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Northern Exposure

By Jennifer Steinberg Holland

Rolf Gradinger is getting antsy. Braced against the ship's cold rail, his orange flotation suit over worn sweater and high-water pants, he runs a hand through his slightly wild beard. The knit hat's off again, and strands of salt-and-pepper hair poke skyward as he scans giant rafts of multiyear ice on the Arctic Ocean. So close—yet still out of reach.

Five days into an exploratory research cruise aboard the Canadian Coast Guard's icebreaker *Louis S. St.-Laurent*, the German ice expert, who teaches marine ecology at the University of Alaska Fairbanks, has yet to lay a boot on the frozen sea. Down below, the ship's hull groans as it battles the white sheet—the thickest so far, maybe eight feet—grinding, clanging, and squealing as steel meets ice. Rolf leans over the rail to watch the pointed bow come down like a sword on the massive slab, sending cracks racing ahead like frightened snakes and ice cubes the size of VW Beetles rolling over along the hull. And he waits for the captain to announce that ice research can commence. And waits. That's the way it's been for Rolf and 43 other scientists on a 24-day, 2,400-nautical-mile voyage—jointly funded by the Ocean Exploration Program of the National Oceanic and Atmospheric Administration (NOAA), Japan Marine Science and Technology Center, and fisheries and Oceans Canada. Their collective mission: to explore the Canada Basin, a 2.3-mile-deep bowl in the Arctic Ocean. Remote, achingly cold, and ice-covered for much of the year, this part of the ocean appeals mainly to whales, seals, and polar bears. Only humans bent on exploration, and with the right ship to get here, have reason to visit. And once they arrive, nothing comes easily.

"Plan for logistical nightmares," chief scientist Fiona McLaughlin of Canada's Institute of Ocean Sciences (IOS) had warned on day one. Her words were quickly borne out. Less than 24 hours after leaving the wee Canadian town of Kugluktuk, the *Louis* suddenly turned around and headed back. It had been called on for a search-and-rescue mission. Two Inuit fishermen and a boy were reported missing. The ship's helicopter crew eventually spotted the trio camping on an island, and all was well. But for the scientists, a full day of travel was lost.

Back on course toward the Beaufort Sea, the teams are eager to get to work at 25 scientific stations en route. But each stop deals them another kind of waiting game: for the fog to lift, for the wind to stop, for one study to wrap up so another can begin. Demand is high for deck space and hands, while moody weather and equipment failures add to the strain. Everyone knows there's too much work for the allotted time. The oceanographers want to extract heaps of data about ocean chemistry and circulation from the basin's stratified water column, in part to better understand its links to the global ocean. The biologists want to sample life from the ice to the sea bottom. The basin's deepest waters have lain quiet and isolated for more than 500 years—the oldest in the Arctic—and nobody really knows what they contain. They could house an "isolated Eden," suggests Kathleen Crane, a NOAA oceanographer and the U.S. mission coordinator. Relict species may lurk down deep and in the pudding-like mud.

Rolf Gradinger is here to examine life in the ice. But first he has to get off the ship. Until now, ice has made appearances, but quickly moved on. Its scarcity in the southern Beaufort Sea isn't a big surprise in August (the winter-long freeze-up starts in September) but is still a major frustration both for him and

for the Japanese team, who will need a sprawling slab of multiyear ice ten feet thick in which to embed a buoy strung with ocean-monitoring instruments. "That's just how it is up here," Fiona says after the ship steams all night using ever changing satellite images to chase floes. "The ice keeps moving, so we do too." Also, summertime floes can be brittle platforms, and Captain Martin Marsden isn't taking risks. The ice is too thin here, too unstable there. As his research stalls, Rolf's sweet smile wanes. Opportunities to come all this way are far between and extremely pricey, demanding monumental feats of organization. Plus, there's a bigger problem. Beyond the typical seasonal melt, the sea ice out here seems to be disappearing.

There's no consensus on the extent of the melt. Data from submarines suggest that Arctic sea ice has thinned by 40 percent in the past 30 years. Scientists who disagree argue that much of the thickest ice had been piled up by winds far from the subs' tracks. Some estimate up to 15 percent thinning, a 3 percent loss of area per decade, and cite natural cycles as at least part of the cause. But few specialists deny that the overall ice trend is downward. And the effect quickly snowballs. As more water is exposed, the upper ocean absorbs more sunshine, speeding up the decline.

That's bad news for the animals and people who rely on ice for home and hunting grounds. It's better news for those poised to profit from summertime shipping routes between Europe and Asia, new fisheries, and oil fields on continental shelves—though major economic, ecological, and sovereignty issues may muddle the benefits. Meanwhile, scientists are grappling with the complex phenomena linked to ice melt, including global warming and a high pressure system over the Arctic—one phase of the Arctic Oscillation (see map pages 110-11). That system could shift, turning today's balmy European winters into nasty cold ones, affecting agriculture, energy use, and tourism. Whatever happens, says Rolf, "there's no doubt the ice is changing, which means my work can't wait."

Finally, the *Louis* grinds to a halt, its nose plunged into the floe, and Rolf and his team zip on survival suits and cram wool-clad feet into thermal boots. They crowd into a steel basket, get lowered by crane, and are set free on the ice. Nine thousand feet of dark ocean lies beneath them, but there's some comfort in the giant red ship nearby and in the rifle-slung Inuit hunters, John Alikamik and Joseph Illasiak, scanning the horizon for polar bears.

A team of divers has come too. Sleek black seals in their dry suits, they make their way to the ice edge and slide in, weighed down with video gear and sampling equipment. While Rolf works from atop the ice, they'll be sampling and documenting its complex underside.

Rolf trudges away from the ship to take ice samples. He wrestles the corer into place, bores down, kneels to coax out the Popsicle-like sample from the tube, and moves to the next spot. Later in the ship's shared lab he'll slice up, melt down, and test the samples for microorganisms. His wife, ecologist Bodil Bluhm, vacuums up samples from a blue melt pond (an ice-top pool). Others take salinity, light, and nutrient readings, crouched like orange-suited spacemen probing a pocked, white planet.

Revived by the bustle of work, Rolf is chatty. "There's nothing quite as surprising as animals specialized to live in ice, in six months of darkness," he says. "Think of putting a plant in the freezer with the door shut for half a year—it's sort of like that. But somehow life has found a way to stay healthy despite the conditions. The ice cores we take out here are full of life. It's still incredible to me."

After five hours on the ice, the researchers pack it in. They've got what they need—at least at this station. Dodging melt ponds, they drag sledfuls of gear to the base of the ship and load the basket for the ride back up. Once fully thawed aboard the *Louis*, Rolf will get his first look at the ice's underside via the divers' videos. "Look! See that?" He points at an amphipod, a common, knuckle-size crustacean. "This perspective tells me so much about how these animals use their environment." And then, finally, a surprise. Caught on film are Arctic cod—a key species in this ocean's food chain—tucked away from predators' jaws in under-ice crevices. "It's a microhabitat we've never documented for these fish," Rolf says excitedly. He rewinds the tape and watches it again. "There! There!" His grin widens each time the hiding fish

come into view.

As Rolf proceeds with his work, others wait anxiously on board ship to begin theirs. Marine ecologist Russ Hopcroft stands with arms crossed and gaze fixed on *Global Explorer*, the sunshine yellow remotely operated vehicle (ROV) parked on the forward deck. The brand-new device can dive to 9,800 feet and zip around for hours, piping back video so the scientists topside can *oooh* and *ahhh* as life-forms zoom into view. "The ROV is key," says Russ, who like Rolf teaches marine science at the University of Alaska (where he's the type of professor to yell "Holy copepod!" if the moment lends itself). "It gives us a first look-see, allowing us to answer the question, Who's there? Any new species? Any species at all?" The robot also has a vacuum wand for gathering live samples intact—vital for identifying species. This will be the first ROV dip in the basin, and a lot is riding on its success.

Problem is, besides two shallow test dives, *Global Explorer* hasn't gotten wet yet. High winds one day, around 30 knots, mean no deployment—the ROV's insurance cuts out at 15. Later, a mechanical failure takes hours to repair. "After all this work, no one wants to come up empty-handed," Russ says. Knowing what's at stake, the ROV engineers work overtime to tweak the system into shape.

And on the seventh day, the waiting is over. The ROV finally splashes down for a long zig-zag trip through the water column. And though the depths appear relatively impoverished, they reveal some strange and wonderful things never before recorded here. In a trailer on deck, a half dozen notebook-toting scientists crowd around monitors to record the jellies and other pulsing pelagic life-forms flying by. Later they'll see the benthic (seafloor) treasures: eelpout and sculpin fish, a ray, an occasional anemone and sponge, and long tracks in the mud where polychaetes (marine worms) made their way, perhaps yesterday, perhaps hundreds of years ago.

The remote view is eerie. It's inspiring. But for the scientists it's not enough—especially with a third of the trip already over. When attempts to snag living animals in deep water with the ROV fail, the teams disperse, hoping for more dives to come, but for now they turn back to basics. The "mud group" relies on a box core—a cable-tethered, 200-pound steel container with a scoop jaw that bites a chunk from the seafloor on impact—to bring up loads of muck for sifting, archaeology-style, in search of life or remnants thereof. Russ reverts to an even lower tech solution. He goes fishing. "If we can't go down to it, we'll bring it up here," he says, hauling up the remarkably primitive ring net—basically a nylon windsock sewn to a five-gallon bucket that's dragged through the water on a cable. Seawater sloshes onto his boots as he lugs the bucket to the lab to take a peek at the sample.

The pelagic micro-zoo is enchanting: Candy red copepods, transparent larvaceans inside mucous "houses," and tiny jellies whose cells refract light to create oily rainbows, their fragile tentacles askew after the wild ride to the surface. Russ peers into the bucket with a flashlight, grabs an eyedropper, and slurps a single animal from the bouillabaisse into a petri dish, then slides it under the microscope.

Hunched over the scope, Russ has the mad scientist look down pat: thin red hair and beard disheveled, sky blue eyes and grin mischievous. An arrowworm, he says, gently poking the twitching, translucent sliver of a creature with tweezers. "It looks harmless, but check this out." He zooms in and refocuses. "It has these teeth folded against the body that hinge out, like pocketknife blades." Demonstrating, he grimaces for dramatic effect, snapping his forearms out, hands clenched into claws. "This thing's an ambush predator, hunting mostly by sensory hairs along the body, which tell it something is in range. Then"—he seizes invisible prey and bites the air—"it strikes."

But there's more. The animal is heavy with young and amazingly begins to release them then and there. Could this late season birth represent an adaptation to climate change—animals making use of longer summers—or simply a normal feat in this basin? Probably the latter, Russ says. Productivity blooms later in the Arctic than anywhere else. Either way, the data are invaluable, another bit of the baseline that will allow scientists like him to assess change down the line. "If we don't get a handle on now, when we look

in 2100, how will we know what's happened?" Russ asks. "It's like this: If the whole world were a city, how would we know that it used to be forests? If we care about change, someone has to record this stuff now."

It's not only about biology, of course. For the physical and chemical oceanographers, the sea pulses with other kinds of energy—shifting currents and temperatures, salinity-stratified waters, freshwater intrusions—the sea's complex inner workings. Adding to a decade of data, scientists at each station have lowered a bulky rotunda of monitoring instruments called a CTD/Rosette (conductivity-temperature-depth), which captures a real-time, detailed snapshot of the water column and brings back samples, from as many as 24 depths, for analysis. Now, with the end of the trip looming near, it's time for one last epic undertaking.

Mary-Louise Timmermans fidgets on the bridge, tapping numbers into her calculator and checking data on her laptop. Her brown hair is slung back into a tangled, careless bun, her slender fingers moving at lightning speed. From up here she monitors technicians and crew assembling a 10,000-foot-long vertical mooring—a string of instruments, some tiny, some hefty, to be anchored in the water like a data-collecting charm bracelet. It will stay put for two years, promising priceless oceanographic information on temperature, currents, and ice thickness and movement—and a research paper for Mary-Louise, if all goes well.

"This gear is worth the next 20 years of my salary," groans the young Canadian scientist. Down below, the crane shrieks, its arm dipping into the ship's hold to retrieve the various devices. Mary-Louise runs the show like the air boss on a carrier, calling down instructions on a walkie-talkie. Each piece must be placed at a precise depth, or the project could flop. Plus, the whole thing is hard to maneuver and the line extremely delicate.

"You can't be too careful," Mary-Louise says. "The strand holding it all together is like dental floss. It can't be snagged or swiveled."

Then, as if on cue, the walkie-talkie crackles with a frantic voice from below. The Kevlar lifeline of the mooring is nicked and could snap at any moment. "We have to put a man over the side to secure the line or we are going to lose it!" someone yells.

Mary-Louise is gone in a flash. She races down three flights to where the crewman struggles to secure the precarious, dangling line. Others scramble to prepare a splice to replace the damaged length. Strong coffee makes rounds. The line is repaired.

Thirteen hours after the team began, in goes the caboose—that last orange buoy—and the massive string of instruments is yanked beneath the surface by the mooring's anchor spiraling to the ocean floor. The deed is done, and the deck explodes in cheers. Arctic field technician Doug Sieberg whips a loonie—the Canadian dollar coin named for the bird that graces its front—across the water like a skipping stone, a sacrifice to Neptune, he explains. He had thrown one in at the start too, to "grease the skids." In triumph, he pumps a fist into the air. "For us mooring folks," he says, "this is the pinnacle." He swivels his hips and shuffles his feet, dancing happily.

And then, after more than 20 days at sea, the ship is steaming home—for the scientists, all too soon. Of course there's plenty to do on land: analyze samples, identify species, write papers. Once compiled, their oceanographic and biological data will provide a much-needed foundation for future studies. And months after the trip they will meet to reveal some intriguing results, including a new jellyfish species, a collection from the benthos of 10,000-year-old otoliths—fish ear bones—whose chemistry can fill in gaps in the climatic record, and a novel microorganism in the sea-ice brine that may dine on ocean contaminants.

But visions of an isolated Eden have faded. The basin didn't pony up a fun house of oddities. Several moorings are in place (including the Japanese team's), promising years of data. But conclusions? Not yet. Is all the waiting, the frustration, the uncertainty of exploration worth it? Absolutely, says the mud team's Ian MacDonald of Texas A&M. "Big breakthroughs often happen just because you are there, and BOOM, something new," he says. "This kind of science encourages that kind of discovery. The peer review system doesn't

really accept it, isn't happy with pure discovery. But that's how the best stuff often happens."

And so the journey ends, with the *Louis* anchored off Point Barrow, Alaska, the researchers awaiting helicopter transport to land, and an intense and welcome sun hitting the deck. A small group, having peeled off fleece and wool, gathers to watch a pod of bowhead whales blowing fountains off the starboard bow. These marine beauties, like a mother polar bear and cub spotted days before on the ice, are clearly the ambassadors out here, obvious reasons to care about climate change. But behind the scenes lies the machinery, still poorly understood: the ocean's chemistry, its movements and sources, the transient ice, and the microbrewery of nutrients sustaining the copepods and cod that feed the seals. Without these there would be no breaching whale or great white bear.

A bellwether for global change and a pool of virtually untapped information, the Arctic Ocean may hold the key to the planet's future. It's also the perfect stage for a magnificent grand finale. The last night at sea, in a moment of clarity, brushstrokes of color streak the dusky sky, the aurora borealis bidding the visitors farewell.

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