preyed upon by almost all major carnivores in the ocean.

THE CAMOUFLAGE TECHNIQUE

There are three features of cephalopod camouflage:

- the background doesn't have to match completely
- they change quickly
- camouflage is possible from both visual and physical features of the cephalopods.

Quick visual change is possible because of special structures called **chromatophores** which cephalopods control with their brain. These are sacs of pigment (color) with muscles attached around the side. Each muscle has a **motor neuron** connected to it, and when the neuron gets excited, the muscle contracts and the color in the sacs spreads farther across the skin (**Figure 2**). Cephalopods also have structures on their skin that are activated by visual signals.

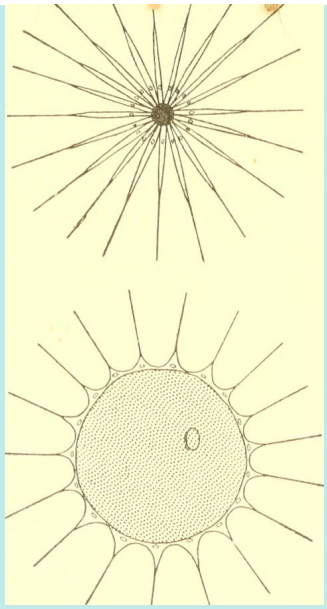


Figure 2: An image of a chromatophore at rest vs when it is expanded.

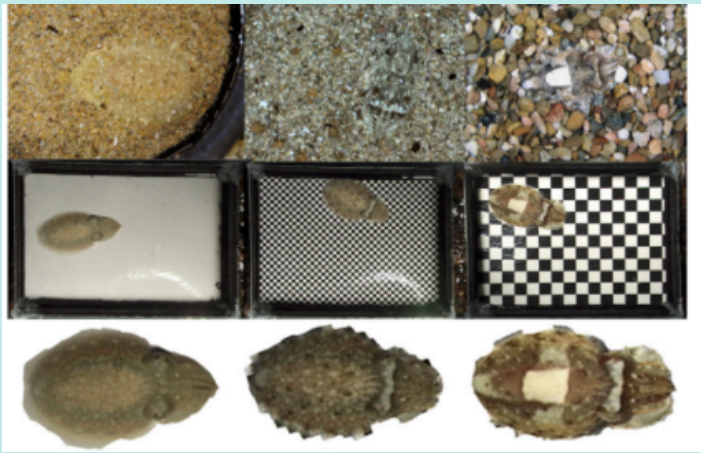
THREE TYPES OF PATTERNS

Scientists have gathered about 5000 pictures of animals of different species and divided camouflage patterns into three categories:

- **Uniform**: Not a lot of variation in the pattern of the skin; smooth appearance
- **Mottle**: Light and dark patches; some pattern repetition on skin surface
- **Disruptive**: Different shaped light and dark patches; high contrast among patches

Studying these patterns using cuttlefish

- Scientists created 3 different checkered background from simple (left) to more complex (right) to mimic different sand environments
- Cuttlefish are placed in each background to see how they use their camouflaging skills
- Cuttlefish are magnified to see which pattern they used for each background: uniform, mottle or disruptive.



Uniform **Mottle** **Disruptive**

Figure 2: A visual driven experiment to test cuttlefish's sense of sight and camouflaging skills

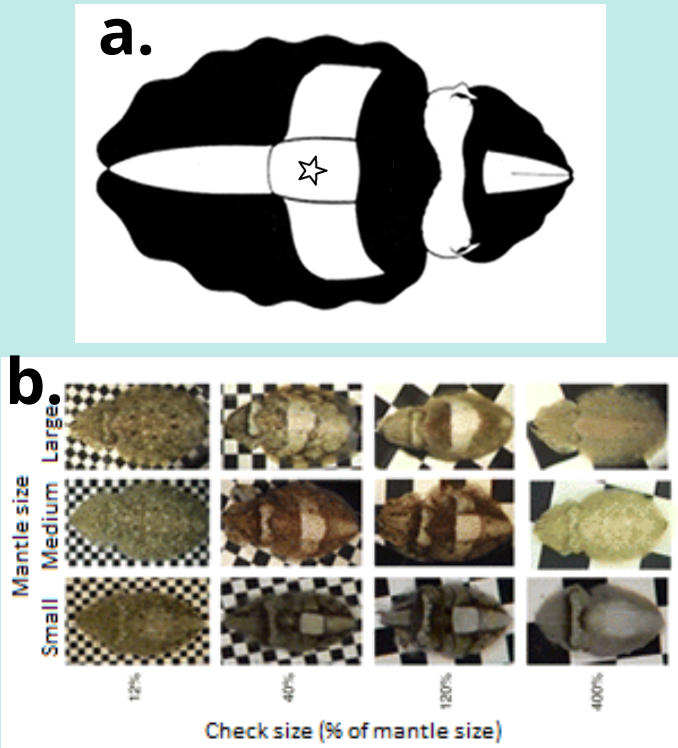


Figure 3: a. The star in **(a)** is used to mark the mantle of a cuttlefish. Cuttlefish use disruptive camouflage when their background checks are 40-120% their mantle size **(b)** (Barbosa et al. 2007).

RESULTS

- Majority of tests done in relation to camouflage in cuttlefish focused on disruptive patterns.
- Cuttlefish use their mantle size (white spot on their back that's actually a muscle) as a frame to match their surroundings.
- Cuttlefish use disruptive camouflaging when checks in a checkered pattern were 40-120% their mantle size (similar enough to their size).
- If the checkered patterns were a lot larger or smaller than their mantle, they used mottle or uniform patterns.

DISCUSSION

- Cuttlefish use neurons that stretch all the way to their skin, to change their pattern and camouflage with their surroundings instantly!!
- Cephalopods have three basic pattern classes for camouflage: uniform, mottle, and disruptive.
- The camouflaging tricks include differences in edges, shadows, outlines, and patterns which is also used in art and photography!
- Based on the results from this study, we can study more about predator and prey interactions both on land and water!

WHAT'S NEXT?

- Future studies on related marine species will push the need for new technology that can be used underwater like miniature computers!!
- We can further investigate the relationship between the cephalopods' environment and the features of the patterns that are used to achieve camouflage.
- Since we know how camouflage works in the water, how does it work on land? What are other ways that animals protect themselves from predators?

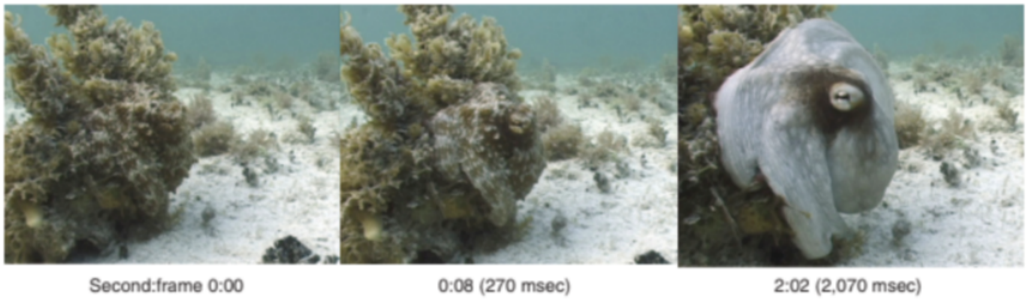


Figure 4. The *Octopus vulgaris* is an example of a cephalopod that is able to camaflouge to its surroundings in less than a second.

Adapted by Deena Haque, Dhara Salazar, and Natalia Santos from *Cephalopod Dynamic Camouflage* by Roger Hanlon, Current Biology, 2020.