Octopods of the Deep Reefs off Curacao

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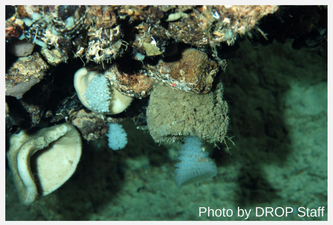
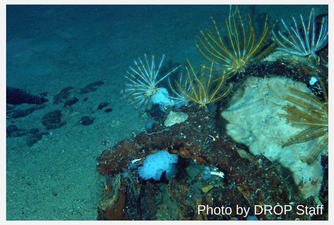
Introduction

Coral reef habitat around the world is in steady decline due to many factors. Because mesophotic and deep water reefs (40-300m) are protected from destruction by storms and thermal coral bleaching[1], researchers hypothesize that deep reefs could form possible refugia for shallow reef coral, fish, and invertebrate species. However, before studying the changes in faunal populations over time, we must first assess the current biodiversity of these reefs. While this had been done for various fishes, researchers have yet to study the cephalopods living in these reefs. With pictures, videos, and specimens collected by a manned submersible in Curacao, southern Caribbean, as well as existing DNA sequences derived from the specimens, I attempted to identify the individuals to species. The objective of this study is to survey the cephalopod diversity of the mesophotic and deep reef communities in Curacao.

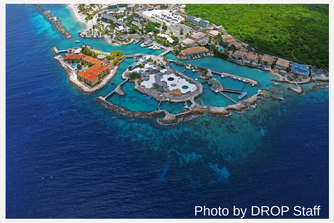




Above: Both photos show habitat typically seen in the deep reef systems.

Deep Reef Observation Project (DROP)

Since 2011, DROP has been surveying the biodiversity of the deep reefs in the Southern Caribbean, with a focus on the island of Curacao. The project employs a submersible, the Curasub, to photograph and collect the organisms living on these reefs.



Clockwise, from bottom Left:
Aerial view of Substation Curacao
Map of Curacao
Front view of the Curasub

Acknowledgements:
I would like to thank Virginia Power, Liz Cottrell, Gene Hunt and the NHRE Program for giving me this opportunity. I would also like to thank Thomas Devine and Cristina Castillo for sequencing the DNA needed for this project, Amy Driskell and Lee Wiegt, the assistant director and director of LAB, Barry Brown for his photographs, Yolanda Villacampa for her help with additional photos, and the crew of Substation Curacao.

NSF
REU Site, OCE-1560088

References:

1. Bongaerts, P, T Ridgeway, EM Sampayo, & O Hoegh-Guldberg. 2010. Assessing the 'deep reef refugia' hypothesis: focus on Caribbean reefs. *Coral Reefs*. 29(2): 309-327
2. Vecchione, M. 2003. Cephalopoda. FAO Guide for Identification of Invertebrates of the western Central Atlantic. 1:150-244.

Materials and Methods

Specimens

- DROP Researchers collected fifteen octopods opportunistically during manned submersible dives from 2011-2016.
- I attempted to identify the specimens using the key to the Family Octopodidae in the FAO Guide for Identification of Invertebrates of the western Central Atlantic[2].
- Researchers took tissue samples from each specimen at date of collection, and LAB technicians sequenced the cytochrome oxidase I mitochondrial (COI) gene from eight of the specimens.
- I attempted to match these sequences with those of known species using the genetic databases from both the Barcode of Life Database (BOLD) and GenBank.

Both octopod photos on the right were taken by the camera on the sub.

Photos and Videos

- Taken with Nikon camera and GoPro attached to submersible
- I reviewed sub logs and sorted and edited videos to match video observations with octopod specimens, then grouped the photos and videos based on appearance, and, when possible, specimens and DNA sequences.

Known Species Found

Octopus hummelincki

- Three specimens with no corresponding video: CURI 11524 (shallow), Misc. Octopods 1 and 2 (114-265m)
- GenBank BLAST show CURI 11524 sharing 99% of COI genes with *O. hummelincki*
- Ocellate; 7 outer gill lamellae

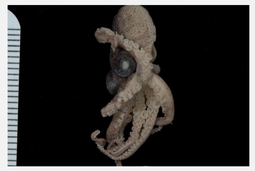
Left: *O. hummelincki* (CURI11524)
Right: *P. tetracirrhus* (CURI14020)

Pteroctopus cf *tetracirrhus*

- One specimen with corresponding video: CURI 14020 (254m)
- Three videos with no specimen (unknown depth, 241m, 276m)
- Narrow mantle opening; 9 outer gill lamellae

Scaeurgus unicirrhus

- One specimen with corresponding video: CURI 14026 (195m)
- One specimen with no video: CURI 14029 (284m)
- 12-13 outer gill lamellae



Left: *S. unicirrhus* (CURI14029)
Right: *P. mercatoris* (Misc. Oct. 3)

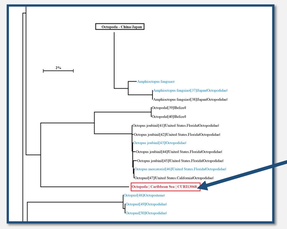
Paroctopus mercatoris

- One specimen with no video
- Mature male, although very small
- 7 outer gill lamellae

Species in Need of Further Taxonomic Work

Species Group A

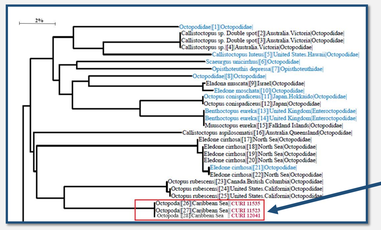
- Two specimens with no corresponding video: CURI 14127 (140-276m), CURI 13068
- Very distinctive chromatophore pattern: 2 rows down arms
- Long, thin arms
- 8-9 outer gill lamellae



From Left to Right: Chromatophore pattern on arms of CURI 14127: BOLD tree showing unique lineage of CURI 13068 in red; CURI 13068

Species Group B

- Three specimens with corresponding video: CURI 12041 (unknown depth), CURI 13022 (unknown depth), CURI 16016 (209m)
- Three specimen with no video: CURI 11523 (120m), CURI 11535 (168m), CURI 16011 (174m)
- Three males, three females
- Very long, distinct hectocotylus with blunt tip (17-19% arm length)
- One specimen with two hectocotyli: third right arm normal morphology, second right shorter with a tapered tip
- 8-9 outer gill lamellae



From Left to Right: Double hectocotyli of CURI 16011; BOLD tree showing unique lineage of three of the specimens in red; CURI 11523

Discussion

Because the many of the octopods of the Caribbean are poorly studied, this work is an important step toward future research such as the effects of global warming and ocean temperature changes on the fauna of Caribbean reefs. If the inhabitants of these reefs are unknown, the validity of the deep reef refugia hypothesis cannot be concluded. The lack of previous research has made it difficult to determine the species of some of the specimens studied here. Many Caribbean octopods do not have gene sequences in either BOLD or GenBank. Three specimen groups did not match any known species genetically; this could be due to the fact they are a described species with no genetic information available or they could be novel species.

While this study is a first step in assessing the biodiversity of octopods living in reefs ranging from 40-300m in depth, only fifteen physical specimens, five with corresponding video, and nine videos with no corresponding specimens were included. In addition, specimens were only collected from one reef, in Curacao. In order to understand the richness and abundance of the octopod species living in mesophotic and deep water reefs, more specimens and collection localities needed in future studies.