A student's experience of an MBARI research cruise

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Should you ever find yourself as a marine science student in your fifth year of a master's program, your first, second, and third priorities are to defend your thesis as soon as possible. Unless, of course, you receive an unexpected opportunity to join MBARI on a deep-sea research cruise. In that case, practicality can wait.

This was my exact situation just over a week ago. I was sitting at home, reading scientific papers, when I received an intriguing email from Amanda Kahn, the new invertebrate ecology professor at Moss Landing Marine Labs (where I am currently rushing to bring an end to my student status). The email was addressed to the full student body and explained that MBARI was about to launch a six-day research cruise to Davidson Seamount and Sur Ridge. They would be researching deep-sea benthic ecosystems via ROVs launched from their main ship, the *Western Flyer.* Moreover, they happened to have two empty berths available and were wondering if any students wanted to join the expedition.

I couldn't believe what I was reading! There are only around half a dozen institutions in the whole world that do deep-sea research, and MBARI had been a tantalizing presence throughout my time in Moss Landing. It's just down the street from the Marine Labs, and MBARI's incredible technology and predilection for attracting world experts elevated it to a level that I thought I would never tread. And so, to the probable chagrin of my advisor and the definite chagrin of my mom, I quickly replied to claim the male berth. Three and a half days later, I would be on the boat.

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The *Western Flyer* is an incredible vessel. Within 35 meters (117 feet) of steel, you can find just about everything a marine scientist could want. It has a wet lab, a dry lab, at least 12 two-bunk berths, a mess hall, a conference room, and even a small lounge. That's not even counting the most exciting part of the ship—the ROV control room—or, of course, the ROV itself. That ROV—the *Doc Ricketts*—is a gleaming five-ton hunk of engineering wizardry that sits in the center of the ship like a thrumming heart. This central position, smack between the *Western Flyer's* twin hulls, means that getting the ROV in the water is as simple as opening a trapdoor and lowering it down on a crane. The *Doc Ricketts* can then descend to up to 4000 meters (1,312 feet) deep, attached to the boat by even more cable. Incidentally, this is where my analogy of the ROV being the ship's heart starts to break down. Four thousand meters (13,123 feet) is a long way. It would be like one of my internal organs emerging from my ribcage on a cord to go a couple of blocks down the street to the grocery store, where it would deploy some time-lapse cameras before returning to my chest bearing valuable specimens of frozen pizza and artichoke dip. That would make an interesting cyborg movie.

The remotely operated vehicle (ROV) aboard the Western Flyer

All these impressive specifications make the *Western Flyer* big enough that it can only exit Moss Landing harbor at high tide. When the tides dictate your schedule, you generally end up with early departures. We needed to get underway at 5:00 a.m. sharp, and since preparation is critical, we all had to be on board no later than 4:00 a.m. One of the benefits of being a student is that you can usually get away with sleeping on the couch at your institution of study, and given my institution's convenient proximity to the early morning launch site, that's exactly what I did. I suspect that at this point I am somewhat notorious as an overnighter at the lab.

Once I was aboard the *Western Flyer,* I learned the boat's layout and met many of the folks on board for this cruise. It takes a lot of talented people to run a research operation like this. There are deck crew, ROV pilots, ship control, research scientists, and a cook, all of whom are Professionals with a capital P. Everyone is a true expert in their role, and the coordination between them is impressive. Given this, I was acutely aware that my usefulness on board would be limited, but everyone was very welcoming.

Turbulent conditions at sea marked our first day on the vessel. This was something we all knew coming in, for the swell forecasts had made it clear that we would start with a rough ride. While I was delighted with the fact that the waters would only improve throughout the week, it is admittedly a rough introduction for someone who has never been on a multi-day boat ride before. I think I am generally okay at not getting seasick, but I came prepared with an array of seasickness medications. And sure enough, I needed them.

There were no delusions of trying to attempt an ROV dive that day. Instead, the plan focused on deploying some instruments off the deck of the ship, but doing this is a deceptively complex process. The instruments that are traveling to the seafloor are big and expensive. A sediment trap, for instance, is much more than a fancy brick hurtling down to the seafloor to bean an unsuspecting urchin. It's a multi-part device that needs to land right side up, and doing so requires a series of weights and floats. Haphazardly pushing them overboard could result in these getting tangled, delivering the device in a destructive manner, or making it much harder to recover later. All of this is to say that the deck crew are specially trained experts at sending Deep Coral Cams and the like off the edge of the boat in a carefully controlled manner.

By extension, this meant that those of us without such training would only get in the way should we go out on the deck, so we were understandably prohibited from the working zone. This gave the majority of us relatively little to do on day one, and for this, I was grateful. I curled up on my bunk and napped the seasickness away.

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The launch of the *Doc Ricketts* the next morning was an electrifying moment. I watched from above, looking through the window from the lounge into the ROV launch room. One pilot controlled the crane, which lifted the ROV off the floor. The trapdoor opened, and the ROV was lowered down into the sloshing water between the hulls. Another pilot, armed with a joystick controller, watched to make fine adjustments to the ROV's initial entry, making sure it didn’t bump into the sides of the boat. Over in the control room, two more pilots watched the process from the perspective of the *Doc Ricketts'* video feed, ready to take command of its decent once the entry was finalized. Once released from the crane, the ROV began its descent into the deep, while the crew shifted their attention to the cable connecting the vehicle to the ship. It goes without saying that it would be very bad if the cable were to snap, and the most likely scenario for this to happen would be if it were to become tangled around the ROV and then be put under stress. To prevent this, crew members attached a series of floats to the tether as it went down, ensuring that it always floats above the action.

Readying the Doc Ricketts for launch

You immediately feel the glow of mystery when you enter the ROV control room. The room would be pitch-black, were it not for the panel of screens covering an entire wall. Four main panels provide slightly different angles of the vehicle's main view, giving the pilots a substitute for depth perception. Surrounding these are several smaller screens showing sonar readings, the ROV's track-path, and video feeds of several specific components of the *Doc Ricketts,* such as its sample containers and mechanical arms. Additionally, two large computer monitors sit in the corners. One provides a video annotation system for cataloging activities performed, samples collected, and creatures seen, making it much easier to go through and review the footage at a later date. The other computer displays high-resolution bathymetry, overlain by the waypoints for locations visited thus far. It's the kind of atmosphere that makes you hold your breath as the ROV hovers over the seafloor, the silhouettes of deep-sea corals and sponges creeping into focus.

The ROV control room

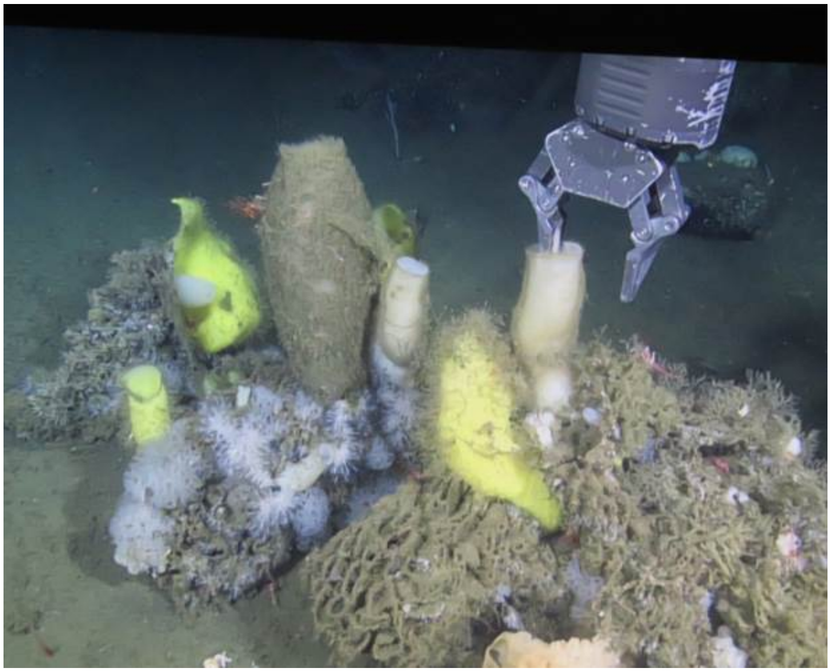
Two pilots sit at the command seats. One controls the vehicle itself while the other controls the various collecting mechanisms. To their left sits the chief scientist, who directs the pilots on what to investigate, and controls the camera. On this trip, that was Jim Barry, MBARI's benthic ecologist. I had met him once before. Back when I was first starting graduate school, I went through a long line of ideas for potential thesis projects of varying workability and sensibility, and MBARI's presence as the coolest-institution-to-potentially-collaborate-with was not lost on me. I had pitched one of these ideas to Jim. It turned out to be one of my sillier proposals—something about the ecological fate of hagfish slime—but Jim did not show any signs of being irritated. He gently explained why it wouldn't work and then took a full hour out of his busy day to discuss other ideas with me. In the end, I didn't pursue any of these alternative projects, as they either didn't quite match my interests, or did, but wouldn't have been suitable for the my lab. But now, sitting in the ROV control room of the *Western Flyer,* I found myself wishing I had. (Jim Barry, by the way, is just as encouraging and welcoming as I remembered).

The ROV drifted over a section of Sur Ridge at the relatively tame depth of 900 meters (2,952 feet). This site is covered in sponges and corals, and the team was curious about the oceanographic conditions that promote these communities. Today, that meant switching out some old AquaDopps for new ones. An AquaDoppmeasures the backscatter of particles flowing through the water, allowing the scientists to reconstruct the speeds and pathways of the currents flowing over the site. These instruments are fairly small, so they can be carried in the drawer that slides out from the platform at the bottom of the ROV. There is then the difficult matter of using the ROV's robotic arms to pull the AquaDopp out of the drawer and placing it in its proper position. It requires concentration and time, not unlike me putting on my socks in the morning.

The smaller of the two arms does most of the fine work. Both are dexterous, but as Knute Brekke, one of the ROV pilots later explained to me, the smaller unit receives feedback from its surrounding environment. This means that if a pilot guides an instrument into a crevice, he will feel resistance in the controls if it starts to press against solid rock, making it clear that the claw should stop. The other arm, by contrast, would just keep moving until devices are shattered, and tears are shed. Even so, maneuvering a multi-jointed appendage through three-dimensional space is still a fine-tuned process. It's a reminder of how much we take our sensory inputs for granted. I'm certainly thankful I don't have to worry about punching myself in the teeth every time I push a taco down my gullet.

In addition to collecting the old AquaDopps and placing the new ones, the ROV arms were put to the task of taking measurements and abducting critters. A fine-point sensor sits in a special compartment in the ROV drawer. It can measure temperature, flow speed, oxygen, and probably some other things that I am not aware of (maybe salinity). The unfeeling claw pulls the sensor out of its sheath and passes it to the sensitive one, which then sticks it into the site of interest. In our case today, those were the chambers of the deep-sea sponges, where we measured the exhalent water that they had filtered.

Next was the sample collection. For the sponges and corals, you just break off a piece with the claw and stick it in a drawer. But for the more crushable animals, the pilots use the arms to manipulate another tool in the ROV's arsenal: a vacuum hose. This is pretty self-explanatory. You hoover up whatever crab, brittle star, or snail that meets your fancy, sending it to one of four cylindrical compartments, which the pilots can rotate between once one fills up with animals. Finally, the ROV can be commanded to activate one of its Niskin bottles—which quickly open, fill with a seawater sample, and close again.



Breaking off a piece of sponge with the ROV's robotic claw

The science team waited with anticipation when the ROV surfaced again, and once we were given the all-clear, we got to work cataloging and preserving the animals collected fresh from the deep sea. I busied myself making labels and labeling sample bags, and we soon had a pretty effective assembly line for photographing and freezing our slimy bounty. I was ready for another day.

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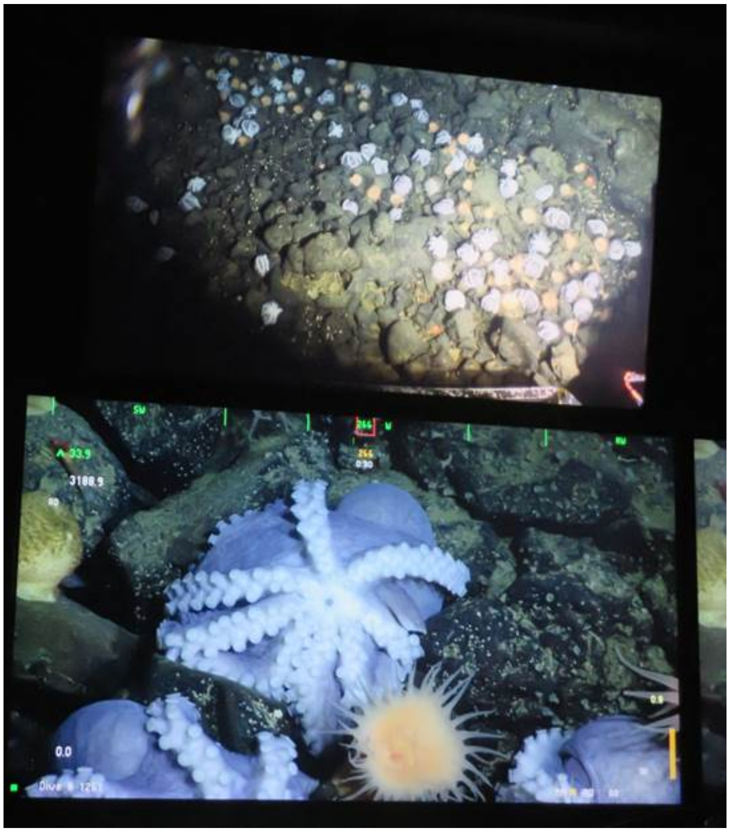
Our third day was the one I was most excited about because we were going to a site on Davidson Seamount covered with deep-sea octopus. Usually, when you are exploring the deep ocean, you find animals here and there, scattered across the vastness of a land with no light and little food. But at this site, dubbed the Octopus Garden, the concentration is jaw-dropping. I had previously watched online videos of the site with fascination, so I jumped out of bed when my alarm went off.

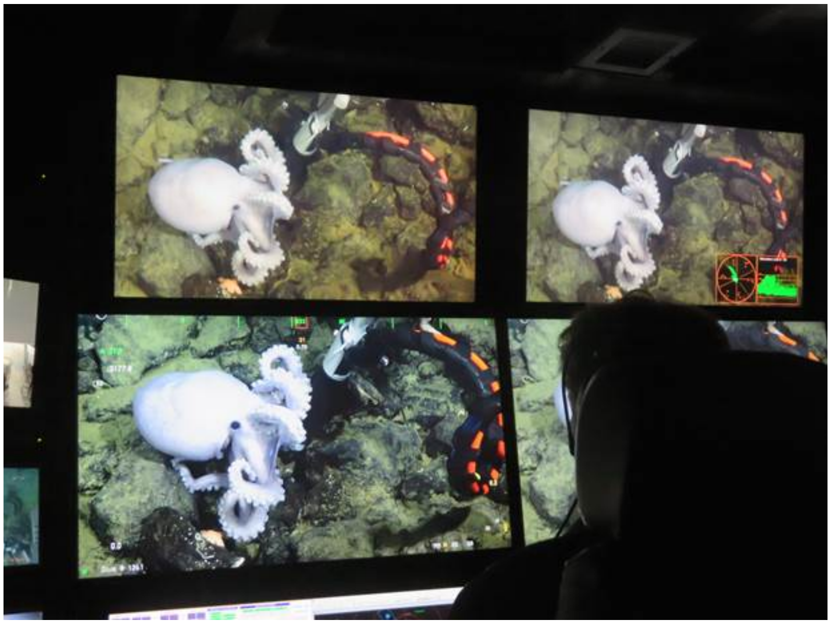
The site feels like the crest of a mountain—a large rocky mass that rises with no view of the sediment-covered plains down below. Even so, we were at 3,200 meters—almost two miles deep. The rock evidently has something of a honeycomb structure. Several shallow pits dot the surface of the seamount, and warm, geothermally-heated water emanates from these holes throughout the site. It is in these warm depressions where the plump, purplish-white octopuses like to lie. Sometimes they are scattered across the slope, but when there is a fault or some other plane of weakness in the rock, you can get an entire row or even a "pond" of octopuses.



The octopus garden on Davidson Seamount

They are clearly brooding. The vast majority of them are sitting on egg cases attached to the rocks in these pits. They sit with their arms spread into an umbrella shape that presumably helps trap the warm water over the eggs.

The MBARI team wanted to gather data to demonstrate the octopuses' preference for the warm water holes and to learn if there was an influence on their respiration rates. We spent the day hopping from one octopus to the next, collecting measurements. We stuck the sensor under each octopus to measure the temperature around the brood, and then next to the octopus' siphon to measure its respiration. We also counted the number of exhalations of each octopus using a timer.



Using the sensor to measure the water under the octopus

The day reminded me that much of exploration is data collection. Everyone always writes about the moments when an extraordinary new site is discovered, as they rightly should. Still, for such a spot to truly inform us about the world, we need to record the quantifiable measurements that allow us to make sense of the discovery, so we can place it in the grand spectra of complexity that is life. Next time I am frustrated about my data for my thesis project, I will think back to this slow but beautiful day of measuring octopus respirations, and tell myself, "data collection is discovery, and that's enough."

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I overslept on the fourth day. With calmer seas, I had switched back to my non-drowsy seasickness pills the day before, and the switch seemed to have done something strange to my sleep schedule. Setting alarms is always essential, even when you think you have gotten the early morning groove.

I rushed down to the control room and saw a vast plain of soft sediment shining in all of the monitors. "We are exploring a new site that we have never been to before," said Jim.

We were at the foothills of the Davidson Seamount, about ten miles from the abyssal plain. Somehow, we were still around 3,200 meters in depth—bathymetry profiles are never quite as straightforward as you might suppose.

We floated over a sea cucumber, then a stretch of emptiness, and then another kind of sea cucumber, then a coral. With every passing invertebrate, I marveled at the fact that this was a stretch of seafloor that no human eyes had seen before. Two things surprised me: One was that creatures were not nearly as sparse as I imagined. They were scattered, sure, but it was usually only a few seconds between sightings. Granted, we were near the base of a seamount, which might be a bona fide oasis compared to the remote stretches of abyssal plain at the center of the Pacific basin. But even then, the vastness of deep ocean means there is a collective bonanza of life down here.

The other thing that surprised me was that even though no one had ever laid eyes on this place, it felt far from untouched. Less than ten minutes passed before we came across some cylindrical instrument that looked like it had fallen off a boat. Perhaps an hour later, we saw some spiraling rings of cable with a coral growing on it. Andrew, one of the scientists, pulled out his iPad to show me a photo he had taken earlier that morning. It was an entire pile of cans and crumpled-up aluminum foil, with an innocent sea urchin sitting next to it. "It looks like someone gathered up all his recycling and dumped it overboard," he said. I wanted to believe that an ocean-wide cult of sea urchins had gathered trash from miles around to appease their wrathful god above, but I knew the truth. Even a place as remote as the deep ocean suffers from the effects of humans. There is indeed a deadly god above, and it is us.

I went back to focusing on the strange little invertebrates we were passing. Every so often, the pilots spotted something big approaching on the sonar. Tension would build. People would comment on the shape, how large it is, how we're almost there. Then we would pass by a patch of rock with some corals on it.

Jim turned around to look at me. "You wanna learn how to work the camera?" he said.

I fumbled my words for a moment before sitting in the chief scientist's chair. There was a joystick for angling the camera around, sliders for zoom and focusing, and automatic and manual options for brightness adjustment. It's a pretty simple setup, but it clearly takes practice. There is some definite inertia behind the camera, so it keeps moving even after you've taken your hand off the joystick. This gives a tendency to bypass your target, but you can't under-account too much, or you'll stop short of it. Since our goal for the day was to make headway in search of interesting sites, it also meant that we were constantly moving, and it's hard to track a subject that will soon pass beneath you. Eventually, I positioned the camera in the default position (facing forward, aligned with the ROV platform, and zoomed out), and watched as we passed by a series of sea pigs. (A sea pig is a type of sea cucumber that looks like a pudgy sausage on long, stilt-like legs, and they actually do look vaguely hog-like).

The most peculiar thing we saw was a series of gouges in the seafloor. They had clearly been excavated by something big. People mulled over the possibility of a sperm whale pinning a squid against the seafloor, or perhaps trying to rub off some parasites. Then Erica, a scientist from NOAA who was annotating the video feed, noted that Cuvier's beaked whales have been reported at this depth, and have been found with grenadiers in their stomachs. As if on cue, one of these rat-tailed fish swam lazily over the scour marks, the latest of many that we had seen throughout the day. We all murmured thoughtfully, and there appeared to be an unspoken agreement to the idea. One of the pilots stuck an ROV claw into the gouge to estimate the depth—about seven inches (170 centimeters)—too shallow perhaps for the sperm whale theory.

By the end of the day, we had reached another rocky ridge. We scaled the cliffs to see what we could find. There was the usual assortment of invertebrates, but probably not anything special.

To some of the team, it appeared that we ended at a place they had visited before. Slowly but surely, MBARI is filling in the gaps for this part of the ocean.

As the ROV started to ascend, and I watched as the seafloor faded away into the abyss, I realized that this was the end of my time in the control room. Although there were still two more days for the cruise, my thesis guilt was starting to nag at me. Two engineers were to be picked up in Monterey the next morning, giving me the chance to return. I also knew that for the next two days, the missions would mainly involve the positioning of equipment: The Deep Coral Cams deployed on the first day of our trip, and a series of logs to be arranged at varying proximities to test larval settlement patterns. Though these would be interesting to see, I decided I wouldn't be heartbroken to miss them, and that in this particular instance, my desire to graduate this semester had won out.

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Like the day the cruise began, I left the *Western Flyer* when it was still dark out (though at a much tamer 6:00 a.m.). I thanked everyone who was awake, hoping my early departure did not mask how much I appreciated the opportunity to join MBARI on this amazing expedition. Then I stuffed some bread and cashews in my paper cup that had previously been designated for puke emergencies (but was never needed) and headed to the back deck. By now, it should surprise no one that the *Western Flyer* has a crane for lowering a rigid-hull inflatable motorboat into the water. It was calm. "Perfect day to be heading back," a crew member said to me. "Every day here was perfect," I thought. Then the motorboat started moving, and the *Western Flyer* shrank away, and soon disappeared behind the breakwater of Monterey.

Departing the Western Flyer