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# Decapodiform cephalopods in focus: A case study on natural history illustration book creation

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**ABSTRACT**

Decapodiform cephalopods are ecologically significant marine animals known for their vivid coloration, complex behaviors, and key roles in trophic webs. Despite their importance, public recognition of these species in Japan remains limited. This study aims to enhance public awareness of decapodiform cephalopods by developing a science picture book that integrates narrative storytelling and natural history illustration as an educational tool. We conducted a case study in Japan involving the creation of a picture book based on a multidisciplinary approach, including scientific literature review, morphological and behavioral observations of live specimens in aquariums, diving-based fieldwork in Okinawa, and detailed examination of preserved museum specimens. Additionally, we designed a supplementary poster illustrating 17 decapodiform species to visually communicate their morphological diversity. Feedback from readers, including educators and museum visitors, indicated that the book was effective in increasing engagement and improving understanding of cephalopod ecology. The poster further supported species recognition and interest in marine biodiversity. Our findings underscore the potential of interdisciplinary collaboration among researchers, illustrators, museums, and aquariums in developing educational materials, and demonstrate the effectiveness of illustrated science communication in promoting marine ecological literacy.

**Keywords:** cuttlefish, decapodiform cephalopods, natural history illustration, picture book

## INTRODUCTION

Decapodiform cephalopods are considered a charismatic animal group due to their colorful appearances, complex behaviors, and overall strangeness (Hanlon et al., 2018). During the evolution of them from shelled mollusks, most species discarded the shell covering their bodies to increase their mobility. From this change, decapodiform cephalopods show the highest mobility among mollusks and use various modes of locomotion and demonstrate co-evolution with fish (Hanlon & Messenger, 2018). They occupy diverse marine ecological niches and have successfully exploited most available ocean habitats as fish do (Nixon & Young, 2003; Omura et al., 2022). In addition, decapodiform cephalopods are widely recognized as playing a pivotal role in ocean food chains, both as predators and prey (Boyle & Rodhouse, 2005; Clarke, 1996; Piatkowski et al., 2001). Therefore they are known to play an important ecological role in marine trophic webs and many species are commonly defined as “keystone” species due to their strong influence on ecosystem dynamics (Xavier et al., 2015). Their importance in global fisheries has also been increasing steadily, and it is likely that more species will be commercially exploited in the future (Jereb & Roper, 2005).

Despite decapodiform cephalopods being such interesting and important organisms, there is a gap in the public understanding and education of marine creatures. The awareness of decapodiform cephalopods is low in Japan compared to other marine creatures. Surveys conducted on children’s awareness of marine organisms show that vertebrate fish have overwhelmingly high recognition, while invertebrates, including decapodiform cephalopods, are less recognized (Omura, 2019). To properly understand marine biodiversity, it is important to have knowledge of and to be interested in various creatures. Therefore, it is crucial to raise awareness of decapodiform cephalopods in marine biology education.

Among the diverse range of biological educational materials, the usefulness of science picture books has long been recognized (ex, Mantzicopoulos & Patrick, 2011; Omura et al., 2025; Yun & Lee, 2015). Scientific picture books serve as an excellent example of the integration of science and art through narrative storytelling. Since the color schemes and the allure of images can have an effect on humans, visualization and artistic beauty in educational contexts are important (Gilbert & Stocklmayer, 2012). In


**Figure 1.** (A) The fish market in Nago, Okinawa, Japan & (B) broadclub cuttlefish sold in the fish market in Nago, Okinawa, Japan(Source: Field study)

particular, natural history illustrations can offer unique advantages. Unlike photographs, which simply capture the subject it is, natural history illustration can easily convey the creator's specific intention or explanation (Orihara, 2015).

Moreover, storytelling can enhance the educational value of educational materials (Negrete & Lartigue, 2004). However, there are few picture books about decapodiform cephalopods in Japan.

In light of this, this report aims to contribute to marine education through a case study on the creation of a scientific picture book about decapodiform cephalopods.

This project aligns with the "Kagaku no Tomo," a monthly series by Fukuinkan Shoten Publishers in Japan, which aims to inspire curiosity about science in children aged 4-6. This report discusses

(1) the process of creating a science picture book and

(2) feedback from readers and discusses the effectiveness of science picture books as tools for marine education.

## CREATING A PICTURE BOOK

### Choosing the Characters

Since the book is intended for Japanese readers, we selected a species of cuttlefish that is found in the waters around Japan. Although Japan is a habitat to many kinds of decapodiform cephalopods, we chose the broadclub cuttlefish (*ascarosepion latimanus*) as the main character for the following reasons:

1. It resides in coral reefs.
2. It is the second largest in the world.
3. It is commonly displayed in aquariums and is popular among divers.
4. 4.It is commercially fished, making it a familiar species.

Additionally, in Japan, only squid is primarily recognized as decapodiform cephalopods, so it is important to communicate that cuttlefish are also a type of decapodiform cephalopods. The main character we meet at the beginning of the story is a male broadclub cuttlefish, and later on in the story he encounters a female of the same species.

### Literature Review

To support our investigation of the broadclub cuttlefish, we reviewed key scientific literature covering its ecology, behavior, taxonomy, and morphology. These sources provided the foundation for the subsequent morphological analysis and behavioral observations conducted in field and aquarium settings.

Relevant literature on ecology and behavior includes Corner and Moore (1980), Okutani (2015), Pratasik et al. (2017), and Hanlon and Messenger (2018). For taxonomy and morphology, we referred to Nixon and Young (2003), Jereb and Roper (2005), Okutani (2015), and Omura and Ikeda (2022).

A detailed summary and application of these references are presented in the following sections: understanding morphology and field and aquarium research: habitat and behavior.

### Understanding Morphology

To accurately depict the structure of the broadclub cuttlefish, we acquired a fresh specimen from the fish market in Nago, Okinawa (**Figure 1**). Also we observed the fixed specimens of broadclub cuttlefish stored in the Natural History Museum, London. We observed these specimens with reference to the literature for the purpose of creating illustrations.

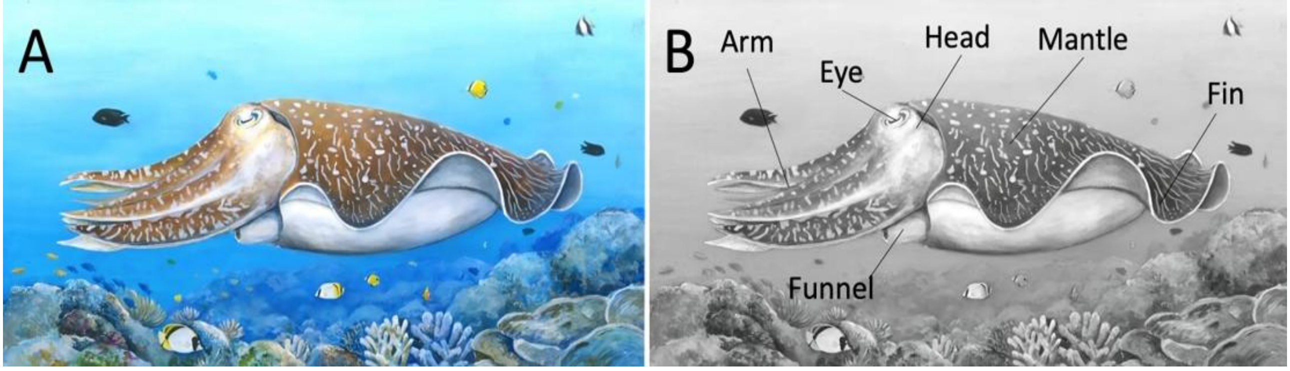


**Figure 2.** (A) The images of the picture book of the broadclub cuttlefish & (B) the explanation of body parts of the broadclub cuttlefish (Omura, 2022)

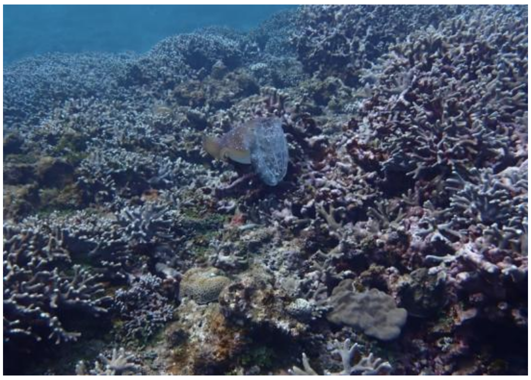

**Figure 3.** An image of a coral reef with a broadclub cuttlefish in Okinawa (Source: Field study)

#### *Basic body structure of cuttlefish*

When illustrating an organism, it is essential to understand its basic body structure and taxonomic characteristics.

The basic body plan of cuttlefish adheres to the fundamental structure of cephalopods. "Cephalopod" literally means "head-foot" in Greek, referring to the fact that the head connects to the numerous arms. The body is divided into the mantle, head, and arms, with the digestive and reproductive organs and gills located within the mantle. The ventral side features a funnel that expels water, providing propulsion and enabling directional changes during swimming. Cuttlefish have large fins, which they use to enhance their swimming ability by undulating them (**Figure 2**). They possess eight arms and two long tentacles. The mouth is located in the center at the base of the arms, equipped with a beak used for tearing food (Jereb & Roper, 2005; Nixon & Young, 2003; Okutani, 2015).

#### *Morphological characteristics of the broadclub cuttlefish*

Several morphological features distinguish broadclub cuttlefish from other cephalopod species. The following details (Jereb & Roper, 2005; Okutani, 2015) are included in the illustrations for the picture book: The mantle is oval in shape. The club is crescent-shaped with a flattened surface bearing 5 to 6 suckers arranged in transverse rows (Omura & Ikeda, 2022). The suckers vary significantly in size, with some being enlarged. The dorsal mantle is covered with numerous large papillae and has elongated papillae along each side, located near the base of each fin. The arms exhibit longitudinal white bands along their margins, appearing as broad white blotches when extended. Arms I to III feature broad, longitudinal brownish bands in the center that extend onto the head. The dorsal mantle displays a transverse saddle mark, small white and brown spots, narrow brown transverse bands, and bold white transverse stripes and spots. These patterns vary, with the saddle mark appearing occasionally. Males show transverse stripes during the breeding season. The eyes typically have yellow margins on the ventral side in live specimens. The fins are pale, adorned with white transverse stripes that extend onto the mantle and a narrow white band along the outer margin (Jereb & Roper, 2005; Okutani, 2015).

### Field and Aquarium Research: Habitat and Behavior

To effectively illustrate the cuttlefish's life in the ocean, it was necessary to correctly depict its marine habitat. During the spawning season, broadclub cuttlefish gather around coral to mate and lay eggs (Corner & Moore, 1980; Pratasik et al., 2017). Therefore, we conducted dives in Okinawa from February to April 2020 and 2021, capturing videos and still images of broadclub cuttlefish in their natural environment (**Figure 3**). To document hunting and escape scenes, we also dived in sandy areas, rich in prey organisms and in drop-off (steep slope or cliff that descends sharply from shallow to much deeper areas) where the broadclub cuttlefish's predators are commonly found. We photographed these backgrounds for reference. In addition, we observed captive broadclub cuttlefish at the Okinawa Churaumi Aquarium Japan allowing us to capture detailed images that are difficult to obtain in a natural field environment.

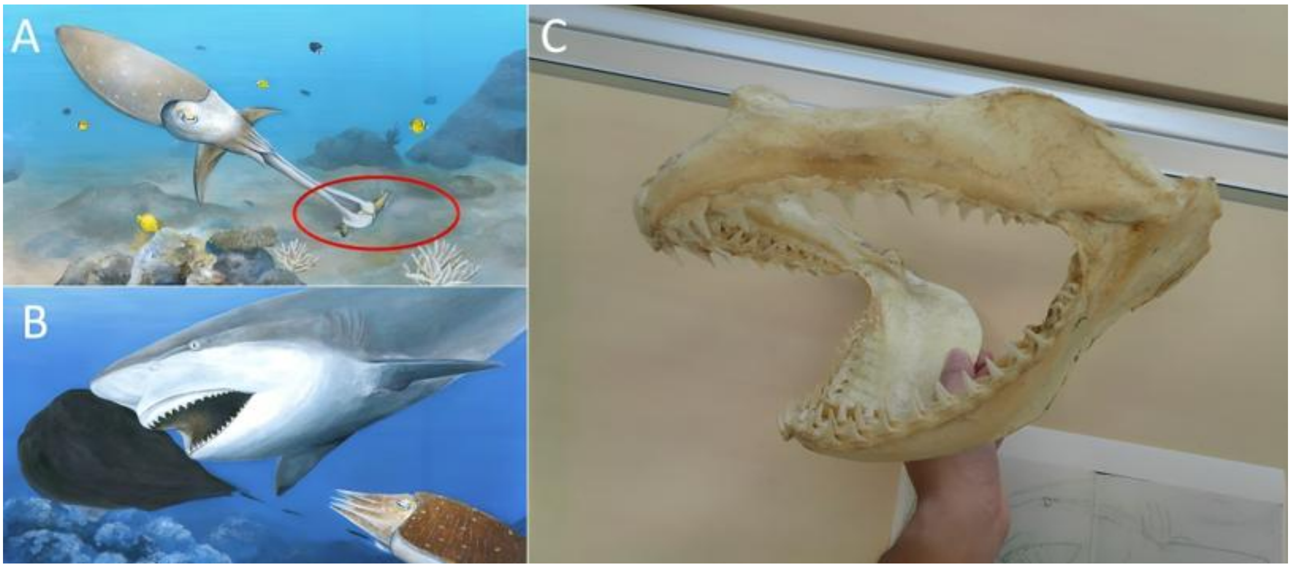


**Figure 4.** (A) The image of the hunting scene of the picture book (the broadclub cuttlefish catches a shrimp), (B) the images of escape scene of the picture book (the broadclub cuttlefish escapes from the blacktip shark using inking), & (C) the skeletal specimen of blacktip shark (Omura, 2022)

## Choosing Supporting Characters

### *Prey for hunting scenes*

Cuttlefish are opportunistic predators and feed on a wide range of prey, such as fish, crustaceans and other marine invertebrates, with crustaceans being their primary food source (Hanlon & Messenger, 2018). We chose the western king prawn (*melicertus latisulcatus*) as a representative prey species, which is commonly found in the sandy habitats of coral reefs where broadclub cuttlefish reside (part A in **Figure 4**).

### *Predator for escape scenes*

When threatened by predators, cuttlefish escape by inking. To illustrate this escape scene, we needed to select a predator. Cuttlefish are preyed upon by a variety of carnivorous animals, including various fish species and other cephalopods, depending on their size. Since the main character is an adult broadclub cuttlefish, whose mantle length is 50 cm (Okutani, 2015), it also has larger predators such as sharks. Reports from fishermen and ichthyologists (personal communication with ichthyologist Senoh in 2020) indicate that broadclub cuttlefish in fisheries have been found with shark bite marks. Reports from fishermen and ichthyologists (personal communication with ichthyologist Senoh in 2020) indicate that broadclub cuttlefish in fisheries have been found with shark bite marks. Therefore, we chose the blacktip shark (*carcharhinus limbatus*) as the broadclub cuttlefish's predator for this book (part B in **Figure 4**). As there are few existing images of the blacktip shark with its mouth open, we created an illustration based on the observation of skeletal specimens (part C in **Figure 4**) and fixed specimens, under the guidance of a shark researcher.

## Thumbnail and Story Creation

Based on the literature, we crafted the story and created thumbnails to allocate page layouts. The general flow of the story is as follows:

- p. 1: Introduction of a male broadclub cuttlefish in a coral reef
- p. 2-3: Explanation of basic body structure and swimming methods
- p. 4-7: Hunting prey and extending tentacles
- p. 8: Eating prey, by holding it in its eight arms
- p. 9: Explanation of the structure and location of broadclub cuttlefish's mouth
- p. 10-13: Escaping from a shark by inking
- p. 14-17: Finding a female cuttlefish, fleeing from rival males
- p. 18-19: Mating behavior
- p. 20-21: Laying eggs
- p. 22-23: Embryonic development from fertilization to hatching
- p. 24-25: Hatching
- p. 26-27: Various behaviors of young cuttlefish
- p. 28: Epilogue

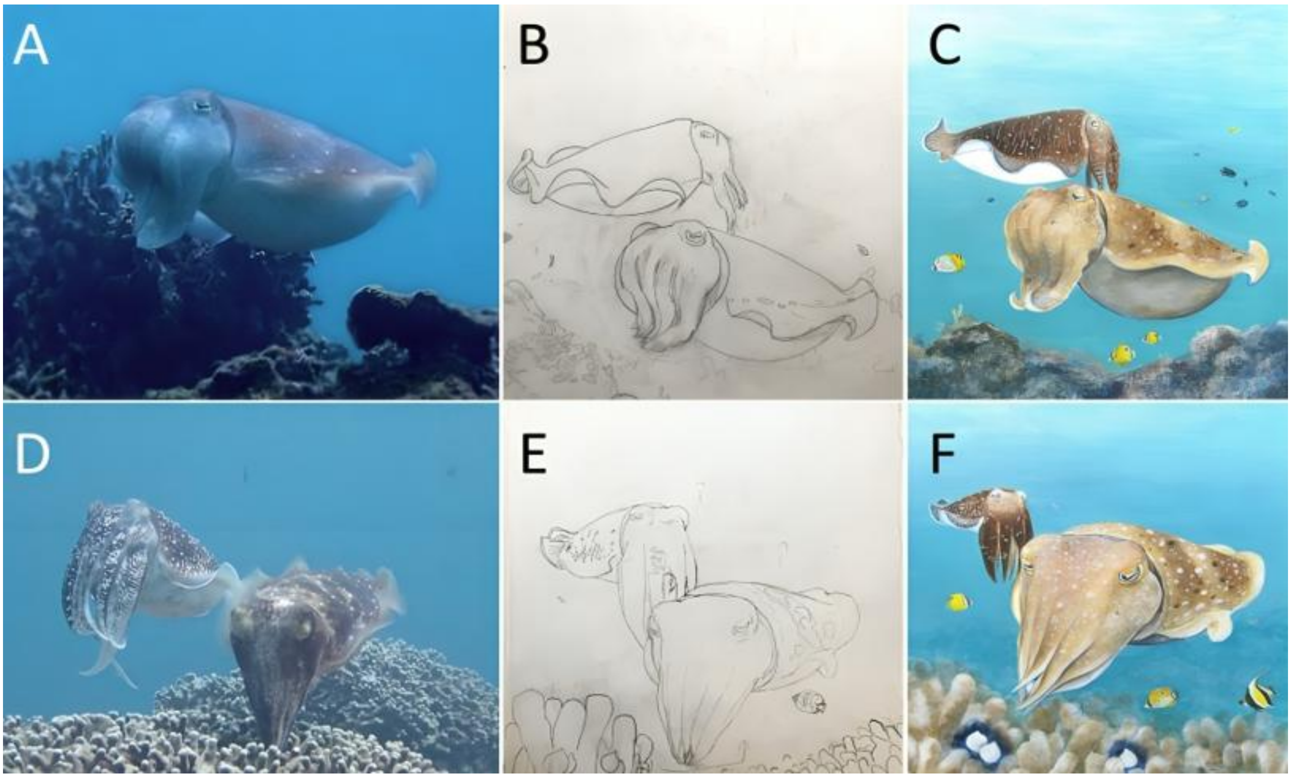


**Figure 5.** The images of underwater photos (A, D), line drawings (B, E), and color paintings(C, F) of the picture book: A-C: the female broadclub cuttlefish shrinks her arms before laying eggs & D-F: the female broadclub cuttlefish lay eggs in the coral reef being while being watched over by the male broadclub cuttlefish (Omura, 2022)

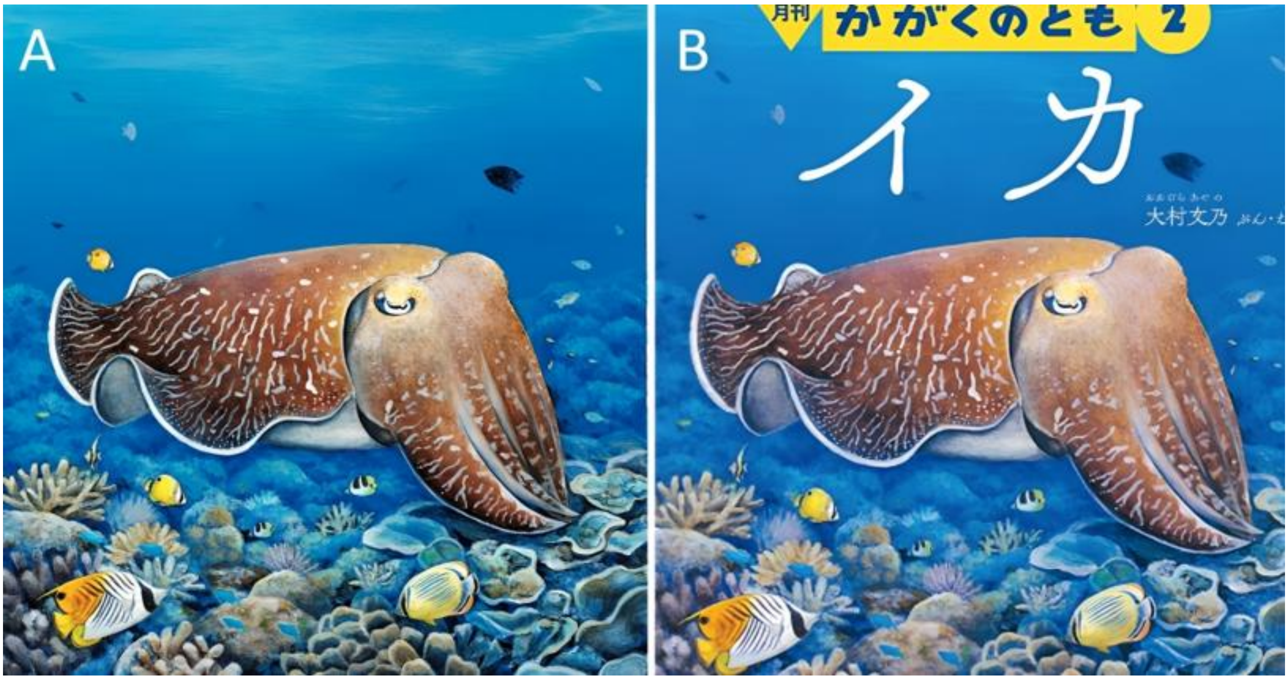


**Figure 6.** Text insertion in the picture book: (A) the cover image of colour painting & (B) the cover image of the picture book after text insertion (Omura, 2022)

### Drawing and Painting Production

Based on the materials given before, we created the illustrations according to the thumbnails and story layout established. The illustrations for this picture book were painted using acrylic on canvas board (**Figure 5**).

### Text Insertion and Color Proofing

We digitized the paintings by photographing them and incorporated the text. After printing the digitized images, we adjusted the colors. Following proofreading, the picture book was completed (**Figure 6**).

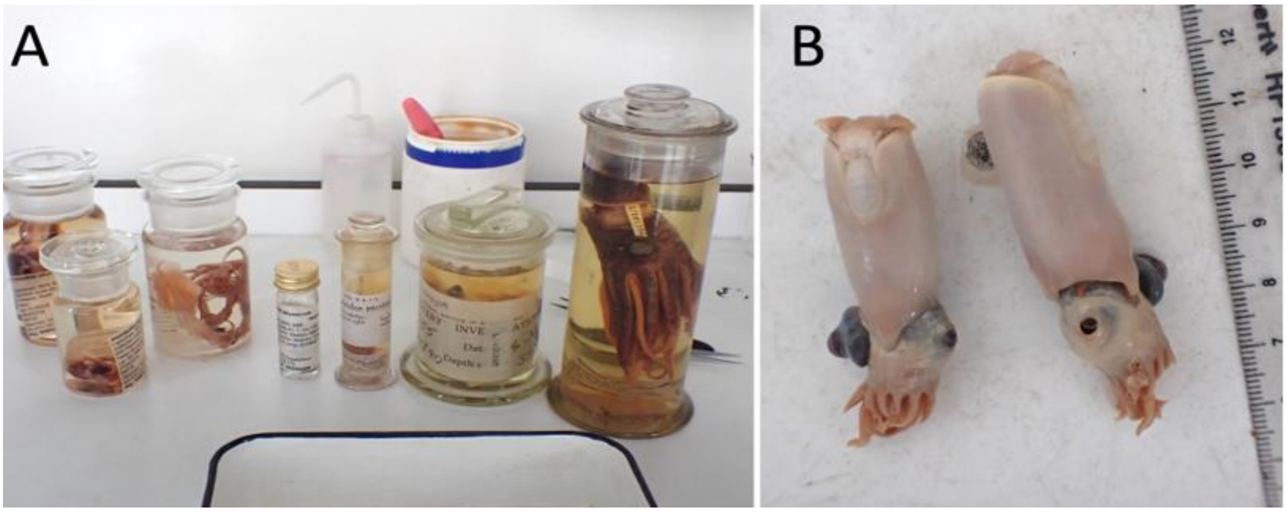


**Figure 1.** Specimens of various decapodiform cephalopods of the Natural History Museum, London used for a supplementary poster: (A) some decapodiform cephalopod's specimens fixed and preserved in the 70% ethanol & (B) ram's horn squid (spirula spirula) specimens stored in the Natural History Museum, London (Source: Field study)

## SUPPLEMENTARY POSTER PRODUCTION

The picture book includes a supplementary poster to deepen readers' understanding of decapodiform cephalopods. While the book itself only introduces broadclub cuttlefish, the poster features illustrations of various decapodiform cephalopods' morphologies to showcase their diversity.

To introduce unusual cuttlefish from around the world, we observed specimens at the Natural History Museum London, which houses many specimens from various countries. The museum has one of the largest collections globally, including numerous types of fixed specimens (**Figure 7**).

The poster features 17 species of painted decapodiform cephalopods: rounded disc-fin squid (*discoteuthis discus)*, striped pyjama squid (*sepioloidea lineolate*), umbrella squid (*histioteuthis bonnellii*), giant squid (*architeuthis dux*), long-armed squid (*chiroteuthis veranii*), giant cuttlefish (*ascarosepion apama*), ram's horn squid (*spirula spirula*), whip-lash squid (*xhiroteuthis picteti*), northern pygmy squid (*idiosepius paradoxus*), bigfin reef squid (*sepioteuthis lessoniana*), butterfly bobtail squid (*stoloteuthis leucopte*), joubin's squid (*joubiniteuthis portieri*), glass squid (*cranchia scabra*), paintpot cuttlefish (*ascarosepion tullbergi*), bigfin warrior squid (*promachoteuthis sloani*), comb-finned squid (*chtenopteryx sicula*), and dana octopus squid (*taningia danae*) showing the variation of color, shape (**Figure 8**).

## FEEDBACK FROM READERS

There were 16 positive comments and 2 negative/suggestive comments on Twitter and 3 positive comments received directly from the publisher. Reader feedback was collected over six month following the book's publication.

– **Increasing scientific knowledge and interest**

Eleven positive comments addressed the increase in scientific knowledge and interest. Feedback included:

- "The ecology of broadclub cuttlefish is easy to understand–hunting, inking, egg-laying, etc."
- "I've grown to love broadclub cuttlefish after reading this book."
- "I learned that there are many different shapes of decapodiform cephalopods."

– **Overall appeal of the story**

Ten positive comments pertained to the overall appeal of the story. Feedback included:

- "Despite the detailed explanations, it's easy to read aloud to children."
- "My child happily read it multiple times."
- "It was really enjoyable."

– **Impression of the Illustrations**

Fifteen positive comments focused on the illustrations. Feedback included:

- "The poster of the world's decapodiform cephalopods is excellent."
- "The cover design is one I want to display."
- "I loved the large depiction of the cuttelfish's mouth."

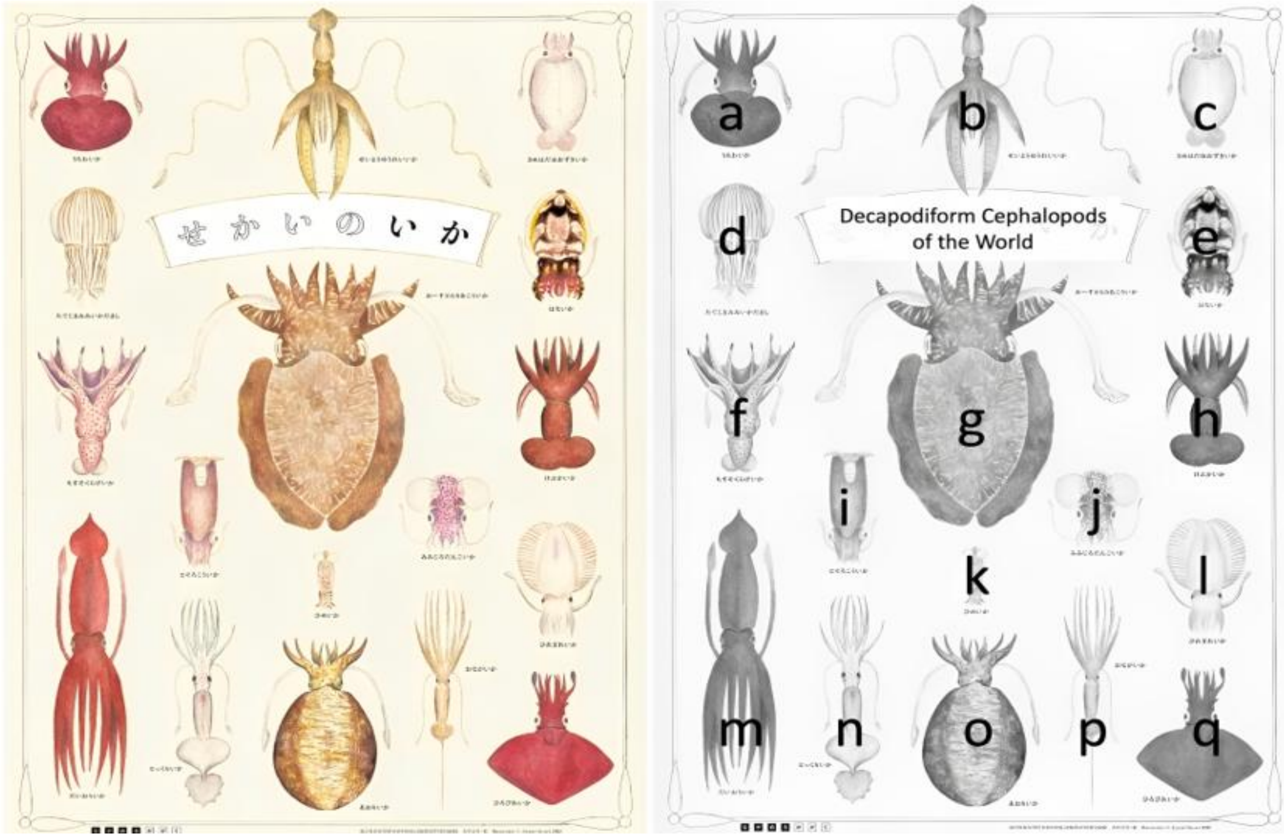


**Figure 8.** The image of the supplementary poster showing 17 species of decapodiform cephalopods. a. rounded disc-fin squid (*discoteuthis discus*), b. striped pyjama squid (*sepioloidea lineolate*), c. umbrella squid (*histioteuthis bonnellii*), d. giant squid (*architeuthis dux*), e. long-armed squid (*chiroteuthis veranii*), f. giant cuttlefish (*ascarosepion apama*), g. ram's horn squid (*spirula spirula*), h. whip-lash squid (*chiroteuthis picteti*), i. northern pygmy squid (*idiosepius paradoxus*), j. bigfin reef squid (*sepioteuthis lessoniana*), k. butterfly bobtail squid (*stoloteuthis leucopte*), l. joubin's squid (*joubiniteuthis portieri*), m. glass squid (*cranchia scabra*), n. paintpot cuttlefish (*ascarosepion tullbergi*), o. bigfin warrior squid (*promachoteuthis sloani*), p. comb-finned squid (*chtenopteryx sicula*), & q. dana octopus squid (*taningia danae*) (Omura, 2022)

– **To improve/negative**

Two negative/suggestive positive comments. Feedback included:

- "I'd like to see an anatomical diagram showing what's inside the cuttelfish's body."
- "Since children are familiar only with deformed squid not cuttlefish as decapodiform cepahlopods, it might be hard to tell at a glance that it's a decapodiform cephalopods."

## DISCUSSION

This case study shows the process of creating a science picture book and its educational effectiveness.

### Effectiveness of the Science Picture Book of Decapodiform Cephalopods

The picture book received numerous positive responses, suggesting that it has a significant educational impact.

Feedback, such as "It was easy to understand the ecology of broadclub cuttlefish," indicates that scientific knowledge was effectively conveyed to readers. This success can be attributed to the careful incorporation of complex ecological information into an engaging narrative, making it easier and more interesting for readers to understand. Research has shown that scientific narratives can significantly enhance comprehension by providing context and relatable storytelling, which helps readers engage with and retain complex information(Dudley et al., 2023; Negrete & Lartigue, 2004).

Additionally, the book was noted as easy to read aloud to children, suggesting that scientific explanations were presented in a more accessible and friendly way through storytelling. Read-aloud books are known to facilitate early scientific literacy (Braun, 2010).

Furthermore, by using illustrations, visual information would enhance readers' comprehension and interest by providing a fuller picture of the material. The visual elements captivate readers' interest, presenting information in an enjoyable way that reduces barriers to learning and inspires curiosity to the content (Gilbert & Stocklmayer, 2012; Hildebrand, 2004; Ramadas, 2009).

The educational impact of science picture books is already well-documented (ex, Mantzicopoulos & Patrick, 2011; Yun & Lee, 2015), and this book also demonstrates high educational value. Specifically, it serves as an effective tool for sparking curiosity about nature and fostering a sense of connection to science through the specific ecology of cuttlefish. Studies show that species-specific books can increase awareness and curiosity in children, as they provide concrete examples of biodiversity and ecological concepts (Patrick & Tunnicliffe, 2011).

However, some areas for improvement were also feedback to us. For instance, requests for anatomical diagrams suggest that readers have an interest in not only the ecology but also the internal structure of the species. While the current book focuses primarily on ecology, incorporating internal anatomy in future editions could offer a more comprehensive understanding. Additionally, in Japan, squid are more familiar as decapodiform cephalopods rather than cuttlefish, but the book intentionally featured cuttlefish, which may need further consideration to enhance accessibility.

### Cross-Disciplinary Collaboration

The creation of a science picture book requires two essential elements: natural history illustration and storytelling. To produce natural history illustrations, it is crucial to observe the form and behavior of organisms closely. For this project, in addition to examining cuttlefish specimens available in the market, the book team collaborated with museums to observe a diverse array of preserved specimens, deepening their taxonomic and functional morphological understanding. Museums housing invaluable specimens not typically seen in everyday life provides the opportunity to create natural history illustrations and more rich insights. Access to museum specimens has been shown to enhance the accuracy and detail of scientific illustrations, which in turn aids in public science communication by providing a reliable visual reference (Winston, 1999).

In terms of behavioral observation, the dive-based fieldwork and collaborations with aquariums to observe the detailed behavior of captive individuals, gaining access to data that would be challenging to gather solely in the field. Moreover, creating the story required knowledge not only of cuttlefish biology but also of prey species and predators., Ichthyologists and crustacean experts, among others, contributed valuable insights for the book. Thus, the creation of a science picture book is a project made possible by the collaboration of experts, educational institutions, and research institutions, underscoring the importance of interdisciplinary support. Interdisciplinary collaboration has been found to enhance the depth and accuracy of educational materials, as input from multiple experts provides a well-rounded understanding of the subject matter (Kelly & Fitzgerald, 2011; Monteiro et al., 2016)

## CONCLUSION

This case study demonstrates the educational value of science picture books focused on decapodiform cephalopods. By blending scientific content with natural history illustration and narrative storytelling, the picture book presents complex ecological information in an accessible and engaging way for young readers. The interdisciplinary collaboration–among researchers, illustrators, museum curators, and aquarists–played a crucial role in enhancing the scientific accuracy and artistic quality of the final product. This initiative may serve as a model for future efforts in science and environmental education, promoting awareness of lesser-known marine taxa and fostering curiosity about biodiversity from an early age.

### Contribution to the Literature

This study contributes to the field of interdisciplinary science education and science communication by illustrating how a picture book integrating natural history illustration, storytelling, and marine biology can serve as an effective educational tool. By focusing on decapodiform cephalopods–an underrepresented group in public discourse–we address a gap in marine biodiversity education for children. The collaborative process involved in this project highlights the potential of cross-sector partnerships in creating educational resources that are both scientifically accurate and visually engaging. This work provides a replicable model for science outreach initiatives targeting early learners and underrepresented taxa in public science literacy.

**Author contributions: AO:** designed the study, created the picture book and the poster, analyzed the data, and wrote the manuscript; **JDA:** provided critical biological specimens and information and wrote the manuscript; & DF: Aided in data collection. All authors agreed with the results and conclusions.

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**Ethical statement:** The authors stated that the research did not involve procedures requiring special ethical approval. Any feedback collected from readers was conducted anonymously, ensuring their privacy and confidentiality.

**Declaration of interest:** No conflict of interest is declared by the authors.

**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

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