

## My Personal View on Science

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# Science Across the Abyss: Knitting Bridges with Butterflies

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### Abstract

Science is built on the pursuit of answers to fundamental questions and the constant expansion of our understanding of the world around us. However, this effort has not been without challenges and inequalities. This article critically examines the issue of diversity in science and the notable disparities that persist in global scientific knowledge. Throughout history, the contributions of scientists from diverse regions and cultures have been pivotal to scientific advancement. Nevertheless, significant gaps in terms of access, funding, and recognition in the global scientific community still endure. We use the concept of the “abyss,” as a metaphor for the disparities in scientific practices across diverse regions of the world within the context of globalization. We seek to shed light on how the abyss influences the very essence of scientific inquiry, ranging from disparities in access to knowledge to the limitations imposed by technology and resources. This article addresses how socioeconomic, gender, and geographical disparities impact who has the opportunity to engage in and lead scientific research. The decolonization of science and the incorporation of indigenous and local perspectives in research are highlighted as crucial ways to address these disparities. Additionally, the concept of participative science is explored as an inclusive approach that allows diverse communities to take part in scientific research. Ultimately, this exploration of diversity in science and disparities in scientific knowledge seeks to inspire deeper reflection on how we can work together to ensure that science becomes a truly global and representative endeavor, enriched by a multitude of perspectives and the collaboration of people from all corners of the world.

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## 1. The Abyss

The concept of the “abyss” that underpins this article is by no means novel and has been previously used by scholars such as Boaventura de Souza Santos (2014). According to him, the Western world is organized around a divide that separates us: one side is visible, while the other dissolves into obscurity as concealed reality. This rift finds its genesis in colonial processes, which sowed the seeds of disparity between the colonizers and the colonized, resulting in contradictions concerning rights and emancipation in the realm of the former, and appropriation and violence in the sphere of the latter. This dichotomy is also mirrored in the

realm of science, where the “truth” on the far side of the abyss is in perennial contention, and where scientific inquiry distances itself from others forms of knowledge prevalent on this side of the abyss. In essence, the concept of the “abyss” highlights the stark differences in circumstances and resources that make the practice of science distinct on each side of the divide, underscoring the social and geographical disparities in scientific knowledge production and access.

In this article, I will use my personal narrative to illuminate how the historical experiences of our ancestors can reverberate in our own academic and scientific journeys, giving us power to act and direction to our effort. Born in Chile in a low income

household during Pinochet's dictatorship, I struggled financially to complete undergraduate studies as a biochemist. Afterwards, several scholarships allowed me to earn a doctorate in France, and to conduct postdoctoral research in Hungary and England. In 2014, I came back to South America, and joined the faculty at the University Regional Amazónica Ikiam, in Ecuador. My scientific journey took me back and forth across the abyss, through different continents, countries and realities, allowing me to obtain a critical perspective of the realities and inequalities of the scientific community, how they span far and wide in space and time, and how they need to be challenged and changed.

## 2. Science Over the Abyss

Why do we engage in science? What are the values we recognize in it? These are fundamental questions that also deeply rooted in the social discourse about science. In many ways, science possesses an emotional quality, a subjectivity of perception that is not always recognized or acknowledged. On the other hand, scientific activity has a very real and concrete impact in society, affecting the lives of both scientists and non-scientists alike. The abyss, in this context, represents the divide in the distribution of scientific knowledge, where the interventions of science tend to serve those with resources to access it. The “why” of science often raises questions about its social equity and justice, particularly concerning accessibility to knowledge. These issues are not new, as seen in the reflections of Jean-Jacques Rousseau in 1750, where he expressed skepticism and a deep concern about its impact on human society. Rousseau believed that the advance of science and reason had led to the corruption of human nature and society. He argued that the pursuit of knowledge and technological progress often alienated people from their natural state of innocence and simplicity. Rousseau was critical of the Enlightenment's emphasis on reason and science, contending that it had contributed to inequality, social unrest, and the erosion of authentic human relationships. Instead, he advocated for a return to a more harmonious and natural way of life, where science and reason were tempered by a profound respect for the human heart and its emotions. These views are still, in different forms, being discussed today, highlighting epistemological challenges that have persisted for almost 300 years.

According to the philosopher Boaventura de Sousa Santos, the abyss represents the idea of a profound epistemological and ontological divide

between different forms of knowledge. He highlights the disparity between the conventional, dominant scientific knowledge, often associated with the Global North, and the marginalized, indigenous, or local knowledge systems of the Global South. This divide, or abyss, underscores the unequal power relations and hierarchies in knowledge production. Addressing this gap is essential for creating a more inclusive and holistic approach to science, acknowledging the diversity of knowledge sources, and fostering a deeper understanding of complex global challenges like climate change, social injustice, and sustainability. Bridging this abyss requires recognizing the validity of multiple knowledge systems and promoting a more equitable distribution of epistemic authority in the scientific discourse. In this regard, I am using the butterflies in this article not only as a model organism for science, but also as emblematic entities symbolizing the ability to traverse the abyss and forge connections between disparate realities.

Irrespective of our location relative to the abyss, we grapple with comparable challenges in our scientific pursuits. The ever-increasing competition for research funding, coupled with limited resources, places immense pressure on researchers. Additionally, issues of reproducibility, inclusivity, and diversity in science persist, highlighting global systemic flaws. Balancing the demands of academia with personal life and mental health concerns adds to the difficulties scientists face. In the modern scientific landscape, researchers often find themselves in power relationships with institutions and funding bodies that may prioritize profit or specific agendas over scientific inquiry. This dynamic can lead to conflicts of interest and compromises in scientific integrity. Additionally, the hierarchical structure within research labs can create power imbalances between principal investigators and junior researchers, affecting decision-making, credit allocation, and opportunities for advancement. Hegemonic academic communities have traditionally favored uniformity and exemplary performance, leaving those who struggle to cope feeling stressed and inadequate.

Scientific research depends on funding, requiring very expensive equipment and materials that are difficult to obtain. From a geopolitical perspective, because scientific knowledge is not distributed in a socially equitable or just manner, scientific interventions in the real world will tend to serve the groups that have the resources to access this knowledge. Where are these groups? The geographical distribution of Nobel Prizes and scientific publications reveals stark inequalities in the

global scientific landscape. Historically, Nobel Prizes have disproportionately favored Western countries, with European nations and the United States claiming the majority of laureates. This inequality reflects disparities in research funding, infrastructure, and opportunities, reinforcing a perception of Western scientific dominance. Interestingly, there is also a significant gender disparity in Nobel Prize awards, with male laureates outnumbering female laureates by a substantial margin. Similarly, scientific publications exhibit geographical bias, with a significant concentration of research output in the Global North, while regions like Africa often remain underrepresented. These disparities in recognition and dissemination of scientific achievements highlight systemic challenges that hinder global collaboration and limit diverse perspectives in shaping the future of science. Addressing these inequalities is crucial for fostering a more inclusive and equitable scientific community.

Poverty, lack of education, and limited research efforts in regions rich in biodiversity are intricately interconnected challenges that perpetuate a cycle of environmental degradation and human suffering. In these biodiverse areas, many communities struggle with limited access to quality education, which hampers their ability to break free from the grip of poverty. The lack of educational opportunities often leads to unsustainable practices that exploit natural resources, further depleting the very biodiversity upon which these communities depend for their livelihoods. Simultaneously, insufficient research and scientific understanding of these ecosystems hinder the development of effective conservation strategies and sustainable resource management practices. Therefore, addressing poverty and promoting education in biodiversity-rich regions is not only a matter of human development but also a crucial step towards preserving the invaluable natural heritage that these regions hold. Effective policies and investments that target poverty alleviation, education, and scientific research can help to create a harmonious balance between human well-being and the conservation of biodiversity.

### 3. The Stories of Our Grandmothers

Human beings are intricate and diverse, and this is also true for scientists. Human minds are complex ecosystems of ideas, where all kinds of influences coexist. Therefore, not only rationality, but also emotions, dreams, intuition and personal narratives are integral aspects of the scientific work.

As Eduardo Galeano once said, “*we are made of stories*”, our lives are narratives, woven from the threads of our experiences, cultures, and ancestors. Stories are the vessels through which we transmit knowledge, wisdom, and emotion across generations, constructing the very fabric of our identities, shaping our beliefs, values, and understanding of the world. Through storytelling we build bridges of understanding in a diverse and complex world. The stories of grandmothers hold profound importance for women scientists. These narratives, often laden with unfulfilled dreams and aspirations due to historical gender limitations, serve as a poignant reminder of the progress achieved and the journey that lies ahead. They embody resilience, determination, and a spirit of overcoming adversity, inspiring the next generation of women in science to break barriers and shatter stereotypes. Grandmothers’ stories instill a sense of purpose, fostering a deep connection between past struggles and present opportunities. They empower young female scientists to not only carry forward the torch of knowledge but also to redefine the boundaries of what is achievable, ultimately contributing to a more equitable and diverse scientific landscape. I am the second woman in my whole family who could graduate from university (the first being my mother). Looking backwards, the women before me were clever, resourceful, motivated, and enjoyed learning. Their context, however, determined that once and again they were denied the opportunity to complete any studies. Growing up, these stories made me angry, but also hardened my determination to succeed in academia, not only for myself, but also as a way of achieving what my grandmothers were systematically denied. That moved me to pursue a PhD scholarship in France, and further postdoctoral stays in Hungary and Oxford. After this, I was expected to find a position in the scientific world; however, the question remained about where to establish myself and in what capacity. To me, at that moment, the academic environment seemed brutal, cold and unfulfilling. There was a huge gap between my past and what seemed to be my future as a scientist, but also, between what I considered to be meaningful and important and the alternatives laid out for me as possible jobs. More importantly, I did not see how my work as a scientist would have any impact in changing the reality of many children, and specially girls, still struggling to get an education, in the same way I did, and my mother and grandmothers did. In hindsight, I can see now that I wanted to save them, through a huge gap in space and time, and I did not know how.

## 4. Persisting in Science: the Power of Butterflies

From Europe, my search for a meaningful scientific project took me to the Amazon region of Ecuador, where I became involved in the establishment of Ikiam University, in 2014. Situated on the periphery of the Colonso Chalupas Biological Reserve, this university was planned to provide quality scientific education to an area previously underserved in terms of higher education. The project placed paramount importance on environmental preservation, research, and the celebration of cultural diversity. However, the university starting from scratch meant spending a long time without the basic infrastructure, equipment and materials necessary to do research. This led some of the teachers to explore unconventional avenues within academia, and I chose to apply the art of knitting for scientific education. Weaving and textile works are practices deeply rooted in indigenous communities, with textiles mirroring their connection to the natural world. As a child, I learned crochet and knitting from my grandmother, and later in life I came back to it every time I felt sad or lost. At Ikiam, knitting emerged as a powerful tool for initiating dialogues and comprehending the interplay between indigenous communities and the local fauna. This undertaking not only empowered Kichwa women but also promoted the conservation of indigenous wildlife. Through these interactions, we succeeded in constructing a bridge between the academic sphere and the local community, surmounting the traditional barriers of titles and social hierarchies.

Once we were able to acquire some equipment and supplies, I decided to establish my research line using *Heliconius* butterflies. I made this choice due to the availability of genetic data, their abundance in the Amazon ecosystems, and their susceptibility to climate change. Our initial focus centered on the expression of heat shock proteins, an area of research that had remained relatively unexplored in Neotropical insects. The initial findings have unveiled potential avenues for future research, particularly concerning epigenetic responses and gene expression in response to environmental fluctuations. In reality, starting from scratch also meant I could have studied almost anything, I could have chosen any model from the great variety and diversity of species that can be found in the forest around the university. But there was another reason to choose butterflies: they can fly over the abyss. In

the realm of biological symbolism, butterflies have long captivated the human imagination. Beyond their biological significance as pollinators and indicators of environmental health, butterflies have assumed a profound symbolic meaning across cultures and throughout history. Representing transformation, rebirth, and spiritual evolution, they are symbols of hope, growth, and the cyclical nature of existence. In my story, butterflies allowed me to establish important and meaningful collaborations with researchers from all over the world, which has brought forth student and academic exchanges, establishment of joint projects with international funding and organization of international scientific conferences and workshops.

Our narrative serves as a testament to the fact that, despite the obstacles and the disparities in geography and culture, science can function as a bridge connecting ostensibly distant realities. Through collaboration, mutual respect, and a willingness to embrace diverse forms of knowledge, science possesses the capacity to flourish anywhere. Science, then, emerges as a potent instrument for forging connections, spanning chasms, and fostering a world that is not only more inclusive but also more sustainable.

## 5. Conclusion

Our experiences on the Latin American side of the abyss have taught us that science recognizes no insurmountable boundaries. While challenges persist, ranging from resource limitations to inequities in access to knowledge, opportunities for collaboration, diversity, and inclusion are equally abundant. Science can function as a unifying force capable of transcending geographical and cultural divides. For that, our personal stories can be much more important than it has been previously thought. The world needs more science, but it needs better science, and this requires the involvement of everyone. It is not just about solving scientific questions; it is also about addressing the great challenges and dilemmas of our society. We live in a complex world, and science must address this complexity. Science needs to be open to different perspectives and needs to consider the ethical, social, and cultural aspects of its work. How can we bridge the gap between science and society? How can we make science more inclusive and participatory? How can we ensure that scientific knowledge benefits all of humanity? These are challenging questions, and there are no easy answers. But there are steps that can be taken to move in the right direction.

We need to move away from traditional, top-down, and hierarchical approaches to science and embrace more collaborative and interdisciplinary approaches that involve a diverse range of voices and perspectives in the scientific process, including

those from marginalized and underrepresented communities. Bridging the gap between science and society is a complex and ongoing challenge. But it is a challenge that we must embrace if we are to address the pressing issues facing our world today.

