

# Teaching Functional Morphology of Cephalopods During Summer Course

BY AYANO OMURA

## ABSTRACT

The need for marine education has increased in Japan, and recently, many marine education programs have emerged. Fishes are very popular with children; however, children are not familiar with cephalopods. There is little opportunity for children to observe marine life from the perspective of functional morphology; hence, we offered a lecture about the functional morphology of cephalopods. The lecture incorporated a presentation and the opportunity to observe body forms. During the observation, we used suckers and arms of squid and octopus. Squid and octopus have tentacles with different types of suckers. The morphology of the suckers is related to their function and ecology. The questionnaire we administered to evaluate the lecture revealed that it was varied for both children and parents, and helped them to understand the morphology of cephalopods.

## MOTIVATION

Japan is surrounded by water on all sides. Therefore, marine education is required to ensure sustainable resource use and environmental conservation (Kohno et al. 2016). Recently, the number of marine education programs has increased, particularly in aquariums. However, there is still little opportunity for children to receive easily understandable academic lectures.

To meet this need, we offered a lecture on marine life at the Gakushuin Sakura Academy, a lifelong learning institution associated with Gakushuin University. The lecture was hosted for parents and children during the summer. On this occasion, we emphasized the functional morphology of cephalopods. Functional morphology clarifies the function of cephalopod shape and how their form relates to ecology. The lecturer specializes in functional morphology and comparative anatomy of aquatic life (Endo et al. 2012; Omura et al. 2014; Omura 2014, Omura et al. 2015 a,b,c; Omura and Endo 2015). Therefore, to invite children to understand ecology by observing shape, we constructed courses from a functional morphological point of view.

Cephalopods are mollusks that are widely distributed in the sea and are also an important fishery resource. Children often observe fish but have little knowledge of cephalopods. Therefore, to introduce children to a wider variety of marine life, we offered a lecture about cephalopods.

In recent years, mollusks, such as squid, have been found to be well-suited for participatory education activities (Sasaki 2004). Squid are used for dissection in anatomical lectures. Observing a live squid is also possible because it is a familiar cuisine to most, and its blood is not red. According to these results, many countries offer anatomical lectures using squid, not only Japan. However, previous lectures have often only focused on memorizing anatomy. There has been little opportunity to think about its form and shape. Comparing the squid to other organisms is one method to understanding the features of the squid's shape.

Allowing real observation is important for understanding nature. When one learns nature, actual experiences are very important (Simizu 1975). However, it is difficult to have actual experiences in nature, especially for cephalopods. Thus, we keep a time for the observation as well as for the lecture. The observation and comparison of squid and octopus suckers during feeding improve students' understanding of the relationship between shape and function. The lecture following the observation of cephalopods shared this from a functional morphology perspective.

## PARTICIPANTS

The target of the course was elementary-aged students (6-8 years old) and their parents. There are many summer lectures for both children and parents in many lifelong learning institutions in Japan. Since the Gakushuin Sakura Academy runs the lectures for parents and children every summer, some learn about the course through visiting or reading about it in the academy's publications, while others have found out about it through the internet.

## THE SETTING OF THE COURSE

The course runs for 90 minutes total, with 30 minutes of lecture, 10 minutes for break, 30 minutes of observation, and 20 minutes for summary, questions, and answers. Then, we conduct a questionnaire. (Note that a typical lecture in an elementary school in Japan is 45 minutes long; thus, to keep the motivation of children, we had the break after the lecture.)

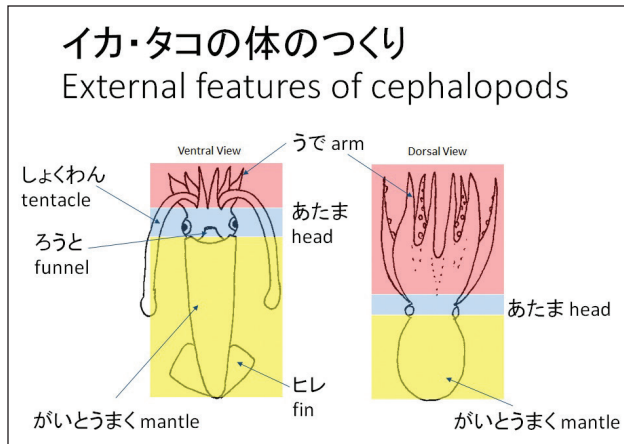


FIGURE 1. Morphological features of cephalopods. Courtesy of Ayano Omura

During lecture, we use PowerPoint slides that are suitable for showing figures, photos, and movies of cephalopods. Sometimes a blackboard is used together with slides for additional explanations and shared content.

### IMPLEMENTATION CONTENT

We focus on easily understandable content, including:

**External features:** We explain the basic system of external features. The basic system is shown in Figure 1. Since the position of the arms are connecting to a head, they are so called “tousokurui” in Japanese. “Tou” means head, and “soku” means legs (properly, arms). The character of cephalopods is often drawn with a face on the mantle with the funnel as a mouth.

**Locomotion:** As there is little opportunity to observe animated cephalopods, we show a movie of them in motion. Squid swim using jet propulsion and their funnel controls the direction of the water jet from the mantle. The speed of jet propulsion is dependent on the velocity of the water as it is expelled through the funnel (Nixon and Yonge 2003). Their fins act as a body balancer. Cuttlefish move slowly using their fins and funnel, and move rapidly by jet propulsion. Octopus also swim by jet propulsion or walk using muscular arms (Nixon and Yonge 2003). The octopus funnel controls the direction of the water jet from the mantle (Nixon and Yonge 2003).

**Body shape and swimming:** Animals have body shapes that are suitable for their habitats. Cephalopods also have various body shapes that allow them to adapt to their marine environment. Squid have a streamlined shape and swim

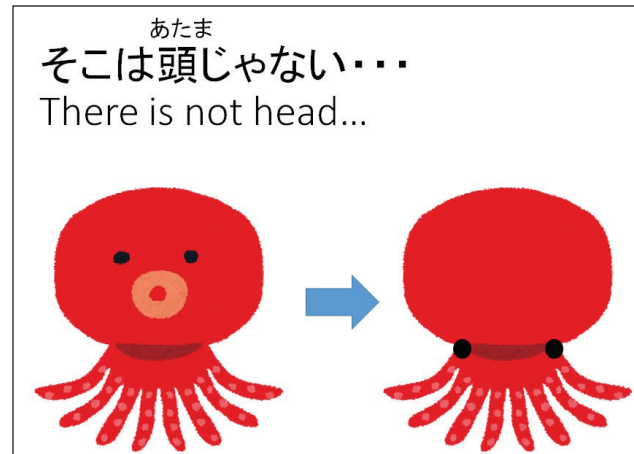


FIGURE 2. Body parts of octopus. Courtesy of IRASUTOYA

more frequently than the flat bodied cuttlefish. A streamlined body is suitable for fast swimming, as the shape offers less resistance in the water. In contrast, a flat shape is suitable for benthic life. Though there are some exceptions in the relationship between shape and swimming, the connection between body shape and swimming can be applied to many other aquatic animals as well (fish, crustaceans, etc.).

**Observation:** An observation of squid (*Todarodes pacificus*) suckers and octopus (*Octopus vulgaris*) arms was conducted. The arms of a squid and an octopus were placed in a petri dish and magnifying glasses and tweezers were distributed. After conducting the observation and sketching the external form, the basic features were explained.

Both catch prey with their arms (in case of decapodiformes, tentacles are mainly used). The squid sucker is divided into three regions: the infundibulum (funnel), acetabulum (cup), and the peduncle (stalk) (Santi and Graziadei 1957). The sucker has cuticular ring bearing spines. Due to the stalk structure, the sucker is said to be hard to detach from its prey even if it struggles to get away. Additionally, because of the spines on the cuticular ring, the struggling prey is hooked (Tuchiya 2015). Conversely, octopus suckers are made of muscles and resemble the suction cups that we place over glass surfaces. These are suitable for adhering strongly to the surface of prey.

### RESULTS

Prior to lecture, there were many children who knew the basic system of squids (10 out of 18 children), but many children (17 out of 18 children) recognized the octopus head as the mantle. The influence of deformed characters seemed



FIGURE 3A. The part of observation for cephalopods. Courtesy of Ayano Omura and IRASUTOYA

to stimulate children's desire for knowledge. There are many opportunities for them to show illustrations that are different from real octopus, whose head was the mantle of it. Children were quite surprised when talking about the basic system.

During the observation of a cephalopod's suckers, children used a magnifying glass and examined the suckers more carefully. When comparing squid and octopus suckers, many children noticed and discussed that squid suckers have a cuticular ring with a spine. It seemed that the peduncle (stalk) was hard to find. However, after the instructor reorganized their messaging, many children were able to observe. It seemed children understood the relationship between shape and function by describing how they caught their prey.

According to the children's questionnaire, there were many responses (14 out of 18 children) that reported it was the first time they had observed the structure of a cephalopod's body. They also noted that the relationship between shape and function was understood. A total of 17 out of 18 children answered that it was very easy or easy to understand, and 17 out of 18 children enjoyed the lecture and had fun answering the questions. Meanwhile, in the questionnaire for parents, 15 out of 18 adults answered that the lecture was easy to understand and they enjoyed it. Some also enjoyed discovering the basic structure and the functional morphology of the sucker. One requested an anatomical dissection of the internal structure for a future lecture.

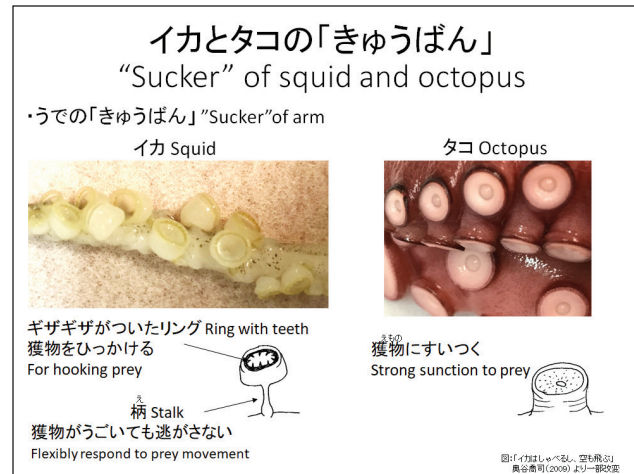


FIGURE 3B. Suckers of squid and octopus. Courtesy of Ayano Omura

## CONCLUSION

The course focused on the functional morphology of cephalopods, which was a useful educational learning experience for the children. Although cephalopods are often seen in the food market, there is little opportunity to observe living cephalopods. According to the questionnaire responses provided by the children, it seemed the body structure and functional morphology of cephalopods was an interesting part of the lecture. This lecture was given on an external form, but next time we would like to devise teaching materials on the internal anatomical form.

## ACKNOWLEDGEMENTS

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## REFERENCES

- Endo, H., A. Omura, T. Sakai, T. Itou, H. Koie, H. Iwata, and Y. Abe. (2012). The differences of the functional-morphological strategy between the first and second dorsal fins of the living coelacanth (*Latimeria chalumnae*). *Japanese Journal of Zoo and Wildlife Med.*, 17(2): 79-86.
- Kohno, H., A. Yatabe, Y. Kase, and Y. Saito. (2016). Fish transparent specimens are effective in marine environmental education: Observing prey-predator relationships in coastal waters. *Journal of the Tokyo University of Marine Science and Technology*, 12: 4-11.
- Nixon, M., and J. Z. Yonge. (2003). *The Brains and Lives in Cephalopods*. Oxford University Press.

- Omura, Ayano, Anzai Wataru, and Endo Hideki. (2014). Functional and morphological variety in trunk muscles of Urodela. *Journal of Veterinary Medical Science*, 76(2): 159-167.
- Omura, Ayano, Ejima Ken-Ichiro, Honda Kazuya, Anzai Wataru, Taguchi Yuki, Koyabu Daisuke, and Endo Hideki. (2015). Locomotion pattern and trunk musculoskeletal architecture among Urodela. *Acta Zoologica*, 96(2): 225-235.
- Omura, Ayano, Anzai Wataru, Koyabu Daisuke, and Endo Hideki. (2015) Ontogenetic changes of trunk muscle structure in the Japanese black salamander (*Hynobius nigrescens*). *Journal of Veterinary Medical Science*, 77(8): 931-936.
- Omura, Ayano, Anzai Wataru, Koyabu Daisuke, and Endo Hideki. (2015). Positional strategy of trunk muscles among aquatic, semi-aquatic and terrestrial species in Urodela. *Journal of Veterinary Medical Science*, 77(9): 1043-1048.
- Omura, Ayano, and Endo Hideki. (2016). The functional-morphological adaptive strategy of digestive organs of decapodiform cephalopods. *Journal of Veterinary Medical Science*, 78 (1): 43-47.
- Omura, A. (2016). Dissection and observation of *penaeus monodon*: Approaches for the improvement of observation skills through sketching. *Bulletin of Teikyo University of Science*, 12: 155-160.
- Sakaki, T. (2008) Anatomy of the mollusca: *Sepia esculenta* (Cephalopoda: Sepidae), *Turbo cornutus* (Gastropoda: Turbinidae) and *Patinopecten yessoensis* (Bivalvia: Pectinidae). *Fossils*, (84): 86-95.
- Santi, P.A., and P.P.C. Graziadei. (1957). A light and electron microscope study of intra-epithelial putative mechanoreceptors in squid suckers, *Tissue and Cell*, 7(4); 689-702.
- Simizu, M. (2003). *Enhancing Observation: A Comparative Study of the Effects of Model-Making vs. Sketching*. Faculty of Education: Saitama University, 27: 179-186.
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