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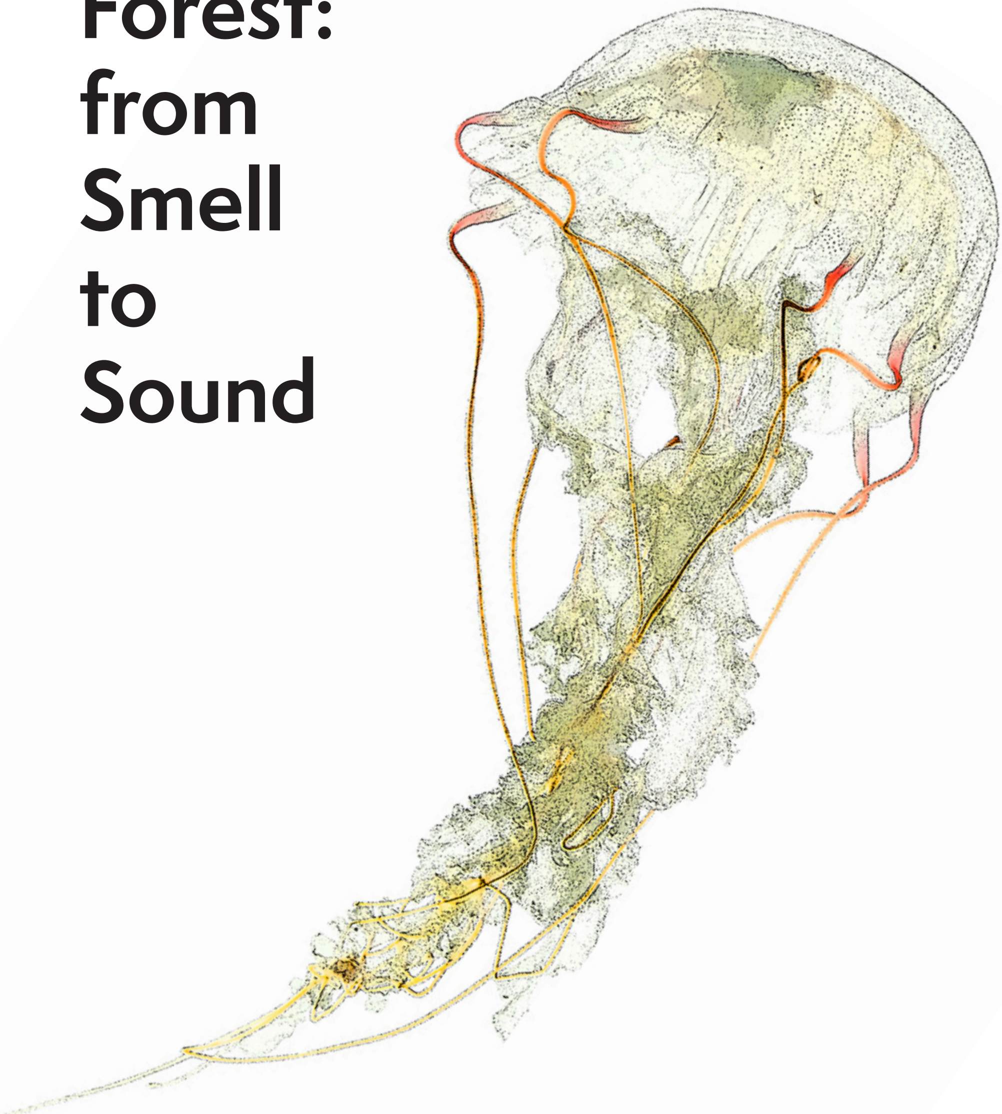
Invisible Kelp Forest: from Smell to Sound



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ABSTRACT

Invisible Kelp Forest: From Smell to Sound is a speculative fiction and an 8-channel sonic composition that explores the possibility that *sound* is an ideal medium for translating senses of *smell*, or chemosensation underwater. It invites the listener to smell the kelp forest with their ears, a mode of synaesthesia. We explore the ways that sound and smell can both convey intensity, distance, dispersion, texture and elements of memory that may be specific to particular organisms. We imagine that the olfactory memory of the kelp forest is multiple, linked to what is meaningful for different marine fauna. In a literary narrative that explores the sensations of four different marine organisms, we develop sonic impressions of their chemosensory experiences of the kelp forest in a scientifically-informed manner. *Invisible Kelp Forest* plays with invisibility in several ways: by denying the listener any visual cues, they must use their imagination to conjure a spatial sense of the kelp forest on their own. We invite listeners to pay attention to the way that listening for smell feels in the body, perhaps deterritorialising the sensorium.

Artist's statement:

'Invisible Kelp Forest' is a collaboratively-written speculative fiction. It draws formal inspiration from Ursula K. LeGuin's 'Author of Acacia Seeds', which itself is written in the style of a scientific report in a hypothetical journal. LeGuin's original story imagines how human scientists might come to decipher the writing forms of several organisms. We offer a variation on LeGuin's story by changing the imaginary scientific discipline from 'thero-linguistics' (beast languages) to 'sensorialogics'. Our objective was to imagine translating not writing, but the sensation of underwater olfaction. In the story, we substitute our own names/initials for the fictional scientists that LeGuin uses. Research for 'Invisible Kelp Forest' was based on our site-specific research snorkelling the kelp forests Santa Barbara, supported by a grant from the Ocean Memory Project and we are grateful to Christoph Pierre for allowing us to observe the porcelain crabs and spiny brittle stars at the tanks he manages at UC Santa Barbara. 'Invisible Kelp Forest' has four companion pieces translating underwater smell into sound, composed by Eli Stine, which we encourage the reader to listen to along with the story that follows.[1]

1 https://www.melodyjue.info/media (linked files are Open Access CC BY-NC-ND 4.0).

INVISIBLE KELP FOREST

Special issue of the *Journal for the Study of Sensorialogics* (formerly Therolinguistics)

Editorial

The Journal for the Study of Sensorialogics is greatly in debt to Dr Ursula K. LeGuin, whose foundational report, 'The Author of Acacia Seeds', remains a canonical study in the field. Looking back in the years since she first penned the study, much has changed – even the name 'Therolinguistics' has shifted to 'Sensorialogics'. This change was made to include more lifeforms than just animals, and more media than just writing. 'Sensorialogics' attempts to translate the sensory worlds of plants, animals, algae and microbes, and unfurl how these sensory worlds give rise to particular kinds of logicality. Sometimes the art of translation takes place in the medium of writing (as you read here), and sometimes necessarily takes place in another medium, such as sound.

Over the years, varied critiques have been made of Therolinguistics; even as it famously reoriented how we think about modes of environmental communication, it tended to hide the practices and sensory habits of the Therolinguists themselves, obscuring their presence in the field and only recording their observations. Dr LeGuin's meditations on Ant writing came close to making human sensory biases more apparent through her noteworthy distinction of revaluing the emotions we project on 'up' and 'down'. In this analysis, she showed how in the lifeworld of an ant, 'up' connotes the danger of being away from home, and 'down' connotes safety and security of the nest – hence her brilliant translation that the inscription of Ant-writing 'Up with the Queen!' mostly closely meant 'Down with the Queen!' in human terms. Yet more needs to be done.

In this special issue of the *Journal for the Study of Sensorialogics*, we have curated four new sensory translations that take place within giant kelp forests in coastal California. These translations are speculative, accompanied by observational context. As members of the oceanic branch of *Sensorialogics*, we have prioritised the chemosensing of four different organisms: porcelain crabs, spiny brittle stars, microbes and the sporophytes of giant kelp. Chemosensing is of particular importance in the lively, mineral, always-in-motion waters of the ocean, and prompts us to ask new philosophical questions about our own sensory norms.

If a logic is a kind of reasoning that follows specific principles, A. Yermakova theorises that logicking is the logic that emerges through the performance of being logical.[2] This is a form of knowing through doing – a mode, perhaps, of gerunding. Living organisms perform their own sensory logicking in ways that could never be entirely predicted by reading the scripts of their DNA; for example, one would be hard pressed to predict the wavy dance of the spiny brittle stars, which we discuss below, from genetic code alone. A focus on logicking lets the organisms retain their mystery, avoiding the sticky philosophical questions about consciousness, intention or whether or not behaviours are programmed. In our case studies, we examine embodied logicalities that are specific to the milieu of the ocean, which – as M. Jue reminds us – can be challenging to do from our own tendencies to think terrestrially.

We hope that our new translations will continue valuable work in Sensorialogics and encourage a greater awareness of human sensory habits, and a softening of these habits, akin to the kind of softening of tension when you breathe in and out to invite a muscle group to release during stretching. Our translations are experimentations in comportment, and you might feel compelled to move, bend or twist your body to try out the forms and movements that we will describe. We hope these four sensory translations offer the reader a renewed sense of wonder and humility about their own *Umwelt*, or sensory bubble. What you ultimately do with an expanded awareness of alternative ways of being in the world is to be determined.

Our translations play with several kinds of invisibility. In one way, we focus on organisms that hide (like crabs) and organisms that are microscopic (like part of the lifecycle of giant kelp), neither of which you would be likely to see if you were to swim or snorkel on the surface of the kelp forest. Yet invisibility is not only about objects one can't see, but about non- or sub-visual sensory modalities that saturate the waters and bodies of the kelp forest. Our translations tune in to the

2 On logicking as performance and practice, see Anya Yermakova, 'An Embodied History of Math and Logic in Russian-speaking Eurasia'. Doctoral diss., Harvard University Graduate School of Arts and Sciences, 2021: https://dash.harvard.edu/handle/1/37368370.

chemosensory worlds of kelp forest organisms, and connect modes of sensation.

In the spirit of Dr LeGuin, who famously offered a ballet as the best translation of the bubble writing of Adelie penguins, the following report is but one component of our translations of the chemosensory worlds we explore. E. Stine has developed an acoustic translation, which we invite you to listen to while reading our descriptive report. A. Yermakova encourages you to think of the report itself as a kind of musical score for chemosensing, a notation from which one might develop other improvisations and embodied engagements.

It should be noted that E. Stine's work is not a sonification, a mode of assigning a particular sound to a particular data value, but a translation – understanding that the work of the translator is never the same as the original, but involves interpretive choices that constitute a new creative work. As you listen to E. Stine's composition, we ask the reader to avoid the habit of assuming that one sense is restricted to one organ. In the immense world of the ocean, to use E. Yong's phrase, sometimes one smells and hears with the skin, a distributed mode of sensing whose implications we will unfold below.[3]

M. Jue, J. Cram, A. Yermakova and E. Stine

A Percussive World [Porcelain Crabs]

Giant kelp forests commonly grow just beyond the surf zone, a frothy and turbulent environment that occasionally presents a physical challenge to aspiring students of Sensorialogics. Yet much can be observed even from the edge. As we shuffled and stooped over the fluffy white foam,[4] we felt a light spray on our faces, the metallic scent of cold ocean.[5] At the same time, we noticed that the opposite process was happening underwater: so many tiny air bubbles mixed into the water, giving

3 Ed Yong, *An Immense World* (2022). We have kept references light throughout the text, since this is a work of speculative fiction that happens to take the form of a report.

4 A. Yermakova notes that whitecaps – waves beyond the surf zone, caused by the wind – are called 'little lambs', or *barashki*, in Russian.

5 Perfumer Yosh Han, who is also a diver and a sailor, has noted the metallic qualities of ocean scents.

the visual appearance of uncorked champagne – a process called bubble entrainment. Would oceanic creatures smell the fragrance or stench of these bubbles, the chemosensory equivalent of auditory staccato, misty bursts of odiferous air? Would the surf zone be a place of such rapid mixing that few smells could be detected, much less acted on (or chased)? Would smell be difficult to isolate from the percussive crash of the waves, the beating sun, the pull of the tide and the flick of the wind? Everything was in movement; even the egret, wading through the surf, as A. Yermakova noticed, used a meandering sideways walk to compensate for the loss of balance as each tidal ebb pulled the sand from under its feet.

One of the hidden creatures in the surf zone is the porcelain crab, a small creature that lives under and around rocks. Although there may have been porcelain crabs at one of our snorkel sites – a foamy entry point perilously guarded by submerged rocks and slicked with plumes of feather boa kelp – we did not dwell long enough to check. Instead, we visited the aquarium of C. Pierre, a university collections manager, who had a dozen Porcelain crabs in a small acrylic tank. Porcelain crabs are not true crabs, but evolved into a crab-like shape from squat lobsters. As J. Cram reminded our team, Nature has made many attempts to evolve a crab (a process called carcinisation), which 'simply must be a favorite form'.[6]

Many lobsters and crabs have chemosensory hairs on their legs and feet, distributing the sense of what we would call smell/taste along each appendage. To a human observer, the sensory worlds of crabs and lobsters exhibit synesthesia – a simultaneity or confluence of two senses, taste and touch. We must be careful not to fall into the trap of assuming that chemosensation is distinct from other senses, just because our skin doesn't act as a nose or tongue. In addition to the simultaneity of taste/touch, we suspect that acoustics are also extremely important to porcelain crabs. For comparative analysis, A. Yermakova lowered a hydrophone into several crustacean-bearing tanks. We heard sharp clicks in one tank, and C. Pierre offered to capture the culprit – *Alpheus clamator*, an inch-long twistclaw pistol shrimp – to be examined by hand.[7] In the tank with the porcelain crabs, A. Yermakova only noticed the gentle

6 Direct quote from Jacob, channeling Randall Munroe, https://xkcd.com/2314/.

7 This came with the risk of being pinched, but M. Jue extended a hand anyway.

sound of bubbling water. At first she thought it was the aquarium setup, until she lowered the hydrophone into the next-door tank with no crabs: no sound of bubbling water! The crabs – which were busily filtering water for bits of their favorite krill with their feathery appendages – must have been producing the sound of the bubbles mechanically, through the acoustic properties of their shelled and hairy bodies. We gather that the experience of being hard-shelled does not predestine the crabs to create only sharp sounds – the porcelain crab's flutters were as soft as our own breathing.

What is it like to sense the world as a porcelain crab? Imagine that the entire shell of your body is a percussive instrument, a drum that tastes the world around you. You might click and clack on rocks, or you might sweep and aerate the water around you, filtering for plankton. You perform a logic through the rhythms of your tasting. Your most vulnerable moment is when you moult, stepping out of your hard shell so that your new, soft shell can expand out into a larger covering. The experience of moulting might be like re-stretching the skin of a drum, the quiet pause that you take before resuming your percussive tasting – producing sounds like bubbling water, a gentleness that belies your hard, resonant exterior.

The Dance of Olfaction [Spiny Brittle Stars]

One of the most profound biases that we bring to the study of olfaction is the assumption that it has to involve a nose – an organ for smelling. This is not always the case in the ocean, when important chemical cues might be wafting in seawater. Spiny brittle stars do not smell with a nose, but with their whole bodies. Relatives of sea stars, they take the name *Ophiothrix spiculata* (ophio- meaning 'snake') for their long, bristly arms that can voluntarily break and regrow. Spiny brittle stars are extremely mobile and can move quickly when distressed – one arm leads, while the other two pairs heave its body forward through rapid jerks. This was not the behaviour that we witnessed for acquiring food, which involved far more fluid movements. The conceptual leap that needs to be made is that chemosensation in the ocean has to be thought of spatially, in three dimensions, attentive to degrees of stillness or turbulence and the positionality of the observer.

We first observed spiny brittle stars at the campus aquarium with C. Pierre. A large rectangular tank contained piles and piles of them – some resting on each other, others half-buried in sand. It was the lowest tank of a stack of three, with water flowing between them. We conducted a brief experiment by pouring the delectable, fragrant juice of chopped-up squid into the upper chamber. The squid juice was slightly purplish, and flowed readily into the stream of clear seawater. We then squatted and peered over the tank to watch the gradual diffusion, tensed but still as we awaited a reaction. It was not as we expected: as the juice reached the tank of spiny brittle stars, the spiny brittle stars did not try and chase down the smell. Instead, they raised their long, spiculated arms above them, expecting to grasp their usual food (fish flakes, according to C. Pierre) and bring the small fragments towards their hungry mouths. It was a moment of smelling/tasting in place. We inferred that the squid juice was clearly something the spiny brittle stars could chemosense – not so much a dinner bell, as a cue to begin doing a small dance in place.

Imagine the act of smelling as a kind of shiver that runs fully down your arms and legs, a rolling prickle preparing your whole body to become available for action. On a chemical level, the squid juice activates the receptors on your skin, your muscles, your fascia. It is a full body response. Observers might call your movements a dance, but what emerges isn't choreographed. You aren't thinking of intricate patterns that would be beautiful to watch, or of an ordered sequence of movements. Your dance is an improvised response to this smell-sensing, and you swirl your appendages to concentrate the sensation more fully. The creation of motion, of turbulence, is a strategy to draw the smell – and maybe tasty particles – closer to your grasping tube feet. You move not to chase down prey, or locomote, but to waft tasty particles closer to you, undulating your arms in place. In this dance, you do not worry about where the smell is coming from, like a detective. Your logicking is source-agnostic. Much like a contact improvisation dance (whose nickname 'armpit dance' is appropriate here), you unfurl your arms in constant contact with the water.[8] The axis of olfaction is not a centre (a nose) but your five appendages rotating through space. Smell is immanence.

Tumbling the Arrow of Time [microbes]

How do smells disperse in different parts of the kelp forest, and to whom does this matter? Predisposed as we are to sight, our team snorkelled to

8 'Armpit dance' is a term used by Jurij Konjar and other improv dancers.

several kelp forest locations with a syringe of green fluorescent dye. This technique was less precise than the one used by A. Alldredge, who engineered a spear-gun-like instrument for deploying dye at a distance to track sinking particles. We quickly realised there was wisdom in such a set-up, given our own difficulty in not accidentally drifting into the cloud of fluorescent dye at close range. Thankfully, our wetsuits were not stained, but the ocean reminded us of a beautiful epistemic lesson – that observers are always entangled with the situations of observing.

The fluorescent dye exhibited dramatic differences in dispersal, depending on where we released it. It disappeared immediately if released in the surf zone, its signature bright yellow-green cloud erased by the next coming wave. But in water surrounded by thick giant kelp, it lingered the most – emerging from the syringe as a bright silken fabric billowing into many folds, as if swirled by an invisible dancer. It formed a soft, hyperbolic origami of thinning sheets before stretching out into mucus-like strings in a vaguely glowing cloud. The behaviour of this drift brought home the realisation that giant kelp forests create pockets of slower water where, unlike the surf zone, chemical gradients might become temporarily sensible instead of immediately churned. If this is true – if slower water helps establish more persistent chemical gradients – it seems that we should always consider seawater movement as a force affecting the sensation of seawater chemistry.

Flows, currents, turbulence – all of these circulate through the soup of the ocean, laden as it is with swirling life forms, minerals, particles and more. Such conditions matter to oceanic bacteria, which use chemical gradients to navigate. Yet here let us pause to note that 'navigate' for bacteria is quite different than it is for humans. When we navigate, we might use a map, or an abstract representation of space. Not so for the oceanic microbe, which completely lacks a map, and instead engages in chemotaxing. Like the spiny brittle star, ocean microbes smell with their whole bodies – but for different physical reasons, having to do with their microscopic scale. Ocean microbes are spherical, rod, spiral or crescent-shaped beings – many are surrounded by two or more flagella. In order to move, the flagella link together in a corkscrew shape and spin in the same direction, motoring the organism forward. The microbe detects chemical concentrations as a way of determining whether or not to continue moving forward. If the microbe senses that it is moving towards a lower concentration of an appealing chemical, it is more likely to stop, tumble, and randomly move in a new direction. In this way, ocean microbes distinguish between *gradients* rather than *objects* – a world of cloudy thicknesses and wispy thinnesses. But what about the experience of making contact with a fluffy particle of marine snow? From a microbial perspective, tuned to a world of flowing chemical trails, would encountering an object feel like hitting a sharp gradient, the sudden surprise of a tasty encounter?

Imagine sensing and describing the world only in terms of concentrations or gradients. You could move 'towards the concentration' (forward) and 'away from the concentration' (not forward) – for example, the ammonium wake of a fluffy particle in the ocean.[9] Upon sensing this trail, you pick a direction and begin to move. If the concentration becomes too faint, you might stop, tumble, and then begin swimming in a new direction. If this was the sensorialogic that framed your world, how would you spatialise time? Would the future or past be a gradient towards which you continually move, and sometimes get wrong? What about the pause of tumbling?

Consider how we think of tumbling across terrestrial and cultural situations: tumbling might imply the motion of spinning or a state of disorientation. If you tumble forward, you may have stumbled or lost your equilibrium. You are no longer grounded, your weight balanced to the force of gravity. Tumbling can also refer to gymnastics/acrobatics, a fight, amorous relations or simply a method of mixing a drink. The a-directionality of tumbling can be exciting or frightful, depending on whether control was voluntarily given up or not. Even for us, tumbling may involve particular conditions of cognition and somatic awareness, such as an intensified attention to gravity, weight, and balance.

For the ocean microbe, tumbling embodies a distinct form of logicality. It is not disorientation, but a form of calculation, an embodied mathematics, the precondition for the making of a directional choice. J. Cram compares ocean microbes to dice – a tempting metaphor at the

9 The human characterisation of 'up-gradient' implies 'more of' something, as if it were a pile on the floor, while 'down' means 'less of' something. We must always watch ourselves for such moments of terrestrial bias and cultural bias in our orientations. For example, not every culture imagines the future as 'ahead' and the past as 'behind'; for the Aymara people, the past is ahead and the future is behind, unseen. What is the arrow of time in an ocean world of varying gradients? If the microbe could philosophise, where would it locate the future?

level of form and function, since microbes are both physically round and probabilistic in how they determine a direction in which to move. Their agency is in the act of tumbling, not in the direction taken. Forward is movement towards a density that you like, and not-forward is the pause that you take to calculate a new angle to turn. Forward is confidence, not-forward is contemplation. In the turbulent and watery world of ocean microbes, perhaps it is normal to never be oriented, sensing the contours of chemical gradients in a map-less game of olfactory Marco Polo.

Invisible Kelp Forest

We have presented speculative translations of the sensorialogics of porcelain crabs, spiny brittle stars and microbes, each with different relations to invisibility. They are invisible because they are either very small or good at hiding in place, which makes these creatures somewhat difficult for us to observe. Yet we have also highlighted the invisible contours of their chemosensory worlds, and how their modes of sensation give rise to different sensorialogics. What we are calling the 'Invisible Kelp Forest' includes not only unseen organisms, then, but unobserved sensory ways of being in the world. The kelp forest is, after all, a metonym that includes not only *Macrocystis pyrifera*, the giant kelp, but also the full ecosystem of organisms that make their lives within the forest.

We have saved the question of the giant kelp for last, the keystone species in the undersea forest that can grow hundreds of feet long. Sometimes several strands of giant kelp braid upwards in magnificent ochre columns, stretching from the seabed all the way up to the surface of the ocean. At this limit, their orientation shifts and the giant kelp grow sideways, forming long floating plumes of canopy. This is the visible part of the kelp forest, the sporophyte phase, that has earned the terrestrial nickname 'redwoods of the sea'. Indeed, giant kelp exhibit many tree-like structures: a root-like holdfast to grip rocks; a trunk-like stipe to extend skyward; and leaf-like blades that photosynthesise sunlight, absorb nutrients from the soil-like seawater and produce zoospores.[10]

As snorkellers floating in the canopy of the giant kelp, we could see the sporophyte (giant) phase, but not the other generation in its life cycle. This alternation of generations requires some reorienting of

10 In evolutionary history, giant kelp is a type of macroalgae, and thus an older form than terrestrial plants and trees.

human norms. Imagine you produced children who looked *nothing* like you, microscopic and drifting along (zoospores). When these children grew to become adults (gametophytes), those adults would also look nothing like you; they would anchor in place and then produce sperm and eggs, which would combine to create your *grandchildren*, who would finally grow to look like you. One generation – yours – would be conspicuously large, growing into giant columnar forms, while the alternating generation would be microscopic.[11] It is a life cycle with two adult phases (sedentary) and two seed phases (zoospores and sperm, drifting) – and thus four kinds of sensory logicality.

Let us start with the sensory logicality of the zoospore – the future forest, microscopic and adrift. It is easy to think of forests as rooted or attached in place, but not so for the tiny zoospore! It floats with the current, wafting along, and can slowly swim through the ocean with the help of two flagella. Although zoospores are denser than water and tend to sink, the buoyant lipids on one side of their body may help them orient towards the seafloor where they hope to anchor. Like microbes, they chemotax towards favorable gradients, and adopt a 'tumble and run strategy' to swim towards a good-smelling environment. This behaviour, along with a propensity to swim downward, eventually brings the zoospore to a pleasantly hard surface in a nutrient rich area, where it will attach and never swim again.[12] Its sensory logicality is twofold: forward / not-forward (chemosensing), and up / down (lipid buoyancy).[13]

11 In *The Biology and Ecology of Giant Kelp Forests* (University of California Press, 2015), David Schiel and Michael Foster note that macrocystis gametophytes are challenging to observe in the wild because they are very small and look like the gametophytes of other organisms. Most of what we know about macrocystis gametophytes is from laboratory studies.

12 The zoospore grows into a tiny and filamentous gametophyte, so small that nobody has ever seen one in the wild. How do we know they exist? Because zoospores grow into these in the lab! This second adult phase then makes sperm and eggs that develop into embryonic sporophytes, which grow into the giant phase of kelp.

13 The giant kelp zoospore senses an array of nutrients, including ammonium, nitrate, glycine, aspartate, iron, boron, cobalt and manganese. While they cannot sense gravity or light, they do sink slowly and have a tendency to float front side down (with the flagella, which pulls located at the front) so they are more likely to move downward than other directions. We wonder: could it smell light photodegrading? Would light impact the chemistry of what it smells? Should we be thinking about smell-light together in our translations, as an *a priori* condition? See Charles Amsler and Michael Neushul, 'Diel periodicity of spore release from the

The sensorialogics of the anchored sporophyte phase could not be more different; indeed, without motility, there must be a different logic. Where zoophytes are microscopic and mobile, the giant sporophytes make decisions about how to grow.[14] Their holdfasts know to grow away from light, towards darkness, forming basket-like structures gripped to rocks, as their bladed stipes stretch in the opposite direction – up, up towards the sunny surface, much like terrestrial plants. What is not known is whether or not adult sporophytes retain the ability to chemosense. The test for chemosensing in zoospores is to put them in a gradient and see which way they swim. An entirely different test – not based on motility – would need to be devised for the giant sporophytes. It is a mystery, then, whether the giant kelp forests *can* smell, or simply *have a* smell, underwater.

We wondered at how different it is to be an adult human. A. Yermakova notes how human children grow rapidly, and slowly gain more agency and mobility as they mature. The opposite seems to be the case in the dual life cycle of the giant kelp: sedentary adults produce a microscopic generation that moves. Does the decision to settle – to become adult – mean giving up a certain amount of agency, sensation or mobility? Or, do we need to rethink the cultural valuations we attach to motion, adulthood and aging itself? Is it a decision at all? Does the thought of being sessile for life bother us? Or does the botanical giant kelp model a different possibility, that an adult might grow continuously? Or is it too much of an anthropomorphism to use 'adult' as a referent in the life of giant kelp?

While these remain questions for future research, what giant kelp dramatically show us is how sensorialogics can be in flux throughout lifetimes and generations. We hope you can feel how the logicality of the porcelain crab differs from the spiny brittle star and the microbe – all under different conditions of motility, and even scale. But what is incredible is that the giant kelp demonstrates such dramatic different

kelp *Nereocystis luetkeana* (Mertens) Postels *et* Ruprecht', *Journal of Experimental Marine Biology and Ecology* **134** (2) (1989): 117–27; Eric Henry and Kathleen Cole, 'Ultrastructure of swarmers in the Laminariales (Phaeophycaea). I. Zoospores', *Journal of Phycology* **18** (4) (1982); *The Biology and Ecology of Giant Kelp Forests* (University of California Press, 2015).

14 Sometimes the zoospore makes a mistake and attaches to a very small rock, only for the entire rock to be lifted away as the buoyant kelp matures, carried ashore by the tides.

shifts in sensorialogics in one dynamic life. Although it is true that we, too, modulate forms of sensorialogics – one might think of how an infant learns to distinguish language, or how hearing might wane for the elderly – the giant kelp seems to exemplify an extreme case of alternation. The giant kelp life cycle is like variations on a musical theme, such as a fantasy or changing moments – forms that have wildly different phases, cued and conducted by the seasons.

Yet we worry about future moments, and the chemosensory memory of the giant kelp forests and all the creatures that live there. Indeed, we visited the giant kelp forest at a time of much concern for the changing climate, of ocean warming, acidification, and anthropogenic pollution.

As a way to better imagine the bubbling and billowing life of the kelp forest, full of scent, we offer E. Stine's sonic compositions.[15]

Melody Jue is Associate Professor of English at the University of California, Santa Barbara. Her research and teaching focus on the ocean and environmental humanities, science fiction, STS and media studies. Professor Jue is the author of *Wild Blue Media: Thinking Through Seawater* (Duke University Press, 2020) and *Coralations* (Minnesota Press, forthcoming 2024). She is the co-editor of *Saturation: An Elemental Politics* (Duke University Press, 2021) with Rafico Ruiz; and *Informatics of Domination* (Duke University Press, forthcoming 2025) with Zach Blas and Jennifer Rhee. Professor Jue regularly collaborates with artists and scientists, bringing experience as a scuba diver to many of her writings.

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Anya Yermakova is a multi-disciplinary artist and a scholar, who researches dynamic, relational and non-binary sense-making. She is interested in embodied understanding, in historical amnesia and in bodies as sites for recovering memories of pre-human evolutionary traces. Her work disrupts assumptions of normative, binary, disembodied logicality and is inspired by the archival traces of experimentalism in logic from the pre-Soviet (early 20th century) Russophone world. Yermakova holds a Ph.D. from the departments of History of Science and of Critical Media Practice at Harvard (2021), was previously a Visiting Assistant Professor of Sound at Oberlin College, an Artist-in-residence with the Ocean Memory Project, at Djerassi, and at UCross, and is currently an ACLS postdoctoral fellow at the Center for Humanities at Washington University in St Louis.

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Jacob Cram is an Assistant Professor at University of Maryland Center for Environmental Science. He is an oceanographer, whose research focuses on understanding the ways that microorganisms interact with their environment, and more broadly how they shape the climate and chemistry of earth. His research spans the open ocean and coastal environments and combines laboratory techniques and computer simulations with the goal of better understanding the ocean. Cram also examines the bacteria that associate with and impact the health of animals including larval oysters and humans. With co-authors Jue and Yermakova, Cram has helped to facilitate transdisciplinary collaborations between artists and scientists, such as this one here.

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Eli Stine is a software engineer, media artist, and composer currently working as an Audio Experiences Software Engineer at Meta (formerly Facebook) Reality Labs-Research. Prior to that, Stine was a Professor of Computer Music & Digital Arts at Oberlin Conservatory. Stine's work explores electroacoustic sound, multimedia technologies (often custom-built software, video projection, and multi-channel speaker systems), and collaboration between disciplines (artistic and otherwise). This work has been mentioned in the New York Times, USA Today, The Wire, The Economist, and on NPR, and has toured Europe, Asia, and India. In his free time Eli (sometimes) waters plants.

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