Karin Pittman

Conversations with Slime

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Slimy gooey stuff is everywhere. From the primordial ooze at the bottom of the sea, heralding the beginning of all life on Earth, to the alkaline hydrolysis of aquatic cremations. From slime we arise and to slime we descend. From the beginning to the end of life, slime remains a transition and intersection, a constant companion between an organism and its environment, attracting or repelling and giving rise to more life. It's a beautiful story, despite some disingenuous facts.

The Great Communicator

While websites overflow with recipes for making "slime" to play with, the real slime produced by living things is not a toy. Slime contains antiparasitic, antiviral, antifungal, antibacterial substances and triggers for the wider immune system. In other words, slime is a communication device. With its molecules and cells there is so much signaling going out and in through this thin transparent layer that some liken it to New York traffic.

This conversational traffic has been the situation for about half a billion years, as slime has protected all aquatic organisms through evolution, ending up lining *our* guts as a continuation of this constant companionship. It is so effective that it has barely changed over all this time—the structure of the skin, gills and gut mucosal epithelia (that slimy layer) is pretty much the same across species including us. If it isn't broken, don't fix it.

Here are some examples of how this "communicating" bioslime works. Take, for instance, the lifestyle of the slick biofilm of some bacteria. If you leave a soggy dishcloth on the counter for a couple of days, the next time you touch it you will notice a textural change to the surface (slimy)—the biofilm has grown in your kitchen, taking advantage of the moisture and the

nutrients embedded in the cloth. Say *Hello*; the bacteria like the new home that you gave them.

Surprisingly this is not limited to your kitchen and is not just a casual *Hello*. In the industrialized ocean sphere, marine infrastructures are contaminated and degraded by slimy biofilms, costing the global economy millions each year. The multispecies communities of bacteria living in that film are able to interact and extract the metals and other substances, even sharing genes to resist new antifouling chemicals. These biofilms produce substances to support their lifestyle "on demand," while effectively outsmarting our primitive strategies of trying to poison them year in year out. Biofouling is ubiquitous, expensive and difficult to combat with current strategies. As late as 1987 these sticky bacterial populations were considered simply random associations of cells (how wrong we were!). As you try to scrub off the expanding fouling on your boat or watch the slowing down of the container ship bringing in new goods, think about the vastness of these small living cells of ancient lineage, how many they are and where they can thrive: brains really are overrated for survival. How is that for a message to communicate?

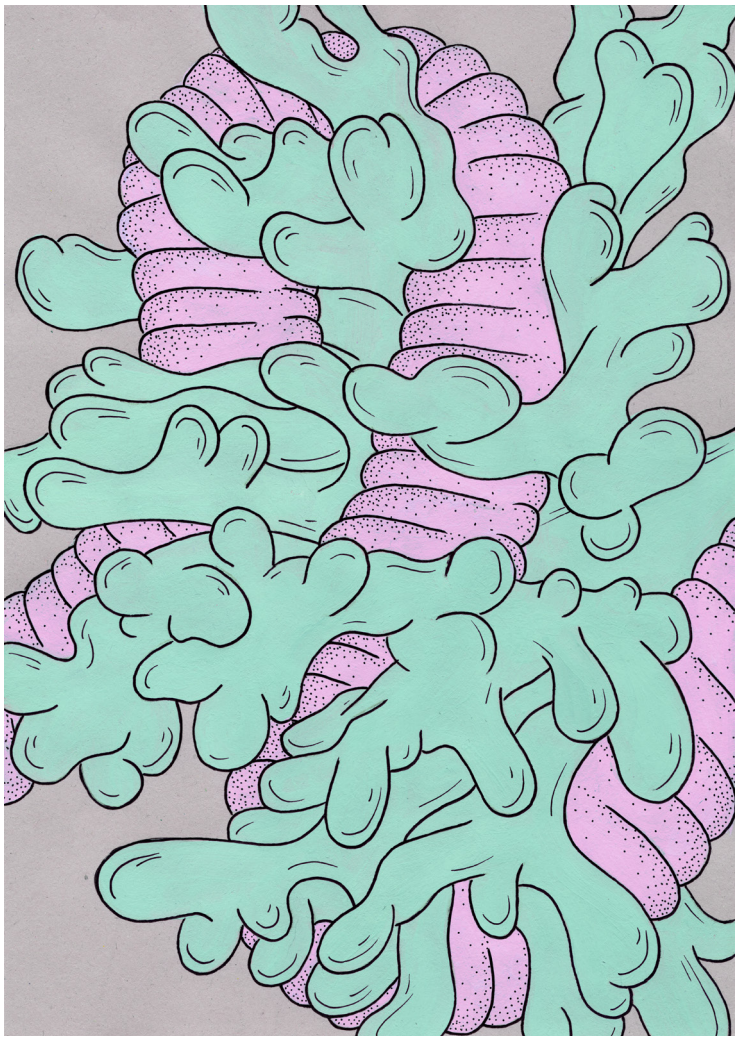
We only have to walk a short distance to see how slime is key on land, too. Stinkhorn mushrooms (yes, they stink) grow on mulch, lawns and bare soil, feeding on dead organic material and recycling the nutrients. They do this rapidly, growing sometimes up to six inches in an hour, even breaking through asphalt, and looking like happy penises. So useful but so stinky. These mushrooms have a band of spore slime, a key indicator of which species is erecting in your garden, which attracts different flies and insects to spread the spores. The position of the slimy band tells you how the stinkhorn mushroom responds to its community members and its sticky spores hitch-hike on selected voluntary transporters.

Slime is not always so subtle. It can be disarming or even weaponized. The charming parrotfish, big toothed and meaty, sleeps at night in its own secreted cocoon of slime. Some species spend an hour every night making this transparent sleeping bag, with mucus that comes from the gills, which, despite their flimsiness, are about half the surface area of the fish. The cocoon encases the scent and is a physical barrier against nasty parasites, acting like a mosquito net, letting sleep descend in healthy circumstances. When weaponized, slime is effective against even predatory sharks. As the shark begins its attack, the hagfish quickly ejects a suffocating blanket of mucus, clogging the gills of the shark and instantly discouraging further interaction. A true shark repellant, the slimy response of the hagfish is lightning fast and many entertaining videos have been made of this.

Between invisible bacteria and large fish, even the limbless slugs and snails use slime in their interactions with each other, their

surroundings and *us*. As a mode of transport (who hasn't seen the trail of a passing snail?) slime is common. But some slug slime has such power that it is used as a flexible surgical sealant, closing wounds on delicate post-operative tissues better than sutures. Here, the stickiness of slug slime is taken to an extreme, containing proteins that strongly bond with surfaces, making a long lasting, waterproof "glue" that pulls the sides of wounds together and supports the cell communication necessary when healing. There is much less scarring when slime is used.

Vanity is promoted with snail slime acting as a skin rejuvenator in cosmetic treatments. The farming of snails in Chile is the starting point of this line of communication. Slime can be exuded by handling, as we have seen, but the Chilean workers noticed their hands were extremely soft and healthy looking from snail farming. The active ingredients in snail slime include glycoproteins, hyaluronic acid and glycolic acid, all of which have documented benefits to skin health. The slime seals in



moisture and then sends other good building blocks through the cells of our skin to make us shiny and bright. Check the ingredient list of your skin cream—slime has contributed there, too. The silent communication between snails and us has become beautiful commerce.

So slime, bioslime, is like a Swiss Army knife of useful applications and interactions, shining and glistening in plain sight, an old familiar subject. Its content is inconstant, produced "on demand." And it talks volumes if we can learn to listen.

This is patently obvious except to those blinded by the "ick" factor. Most people are repulsed by slime, a repulsion which is perhaps a residual fear of disturbing the protective slime environment, or perhaps nature's way of telling us, *Hands off*! As the interactive user-interface between aquatic organisms and the environment, it has proven its vital use over millennia. In salmon farming this outer slime layer, a large part of the innate immune system, is frequently dismantled by procedures which seek to scrub off ectoparasites much like we do in sheep farming. The result can be extreme mortality, with 58 million farmed salmon dying in Norway in 2022 before harvesting and sale. Even a gentle swabbing off this slimy layer on fish skin, to find out what is in it molecularly, can cause notably higher mortality, because it leaves them more defenseless than if the skin is cut. Disarming this protective layer undoes millions of years of natural optimization and adaptation to the environment. This slime is part of the biological arms race, often evolving quicker and more effectively than our chemicals, but still vulnerable to the brute force of scrubbers costing the life of the animal. We could strengthen the slimy communication of the skin instead, so parasites and pathogens make their own decision to detour.

Communication Breakdown

Eat, sleep, slime, repeat. It is an ancient recipe for successful life forms with and without brains. But when the non-verbal conversation is ignored we get an upset correspondent. In humans, this can take the form of irritable bowel diseases where the mucous cells, factories of this slime, gradually disappear. It can also take the form of dry membranes impaired by pollutants and deprived of their full range of protective abilities, or succumbing to the ravages of chronic stress and making a permeable raincoat of the slimy barrier. In fish, when gills are afflicted, these aquatic "lungs" do not breathe well and fill up with slime trying to combat incessant external challenges. The activity of the slimy barrier can also be an indicator of toxicity in the environment, like heavy metals or pesticides, and can tell us much about the (sorry) state of the ocean. Aquatic organisms are succumbing to the futility of signaling to the blind and are dying because of it.

What of the disingenuous facts mentioned at the beginning? We pretend to know less than we do by allowing some falsehoods to persist as part of a beautiful story. Like that primordial ooze, first discovered in 1868 when a slimy substance was found on deep sea samples taken while laying the transatlantic telegraph cable. Gripped by the fashionable "evolution fever" of the day, Thomas Huxley thought it might be a protoplasm from which all

life derived, showing veins and responding to caustic soda, and it was even named *Bathybius haeckelii* after another eminent biologist. He even thought it could be found on the bottom of all oceans. It could not, and was later shown to be an inorganic precipitate when John Buchanan added alcohol to the benthic mud (a common way to preserve organisms) and produced a goopy slime. Huxley admitted his error and tried to correct the public misconception about this "protoplasm." The Goop Troop, however, was stymied by the popularity of this easy shorthand for evolutionary change, and the concept of a primordial ooze from which we all came lives on in myth if not in fact.

But considering slime as a beginning of life is not entirely off the mark. Next time you make use of a bedside tissue, look at what you are wiping. The beginning? The end? Is it life? Slime and its factories have been conducting thrust and counter-thrust between the living and the environment for as long as there has been life. It is the great mediator. A continuous sticky circle of communication in plain sight, a scintillating Morse code for the blind. Respect the slime even if you cannot understand it. The conversation is getting serious.

BIO

Karin Anna Pittman has been traveling the world since before she could speak, and became a biological oceanographer/fish biologist because it was endlessly fascinating and because where there was water she would have a job. As a result she continued to travel and work with FAO, Norad, ICES, NUFU and other organizations as well as being Hon Consul of Canada for 15 years in Norway where she works as a tenured professor at the University of Bergen. She has been focusing on the slimy mucosal barriers of fish, particularly those in fish farms, for the last 12 years by applying a trademarked quantitation of the skin, gills and guts, Veribarr (verification of barriers), to fish around the world.

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