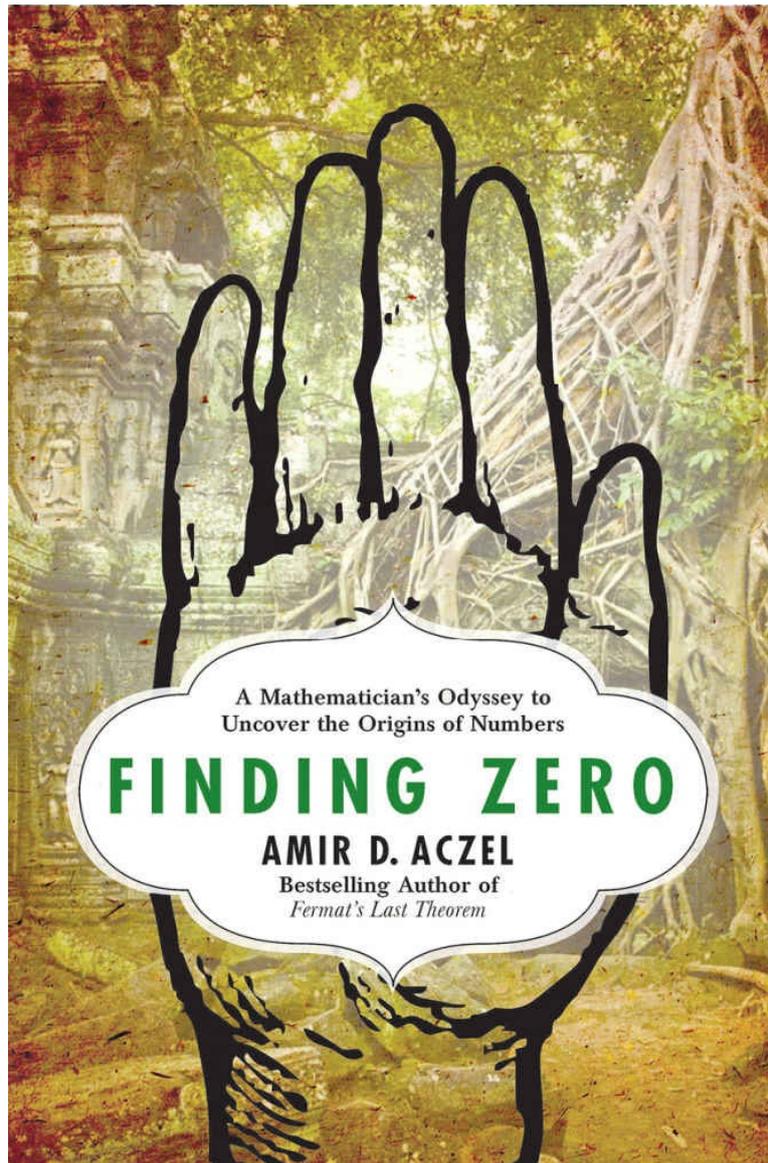


A Mathematician's Odyssey to
Uncover the Origins of Numbers

FINDING ZERO

AMIR D. ACZEL

Bestselling Author of
Fermat's Last Theorem



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For Miriam, who loves science

CONTENTS

[Cover](#)

[Title Page](#)

[Copyright Notice](#)

[Dedication](#)

[Introduction](#)

[FINDING ZERO](#)

[Notes](#)

[Bibliography](#)

[Index](#)

[Acknowledgments](#)

[About the Author](#)

[Copyright](#)

INTRODUCTION

The invention of numbers is one of the greatest abstractions the human mind has ever achieved. Virtually everything in our lives is digital, numerical, quantified. But the story of how and where we got these numbers we so depend on has been shrouded in mystery. This book tells the personal story of my lifelong obsession: to find the sources of our numbers. It briefly traces the known history of the very early Babylonian cuneiform numbers and the later Greek and Roman letter-numerals, and then asks the key question: Where do the numbers we use today, the so-called Hindu-Arabic numerals, come from? In my search, I explored uncharted territory, embarking on a quest for the sources of these numbers to India, Thailand, Laos, Vietnam, and ultimately to a jungle location in Cambodia, the site of a lost seventh-century inscription. On my odyssey I met a host of fascinating characters: academics in search of truth, jungle trekkers looking for adventure, surprisingly honest politicians, shameless smugglers, and suspected archaeological thieves.

1

When I entered first grade in the late 1950s, at a private school in Haifa, Israel, called the Hebrew Reali School, I was asked a question the institution always asked its entering students. My teacher, Miss Nira, a young and pretty woman who smiled a lot and wore long, bright-colored dresses, inquired of each of us six-year-olds what we hoped to learn in school. One child said “How to make money,” and another, “What makes trees and animals grow,” and when my turn came, I answered that I wanted to learn “Where numbers come from.” Miss Nira looked surprised and paused for a moment, and then without a word turned to the little girl sitting next to me. I wasn’t a precocious child who comes up with a question the teacher cannot address—I just had a most unusual childhood. And my answer to the teacher’s question was a direct result of an experience I’d had during that special childhood.

My father was the captain of the *SS Theodor Herzl*, a cruise ship that sailed the Mediterranean at 21 knots, traveling from its home port in Haifa to the mythical islands of Corfu and Ibiza and Malta and—often—to fabulous Monte Carlo. One of my father’s benefits as captain was the right to have his family join him on the ship whenever he wanted. We took advantage of this privilege very frequently, so that I ended up attending school only part of every year, making up for lost class time with tutors and self-study and, once back at school, by sitting for deferred exams.

As soon as the *Theodor Herzl* would arrive at the charmed principality of Monaco, with its magnificent palace perched on a rock over the Mediterranean, my father would drop anchor and a fast motorboat would ferry passengers and crew ashore. At night, many would head to the great Casino de Monte Carlo by the water’s edge near the center of town. This was the undisputed high-class gambling capital of the world. But minors like me were forbidden entry into the famed gaming rooms, where princes and movie stars and celebrities still try to woo Lady Luck. So while the adults from our ship, including my parents, played at the roulette tables, I was entertained by ship’s stewards outside this white marble baroque palace surrounded by tall palm trees, bougainvillea, and white and red oleanders. There, my sister, Ilana, and I would run along the paths of this exuberant garden and play hide-and-seek among the

fragrant bushes.

Ilana and I often fantasized about what it might be like inside this imposing building we thought we could never enter. Were people dancing? Were they eating fancy meals, as we often did aboard ship? We knew the adults played some kind of game inside—they always talked about it afterward on the ship—but what kind of game was it? We were dying to find out, and whispered about it between us.

And then one day it was my father's personal steward's turn to take care of us on the periphery of the casino. Laci (pronounced "lotzi"), a Hungarian, concocted a scheme to take the girl of three and boy of five right inside the gaming halls. Laci was my favorite steward; the rest of them were boring middle-aged men who took care of us reluctantly (it wasn't really in their job descriptions). They were courteous and polite, but somewhat cold and formal. Whenever Laci took care of us, however, fun things would happen, and often rules of expected behavior were broken. "The boy needs his mother immediately—it's an emergency!" Laci hissed at the stern-faced, hulking, tuxedo-wearing bouncer at the door, and without waiting for an answer ushered us right inside the casino.

I was deathly worried about being kicked out. I knew the casino was taboo for us kids. But to my surprise nothing happened, nobody ran in to chase us away. I was dazzled—on the ornately carpeted floor I saw large, elegant tables covered in green felt, and on each one a checkerboard of numbers in red and black and one very special, round circle of a number alone in green. The atmosphere was heavy with cigar and pipe smoke, and I struggled hard not to cough.

I was excited to see my parents seated at one table. But I knew I dare not disturb them. So I kept very quiet, and didn't move. I feared this dream-come-true might end any minute.

At the head of the table, across from the croupier, was my father, dapper in his black captain's uniform displaying numerous British wartime decorations, and next to him my mother, stunning in a light blue evening dress. They were flanked by a US congressman from a southern state on one side and the famous French-Italian singer Dalida on the other, both VIPs traveling with us on this voyage. Other passengers were also seated around this table, and everyone was looking with rapt anticipation at a large black bowl at its center; at the bottom of the bowl was a spinning wheel.



My father, Captain E. L. Aczel, with the French-Italian singer Dalida, aboard ship off the coast of Monaco, 1957.

Their attention seemed focused on a little white ball that had been flung into the bowl by a man in a short black coat, a white collared shirt, and a black bow tie. Laci kept inching us closer until we stood right behind my parents. This was so exciting—to be at the heart of this magical activity forbidden to anyone younger than 21. Laci was holding my sister and me, each of us sitting on one of his arms; from our high vantage point above the table I could clearly see what was taking place below.

There was an eerie quiet as the ball twirled around in the bowl. I could hear every time it tapped a metal groove separating numbers at the bottom of the wheel, or when it struck one of the four diamond-shaped metal decorations above the numbers on the inner sides of the bowl, bouncing right back down whenever it did. I could feel the tension and anticipation. My father suddenly turned around when he noticed us, smiled knowingly at Laci, and then turned his attention back to the table.

“Look,” Laci explained to me in a whisper, “you see, these are numbers on the table, and notice that every one of them is also on the wheel. Now watch what happens.” I sat on his arm and stretched my neck forward—I did not want to miss a thing. The little ball was still bouncing around in the bowl, but more slowly now. Soon it would come to a stop. But where? On which number would it land? Laci told me the ball could choose only one number to land on, since every number was separated from its neighbors by metal dividers. I tried hard to guess where the ball would end up as the wheel slowed down further. I could now make out the separate numbers marked on its bottom.

I was fascinated by these colorful numbers—ornate signs that beckoned me by their mystery, and which as I matured I would understand to represent fundamental abstract concepts that rule our world. I will never forget their shapes on that velvet board. I fell in love with their magic, associating them in my mind with something alluring and

forbidden, an unknown pleasure awaiting discovery. The ball finally made one last bounce and came to a stop right on the number seven. Suddenly, a commotion erupted at the table. Across from us an elderly woman in a bright yellow evening gown jumped up from her seat and cried, “Yes!” Every head turned toward her. Some players, perhaps vicariously sharing her big win, congratulated her. Others, maybe envious and upset they had lost, expressed their disappointment.

The croupier forked over a large heap of chips of different colors, the smaller ones round and the bigger ones rectangular with large numbers visible on their faces; I understood these pieces of plastic represented money, each color and shape a different amount. Not knowing much about money at my age, I still could sense by the number and size of these chips, and by the continuing excitement around the table, that this woman had become rich. Laci explained to me that the croupier was giving her many times more than the wager amount since she had bet on a single number. I looked at her, noticed the elation in her face, the happy smile, and heard her rapturous exclamations: “I won! I won!”

Then Laci muttered, as if to himself, “Seven, a prime number.” I was curious to know what this meant. Laci always had important things to say, and I knew this whispered exclamation had some meaning.

Later, Laci became my self-appointed math tutor on the ship; he taught me also about prime numbers. They would become a lifelong fascination. One day, having observed Laci teaching me math for some time, my mother asked my father how come he knew so much about the subject. My father told her that Laci had been a brilliant mathematics graduate student at Moscow State University right after the war, but that there had been a big scandal about his research having to do with secret information, perhaps even a suspicion of espionage, and under pressure from the KGB the university asked him to leave. The episode was shrouded in mystery; Laci never talked about it, and nobody knew any details.

But Laci apparently got his revenge on the Soviets, for what happened next was well-known and published in all the newspapers. After he quit his studies, he went to Czechoslovakia to learn to fly military airplanes. Then, in 1948, the Jews of the fledgling state of Israel found themselves attacked by the surrounding Arab states. Laci heard that they badly needed airplanes, so this non-Jew sneaked into the pilot’s seat of one of the Czech planes he had been training on, took off, and flew it alone all

the way to Israel, handing it over as a gift to the newly founded Israel Air Force.

Then, having nothing else to do in this new land, Laci started working for the shipping company Zim Lines and eventually became my father's steward. Both were Hungarian and shared bonds of common heritage, outlook, and lifestyle. (Incidentally, the *Theodor Herzl* was named after another Hungarian, whose political theory had laid the groundwork for Israel's founding.) My father and Laci were close, and Laci took seriously his role as the captain's steward and was never too far from him. Given his clout aboard ship as the crewmember closest to the seat of power, everyone wanted to be his friend. This was his new life, but Laci never lost his love of mathematics—and he taught me much about it over the years.

"So where do these numbers come from?" I asked him when he put my sister and me to bed on the ship the night of the big casino adventure. "It's a mystery," he answered. "We don't really know." And since Ilana and I were wound up from having been up late in a place we'd always dreamed of entering, he told us part of what he did know as our bedtime story.

"We call these numerals—that's the name for the shapes of the numbers you saw—Arabic," he said, "or sometimes Hindu, or even Hindu-Arabic. But when your father and I were once detained with the rest of the ship's crew in an Arab port city, I spent my time there learning the numerals the Arabs use today." He then opened a drawer and took out a piece of the ship's stationery and drew on it in large print all ten Arabic numerals. "You see," he said, "they look nothing like the numbers we saw on the tables tonight, the numbers we know so well." I looked at these numbers in amazement. I'd never seen such signs. Only the one looked like our 1; the rest of the shapes were totally foreign to us. The five was a small uneven circle, and the zero a dot. I tried to copy the drawn numbers but didn't do too well.

Then Laci took out a deck of cards he had brought with him and placed them face up on a table. I tried to read all their numbers, and little Ilana played with them, turning around the ornately drawn kings, queens, and jacks in black and red. Ilana noticed that they looked the same when upside down. Finally, after playing with these wondrous numbers and shapes for perhaps half an hour, we fell asleep.

The next night, Laci came again to put us to bed. My sister and I shared a cabin next to the captain's, where my parents slept and where we spent our days. "Today let's talk more about the numbers," he said. "So you remember that they don't look very much

like the Arabic numerals. Well, guess what: They are not like the Hindi numbers either.” Then on a new piece of stationery he drew the Hindi numbers, which some people in India use today, and explained that similar signs are in use in Nepal and Thailand and other Asian countries. “I learned this,” he said, “also from experience, when our ship docked at Bombay a few years ago on a world cruise.”

I looked at these curious numbers and tried to copy them, and my sister made some drawings. We all laughed at my attempts until we children fell asleep. The following night, I had many questions for Laci about the origin of the numbers: “Where do these numbers really come from? Why don’t we use the Arabic numbers? Why do different peoples have their own different numbers? And who invented them all?” I wanted answers right away—I was so curious, so fascinated by them, that I could think of nothing else.

Laci’s answer disappointed me a little. All he said was, “Why don’t you ask your teacher when you start school next month.” This was painful for me to hear. It was late August then, and I knew that, sadly, I would soon have to leave the ship with my mother and sister for at least a few months of school before we could rejoin my father for more cruising. I would miss Laci and the stimulating conversations we had almost every day about ships and ports and cities and sailings—and about numbers.

At school I was often bored. I enjoyed immensely the experiential learning I could pursue aboard ship: finding out firsthand how the world works, even as seen from the still-developing vantage point of a child. I liked being taught about life by my parents and by ship’s stewards, and mostly by the dedicated, highly attentive, and instructive Laci. At school, on the other hand, everything seemed rote, divorced from reality, and lacking excitement. There, I simply coasted, doing the minimum and counting the days till we could join my father on the ship. I couldn’t wait to be back aboard with my friend and mentor; and my child’s intuition told me that he knew much more than he was teaching me.

I had developed an obsession with finding the origin of the ornate numerals I had seen on the gaming table at the casino. I wanted to know where the numerals we use everywhere originally came from, and I was looking forward to Laci telling me more about them—and showing me new things about numbers through our travel experiences. I was barely beginning to understand that there were two related concepts here: numerals and numbers. Numbers were abstract entities. And I felt that there was

much more here to be discovered, even if the true depth of the concept of *number* was still beyond my abilities to fully understand. I was mature enough, however, to want to learn how the signs that stand for numbers, the ten numerals we use today, came into being.

THE NEXT INTERESTING SAILING we did with the ship was something special. Instead of the usual pleasure cruises to party islands or opulent casinos (this was before gambling aboard ships had become the norm), the shipping company sent its flagship, captained by my father, on a historical-educational cruise (this, too, was a novelty—it happened before mass “cultural tourism” was born). We sailed first to Piraeus, the port of Athens, and the passengers had an expertly guided tour of the Acropolis and lectures on the birth of Greek democracy, architecture, sculpture, and mathematics.

My father loved the good life—and as ship’s captain, he lived it. In every port, the local shipping agent invited him to dinner at the most expensive or most unusual restaurant in town. In Piraeus, the ship’s agent was Mr. Papaioanis, a jovial, paunchy Greek originally from the island of Patmos. He invited us all to dinner at a beach restaurant called *To Poseidoneion* (Poseidon’s), on one of the backstreets facing the sea. When I think back to that outing so many years ago, I can still smell the fresh shrimp grilling on an open fire and feel the gentle sea wind brush my face; when I close my eyes, I can still see the lights of distant fishing boats gently rolling in the water and hear the waves crashing on the sand. It was a wonderful evening and I hoped it would never end. It was my introduction to Greece and its pleasures. After this wonderful meal, we all took a long walk along the edge of the water, eventually winding our way all the way back to the Port of Piraeus and to our ship, docked by a central pier flanked by two ferries.

The next morning, Laci woke me up early. “When your sister and mother go shopping today, let me take you to see the ancient Greek numbers,” he said. “Great!” I answered as I jumped out of bed and started to get dressed. This was going to be an exciting day. I went to my father’s large cabin to wait for Laci. He had already prepared my breakfast, and I enjoyed the hot chocolate and the freshly baked, still-steaming croissant made in the ship’s ovens.

My father was up on the bridge, and while I was finishing my breakfast—my

mother and sister were still asleep—he came down and into the cabin. “You’re up early,” he said. “Yes,” I answered excitedly, “Laci is taking me to Athens to look at ancient Greek numbers!” My father nodded. I wasn’t sure that he understood—or appreciated—how important to me my relationship with Laci was: that I would even give up time with my family to go look at some numbers with him.

Laci came, and we went down the gangway to the pier and into a cab that was waiting for us. We drove through the heavy morning traffic of greater Athens, climbing up the densely populated hills between Piraeus and the Greek capital. The pollution was heavy—the Athens area, like Los Angeles, suffers from a thermal inversion pattern that traps gasses and particles—and the bad air made me cough frequently. In about an hour we came to the center of Athens and the cab dropped us off at the Plaka, the city square below the acropolis, full of shops and boutiques and cafes. From there, we climbed up the steep path of the acropolis hill to the Parthenon, the fifth-century BCE temple to the Greek goddess Athena.

We walked slowly up the white stone path. The air was clear and crisp here, and crocuses were blooming; I could smell the fresh scent of the pine trees around us. At the very top, we paid the entrance fee and went into the ruins of the ancient acropolis. We then slowly climbed up the stone stairs to the famous Parthenon. I stopped from time to time to catch my breath and to admire the incredible view of the temple from below as I climbed toward it.

“Beautiful, isn’t it?” asked Laci.

“Yes,” I said. “It’s a very pretty building with these columns.”

“These are made of marble,” he said. “But you know why you find it so beautiful?” I said I didn’t know. “It’s the proportion,” he said. “The Parthenon follows the ancient Greek proportion called the golden ratio. The ratio of its length to its height is about 1.618, a number that seems to characterize many things we consider beautiful—and it also appears in nature.” I was fascinated. He explained that the golden ratio came from a mathematical series of numbers called the Fibonacci sequence, and he showed me how it is obtained, each number being the sum of the two previous ones: 1, 1, 2, 3, 5, 8, 13, 21, 34, and so on. If you divide a number by its predecessor, you get something approximating the golden ratio of 1.618. (For example, the sequence continues with 55 and 89. The ratio of 89 to 55 is 1.61818 . . .) I found this idea enthralling.

We went into the Parthenon and saw some statues, beautiful likenesses of the

goddess Athena still with traces of ancient red and gold paint on her face. Laci bent down and pointed to the pedestal of one of the statues and showed me letters carved in the marble. “Look,” he said. “This is what I wanted you to see.” I saw a letter I did not recognize—it was Greek. “Greek letters were not only used for writing, but also for numbers,” Laci said. The letter he was pointing to, he explained, was the Greek delta. It stood for the number four. “This was the fourth statue out of the assemblage that once stood here,” he said.

After spending an hour admiring this monument of ancient Greek civilization, we left the temple and began to descend slowly. We stopped to sit down on a flat marble slab that was once part of this columned edifice. From here we could admire the Parthenon. It was hot, and we drank water from plastic bottles Laci had bought. After a few moments, he took out a notebook and showed me how the Greeks used letters as their numerals, and how their arithmetic, using only letters and no zero, worked. Here is what he wrote:

Α	Β	Γ	Δ	Ε	Ζ	Η	Θ	Ι	Κ	Λ	Μ	Ν	
1	2	3	4	5	6	7	8	9	10	20	30	40	50
Ξ	Ο	Π	Ϟ	Ρ	Σ	Τ	Υ	Φ	Χ	Ψ	Ω	Ϡ	
60	70	80	90	100	200	300	400	500	600	700	800	900	

The Greek letters used as numbers (including the archaic letters digamma, koppa, and sampi).

The Greek alphabet of that time, the fifth century BCE—the height of classical Greece—included letters that had been extinct since antiquity: *digamma* (Ϟ) for 6; *koppa* (Ϟ) for 90; and *sampi* (Ϡ) for 900. So by the fifth century BCE the Greeks had revived letters in an alphabet they no longer used for writing, just so they would have enough symbols for numbers.

Laci pointed out that the custom of using letters for numbers was rooted in Phoenicia, from which the Hebrew alphabet hails as well. Some Orthodox Jews to this day, he explained, have watches with faces displaying Hebrew letters for the numbers from 1 to 12.

We then went to the museum of Athens, one of the greatest archaeological museums in the world. Among beautiful statues of gods and goddesses I saw several stone inscriptions with numbers represented as letters.

On the way back to the ship, Laci asked the driver to stop in an alley in Piraeus and had me wait in the cab while he went into what looked like a store selling discount electronics. When he came back, he had a small package in his hand. “It’s just a small

transistor radio,” he said to me. These were the new popular products of the time, the early 1960s, and people were going crazy over them. You would see a person walking down the street listening to a transistor radio as often as today you might see someone talking on a cellular phone. “Just a present for someone,” he said. I thought nothing more about it at the time.

After leaving Piraeus that evening, the *Theodor Herzl* sailed to Naples, and the passengers spent the day visiting nearby Pompeii. Next, there was a stop at Civitavecchia, the modern-day port of Rome (in antiquity Rome’s port was Ostia). The passengers had a tour of the city, with an in-depth study of Rome and the history of its empire. For a boy interested in the history of numbers, this was a cruise to remember.

In Pompeii, Laci and I traced the Roman numerals—all Latin letters—that were used for house numbers in this ancient town. Its ruins were in a remarkable state of preservation as they had been covered by volcanic ash for almost two millennia after the catastrophic eruption of Vesuvius in 79 CE. At its museum we saw more numbers written using letters, and it was fun to read them and even try basic arithmetic.

Rome was a feast for a budding number-hunter. Roman numerals were everywhere. Most interesting were the milestones the Romans had placed along their straight-as-a-ruler roads, and I slowly became adept at reading the distances on these ancient markers, which I saw in museums and on the most famous of Roman roads, the Via Appia Antica.

Laci explained to me how the Romans devised their number system. He drew for me all the Roman numerals: I is one, V is five, X is ten, L is 50, C is 100, D is 500, and M is 1,000. He explained that this method made it necessary for the written numbers to grow, and grow, and grow . . . He showed me how a Roman might have had to multiply XVIII by LXXXII, and ultimately get the answer MCDLXXVI. For us today, this operation is simply $18 \times 82 = 1,476$, and we can do it quickly and efficiently. Laci challenged me to perform such a calculation in the Greco-Roman system and made me construct its multiplication table; it was so huge and complicated that it took me a week to do. Amazingly, he said, this inefficient numerical system remained in wide use in the West until the thirteenth century, when it was replaced by the numbers we know today.¹

I learned more about numbers from this lover of mathematics than I ever did at school, and I was grateful to him. But the mystery of where the ten numerals we use

today originally came from continued to haunt me. At the same time, as I matured through school and pursued adventures to discover numerals while traveling the Mediterranean aboard my father's ship, I began to understand the abstract—and even more mysterious—concept of a number. I realized that 3, for example, stood for the *idea* of “threeness”—something that was shared by all things in the universe that were three. All of them were to be described, in their quality of threeness, by the unique symbol 3. Equally, 5 stood for the quality of “fiveness” shared by everything that was five in number. This fascinating discovery made me even more eager to find where the numerals came from since they actually stood for something even deeper and more alluring than I could have ever imagined as a young child. I wanted to dedicate my life to traveling the world in search of an answer to the origin of numbers. Who invented these wondrous ten numerals? I asked myself this question all the time, and also, Who ever came up with the amazing idea that a concept of “threeness” or “seventeenness” or “three-hundred-and-five-ness” could be captured simply by a combination of ten signs arranged in certain ways?

2

In 1972, after high school and the obligatory service in the Israeli army, I was accepted as an undergraduate in mathematics at the University of California at Berkeley. I now made one more voyage on my father's ship. By then, all the passenger ships had been sold because Zim Lines had lost too much money due to poor management of the company's cruise division, called Zim Passenger Lines, and my father was now the captain of a small, slow, old cargo ship, the *M.V. Yaffo*, which sailed between the Mediterranean and the Americas. So I hitched a ride aboard my father's ship, embarking in Haifa in late July for the long trip that would ultimately bring me to Berkeley.

A cargo ship is as different from a cruise ship as a truck is from a limousine. Like a working truck, a cargo ship can be dirty and dusty, but its cabins are roomy; with no passengers, there's no need to cram many people into limited cabin space, and the crew is therefore more comfortable. But the flipside is that there is nothing to do: no cocktail parties or bars or ballrooms, and no exciting social gatherings. A voyage on a cargo ship can be lonely. But Laci was still my father's steward, and I was very fond of him. We often talked about mathematics during this trip.

As an adult, I now understood that the mystery that had held my attention since early childhood was really two mysteries. One was where the first numerals originated: In which part of the world, and when, did people first invent the nine numerals, and zero, that with time evolved into the numbers that rule our world? And the second was a deeper conundrum, which I was now sophisticated enough to discern: How did humans abstract the concept of number? How did the idea of a number originate, and how did it develop and mature through history, to bring us to the digitally dominated society in which we live today?

Laci and I spent many hours together discussing this latter idea as the ship slowly made its way across the ocean. It was a far deeper discussion than I had ever had with him as a child, certainly, and he brought to it his full intellectual abilities as a one-time doctoral student of pure mathematics at the top Russian university, where mathematics

has always been one of the most important fields of study. It was a pleasure to sit with Laci on deck chairs discussing mathematical concepts I was only beginning to understand and be fascinated by—building on the earlier ideas he had taught me as a child: numerals, numbers, prime numbers, and the mysterious Fibonacci sequence.

HAVING FINALLY CROSSED THE ATLANTIC, we docked for a few days in Halifax, Nova Scotia, and then continued to New York City; Charleston, South Carolina; and finally Miami, where I disembarked before the ship continued on to the Caribbean and South America. Before I left ship to fly to San Francisco and start my studies, Laci said one last thing to me in parting: “Remember how when you were little we used to talk about where the numerals came from? Maybe you’ll find out. I once read in a science magazine that a French archaeologist may have found something about the numbers in Asia decades ago—something important relating to the zero. But I don’t remember any of the details.”

Laci’s parting words intrigued me, but I had no opportunity to pursue this research further. At Berkeley, I had a full plate of math courses, challenging but often enjoyable, and I had to worry about grades and exams and learning to become a mathematician.

However, through my courses—mostly mathematics, but also anthropology, sociology, and philosophy—I learned a fair amount also about numbers and their development.

Numbers, as a concept, are much older than we might think. In 1960, a Belgian explorer named Jean de Heinzelin de Braucourt was surveying the region of Ishango, at the border of present-day Uganda and Congo (then the Belgian Congo), when he discovered a strange-looking bone: a baboon’s fibula bearing what looked like numerous tally marks. Analysis later concluded that these markings might evidence very early counting. The bone has three sets of identical notches, adding, respectively, to the totals 60, 48, and 60. The markings are grouped in several sets containing 5, 7, 9, 11, or 13 tally marks each. This bone was scientifically dated to about 20,000 years ago—the Paleolithic era—when humans lived in hunter-gatherer groups. The Ishango bone provides some of the earliest known evidence of a form of counting by humans who lived in Africa so long ago, and it is now displayed at the Royal Belgian Institute of Natural Sciences in Brussels.