



Biotechnology

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From Hive to Biome: A Personal Reflection on Communities of Knowledge, Service, and Transformation

I was born into a hive: thirteen siblings, nonstop voices, and constant daytoday negotiations. If fish do not notice they are wet, I failed to notice how deeply I belonged to my community – how it shaped my instincts, questions, and work. As I moved from family to school, from university to laboratory, and from neighbourhood to international networks, the layers did not replace one another; they accumulated, refracting who I am and what I do.

As a scientist in environmental biotechnology and a university teacher, I share in a community of curious minds. Every hypothesis I give shape to is an echo of the past – papers I read, prior discussions, comments from students that prompted outside-the-box perspectives. Knowledge is not personal property: it is coauthored across time, geographies and worldviews.

In fact, when I come across a socialmedia thread on urban heat islands, or an official report on stormwater, I am changed – whether I agree with those ideas or not. The inputs, large and small, influence the way I approach problems. The laboratory is never a room alone – rather becomes a permanently evolving confluence.

In my research group we develop tools to preserve and restore water and soil: we evaluate pollutant biodegradation, search for bacteria and other microorganisms for biofertilizers, model behaviours, and explore more sustainable alternatives. Now, even this list reads like a map of interplaying communities: from microbiologists to farmers, from engineers to utility companies and municipalities and the anonymous

citizen, all intervene at some point and leave their mark on every final outcome.

Teaching makes these collective dynamics clear in real time. In an Environmental Microbiology class the first priority is not content but connection: sensing the collective pulse, finding a shared rhythm that allows understanding to happen. A lecture becomes a negotiated pathway – who needs an example here, who is ready to be stretched there. Service begins with listening, which is in fact a communal practice. The same dynamic shows up at home, where I catch myself repeating my parents (“so many people are hungry so don’t waste”) and realize that values ripple across decades, more deterministic than any instruction manual. We do not start from a blank page: our life follows a script drafted by others, even as we choose where to place the emphasis.

I choose to emphasize research with, not for, the communities who may give it some use. When testing a biofertilizer growers are invited into the design phase and get prompted for the meaning of “success” in their reality: not just yields, but risk, costs, labour, and trust. When we simulate pollutant degradation we learn about operational constraints directly from water managers. When we write we’re translating, not just between English and Portuguese but across cultural dialects so that results can travel. Making knowledge usable is both technical and relational; it requires a social bond where information can be mutually felt before it can take root.

Cooperating with colleagues in law and management adds yet another dimension of challenges: the policies and market conditions that throttle or catalyse adoption. Can urban green roofs be advanced by procurement guidelines and better building codes? Can socioeconomic assessments anticipate barriers to biofertilizers so that we design for equity and feasibility from the start? Such questions push the work we do at a scientific level to real world implementation and remind me that uptake frequently involves a disconcerting exercise in community relations. Manufacturers, regulators, funders, farmers, and citizens bring ideas together in a way beyond the ideologue’s control.

There is also a quieter but constant kind of nonlinear fluctuation that unfolds in a scientist’s daily life. A student reframes a problem, or a junior colleague asks an odd question, and the whole group shifts direction. These moments rarely make headlines, but I have come to see them as

the beating heart of academia: we are not only generating data; we are shaping those who will shape their own communities.

Since none of us belongs to a single community, each of us is a carrier. I arrive at any meeting already slightly transformed by the previous conversation, newest lab results, or latest email. I leave that meeting with a new alignment for the following junction. No communities are sealed when even a single person moves between them. Culturally we belong to endless communities, unlimited by physical constraints: we are influenced both by those we'll never meet and those long gone, and we will change those we can never know.

The environmental reality raises concrete and urgent issues. Water and soil ignore borders; microbes do not apply for visas. The biotic community – human and otherwise – demands our sense of belonging extend beyond our own species. When I study biodegradation, I learn from organisms whose agency may elude me, yet whose work can help remediate the harms, even if unintended, of human activity. When advocating for green infrastructure we are effectively designing with plants, fungi, and microbes as much as with people. Community is no longer a metaphor: it is the operational truth of all ecosystems.

What began as the noise of a busy household taught me a durable lesson: more than a backdrop to knowledge, service, or transformation, community is the method and vessel where they come to happen. Knowledge is the collective refinement of attention; service is knowledge rendered shareable and actionable; transformation is the long arc of their circulation through linked communities until practices and policies bend. My role – as with any link in a chain – is modest and tentative. But links matter. If I partner with the communities I am in touch with using scientific rigour, humility, and with an eye to the global web, then the hive hums, the tapestry holds, and the biome breathes just a little bit easier.