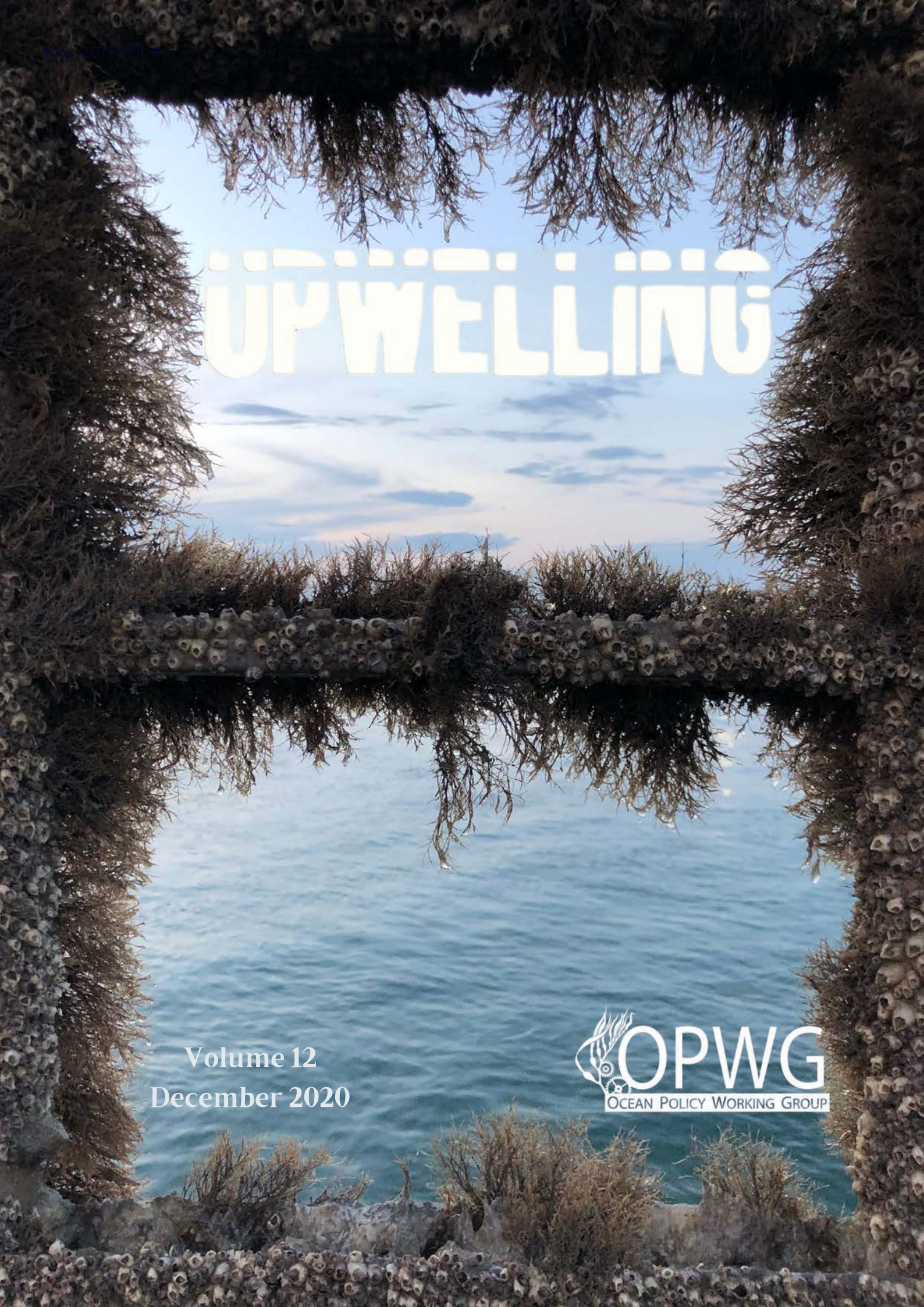


UPWELLING

Volume 12
December 2020

OPWG
Ocean Policy Working Group

Letter from the Editor

Welcome to the twelfth volume of UPWELLING, which is exclusively digital this year. Rachel Carson, who was so talented at translating the beauty and science of the natural world into elegant, accessible writing, said it well: “In every outthrust headland, in every curving beach, in every grain of sand there is the story of the earth.” Students at the Nicholas School and Duke Marine Lab are uniquely positioned to find and share those stories. They have, as always, submitted thoughtful writing and creative art to this publication. It was truly a pleasure to curate this semester's issue.

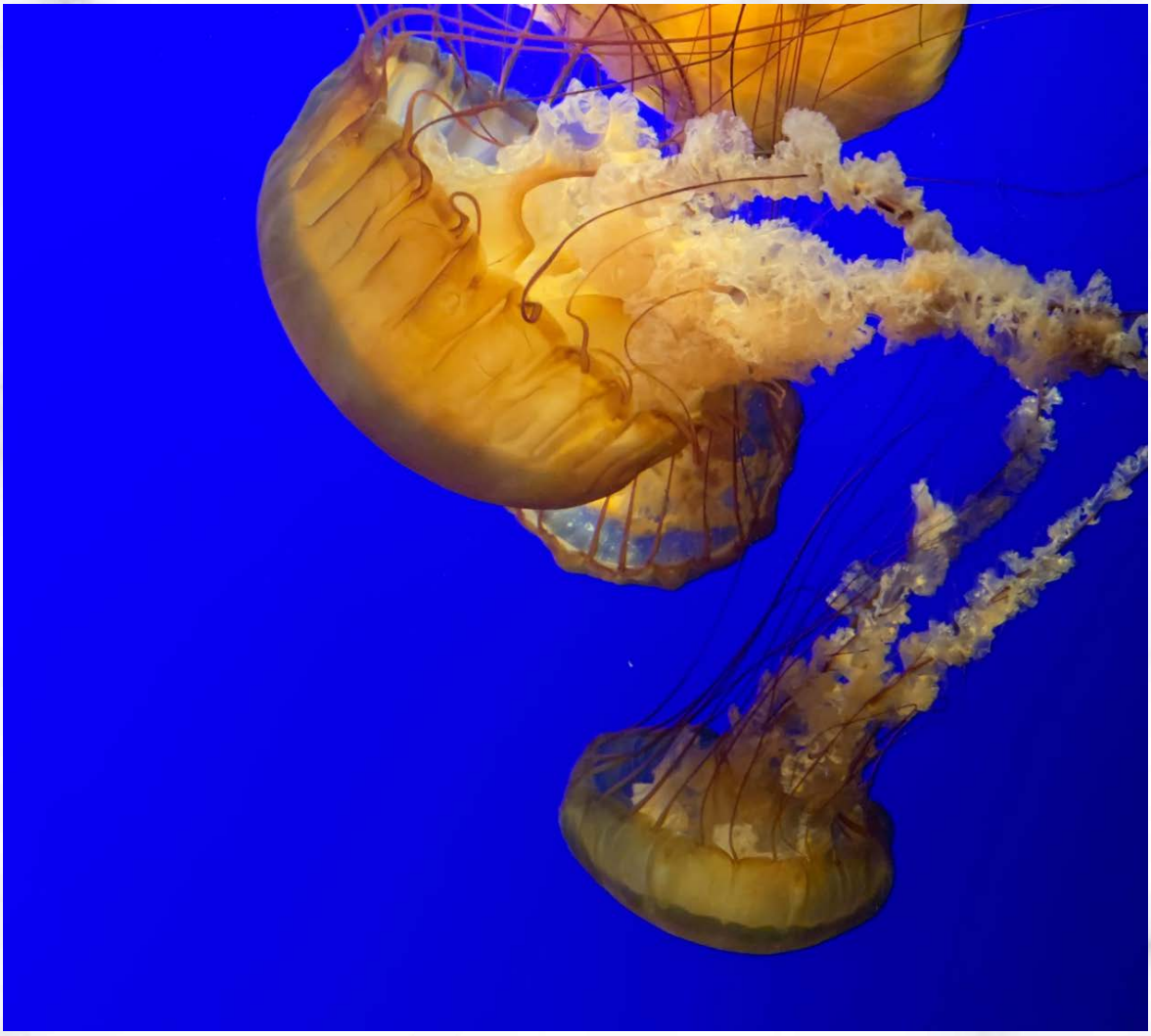
This issue of UPWELLING features articles about two new exciting projects, a podcast and a working group, at the Nicholas School that are connecting more people to ocean research and engagement opportunities. I expect you will also emerge with a newfound respect for the humble Nudibranch after reading the delightful ode included here. The visuals in this issue invite you to be in awe of the expansive ocean and also to lean in closer to examine the understated beauty of creatures like sea nettle and barnacles. The featured photographs offer a window into the waters of the Bahamas, New Zealand, Alaska, and beyond. Enjoy your journey through these pages... let yourself be transported and feel the wind in your hair, the salt on your skin, and the seaweed betwixt your toes.

A warm thank you to the Nicholas School of the Environment, the Nicholas School Student Council, and the Duke University Center for International Studies for their continued support of the Ocean Policy Working Group and UPWELLING.

Fair winds,
Rachel Earnhardt
December 2020

Brighton, New Zealand.
Background Photograph by Rachel Earnhardt

In this Edition



Pacific Sea Nettle (*Chrysaora fuscescens*)
Photographed at the California Academy of Sciences by Juliette Lee

Featuring Photography by

"Window to the Sea" Cover Art by Maddie Paris

Seas the Day Podcast:

My bright spot in the pandemic

by Rafaella Lobo, 3rd year PhD student in Marine Science and Conservation

I became addicted to podcasts in 2016. I was busy doing pilot whale photo ID 40 hours a week - a task requiring visual concentration, and I was thrilled to find a type of media I could listen to simultaneously. Podcasts allowed me to learn about all sorts of things while being productive. When I first got into my PhD program, in 2018, I learned that my advisor, Dr. Lisa Campbell (and now podcast co-conspirator, as she calls it), had long wanted to launch a marine lab podcast of some sort. She had students making podcasts as a class assignment but hadn't published them. Fast forward to the spring of 2020, when somebody suggested we make podcast coordinator a PhD student job - and I 'lobbied' hard for it.

My fellow students were initially concerned that a podcast might work well for some time, with a passionate student taking care of it, but would die out after a while, like some previous initiatives. I knew, though, that faculty and staff were already interested in a podcast, so the first step was to get a group of us together: Dr. Lisa Campbell, faculty at the lab; Stephanie Hillsgrove, program coordinator and assistant to the director; and Janil Miller, our amazing librarian. From the get-go, we planned for the podcast to serve as an umbrella to cover the wide range of interests at the lab, any of which could be captured in more specific 'series.' If any one series lost momentum, others would still be there, and new ones could emerge. So, the podcast will continue, whether or not a PhD student is involved.

As COVID-19 hit the US and we went into lockdown, with our lives turned upside down, I had something to look forward to every Friday morning. Initially, we had no idea what we were doing, but our excitement and enthusiasm were high. We had fun envisioning different series, brainstorming episodes, and figuring out a schedule. The technical side was less fun, but we had great help from Jeff Priddy and Jill Powell. We wanted, above all, for people at the Marine Lab to see the podcast as a lab project and to feel a sense of ownership. We held a podcast naming contest, and Seas the Day won the popular vote. Our theme song, 'Oyster Waltz', was composed by our own Joe Morton. Stephanie Hillsgrove wrangled our thoughts on a logo into our artwork. Two of our series' episodes are produced by students in class (Conservation & Development and Whale Pod), and one focuses on the lives of our graduate students (PhDeep). We hope, as people get familiar with the format, that students, faculty, and staff will have ideas for one-off episodes. We will be standing by to help them through the production process.

We have come a long way since our first meeting. We have two new members: Brandon Gertz and Nora Ives, both CEMs. We have released, at the time of this writing, 7 episodes from 3 different series; We have figured out how to post them on Apple Podcasts, Spotify, Radio Public, and how to stream them on our website. Our website, by the way, is beautiful and we keep it up to date - with photos, references, transcripts, student bios, etc. We have a strong social media presence (Instagram and Twitter), where we share not only the science and other info discussed in each episode, but we also take the opportunity to highlight the work being done at the Marine Lab. Stop what you are doing now and follow us!

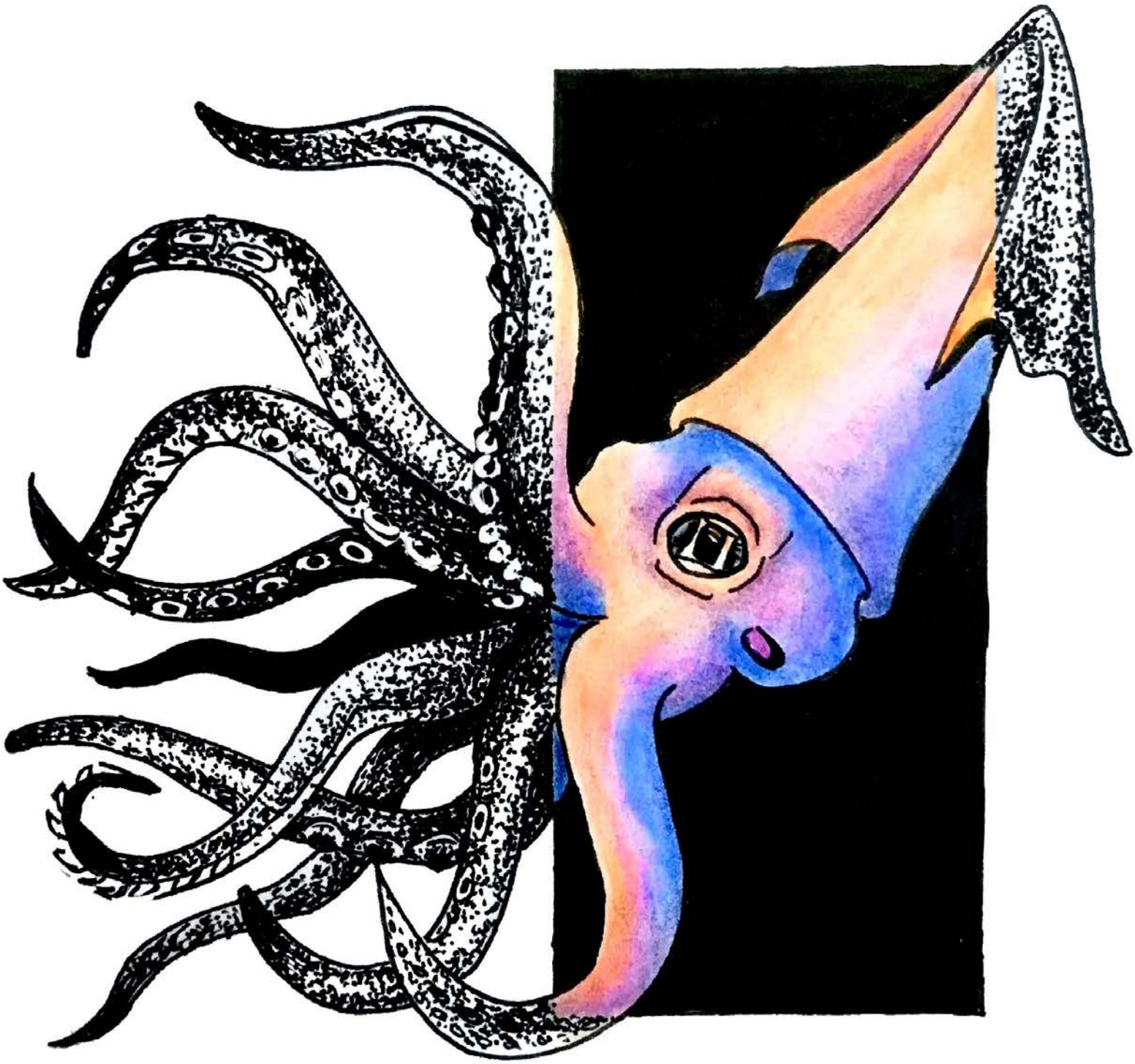
It is quite a lot of work, but we have an amazing team. Sometimes I feel guilty spending time working on the podcast when I struggle to find motivation for my own research. I know this is a balance I'll have to find moving forward, but I believe that, as we get more students to join, pitch ideas, and help produce episodes, I'll get there. For now, I am just thankful I had something exciting to look forward to when it felt like the world outside was ending.

If you want to learn more about our Seas the Day podcast, please visit our website https://sites.nicholas.duke.edu/seastheday. You can follow us on Twitter and Instagram @SeasTheDayPod.

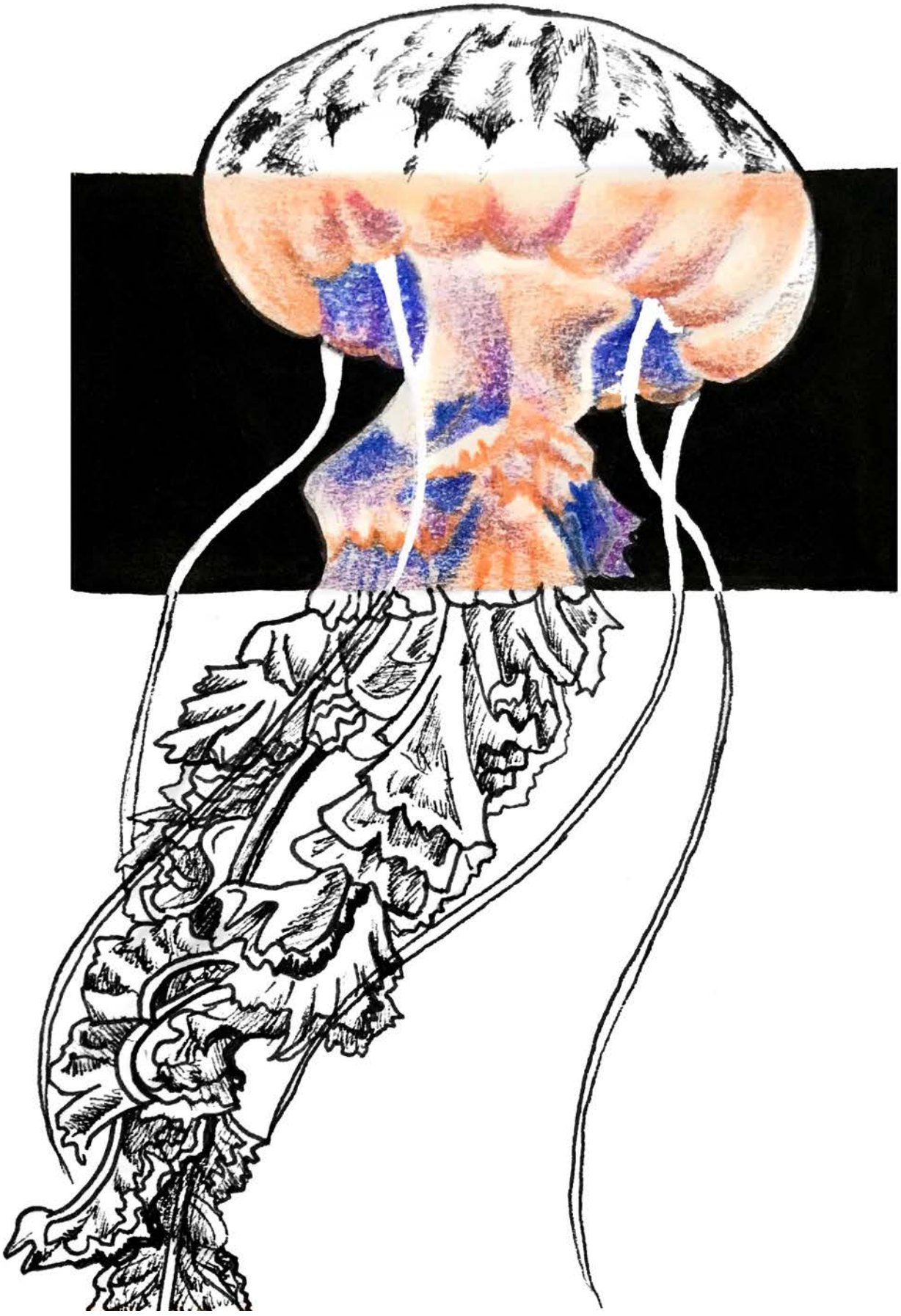
Have an idea for a podcast episode you want to lead? Write us: duml-podcast@duke.edu

Sanderling *(Calidris alba)*. Photograph by Maddie Paris

Original Illustrations by **Claire Huang**



Humboldt Squid (*Dosidicus gigas*)



Pacific Sea Nettle (*Chrysaora fuscescens*)

Oceans@Duke

By Kim Corcoran, Cristiana Falvo, & Juliette Lee

Oceans@Duke is a multi-disciplinary working group of faculty and students from multiple schools and disciplines across Duke University working in the oceans realm. The group develops programming to connect Duke's scientific, governance, and business expertise with an external audience and position Duke as the Oceans University. Students are encouraged to participate in Oceans@Duke events to network with industry leaders and stakeholders who are engaged in work to sustain our oceans.

Green sea turtle *(Chelonia mydas),* in Tobago Cays in Saint Vincent and the Grenadines.
Photograph by Juliette Lee

The events planned for 2021 include the Future of Our Oceans webinar series which will debut on January 14, 2021 with Nicholas School Professor Dr. Patrick Halpin and his colleagues. This will be followed by episodes featuring a diversity of other ocean experts from Duke. This webinar series will explore the critical role that the oceans play in our planetary systems, geopolitics, local communities, culture, medicine, and the economy. Duke hopes to share new research-based insights, explore complex and contested questions, and shed new light on how to balance human demands and ocean health. While this webinar series targets industry leaders and experts outside of Duke, Oceans@Duke welcomes students to attend to expand on their connections between Duke and the private sector.

Free diving off Toyon Bay, Santa Catalina.
Photograph by Juliette Lee

Oceans@Duke is planning a conference for the Fall of 2021 which aims to help graduate students from diverse disciplines better understand the changing ocean economy and ecosystems, and highlight how their current and future work can shape a blue economy. The discussions and interactions will illustrate a vision for the blue economy students can contribute to by balancing ecological, social, and economic objectives. Students on an ocean-related career trajectory can take advantage of Duke University's diverse and dynamic expertise in the oceans sector while gaining a better perspective about how sustainability will factor into their work. Students will also have the opportunity to connect with stakeholders and leading policy makers, scientists, entrepreneurs, investors, military leaders, and industry experts, and gain access to the latest advancements shaping human engagement with the oceans.

Barrier reef ecosystem off the coast of Kamalame Cay near Andros in the Bahamas. Photograph by Juliette Lee

To learn more about Oceans@Duke, our events, and who we are, please follow us on: Twitter @OceansatDuke Instagram @OceansatDuke

Visit our website https://sites.duke.edu/oceansatduke/

Pacific Ocean Meets Sky. Photograph by Ardath Dixon

Galapagos Lobsters (*Panulirus penicillatus*)

CRUSTACEANS

Photographs by Maddie Paris

Sally Lightfoot Crab
(Grapsus grapsus)

Blue Crab with Egg Sac
(*Callinectes sapidus*)

Nudibranchs: A Celebration

Defending the Naked Nudes

by Nannaphat Sirison

Nudibranch. Photograph by Izaak Earnhardt

Nudibranchs are carnivorous marine slugs and are separated into two morphological groups: Dorid and Aeolid nudibranchs.[1] Ecologically, nudibranchs are carnivorous mollusks that feed on cnidarians such as sponges, anemones, and hydroids.[2] Several species also prey on nudibranchs, including turtles, crabs, shrimps, fish, and gastropods. All nudibranchs are soft bodied with a mantle, a muscular foot, and tentacles called rhinopores (see Figure 1 & 2)-- imagine a land snail without its shell. One might wonder how it makes any sense that nudibranchs have evolved to not have any form of physical protection against predators. Nudibranchs lose their protective shell covering after the larval stage; as a consequence of this reversal, both Dorids and Aeolids have appropriated other methods for self-protection, namely a chemical defense system.

Dorids secrete biological compounds distributed across the body. Dorids have MDF's (mantle dermal formations) that cover most of the slug. The MDF itself has no actual functional use for the nudibranch and is the most readily exposed body part. Found in these MDF's are chemical metabolites that are associated with feeding deterrence. Studies have also successfully demonstrated that not only are the metabolites found in the MDF's most effective in deterring predators, but that predator preferred attack location is positively correlated with MDF position.

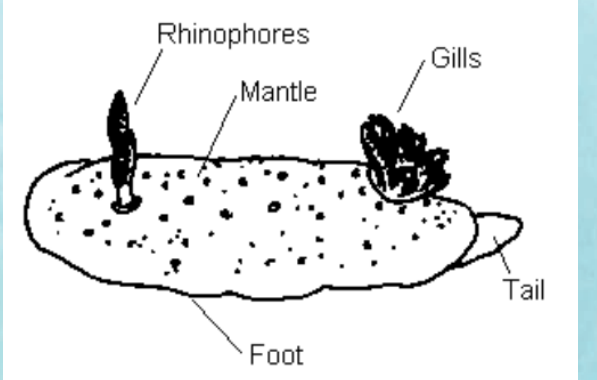


Figure 1. Dorid Nudibranch Body Plan [3]

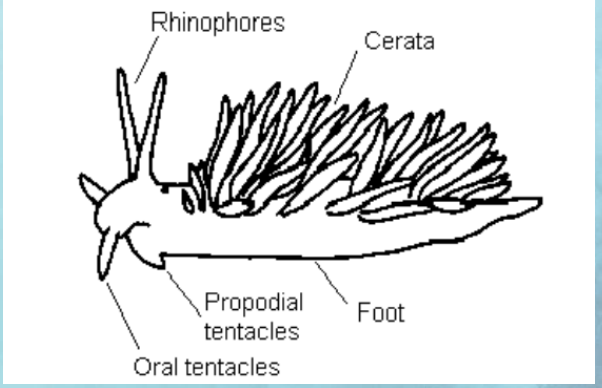
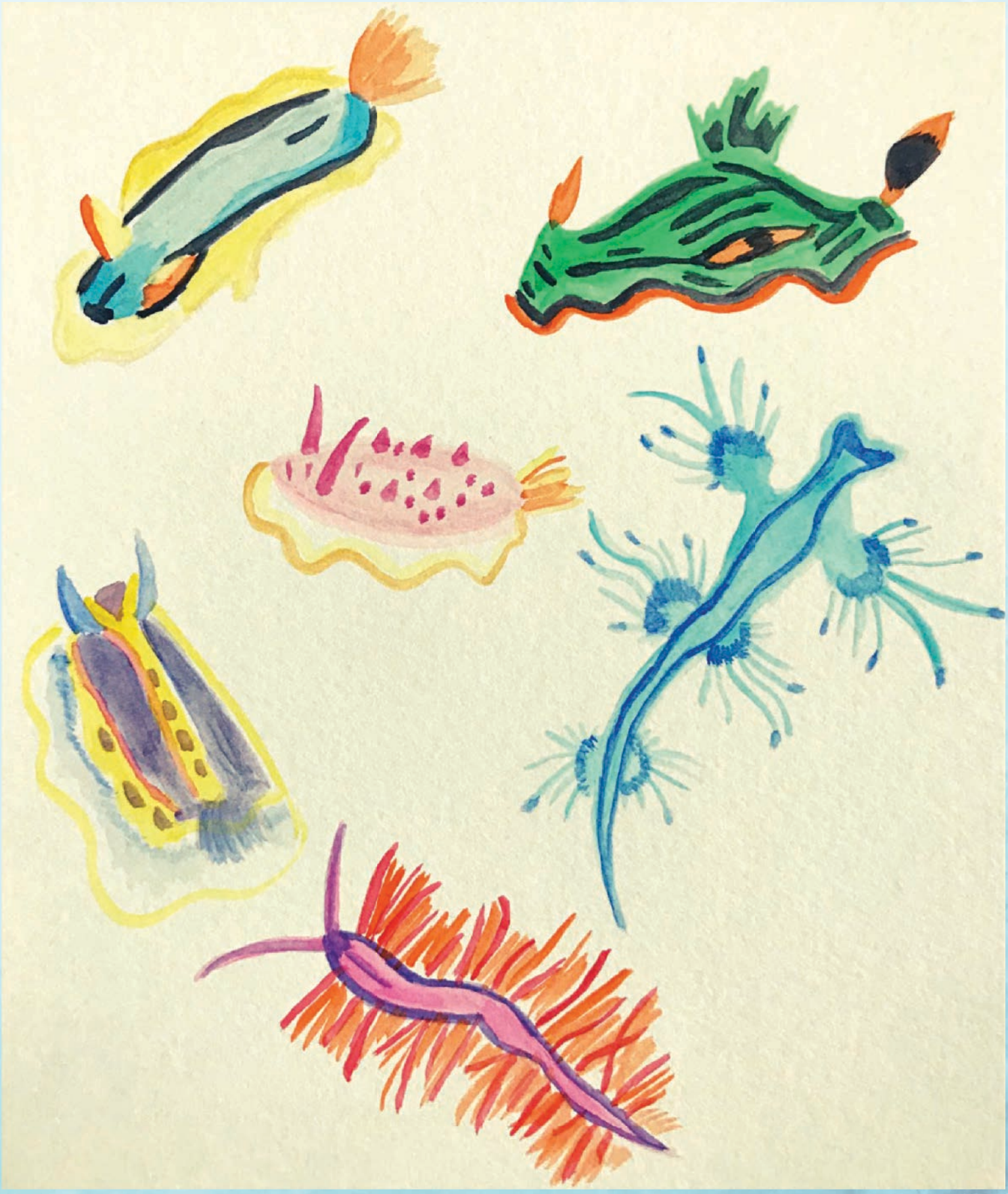


Figure 2: Aeolid Nudibranch Body Plan

NUDIBRANCHS

Original Watercolors by Nannaphat Sirison



The metabolites in Dorids are either synthesized via De Nova biosynthesis or sequestered from the nudibranch diet, specifically, from sponges. An experiment was able to conclude that where nudibranch prey is abundant, Dorids sequester all necessary metabolites from feeding on sponges alone. On the other hand, in areas where sponges are less abundant, Dorids synthesize their own metabolites to make up for the short supply.

Phyllidelliia nudibranch in Weda Bay, Indonesia
Photograph by Izaak Earnhardt

In comparison to the Dorids, the Aeolid chemical defense system integrates cnidarian nematocysts into the cerata via feeding. Cerata are external projections from the nudibranch body, comparable to MDF's found in Dorids. Studies have confirmed that toxins present in the cerata of Aeolids and toxins found in the tentacles of prey cnidarians are the same, by comparing the endobacteria found in the two structures.

[1] Dean, Lewis J, and Michèle R. Prinsep. "The Chemistry and Chemical Ecology of Nudibranchs." Natural Product Reports, Royal Society of Chemistry, Feb. 2017, pubs.rsc.org/en/conte
[2] Conway, Jenny. "Nudibranchs." Creature Feature, 2010, www.dive-the-world.com/creatures-nudibranchs.php.
[3] Figure 1 and 2 sourced from Anatomy. http://www.seaslug.org.uk/nudibranchs/anatomy.html Retrieved December 2020.

Spanish Dancer (*Hexabranchus sanguineus*)
Photograph by Izaak Earnhardt

Despite the reversal of the slug like ancestral trait, nudibranchs have developed a unique and robust chemical defense system. Both Dorids and Aeolids utilize toxins in their defense mechanisms. Aeolids sequester toxic nematocysts from prey species, while Dorids either sequester metabolites from prey species or practice De Novo biosynthesis of metabolites. Both Dorids and Aeolids demonstrate defense schemes in which toxic metabolites are found in body parts most readily exposed to the external surroundings, namely the MDF's and the cerata. The parallelism found here provides significant clues about the evolvement or adaptation of sacrificial body parts in all nudibranchs. These small colorful naked slugs may not be as helpless as they look!

Tenellia nudibranch in Weda Bay, Indonesia
Photograph by Izaak Earnhardt.

Coccolithophore Bloom in Sitka, Alaska.
Photograph by Angela Hessenius

Postcards from Paradise

Bay of Islands, New Zealand. Photograph by Rachel Earnhardt

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Action Team Coordinator
Andy Zou
Publication Coordinator
Rachel Earnhardt

West Indian sea star (*Oreaster reticulatus*). Photograph by Juliette Lee

UPWELLING is a biannual publication that provides a platform for the Duke community to share their thoughts, art, and research pertaining to any and all things ocean. We are interested in all ocean-related work, including short research articles, essays, photographs, illustrations, and other creative content. We welcome work from students in any department, alumni, faculty, and staff. To learn more and to view past issues, please visit https://sites.duke.edu/opwg/.

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