

## CHAPTER THREE

# Singing the Morning Glory Blues

## *A Fictional Science*

Walking along the great Prospect of our city, I mentally erase the elements I have decided not to take into consideration. I pass a ministry building, whose facade is laden with caryatids, columns, balustrades, plinths, brackets, metopes; and I feel the need to reduce it to a smooth vertical surface, a slab of opaque glass, a partition that defines space without imposing itself on one's sight. But even simplified like this, the building still oppresses me: I decide to do away with it completely; in its place a milky sky rises over the bare ground. Similarly, I erase five more ministries, three banks, and a couple of skyscraper headquarters of big companies. The world is so complicated, tangled, and overloaded that to see into it with any clarity you must prune and prune.

—Italo Calvino, *If on a Winter's Night a Traveler*

## Prologue

Singing the morning glory blues . . . voice soaring . . . floating through the expansive landscape . . . unhindered, uncontrolled . . . the cadences riding the winds . . . free floating. No obstacles, not limited by the ground or the sky . . . but free to explore, to roam the world, all the world. Free to go where the notes take me, without care, without fears of betrayal or unemployment. Not having to pledge allegiance to a university, a discipline, or an epistemology. No threats, no retribution. No accusations of being naive, unscientific, or delusionally objective. No disdain of playfulness, of stories, of positivism, subjectivism, or emotionalism. . . . What would it feel like, I wonder. Dare I dream? Dare I try?

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How do I imagine a reconstructive project for biology? I do not want to endlessly deconstruct science from the outside, pure and untainted in my epistemological location. After all, scientific work is performed by human actors in relation with their objects and subjects of study. Their rich histories, identities, and social locations, their dreams and nightmares, are entangled in the process of science. I want to keep my hands dirty, tilling the soil to plant morning glories, watching in awe as they grow and then desperately willing them to stop! But I do not want to narrow my vision to this small piece of land. I want to know how this piece of land relates to the city, the country, the world at large, to politics, to poetry and everything else. I do not find the feminist studies of science irrelevant. Rather, they are deeply engaging, productive, and useful. And so, I find myself between disciplines, one that expands my vision, one that narrows it to fine precision.

Inspired by Italo Calvino, I take on the mental exercise of undoing my disciplining. To prune and prune my mental garden . . . to reroute and replace old reference points, those epistemological locations, the familiar methodologies that have ordered my thinking so very easily. Having pruned and weeded and rerouted everything, to learn to live again, to think without those same paths, plants, ground, and walls. The exercise is excruciatingly difficult—I am haunted by memories of my disciplining. Whoever thought it would be so much more difficult to unlearn than learn? I persist.

And so, gentle reader, kick your shoes off, put your feet up, find a nice warm cup of tea or better still a glass of wine and join me in this story told in three parts . . .

#### A Reader's Guide

As I begin a reconstructive project, such as this, you might well ask: what form, style, and analyses can she use that draws from both the sciences and the humanities but still does not belong to either? My answer here is fiction. The story you are about to read traces the intellectual adventures of three high school girls who encounter a group of researchers. The researchers have just begun work on a morning glory field in the girls' town. Each of the researchers asks particular questions that are disciplinarily based. Each is convinced that his or her question is the most important and the most methodologically sound.

The story is told in three parts. *Part One, The Encounter*, introduces the researchers and their individual perspectives and research questions. In *Part Two, The Debate*, the researchers are forced into a conversation with each other. What might the disciplines have to say to each other? Can they learn from each

other to enhance and expand their disciplinary perspectives? In *Part Three, The Synthesis*, I present a fantasy where I locate the three girls in a futureworld of an alternative science, a fictional science. I believe we need not only science fiction, but fictional sciences—imagining other configurations of knowledge making, reconstructing alternate inter- and a-disciplinary lenses, new conceptual practices, and more engaging plots and stories that are located in the interdisciplinary fissures of the sciences and the humanities. As Faye Harrison (1996: 234) argues, “Fiction encodes truth claims—and alternative modes of theorizing—in a rhetoric of imagination.” Now, on to the story . . .

## Part One: The Encounter

I don't like jargon. In fact, the more I write and the older I become, the more I abandon it, by a progressive effort toward the greatest possible clarity. Technical vocabulary seems even immoral: it prevents the majority from participating in the conversation . . . You can almost always find a lucid way to express delicate or transcendent things. If not, try using a story!

—Michel Serres, *Conversations on Science, Culture, and Time*

The story begins in a small town on the outskirts of Chennai called Thirumbaram. And our heroines are Tara, Tulasi, and Tabrez—the Thirumbaram Three, or T3, as they were affectionately called. The three, friends since childhood virtually grew up together and were jokingly called “the national integration project.” Like state propaganda encouraging India's diverse religions, castes, and linguistic groups to get along, the three personified this mission since they came from different and often mutually hostile religious, linguistic, and caste communities. Into their deep, abiding friendship they brought cohesion and stimulated interactions and together created a strong and diverse community. It was a warm summer morning. Dawn was just breaking. T3 strolled down a dusty side road, savoring the freedom of their summer holidays. Their *pavadais* swished around them, their pigtails swinging in the gentle morning breeze. They approached their favorite tree, which had three perfect perches. It had taken them many a summer to find this favored spot; hours of pruning gave each a perfect view of the stunning field of morning glory flowers. The morning air was crisp and the gentle breeze created an illusion of a morning glory field dancing in a beautiful hue of blue. This was their favorite part of the day, staring down on the sea of flowers, glorious in the morning sun. A few hours from now the sun would blaze down on the field, flowers wilting to a quick one-day death. New flowers would emerge the following day, just as spectacular. It was the metaphor of the dying flowers and their dwindling holidays that captured

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their fascination. They spent much of their holidays outside their homes. Their curious minds experimented with plants and unusual physical phenomena that captured their imaginations. They were in fact quite notorious in town for their exploits. But their charm always won people over. People often called on them to fix their household gadgets, help ailing plants, or repair bicycles or cars. Their reputation grew each year.

This morning seemed like any other morning. They nimbly climbed up their favorite tree, only to find that they were not alone. There on Tara's favorite perch sat a man who was as startled as they. They quickly glanced down to realize that the field looked different. Several people were crouched down in rapt concentration. Curiouser and curiouser, they thought. They turned their attention to the matter at hand, to the man on their favorite perch.

The man was sitting with his legs hanging down, holding a book into which he was scribbling furiously. His skin was as white as snow, or the way they imagined snow at least. He was wearing clothes with blotches of green and brown. Camouflage gear, our heroines thought. He was hard to spot. The man seemed startled by the three menacing faces demanding to know who he was.

"I am the Dhanush of Manush," he said. "I am studying all those researchers down there. Observing what they do, watching how they study what they study, whom they talk to. See my data collection book? I score their activities. They study plants, bugs, soil, and rocks, and I study them. You see, we are an international group funded by the Bored Foundation of the U.S.A. What is really unique about this project is that it tries to bring researchers from different fields to work together. Usually, each of us works alone and then publishes our work in our own disciplinary journal. But this project allows us to share our insights and perspectives with each other to create something new. Might the whole be more than the sum of its parts? This is the first of the experiments," he said importantly.

"So what are they studying?" asked Tabrez.

"Why don't you go ask them yourself?" he said, bursting into a fit of nervous laughter. His face scrunched up and his eyes peered brightly through it. It was an unnerving sight. Not wanting to show their discomfort, they chorused, "We'll be back," and deftly scaled down the tree's trunk.

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They approached the first of the researchers, The Vidhvan of Vigyan. He was skillfully inserting a small tube into a flower. His clothes were muddy, his jeans frayed at the knees. His skin was tanned and tough looking. He looked up as the girls approached.

"What are you doing?" asked Tulasi.

"Well," he said, "I am extracting the nectar from these flowers. I will then take this fluid to the lab and measure the sugar content. Why? You see, I am working on morning glory flower color variation. See the variation in flower color? This is one of six sites we have chosen to work on around Chennai. We want to understand why this variation in flower color persists. Morning glories are hermaphroditic—that is, each of the flowers has male parts and female parts."

"Really, male *and* female?" Tabrez countered.

"Well, to be accurate, I should call them pollen and seed vehicles. But that gets tiresome sometimes and difficult to explain to little girls like you." He smiled. "You see the field in front of you? The flower colors exist in a particular ratio. I am interested in whether these ratios are in equilibrium—do they stay the same frequency year after year, and will they return to the same frequency if perturbed? What makes my work so unique is that I don't just count seeds or the female contribution to fitness. I also look at the male contribution, that is, pollen. Bees are central to this. I watch the patterns of bee visitation, which flowers do they visit and in what order. Variation in sugar content of the nectar can be important in bee choice. When bees visit a flower, they transfer pollen from that flower to subsequent flowers they visit. So, if they visit a blue flower first and then a white flower, they are taking alleles for blue flower color to white flowers."

"Why can't you just come back and watch this field next year and the year after?" asked Tabrez.

"We'd like to. But then I can't publish papers for years. I'll never make tenure!" he grimaced. He continued, "Who's to say the Bored Foundation will still want to fund my work next year or the year after?"

"You mean you are trying to understand long-term evolutionary factors but study it just in one year?" asked Tara.

"Well, it's unfortunate. But you can try and get a snapshot of evolution. I wish I were rich and free to squander my wealth away, with a large house, a huge field in my back yard . . .," he went on dreamily only to realize that the girls were gone.

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The Raja of Baja was lying on the ground staring at the dancing flowers, his eyes transfixed on the field. His white *veshti* was tied loosely around him, his *thundu* curled around to serve as a pillow under his head. The whiteness of his clothes stood out starkly against his dark complexion. It was not an unfamiliar sight in these parts. He sat up as the girls approached. They inquired after his work. "I'm one of the resident poets and musicians," he said. "I am to be inspired by

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these beautiful flowers, the wondrous scenery, and translate these into words and song. This is the life I always dreamed of. Who usually gives you money to do this? I'm enjoying every minute of it." He closed his eyes and started reciting his poetry. The words flowed in a gentle rhythm, capturing the singsong Tamil language. The girls listened in rapture. The music was most haunting. His voice rose, the breeze carrying the lilt of his voice across the field. A man they had not met yet rose from the field a few yards away and told him to be silent.

The Raja shook his head. "They have no soul," he barked at no one in particular. "Stick their heads in the mud all day, coming up with pages of numbers. Look around you. Who can reduce this beauty to such numerical nonsense? How can you sit in this field and not be moved by this glory?"

"But maybe it's a different kind of beauty they see," suggested Tulasi. "You both seem to draw your work from the same field, don't you? Maybe you tell different kinds of stories."

His face suddenly grew animated. "I write about beauty, the soul, and the greater meanings of life."

"Do you ever write about evolutionary change, how rocks weather to soil, how transposable elements move around in the genome? Seems like it's wonderful material," said Tara.

"Oh, no! Scientific language is unpoetic, and honestly, science was never my strong point. I never did well in the sciences in school," he said sheepishly. "But scientists have all the power. When they work, it is pure and true. Me? I'm only a storyteller," he said bitterly.

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They walked toward the man who had yelled at the Raja. The Kahani of Rasayni was an immense man with a commanding presence. Around him were three students taking samples of the soil. He seemed to supervise their activities carefully. "My graduate students," he explained. The students handed him the samples and he put them away in specimen containers. "I'm sorry I yelled," he said, "but the damn fellow was breaking my concentration."

"What's in all these tubes?" asked Tabrez.

"I'm analyzing the soil in this field," he said. "This is a very interesting area geologically. And I have become fascinated by its soil. I'm interested in measuring the heterogeneity in this field. In this area you see bands of soil types. This area is very recent, maybe two thousand years old. A most intriguing finding. But the geological record is not very well preserved. Much of it was destroyed. We would love to find a better history of climate conditions here. But the written scientific record is poor."

"How about reading the literature of the time? Exploring mythologies, listening to the oral histories of this region? It's very rich you know," said Tabrez.

"That's the work for historians. We work with rocks, only hard data," he said dismissively.

"So you won't enjoy the view like the others," said Tara, changing the subject. "You'll be stuck in your lab."

"Come the afternoon heat, we'll see who is complaining!" he said. "I like lab work. It is precise, exact. You get the right value and you can replicate it any number of times."

"But," said Tara, "the Raja was saying that it was just a different story than the one he tells."

The Kahani's face turned red. "Nonsense!" he said. "How can you compare that to what I do? If you measure the nitrogen in the soil, it's exact. That is science. But to compare that with beautiful words and elegant phrases? I appreciate a good poem, a good story, before I go to bed. That entertains, relaxes. But . . .," he was shaking his hands furiously, "that is not science. We do not tell stories. I don't make up numbers. This is fact, clear, irrefutable data. Get it?" The Kahani was becoming increasingly agitated, now towering over them, his finger jabbing the air in front of their faces. The three girls nodded and left quickly.

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The Pundit of Poojyam<sup>1</sup> was admiring a flower as they approached him. "I heard your conversation with the Kahani." He smiled. "What emotionalism. What he does not realize is that we are all part of the same act of creation, all a particular finite number. The world is best described by mathematics. Take the number zero. It epitomizes the absolute, the all encompassing, or in our Hindu philosophy, '*Nirguna Brahman*.' This absolute can never be comprehended by words, can never be described by us mortal humans, and is beyond the comprehension of the human mind. Our small, inconsequential mind. Take 'infinity,' the cornucopia of reality, which has all the possibilities that we can see in our reality. Now when you multiply zero and infinity, you get the entire supply of finite numbers . . . and you and I and everyone else is the product of one such union."

"So, we humans and mathematics and science are all part of a divine order?" asked Tulasi.

"Yes, algebra and geometry and the rest of mathematics constitute a language, a grammar by which to write the story of the cosmos. You know," he said, "I sometimes have dreams where the god Narasimha talks to me through



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scrolls covered by the most beautiful theorems. My life and my work merely describe the grand design of life.”

“What do other people think of your work?” asked Tulasi.

“Well, my mathematical work is well received. I am considered to be quite brilliant. But no one recognizes what this work means to me. They brush it aside, unwilling to listen. All they care about is abstract numbers. Not what those numbers mean, their divinity, their cosmic connections . . .” His eyes suddenly glazed over as he stared into the sky, lost in thought.

. . .

The Sheikh of Leikh looked wistful as the girls approached her. Another researcher, scribbling away! They use up more paper than the entire town of Thirumbaram, Tara thought. The girls approached her. The Sheikh was the linguist of the team. She explained, “I am interested in language—words, metaphors, and analogies we use to describe the world around us. What we know, and see, is always mediated by language. Our oral and written traditions are all mediated through words.”

“What does it matter what words we use?” asked Tabrez. “Aren’t we describing the same thing? As the Kahani of Rasayni argued, whether we called it an insect or an oolong, isn’t it the same creature?”

“Well, not quite,” said the Sheikh. “It may be true that the insect remains the same creature with its mosaic eyes, pair of antenna, six pairs of legs, et cetera, but we give meaning and symbols to creatures as we name them, and these words take on particular significance and meanings. For example, we belong to the class Mammalia. Mammals are named mammals because when Linnaeus was naming his classification system, there was a big campaign in England to promote breastfeeding. Therefore, even though mammals are defined by many characteristics such as hair, a four-chambered heart, a single-boned lower jaw, three middle ear bones, a diaphragm, and mammary glands, and although they all maintain a high body temperature, it is the feeding of the young that came to define us. I would add that it is not accidental in a culture where we name nature as female, that the focus on breastfeeding would only add to our self-definition as a species where women are the caregivers. Where women are taught to sit at home and take care of babies and cook and clean. Words are powerful; they tell us how to think of ourselves. If you ask kids what a scientist looks like, they inevitably draw a white man with a beard, glasses, unkempt hair, and a white lab coat, even when female figures in their families might be scientists! There is nothing innate in what we know, it is all learned.”



“So you think that scientists are oblivious to both the consequence of their language or how their work is a consequence of language?” Tara asked.

The Sheikh smiled. “That’s beautifully put. Will you go explain that to them?” she said as she burst out laughing. “They never get it!”

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The Kondai of Mandai had just finished interviewing the Mantri of Tantri. Like her name suggested, a humungous *kondai* sat on her head. This sight transfixed the girls, who wondered when her head might give way to the weight of the massive ball of hair above.

“Well, I am the psychologist of the group. I am studying the individual psychological motivation of these researchers in doing the work they do. What propels them to leave their hometowns, or in some cases cross the seas to this godforsaken place?” T3 were not amused with their town’s description. The Kondai went on quite obliviously. “I cannot of course go into the details of the personal lives of all the people here, but when I interview them, each of them lets escape their motivations. Nothing can miss my eye,” she said shaking her finger.

“But what about random chance and serendipity?” Tabrez asked.

“Individual narratives are notoriously inaccurate. People constantly reconstruct the past. My conclusions come from very strong evidence in my field. Robust findings. Whether these individuals recognize my conclusions is irrelevant. I am right.”

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Skipping down the field, they almost collided with the Saraswati of Sansthithi. She was crouched low, examining the amount of damage on a morning glory leaf by a herbivorous insect. “I am testing whether and how natural selection is acting on this flower color variation,” she said.

“How do you measure that?” asked Tara curiously.

“Oh! Let me explain.” She sat down on the ground and the girls sat around her. “Charles Darwin, the founder of evolutionary biology, made two important theses in his famous book, *Origin of Species*— descent with modification and the process of natural selection.”

“Huh,” said Tabrez.

“Think of it as a slower version of artificial breeding. In fact, Darwin did a lot of observations watching artificial selection of pigeon fanciers. How do you get such a variety of pigeons, of dogs, of cats, of cows? Breeders do this by selecting for particular traits and then making sure that individuals with those

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characteristics reproduce with each other. It is amazing how quickly we can produce distinctly different animals and plants.”

“So who does the selection in nature?” asked Tulasi.

“Well, Darwin argued that it wasn’t about any creative force but about individual variation, adaptation, and selection. So, for example, in this field, all the plants will produce seeds and die. Next year, those seeds will grow. One plant might produce no seeds at all and will leave no offspring, another might leave twenty offspring, and yet another twenty thousand. Therefore while the ratio of the three plants is 1:1:1 in this generation, they will be 0:20:20,000 next year. While Darwin did not know about genes or Mendelian inheritance, we now understand how, for example, purely by chance, you may get a field of all blue or white flowers,” she said, her face red with excitement.

“But what if bees liked blue flowers and not white flowers? Or if white flowers produced more seeds?” asked Tara.

“Aha!” said the Saraswati. “Then natural selection will favor and select the blue in the first case and the plants with white flowers in the second. But it won’t be about chance. Or there may be selective advantages to both and we might find an equilibrium of both colors to sustain a flower color polymorphism, as we have here.”

“Do you think that is the case here?” asked Tabrez.

“That is what my intuition tells me. Only through developing carefully controlled experiments can we reject some hypotheses.”

“How important is intuition in science? We were talking to the Kondai of Mandai and she was suggesting that it would help scientists to reflect on the origins of their beliefs,” said Tara.

The Saraswati smiled. “Forgive me, but that’s psychological babble. The beauty of science is that it doesn’t matter. Ultimately, you need produce experimental proof. Period. Psychology has no contribution to make to science. None whatsoever.”

. . .

It was getting close to lunchtime. And the girls spotted a man with a big white hat approaching the field. The Surdas of Ithihas was accompanied by a man who carried a large bag filled with lunch. The girls rushed to greet him.

“Why aren’t you here studying the field like the rest of them?” asked Tabrez.

“I am the project historian,” he said. “My work keeps me at the archives of the local museum.”

“You mean if someone had discovered something different one hundred years ago, you would all be doing very different research today?” asked Tara.

"Exactly. But not everyone agrees. For example," he continued, "some of the scientists here would say that even if Darwin had not postulated his theory, someone else, like Wallace, eventually would have because the forces of natural selection are real. This is the overdeterminationist position. I, however, take an underdeterminationist position—that history takes a particular direction only because of particular events. A different set of events? Different futures."

"But," said Tulasi, "wouldn't some questions be obvious? Wouldn't someone eventually have noticed the falling apple or discovered that the earth was not flat?"

"I'm not denying that some discoveries are inevitable. But depending on the cultural moment, their meaning and significance shifts, as do the frameworks, theories, and cultural beliefs. Science is not a linear progression to greater truth. You see, new ways of looking at the world can completely change and transform everything we know. There is a relationship between knowledge and power. Louis Pasteur's experiments alone did not account for how profoundly he changed seventeenth-century France. His success depended on a whole network of social forces. We need to give up the model of the lone scientist battling the world on his own, and the belief that truth ultimately conquers all. The world does not and never did work that way."

He continued. "You see I work on the history of the 'gulisthan particles.' They are tiny particles that were discovered in cross sections of rocks about one hundred years ago. This discovery transformed the subfield of gladiolar geology. Because these particles change the composition of the rock around them. It was unheard of. But what does this say about the field of gladiolar geology before this discovery? Did gulisthan particles exist? Did scientists just miss them? Or did their slide preparation techniques not allow them to see these particles? What was it about that period that allowed for such a discovery? It is fascinating when you locate scientific discoveries in their social context."

"But" suggested Tara, "couldn't you just take the slides from the periods before to see if you could spot the gulisthan particles even though scientists one hundred years ago could not?"

"Ah! But you see I'm not scientifically trained. I don't know how to do that. And to scientists it is irrelevant."

He quickly glanced under the tree where all the others gathered, waiting hungrily. "I really ought to go," he said quickly.

. . .

The Mali of Pali was taking a break. He was lying flat on his back, his eyes closed. A bottle of sunscreen stood on the ground beside him. He woke up upon hearing the approaching footsteps of the three girls.

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"Hello," he said. He began to talk about evolution and Darwin when the girls cut him off, telling him they knew all about Darwin.

"Ah! You've been talking to the great Saraswati, I see," he said.

"Do you do the same work that she does?"

"Well, yes, but our intuitions are very different. What she says is important. Equilibrium models are important in ecological systems from a global perspective. But scale matters. So if you look at islands, ecologists would argue that the number of species on an island remains relatively constant while the identity of the species present changes continually. Yet here, I'm convinced that equilibrium models of evolutionary change are of practically no use. For equilibrium models to work, you need some sort of stability, where the same selective forces can act year after year. Look at the weather record of this region. It's volatile—plagued with droughts, floods, hurricanes."

"Yeah," the girls said. "They are predicting heavy rains again next week."

"Nature seems much too random, much too unpredictable here. It is a pity that the meteorological records are so poor in this area," he sighed. "Nothing to be done about it."

"You know," said Tulasi, remembering, "there is an old man here called Ramabadran. He has been keeping records of the rains and the temperature for the past eighty years. Was a hobby of his from childhood."

The Mali grew thoughtful. "It is unlikely that we can use his data. Data have to be calibrated accurately to be useful. No scientific paper would accept such observations. Could I continue my midday nap? I am exhausted."

. . .

The Mantri of Tantri pulled down his spectacles as he saw the three girls approach. He sat on a fallen tree. "I am a philosopher," he said, "and I am interested in how we know what we know."

"What do you mean?" asked Tara. "Could you give us an example?"

"Certainly," he said. "Take the claims of science that it produces real, value-free, objective knowledge. That it describes nature precisely and exactly. History proves otherwise. We now know it is deeply entangled in politics. Take the whole history of eugenics, or the scandal of Cyril Burt and the IQ tests. Science is not magically exempt."

"So who controls science these days?" asked Tabrez.

"It's not an easy answer. Some would say the corporate world and defense-related research. It is unfortunate what has happened in the name of development in this country. With colonialism came western science and technology and we the colonized have taken to it and embraced it whole-heartedly, without critique. We have tried to be better *sahibs* than the English. We have delegiti-

mized the rich traditions of indigenous science and medicine even while they enjoying a boom in the west. It is ironic, this postcolonial condition!" he said, shaking his head.

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The sun was setting and the girls had had their fill of information. It seemed so much to take in during a single day. A woman sat at the edge of the field watching them. Her sari was wrapped around her head to shade out the sun. "I am the Rani of Pani," she said. "This land used to belong to my family."

"What happened" asked Tulasi.

"We were farmers. We put a lot of our money into buying new technology, high-yield seeds, fertilizers, pesticides, and herbicides the same year as a big drought. The following year we were greeted with a flood. My family never recovered from that. Here I am without land, without food, and there are all those people studying a field of weeds," she spat out. "Weeds! Can you believe that? What a waste of land."

## Part Two: The Debate

You seem to think that no idea exists or blooms except in opposition to another or others . . . An idea opposed to another idea is always the same idea, albeit affected by the negative sign. The more you oppose one another, the more you remain in the same framework of thought.

New ideas come from the desert, from hermits, from solitary beings, from those who live in retreat and are not plunged into the sound and fury of repetitive discussion. The latter always makes too much noise to enable one to think easily. All the money that is scandalously wasted nowadays on colloquia should be spent on building retreat houses, with vows of reserve and silence.

—Michel Serres, *Conversations on Science, Culture, and Time*

Several days elapsed. The girls developed a routine of visiting the field each day, watching the researchers and growing fond of them. But researchers usually talked to them individually, never together. On the rare occasion they did, the researchers inevitably grew frustrated with each other. The researchers continued to work in their isolated and individual worlds; some divisions seemed sacrosanct. The girls found this most curious. Having eaten lunch with the researchers each day, they invited the entire team to dinner at Tulasi's parents' restaurant. Quite a feast! A spread of *idlis*, masala *dosas*, *sambar*, various chutneys, *puliodarai*, *bisibele bhat*, *vangi bhat*, *bagla bhath*, sumptuous *payasam* . . . the spread went on. The spicy aroma filled the room, the colors mesmerizing.

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Everyone dug in, appetites piqued and gradually happy, contented bodies lay on the floor, satiated. It seemed the ideal moment for the girls to get all the researchers talking.

"When we were walking back the other day," began Tabrez, "we met the Rani of Pani. What do you think of her story? How do you rationalize your work in her presence?"

"Well," said the Mantri of Tantri, "it is most unfortunate. But it is what western science and technology has done to this country."

"Come on," said the Mali of Pali. "You surely cannot write off all of western science and technology with that. Do you realize that the farmer who owns the field we use makes much more money renting it out for cultivation? I have little patience for those who blame all the ills of India's government and its stupid and corrupt policies on western science and technology. What was so wonderful about the India of the past that we want to hold so sacred? Isn't it mainly the rich activists who make such arguments? Why cannot the poor enjoy the benefits of technological growth?"

"You misunderstand me," said the Mantri of Tantri. "When I say western science and technology, I include the Indian government. The invasion of western science and technology is a colonial legacy, as is the corruption and bureaucracy in the government. How can you argue with that?"

"Sure, it's a colonial legacy," agreed the Mali of Pali, "but is it about western science or how we use it? Can't we use science to benefit India? Aren't machines more humane than humans doing backbreaking work in hundred-degree weather? Science and technology have really improved the quality of life everywhere. We need basic research. While morning glories are a weed species, we are uncovering fundamental processes that govern nature. How will we learn to conserve our forests? How do we feed our overpopulated world?"

"You are missing the point," said the Dhanush of Manush. "I don't think the Mantri is against basic research. It's about the power of science and technology. Scientists have a carte blanche to do whatever they please. We have more than enough food to feed the world today, yet people go hungry. And don't the humanists improve the quality of life also?"

"We don't expect to pass judgment on your poems and literature," said an agitated Mali of Pali. "Stay the hell away from our experiments. You know nothing about it." With that, he left the room, disgusted.

"I think we are confusing issues here," said the Saraswati of Sansthithi, trying to sound reasonable. "I think we are confusing the content of science from the context of science. Now, I completely agree that the context of science needs changing. That we need to examine the directions we take. Whether we

ought to continue with nuclear power, how we spend public money. I also agree with the Dhanush of Manush when he points out that the culture of science is fraught with problems. As a woman working in the so-called third world, I am deeply aware of it. I am not respected, easily dismissed as a woman. And in international conferences doubly dismissed because I am from the third world. We have limited resources and poor networks. I cannot afford to work on questions the west considers the cutting edge. I find research problems that are less flashy but interesting. Listen to all the names of the famous researchers we quote. They are all from the west and largely male. So, I relate to arguments about needing to change the context of science. But," she continued raising her finger, "this does not mean that when I undertake a problem, I approach or solve it any differently. It is a universal science, a universal scientific method. When you start making claims of scientific content and interpretation, I disagree there."

"Come, come, now," said the Sheikh of Lekh. "That is much too general a claim. Take, for example, the work of the Vidhvan of Vigyan on the 'male' contribution to a plant's success. Why male? Why take heterosexual norms of human culture and impose it on plants? Don't you see how we anthropomorphize? How the pollen grains now start fighting tooth and nail as they penetrate the stigmatic surface and make their way down the pollen tube? They are metaphors about brave male warriors, not descriptors of the plant. And scientists claim they are being objective? Really!"

"But we never claim to be infallible," protested the Saraswati, "nor to be producing the absolute truth. No scientist worth anything makes such claims. We try to be objective" she said stressing, "try," "and most of us realize that we don't always succeed. But what we always strive to do is to produce the best possible knowledge we can. Incorrect information, fraud, anthropomorphisms—they get discovered eventually. Science self-corrects. That is the power in it."

"Don't you realize," cut in the Sheikh, "that self-correction is contextual itself—it only seems that way because it conforms to a new cultural and political order?"

"I don't think that is always true," challenged Saraswati. "But exactly how do you prove your theories? How can you tell that scientific progress would have been any different with a different language or discovery?"

"No, we can't," agreed the Surdas of Ithihas. "But there are many ways in which to produce knowledge. True, it's an unfalsifiable hypothesis. So what? Can't we draw inferences on the meaning of scientific discoveries? About language? The relationship of knowledge to power?" The Saraswati shook her head and left.



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"Getting back to your point," said the Vidhvan of Vigyan. "I will grant you that we need to be more precise with language. But what's in a name? The example you give is blatantly bad science. You ought not to be anthropomorphic. Any scientist will agree with that. But I still don't see what difference that makes."

"Okay," said the Sheikh, "take your example. Is it accidental that so far we have only focused on the female contribution? Isn't that because we see females as caregivers? Talk about reproduction and we think 'female.'"

"Absolutely not!" yelled the Vidhvan of Vigyan. "We have not had the technology to follow pollen grains. It's only with the advent of molecular biology that we can create molecular markers to do this work. Do you know how much more difficult and laborious this is? Do you know how tiny pollen grains are? Some things are just not possible!" he said, walking away followed by the Sheikh.

"I am not entirely convinced by that argument," Raja of Baja interjected. "Things seem impossible to you because you are caught up in your own framework. Technology is not the only thing that can solve problems, sometimes it takes a shift of mind."

"Clearly you know nothing about science," retorted the Kahani of Rasayni. "You keep accusing science of being too dominant and yet you give to it powers that it does not and cannot possess."

"We are not magicians," added the Mukhiya of Sankhya. "Before the advent of computers, we could not solve certain problems. They were too complex. It was just not possible. To say that we should have sat down and spent ten years solving one problem is just plain silly!"

The Saraswati and the Kalainyar walked out together, the Dhanush and the Mantri closely behind, eyes averted.

"You know," said the Mukhiya of Sankhya, "I find this refusal to accept scientific facts and laws most curious. Why are you so resistant?"

"Well," said the Kondai of Mandai, "of course we accept some scientific facts and laws. Of course I would not jump off a building and expect to fly. But it is what we embed these observations in that interest us. We shrine them in laws, sometimes being careful to specify the conditions under which they operate. It's the embedding, the need to universalize everything, the impulse to control and manipulate at the stroke of the hand." The Mukhiya walked out.

"I have no idea what you just said," said the Pundit of Poojyam.

"You expect me to labor through all your statistics," protested the Kondai, "but you won't learn my language? Humanists should always be immediately transparent! We can't have jargon, our own vocabulary, theories, methodologies? This is impossible! The same issues, again and again," she muttered, leaving.

"I want to bring up the issue of aesthetics and beauty," said the Raja of Baja. "To me, as a poet, they are paramount. Each word is deliberate, and each sentence carefully crafted. Aesthetics is above all important. But you scientists reduce it all to numbers."

"Wrong again," exclaimed the Pundit. "What's the use?" He stormed out.

"What he meant," said the Surdas of Ithihas, "is that beauty and elegance are very important in science. It is common to talk about an elegant experiment, an exquisite theory. Simplicity is extolled. Scientists go into rapture in the presence of elegance. Read the memoirs of scientists. They are passionate, immensely creative beings. You know, that among the famous geneticists, Dobzhansky compared natural selection to a composer, Ernst Mayr to a sculptor, and Julian Huxley to Shakespeare! There can be something in common between us after all."

The Surdas of Ithihas and the Raja of Baja left together. The girls grinned. What a melodramatic evening! The emotional outbursts, the wounded egos, the grand stances. Stifling their giggles, they helped clean up and went home.

. . .

Several weeks elapsed since the fateful evening. The egos calmed, and the cold shoulders warmed. Yet, the air of hostility persisted. The researchers had agreed to disagree. At the end of the summer, they left. The T<sub>3</sub> received the published work. There were few collaborative papers. In this sense, the project, they heard, was considered a failure. The summer ended and the girls went back to school. The years sped by. This extraordinary summer, however, unknown to them, was the beginning of something wonderful.

## Part Three: The Synthesis

How do you live and think together beneath a light that warms our bodies and models our ideas, but which remains indifferent to their existence? We contemporary philosophers cannot ask this question while ignoring the sciences, which, in their very separation, converge to ask it, even to exacerbate its terms.

And when 'the world' means purely and simply the planet Earth, . . . when humanity is finally solidary and global in its political existence and in the exercise of science, it discovers that it inhabits a global Earth that is the concern of our global science, global technology, and our global and local behaviors. This is the reason for the necessary synthesis.

—Michel Serres, *Conversations on Science, Culture, and Time*

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We return to the same morning glory field three decades later. We arrive at the Chennai airport. Buses and trains fueled by solar energy await eager passengers. The town seems to have lost its name to the famous Saraswati Institute, now a decade old. Thirumbaram is transformed. It is bustling, with an air of activity and excitement. The world-renowned institute brings scores of researchers across the globe. We hear that the institute was conceptualized and constructed by the Thirumbaram Three as a unique project of synthesis.

As we probe, we learn that two decades ago the Thirumbaram Three were granted the first joint, group Ph.D. in India. It was a unique event. While they had each specialized, they were broadly trained as generalists. They were known to be the founders of a new movement of synthesis. Saraswati, the Goddess of Knowledge, provided that larger rubric, the impulse to create knowledge, unbounded and unhindered by disciplinary barriers. As we enter the Saraswati Institute we are impressed by the functional elegance of the building and its decor.

The space houses a large number of people, yet allows for private conversations and discussions. We see schoolchildren working on projects, touring the facilities. Researchers bustle along. The center of this multi-winged structure is a huge hall. The dome-shaped ceiling envelops you the moment you walk in. There is something immediately warm, energizing, and inviting about the room. Maybe it is the lighting, or the architecture? We are not quite sure. We hear that this room has been nicknamed the “well of answers” because so many problems have been solved here.

We step outside to the field. While it was originally one small field, the area has grown. Our eyes feast on acres of plants dancing in the morning breeze. It is quite a spectacular sight. We notice that there are plots that house other plants. It is not clear exactly what those are. As we walk to the field we see the T<sub>3</sub> in discussion. They are delighted to see us and eager to talk.

“Well,” began Tabrez, “we’ll try and summarize quickly what we’ve been up to for the past thirty years. My! How time flies!” she says, laughing. “Our approach to research has been marked by collaboration, both among ourselves and with the town itself. We were not interested in creating an institute as an ivory tower, removed from the lives of the people and with little meaning. We wished to involve them in the work. We grew up in this town that has been very kind and generous to us over the years.”

“You can call it a kind of symbiosis, if you like,” said Tara. “We need them and they need us. We have brought a great deal of respect and fame to this town. Our work is driven by world problems.”

"We always wonder," said Tulasi, "why our results have been so spectacular. Is it our long-term collaboration? Open minds? Communal training? Broad and interdisciplinary training? Collaboration with the community?"

"You see, after the researchers left that summer, we began studying the morning glory field ourselves," said Tabrez. "Tara got fascinated by the literature that came from this region. They were written in this particular dialect that Tabrez's family speaks, and they were invaluable in helping her translate. Tabrez's long interest in literature was invaluable." They all smiled in nostalgia. "Along with these stories, we also reviewed town meeting transcripts. We talked to town seniors. What fascinated us were repeated descriptions that were hauntingly similar—visions of green and yellow swarms. We saw it appear every twenty years or so, rather consistently. It was most curious."

"Tulasi is a big fan of this man called Ramabadran. Her family and he had a long, established history. Ramabadran's community followed animist traditions and have deep connections to nature," continued Tara. "Ramabadran kept meticulous records of the weather and gave us access to them. Among other data, this man who was in his nineties had been collecting records of rain, temperature, humidity, and other weather patterns since he was a child. Tulasi, you know, has quite a mathematical bent. I don't know how she sees these relationships between numbers. Quite escapes me. But anyways, she realized that with the right coefficients, a combination of the weather variables created a thirty-three-year cycle. In this cycle, the monsoon winds were crucial."

"Then one day it happened. Right before the monsoons, for the first time in our lives, we witnessed *Morисуca frambia* swarm into town. They were green-colored lepidopterans. We had heard about this, and it was well known, but no one had noticed the pattern of their visitation. And of course, no one noticed that they laid their eggs on the blue morning glory plants and that the larvae then fed on these leaves, decimating them. Tara did the necessary chemical analyses of the cyanidins, showing that compounds in the blue pigmentation pathways were crucial for the *Morисуca frambia*'s survival. Without that, the adults are infertile. As a result, for a few generations, the blue-colored morning glories do very poorly and the white ones take over. Now the feces of the *Morисуca frambia* have an unusual compound we called *frembia*. Growing morning glories with this compound particularly affects the white genotypes. We showed how these effects, even though environmental, are indeed passed down epigenetically to future generations of white genotypes. It was this non-Darwinian mode of inheritance, where an environmental character fundamentally altered the expression of genes for many generations, which aided the proliferation of the white genotypes."

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“And the wonder of it is that a few decades later, you get a yellow fungus, *Gorima stabia*, which thrives on a compound in white-colored flowers. And here, Tara’s background in virology proved invaluable. Tara comes from a family of ayurvedic doctors who have a unique specialization in diseases, especially a local illness called *Gorima pani*. *Gorima stabia* carries a virus that causes this local fever. The virus affects the mitochondrial DNA of white-colored flowers, inserting elements into it. For a few generations following the yellow swarms, the white genotypes find their fitness severely depressed. Again, a complex non-Mendelian mechanism through the mitochondrial DNA, which in concert with the nuclear DNA depresses growth of white genotypes. And so the pattern goes. First, the blue flowers affected and then the white. Now, you are probably wondering what causes these cyclical patterns.” Indeed, we are.

“Tabrez, our weather whiz, figured that out,” said Tulasi

“Well, the trade winds are really crucial to this. Once the lepidopterans have decimated the morning glory population, the trade winds carry the adults to the next spot. We actually followed the path of the winds to show similar patterns in morning glory fields right across its path. And indeed within a few decades, they return to this same site and by then there is enough food for them again and so they cycle. Amazing! If not for weather data of Ramabadran, the historical and literary data, and indigenous medical knowledge, we would never have stumbled on to this. It created quite a stir when we figured out the whole story. The stochastic pattern of the weather creates variations on the themes—only in pulling together local knowledge of weather patterns, lepidopteran history through Tamil literature, and the well-documented indigenous knowledge practitioners of Ayurveda could we figure this out. It was quite something.”

“And then, of course, came Tulasi’s great theory that also created quite a reputation. Tell them, Tulasi.”

“Well, we were doing some cage experiments to test our hypotheses. We were doing our master’s degree then. And Tara had just read Foucault’s *The History of Sexuality* and we had had a really intense discussion of it that night. And it really got me thinking about the ways in which we measure a plant’s reproductive success or, namely, its fitness. And so we had to follow both the contribution of the pollen parent and the seed parent to really get an accurate estimate. Tara, bully that she is, got me thinking about the ways in which we introduce heterosexism even into plants. I mean, here are these creatures that produce pollen and seeds that we immediately assign into a binary male/female and trace their lineages just as we do in human beings. Should we really read the same kind of sexuality into plants? Here are hermaphroditic creatures—that is so cool! I began wondering if there wasn’t another way to measure fitness.

And so one day I was running these gels to figure out the pollen parents and made a serendipitous but glorious mistake in using a wrong chemical and got the most amazing pattern. This critique of sexuality hot in my head, I investigated further. To cut a long story short, I discovered a set of markers that were unique in plants, sort of like fingerprints that can be inherited. And so you can trace lineages without having to think of binary male/female or even pollen/seed. And this was so freeing. You could track horizontal and vertical transfer of genetic material. You could now construct models where passing down genetic material was a communal dance. How perniciously promiscuous plants were—not only with their heterosexual counterparts, but a host of other microorganisms. How much information we lost in seeing plant generations as heterosexual reproduction! And so I developed a new theory and mathematical models to go with it,” said Tulasi modestly.

“Indeed, Tara’s family background was important to challenging traditional biological definitions of the individual. We were very taken with the biological work we read on symbiotic, multispecies biology. After all, we are technically more bacteria than *Homo sapiens*! We have multiple species in our bodies and yet we write them off in typical gendered and classed term as ‘housekeepers’ and support staff not worth considering. The master-mind ‘brain’ gets all the credit, as usual! One line of our work has taken seriously the attempt to decenter the human and think more holistically about biological evolution. It has been exciting!”

“Can you imagine—developing a story where non-Darwinian evolution, non-Mendelian inheritance, challenging the ‘sex’ and the ‘individual’ as a categories all at once? Created quite the storm. But, you know, once you have a broad training and an open mind, it is so much easier to identify the myopia and blind spots of disciplines. Suddenly you observe things that are really staring us in the face—if we are open to recognizing them. It is cool to be the stars in a sea of white male scientists,” said Tabrez gleefully. “But you know, if not for our friendship, if not for our diverse backgrounds, if not for the community, and if not for us talking about and teaching each other wide range of fields and thinkers—Foucault and Darwin, literature, gender and queer studies, postcolonial studies, geology, biology, math, biochemistry, statistics, and meteorology—we would never have come upon this amazing discovery.”

“The summer with the researchers really planted so many seeds. We saw the futility of disciplinary silos. We’ve never forgotten that,” said Tara.

“Now, that is a requirement in all our work,” laughed Tabrez.

“We also work on integrative medicine. You see, we realized early on that it would not be easy for us to continue to work in this little town. And we really



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love it here. We also would all like to continue to work together. We find the western model of academic tenure and mentorship such an intellectually inbred model that closes rather than opens the mind. Now, through this institute we are entirely self-funded. And all this we owe to Tara's puttering around," said Tulasi.

"Yeah, I was really taken with the Mantri of Tantri. And so I began to read more about alternative medicine in the west. It was funny because we have such a rich tradition. And while Indians ignored it, pharmaceutical companies were increasingly exploring local traditions and medicines, then finding the indigenous plants, patenting the active ingredient. Ultimately, locals could not afford that medicine! I thought, why can't we do it ourselves? Bring scrutiny to alternate medicine."

"So we began a center for integrative medicine here. Over there," she pointed to various buildings, "are the labs. The facilities are owned by the town. It's a complex co-operative in structure. Local knowledge through oral history, traditions in various communities, local medical systems have proved invaluable in discovering new treatments and systematizing this knowledge. Very often we discover that the answer isn't in just a little 'pill' but a way of life. It is this holistic conception of the body and health we are trying to promote. But as you can see, we continue to work with morning glories. We've retained those origins. Tara also found some medicinal uses for morning glory roots. They are bronchodilators and help with asthma and other respiratory illnesses."

"And there's always the seeds!" said Tulasi with a mischievous look about her.

"And there you have it," said Tabrez. "You know it's been so much fun. I don't understand how people work alone, stay stuck in their labs, write individually. I'd die of boredom. The three of us have had such a blast, it's hard to communicate that adequately."

And so we leave the Thirumbaram Three as they continue laughing, Tara's hair blowing with the wind, Tulasi twining a plant around its stake, and Tabrez clowning around. They walk by the now famous field. The morning glory buds are full, ready to bloom early next morning. They climb up their favorite tree and sit down on each of their perches and watch the sun go down.



