

## The Diverse Morphology of Decapodiform Cephalopods: A Summer Lecture

Ayano Omura <sup>1\*</sup> , Yuzuru Ikeda <sup>2</sup>

<sup>1</sup>Nihon University, College of Art, JAPAN

<sup>2</sup>University of the Ryukyus, JAPAN

\*Corresponding Author: [cuttlefish.ayano.o@gmail.com](mailto:cuttlefish.ayano.o@gmail.com)

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### ABSTRACT

Today, the need for marine education has been declared for the conservation of marine life and the marine environment. Understanding the diversity of marine life is essential, especially since there are many organisms that live in the sea. The first step in understanding biodiversity is to follow your interest in exploring many different kinds of life. However, there are many opportunities for marine life education centered on fish, but few on decapodiform cephalopod education. Decapodiforms are morphologically diverse. However, the squid is generally recognized as a decapodiform, and little recognition of other types of decapodiforms is expected in marine education. To teach marine biodiversity more effectively, it is necessary to raise awareness of decapodiform diversity. In this study, we conducted a summer course for children using many specimens of different decapodiform species to understand decapodiform diversity. In addition, in order to examine students' degree of recognition of decapodiform diversity, we asked students to draw decapodiform illustrations before and after the course. As expected, all participants drew a squid before the course. On the other hand, after the course, 58.3% of the students drew other decapodiform species. In the questionnaire survey about the course, more than 80% of students showed a high evaluation of impression and understanding. It seems that giving lectures on various types of decapodiforms is an effective way of raising awareness of decapodiform diversity.

**Keywords:** cephalopods, decapodiforms, marine biodiversity, hands-on, recognition

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### INTRODUCTION

In recent years, the extensive deterioration and pollution of the global marine ecosystem have become severe. To secure sustainable marine resources and preserve the marine environment, various measures have been taken, and the need for marine education for the next generation has been highlighted (Kohno, Yatabe, Kase, & Saito, 2016; A. Omura, 2019a, 2019b).

Hands-on experience is the most useful technique for learning natural sciences. In the hands-on courses that go to the sea, a high educational effect has been reported (Brinson, 2015; Jones, Chang, Carter, & Roden, 2019; Prokop & Fančovičová, 2016). However, many children do not have the opportunity to actively experience nature (Iwama & Hatogai, 2010). In addition, the current situation is that marine education is only directed toward a limited number of students. Therefore, courses at lifelong learning institutions are very important for providing marine education to a wide range of children (A. Omura, 2019a).

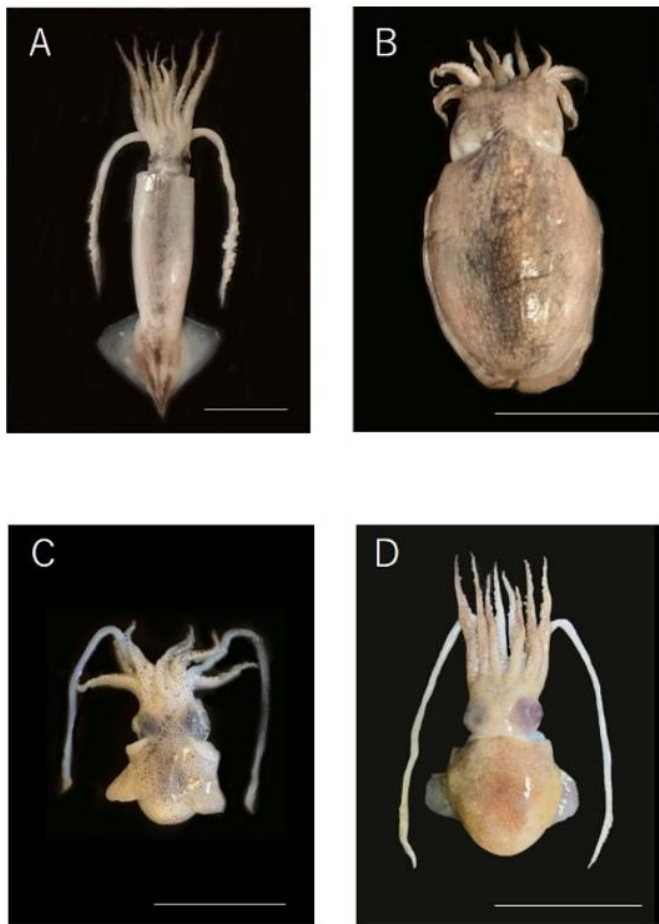
Understanding biodiversity begins with an interest in the existence and way of life of different organisms. There are many species in the marine ecosystem; members include not only by vertebrates but also

many invertebrates (Nixon & Young, 2003). However, recognition of vertebrate fish is overwhelmingly high, while invertebrates have a low rate of recognition in marine life education for children (Kishishita & Wada, 2014; A. Omura, 2019). Therefore, in marine education there is a strong need for lectures on marine invertebrates.

Decapodiform cephalopods are one of the major types of marine invertebrates, and they have an especially high locomotive ability, using the three dimensions of the marine water column unlike other marine invertebrates (Hanlon & Messenger, 2018; Nixon & Young, 2003). Many decapodiforms are important fisheries species for us (Okutani, 2010).

Superorder Decapodiforms is composed of 4 orders: Spirulida, Sepiida, Sepiolida, and Teuthida, in subclass Coleoidea, class Cephalopoda, and phylum Mollusca. However, looking at many illustration it seems that many people only recognize squid (external form: Teuthida) as decapodiforms (Nixon & Young, 2003). Therefore, it is crucial to determine the morphological and ecological diversity of decapodiforms in marine education programs.

For more effective learning, hands-on education that allows students to observe and touch things is beneficial in addition to comparatively passive lectures (Brinson, 2015). Recently, squid are



**Figure 1.** Specimens used in this lecture

A: *Todalodes pasificus*, B: *Sepia esqulenta*, C: *Euprymna morsei*, D: *Rossia pacifica*. Scale bar=5 cm.

often dissected as educational exercises to teach about decapodiforms (McGinnis, 2001). Omura (2019) reported that observation of the suckers of squids and octopus instead of the dissection has a high educational effect. However, many hands-on lessons about decapodiforms are often conducted using only squid, and this is not enough for students to understand decapodiform diversity.

Hence, to show children the diversity of decapodiforms, a summer lecture using a variety of decapodiform specimens was conducted. In addition, to clarify the educational effect, the change in the children's recognition of decapodiform diversity was surveyed.

## MATERIALS AND METHODS

### Location and Participants

The summer course for children (1-2 grades of elementary school students) was held in August 2019. We offered a lecture at the Gakushuin Sakura Academy, a lifelong learning institution attached to Gakushuin University, Japan. Because there were 12 participants, the course was given to 12 children.

### Lecture Contents and Survey

Specimens for observation used included (Figure 1) in order Teuthida (squid): *Todalodes pasificus* (Figure 1A); in Sepiida (cuttlefish): *Sepia esqulenta* (Figure 1B); and in Sepiolida (dumpling squid): *Euprymna morsei* (Figure 1C); and *Rossia pacifica* (Figure 1D); Although



**Figure 2.** The shell of the cuttlefish (*Sepia latimanus*)  
Scale bar=5 cm.

decapodiforms have no vertebrate, cuttlefish do have a hard shell. To understand the characteristics of the cuttlefish, the cuttlefish shell (*Sepia latimanus*) (Figure 2) was also used as an educational specimen.

Furthermore, Omura (2019) reported that the functional morphological viewpoint is useful for biological education. While showing the specimens, it was observed that the squid type swims quickly, the cuttlefish type is mainly benthic, and the dumpling squid type is good at burying itself in the sand. Then, the presentation of functional morphology and biology of observed specimens was conducted with slides and movies for children.

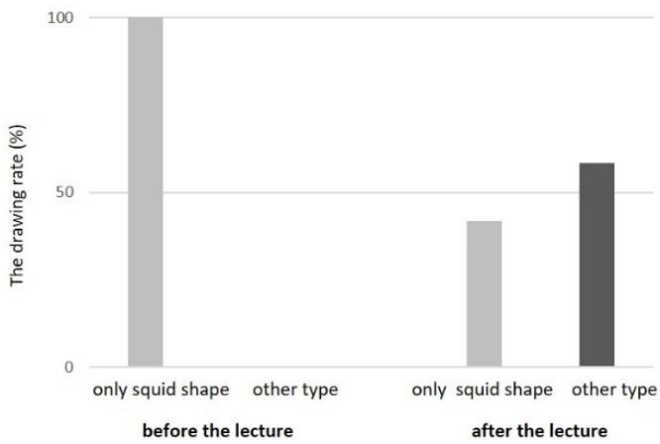
The survey of educational effects was collected from the children to investigate their degree of recognition and understanding of the morphological diversity of decapodiforms. It was expected that the children would use a squid shape to represent decapodiforms before the lecture. We asked students to draw a decapodiform cephalopod before and after the course. We compared the rate of squid-only illustrations to the rate of other decapodiform illustrations (cuttlefish, dumpling squid, etc.) before and after the course. Illustrations were judged as squid if the mantle was long and the ridges were triangular.

After the course, a questionnaire survey was conducted with a five-point evaluation of ease of understanding and enjoyment. In addition, the questionnaire form had a free description field for investigate the more detail impression and opinion for the lecture.

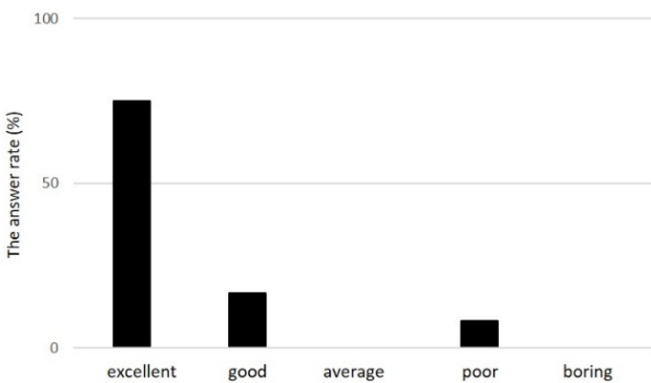
## RESULTS

Figure 3 shows the rates of different decapodiforms in the children's illustrations. Before the lecture, all students drew a squid to express decapodiforms (100%). In contrast, after the lecture, 41.7% (5 of 12 people) drew only a squid shape, while 58.3% (7 of 12 people) also drew other types of decapodiforms.

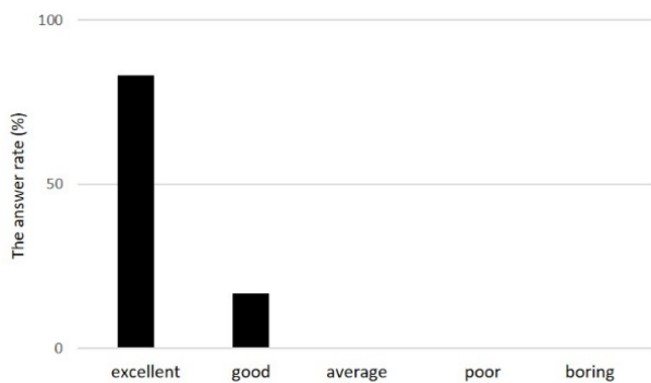
Figure 4 shows the responses to the questionnaire survey about impressions. According to survey answers about their impression of the course, 75% (9 of 12 people) answered that it was excellent, 16.7% (2 of 12 people) answered that it was good, and 8.3% (1 of 12 people) said that it was poor. Figure 5 shows the answer rate of the questionnaire survey on comprehension. Evaluating their comprehension of the various morphologies and the diversity of cephalopods, 83.3% (10 of 12 people) answered that it was excellent, and 16.7% (2 to 12 people) said it was good.



**Figure 3.** The rates of different decapodiforms in the children's illustrations



**Figure 4.** The answer rate of the questionnaire survey of the impression



**Figure 5.** The answer rate of the questionnaire survey of the comprehension

In the free description, representative answers include, "I learned that decapodiforms were not only composed of squids but also the cuttlefish and dumpling squid," "It was great that I got to see many rare specimens," "It was my first time observing rare cephalopods," and "It was fun to see the interesting external shape of the dumpling squid."

## DISCUSSION

Since all students drew a squid illustration to represent their understanding of decapodiforms before the course, the squid seems to be widely recognized as a decapodiform cephalopod. As expected, the recognition of decapodiform diversity was very low (Figure 3). However, as a result of explaining the various types of squid while

observing specimens and explaining their ecology, the number of children drawing other types of decapodiforms increased (Figure 3). It seems that their recognition of many types of decapodiforms was certainly increased.

Since there are so many different organisms living on the earth, it is crucial to recognize their existence. The many courses on fish mean that there are many opportunities to learn about fish diversity (Iwama, Hatogai, Matsubara, Yamagishi, & Shimojo, 2008). However, decapodiforms, which co-evolved with fish, have high motility for mollusks, and are critical to the food web, have very low public awareness despite being an important part of the ecosystem (Omura, 2019). Therefore, as shown in this study, a course that increases the recognition of various decapodiform types seems necessary.

It is said that using familiar things as teaching materials in order to spark students' interest is effective (Nozaki & Katayama, 2017; Shimada, 2009). However, showing only what the student has already seen or knows does not increase their knowledge. New knowledge increases what learners can recognize (Iwama, Matsubara, & Shimojo, 2008). For this reason, it is necessary to introduce things that are familiar to attract students, but it is also necessary to show new or unknown things actively.

In the questionnaire results, more than 80% showed a positive reaction to their understanding of new material and impression of the course (Figures 4 and 5). Even in the free description column, the statements "I saw it for the first time" and "It was fun to see for the first time" were conspicuous. It will be one of the challenges of educators education to show their first experience.

The reason why there are few educational opportunities on decapodiforms is that it is difficult to carry out dissemination activities (Omura, 2019), in addition to the difficulty of long-time rearing in the normal institution (Ikeda, Sakurazawa, Sakurai, & Matsumoto, 2003). In education, observation of the real thing is effective (Saijoh & Ohashi, 2018), but the number of possible species is limited. In this course, in addition to the observation of the immersion specimen, the lecture was given in combination with observing cuttlefish shells and using slides with moving pictures and photographs. Other marine organisms, such as fish, provide both two-dimensional and three-dimensional information (Hosoyama, 2012; Kamezaki & Nakamura, 2017; Kohno et al., 2016; Saiki, 2017). However, in the case of decapodiforms in particular, it may be important to teach this subject by using a variety of media.

In this study, we show an increasing recognition of the diversity of decapodiforms in elementary school students. Further study of methods for more effective educational marine programs collaborating with other institutions is needed.

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