Note

Capture of the Coronate medusa *Periphyllopsis braueri*, by the Giant Seven-arm Octopus *Haliphron atlanticus*

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Abstract: The Seven-arm Octopus, *Haliphron atlanticus*, was observed holding a coronate medusa, *Periphyllopsis braueri*, by the remotely-operated vehicle (ROV) *Dolphin-3K*. The jellyfish was held by the aboral surface within the arms of the octopus. Although obscured at first, the lappets and tentacles of the jellyfish became exposed as the octopus turned toward the ROV. Based on recent reports, it appears that gelatinous prey species are important components of the diet of *Haliphron*. Furthermore, gelatinous prey may be generally underappreciated as a food source and important trophic link in open-ocean, deep-sea, pelagic food webs.

Key words: gelatinous, *Haliphron*, *Periphyllopsis*, ROV, trophic

Introduction

Collecting behavioral information on deep-sea animals is an arduous task. The challenges in accessing such remote life are both technological and financial. Animals living below the well-lit surface waters are often widely dispersed and many are gelatinous. *In situ* observations using submersibles and remotely-operated vehicles (ROVs) remain an important source of information regarding the ecology and behavior of little-known gelatinous fauna.

Cephalopods are important members of marine ecosystems. Although commonly known as muscular and active predators such as the familiar octopuses and squids, many cephalopods are actually slow-moving and gelatinous in nature. While there have been reports of cephalopods feeding on gelatinous prey (Smith 1963, Brodeur et al. 1987, Brodeur and Percy 1992, Heeger et al. 1992, Hunt 1996, Arai 2005), recent observations suggest a more diverse feeding ecology for cephalopods than previously thought, particularly for deep-sea species. Recent reports include gelatinous species like *Grimpoteuthis* feeding on swarms of small crustaceans (Hunt 1998), and the Seven-arm Octopus (*Haliphron atlanticus* Steenstrup, 1861) eating the jellyfish *Phacellophora camtschatica* Brandt, 1835 (Hoving and Haddock 2017). Rather than being a rarity, we support the assertion of Hoving and Haddock (2017) that feeding on jellyfish is normal rather

than the exception for *Haliphron* and we report a potential new species of jellyfish prey, *Periphyllopsis braueri* Vanhöffen, 1902, for the first time.

Methods

The *Dolphin-3K* is a remotely-operated vehicle (ROV) capable of diving to depths of 3,300 m. At the time, it was equipped with a Victor/JVC KY-F32 three chip CCD camera and six lights: three 400W SeaArc HMI/MSR metal halide lamps and three 250W SeaLine SL-120/250 halogen lamps (one in the rear, two in the front of the ROV). Video footage was recorded simultaneously on both ST-120PRO S-VHS and BCT-D124L Digital Betacam tapes (see Hunt and Lindsay 1999) and a digitized version is available at http://www.godac.jamstec.go.jp/jedi/static_player/j/3K0297SHSV40_00375800.

Results

On July 25, 1996, the ROV *Dolphin-3K*, operated by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), recorded the Seven-arm Octopus, *Haliphron atlanticus*. The encounter occurred in Sagami Bay, Japan, at a depth of 529 m (35°00'N, 139°13.5'E). A midwater jellyfish, *Periphyllopsis braueri*, was revealed to be caught within the oral web of the octopus. This is the first record confirming the capture of a coronate scyphomedusa, in this case *P. braueri*, by *H. atlanticus*.

The octopus first appeared at 9:23:44, slowly swimming

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Fig. 1. A) *Haliphron atlanticus* swimming slowly downward when first approached by the ROV. Note the wide mantle aperture along the right side. B) arms tips curl inward, forming a mirrored symmetry around the midsagittal plane. This is a stereotypical response of octopods when resting or disturbed. C) arm web open, exposing the lappets of *Periphyllopsis braueri* underneath. The medusa's shape is aligned with the bell-shape of the inner (oral) arm web of the octopus. D) animal is approached by the ROV. Note: funnel opening observed in picture is approximately 30 cm diameter for scale. E) arm web is retracted as *Haliphron* prepares to swim away. F) *Periphyllopsis braueri*.

downward. The arms were closed and not undulating; it was holding onto something obscured from view. There was one narcomedusa (*Solmissus*) and several larvacean houses in view. The octopus turned away from the ROV, disappeared from view, then reappeared at 9:25:14, at which time the arm web appeared distended and the distal edge of the web margin was slightly open. From 9:26:05 to 9:26:29 (24 seconds) the mantle opening on the right side of the animal could be clearly observed to go through 4 respiratory cycles, one about every 6 seconds as it continued to slowly swim back from the ROV (opening clearly visible in fig. 1A). It was moving ap-

proximately 1 body length every 3 to 4 seconds.

At 9:26:34, *Haliphron* was disturbed by the bow wake of the vehicle. It turned while curling its arm tips symmetrically about the midsagittal plane. The bell opened slightly (see image in fig. 1B). As the arms curled back, lappets of *Periphyllopsis* were observed extending out from the arm web of *Haliphron*.

The octopus turned back and forth (facing away from the ROV) and then extended the arm web again, covering the medusa, and beginning to increase its speed and respiratory rate. The interbrachiate web margin had receded compared

to when first observed so that the arm tips appeared long and whip-like (see fig. 1E). Although the mantle openings were obscured, there were two visible motions from a more forcible siphon jetting, indicating respiratory cycles had shortened to about every 4 seconds and speed increased to one body length every 2 to 3 seconds. The increased speed was short-lived and within seconds the animal stopped swimming (and was approached by the ROV for unsuccessful capture).

Discussion

The current encounter of a deep-sea octopus manipulating a jellyfish is an important observation given the scarcity of such encounters. Recently, there have been reports of a few live observations of *Haliphron* (e.g. Miller et al. 2018) including some associated with jellyfish (Hoving and Haddock 2017, Rosa et al. 2017). Possible explanations for such associations include as an energy-saving mechanism (riding on the medusa), defense (using the tentacles against potential threats), and predation events. Gelatinous stomach remains have been reported for *H. atlanticus* (Willassen 1986, O'Shea 2004) with more convincing evidence for direct feeding presented by Hoving and Haddock (2017) for the species. We believe the encounter presented here supports the assertion in Hoving and Haddock (2017) that medusae are a common food item for *Haliphron*.

Hoving and Haddock (2017) relay an observation by Heeger et al. (1992) that *Argonauta* held the exumbrellar surface of a jellyfish, consuming its way to the gastric cavity, perhaps taking advantage of prey items caught by the jellyfish (*Phyllorhiza*). They note that in their observations of *Haliphron*, it also held the medusa by the external bell with the oral surface open and suggested the octopus may acquire more nutritious food in addition to feeding directly on the jellyfish. We too note that in our observation *Haliphron* held *Periphyropsis* in precisely the same manner.

The notion that deep-sea cephalopods that eat medusae might use the stinging abilities of their cnidarian prey to obtain more nutrition is an intriguing, although unproven, idea. Miller et al. (2018) noted an apparent escape response during two separate observations of *Haliphron* by other authors, but no escape response for the individual of Hoving and Haddock (2017) that was holding a jellyfish in its arms in a manner similar to that described here. Rosa et al. (2017) discuss the "hitchhiking" behavior of one *Haliphron* holding onto the oral side of a jellyfish. They suggest a defensive mechanism based on reaction to divers, though they acknowledge the interaction could be predation.

The use of submersibles to record the living behaviors of poorly accessible deep-sea creatures is of tremendous value. It is clear that observations of living *in situ* animals such as *Haliphron* capturing *Periphyropsis* will continue to inform our understanding of pelagic open-ocean systems, as they will continue to spur new questions and inquiry into the ecology of our open seas.

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