

INTRODUCTION

“The Jewish Mathematician”

Vito Volterra, born in 1860, died in Rome in 1940, having lived a tumultuous life that spanned the period from the unification of Italy to the outbreak of World War II. Born into a Jewish family of modest means, he became a world-renowned mathematician, developing a powerful mathematical language and theories whose influence would be felt in fields ranging from physics and applied mathematics to biology and economics. The literature of modern mathematics and applied mathematics is shot through with his name, the hallmark of immortality for a scientist. *Volterra processes* are widely used in materials science and control theory, and *Volterra integral equations* and *Volterra integro-differential equations* inform the theory of elastic media. The *Lotka-Volterra equations* appear in the first few pages of any contemporary treatise on theoretical ecology, sometimes disguised as the *Volterra population equation*. Elsewhere we find *Volterra systems*, *Volterra series*, *Volterra operators*, *Volterra kernels*, and *Volterra functionals*. Few mathematicians of any time and place have left behind such a legacy. By the age of twenty-three, Vito Volterra was a tenured university professor at Pisa, and he scaled the academic ladder quickly, becoming a professor at the University of Rome in 1900. Five years later, he was a central figure in international academic, political, and intellectual circles, and that same year he was appointed a senator of the Kingdom of Italy, making him a member for life of the upper house of Parliament.

For the next twenty years, Vito Volterra was the undisputed head of the Italian school of mathematics, which included a formidable group of Jewish university professors, among them Tullio Levi-Civita, Federigo Enriques, and Guido Castelnuovo. An aristocratic and imposing figure, Volterra zealously promoted the cause of science within and outside his country. He became president of the faltering Italian Physical Society and breathed new life into it. In an era when scientists in northern and central Europe were presiding over the birth of modern physics, Volterra and his circle of mathematicians filled the lacuna created by the absence of such physicists in Italy, a vacuum that would persist until the emergence of Enrico Fermi.

It did not take long for the fruits of Einstein’s 1905 “annus mirabilis,” particularly his special theory of relativity, to claim the attention of these articulate, versatile, and consummate mathematicians. In Italy, they alone had the training, temperament, and breadth of interest to embrace the new theory, and the story of relativity in the Italian Peninsula belongs to them.

Quick to grasp the profound importance of Einstein’s ideas, Italy’s mathematicians quickly set about making the theory known at home. Volterra organized discussion groups within the Italian Physical Society. Guido Castelnuovo—who, along with Federico Enriques, took a keen interest in the philosophical implications of the theory—encouraged the translation and publication of Hermann Minkowski’s famous 1908 address on “Space and Time” in the physics journal *Nuovo Cimento*. He also lectured and wrote about relativity and helped organize, in 1919, the first series of seminar talks on general relativity at the University of Rome. Enriques enlisted his own journal, *Scientia*, in the campaign. Between 1908 and 1914, a number of relativity articles, both favorable and unfavorable to relativity, appeared in his journal. (“To be sure,” Einstein wrote to a friend in 1914, after reading an article contributed by Max Abraham, an outspoken critic of Einstein’s efforts to generalize the special theory of relativity, “he fulminates against all relativity in *Scientia*, but he does it with understanding.”)¹

The contributions of Italy’s foremost mathematicians to the intellectual migration and reception of relativity theory, both special and general, culminated in an extraordinary correspondence in 1915 between Einstein in Berlin and Tullio Levi-Civita in Padua, in which Levi-Civita took Einstein to task for not being rigorous enough in a particular proof. On April 14, 1915, after a flurry of letters, Einstein conceded that his proof failed in the special case treated by Levi-Civita and offered to “include the corrections I have learned from our memorable correspondence,” if the occasion to do so arose. He continued in a more personal vein: “I shall take pleasure in striving to allow our acquaintance by letter [to] turn into a personal one: one more reason at last to cross the Alps again one day. It is to be hoped that our fatherlands will not rebel against each other as well!”² But Italy’s decision later that year to take up arms against its one-time treaty partners Austria-Hungary and Germany forced Einstein to postpone his visit to the Italian mathematical community.

These dedicated mathematicians were also proud Italian patriots. When Italy entered World War I in 1915, the fifty-five-year-old Volterra volunteered as a lieutenant in the Italian Army Corps of Engineers. He spent the next two years working at the Aeronautics Institute in Rome, carrying out aerial warfare experiments on airships in Tuscany and testing various photo-telemetric devices, first along the Italian-Austrian front between Verona and Gorizia and later on the French front from Reims to Soisson. While in the army, he also made several trips to England and France to see how Italy’s allies had organized and recruited scientists to work on military problems, developed his own plans for an organization to support such work in Italy, and participated in the founding of the International Research Council in London; in all, he did not don civilian clothes again until the Armistice of November 1918.

When the war ended, Volterra returned to the University of Rome. There he resumed his teaching and administrative duties as the dean of

the science faculty, and continued his rise, which, ominously in retrospect, can be seen to have paralleled that of the dictator. By 1925, when Mussolini had completed his takeover of Italy, Vito Volterra was president of the Accademia dei Lincei, the world's oldest scientific society, to which Galileo had been elected in 1611. He had also by that time founded Italy's National Research Council, which was charged with organizing and promoting scientific and industrial development and national defense. He acted as its president while also serving as vice president of its parent International Research Council, the new multinational federation of research councils in fifteen Allied and neutral countries. Indeed, Volterra's importance loomed even larger internationally than it did in Italy, where, according to his American friend the astronomer George Ellery Hale, he was "the leading spirit"—Mr. Italian Science, if you will—of his embattled nation.³

The rise of Fascism, however, brought a halt to the golden age of Italian mathematics. To be sure, age may well have been a factor: By 1925, the members of Volterra's influential circle, all born between 1860 and 1873, were well into, if not past, their scientific prime. Be that as it may, Mussolini's regime was actively hostile to the circle of Jewish Italian mathematicians who, in effect, had dominated the old scientific order. The records of the Accademia d'Italia—the most prominent of Mussolini's new institutions of culture—shows only too clearly that the Fascist state did not seek an accommodation with Volterra's circle, and in fact used the new academy as a means of isolating them and marginalizing their scientific contributions. The selection of candidates both for membership in the new academy and for its major prizes reflects a pronounced anti-Semitism, despite the regime's initial disavowals. Matters had already deteriorated badly by the time Anti-Semitism became an official component of the Fascist state in 1938. That year, the government issued the *Manifesto of Italian Racism*, which declared in part that Jews could not be considered members of a so-called Italian "race," and put into effect the infamous racial laws, which among other measures banished Italy's Jewish professors from their universities. The racial laws exacted a heavy toll on Italy's scientific community, in which Italian Jews were represented far out of proportion to their percentage of the population.*

Seven years earlier, in 1931, Vito Volterra had refused to sign the oath of allegiance to the Fascist government, which all university professors were required to sign. For this courageous act—he was one of only twelve Italian university professors who refused—he was drummed out of Italy's scientific establishment and ostracized by his profession and his nation. Upon learning the news, George Ellery Hale sent him a letter of support. "I wish I could also tell you personally of. . . my admiration of your attitude and courage,"

*In the early thirties there were only about 39,000 Jews in a country of some 40 million people. Although they figured as only 0.1 percent of Mussolini's subjects, ninety-seven of them were professors, 7 percent of the total. (1931 census figures reported in Renzo De Felice, *Storia degli ebrei italiani sotto il fascismo*, 1st ed., Turin: Einaudi, 1961, p. 6.)

he wrote. In his answer, Volterra, by now all but banished from public view, made it clear that he harbored no illusions. "If you no longer see my name among the membership of the Accademia dei Lincei," he wrote to Hale in 1934, "do not think I am dead."⁴

Vito Volterra had become an invisible man. Late in 1938, Enrico Fermi, that year's Nobel laureate in physics and the new Mr. Italian Science, left Mussolini's Italy for good. Accompanied by his wife Laura, their two children, and a nanny, he headed for America, stopping in Stockholm to collect his prize before continuing on to Columbia University in New York. Two years later Volterra died—in such obscurity that when the Nazis occupied Rome in 1943, German soldiers knocked on the door of his house in Via in Lucina 17 confidently expecting to arrest him and deport him to a concentration camp.

Volterra's life exemplifies the post-unification rise of Italian mathematics, its prominence in the first quarter of the twentieth century, and its precipitous decline under Mussolini. This intellectual history in turn parallels the rise of Italian Jewry in the latter half of the nineteenth century and its travails during the Second World War. The meteoric rise and tragic fall of Volterra and his circle thus constitutes a lens through which we may examine in intimate detail the fortunes of Italian science in an epic scientific age.

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With the proclamation of the Kingdom of Italy in 1861, Victor Emmanuel II of the House of Savoy took his place among other European monarchs. Before the Risorgimento, the Italian peninsula's campaign for national unification, Italy had been a patchwork of states governed, protected, and fought over by foreign rulers. Between 1859 and 1861 Camillo Cavour, the prime minister of Piedmont, in the northwest corner of the country, engineered the annexation of Lombardy to the east and the provinces of Parma, Modena, and Tuscany to the south, and sent the King's troops into the Papal States. When the fighting ceased, the Adriatic coast from Ancona to Bologna and the lands of Umbria and the Marches had been annexed to the Kingdom of Italy as well. The charismatic Risorgimento general Giuseppe Garibaldi and his army of volunteers had in the meantime conquered the island of Sicily and now moved north and chased the Bourbons out of Naples. Garibaldi planned to march on Rome, but under pressure from Cavour he surrendered southern Italy to the King in October 1860. Only Venice (until 1866), Rome (until 1870), and Trieste (until 1919) remained outside the fold.

In September 1858, inspired by the unification fever that gripped their country, a trio of Italian mathematicians packed their bags and set out on a scientific expedition across the Alps. Motivated in part by a sense of scientific isolation at home, in part by the lament of colleagues that their work

was unknown abroad, Enrico Betti, Francesco Brioschi, and Felice Casorati headed for Germany and France, home to some of Europe's finest mathematicians. Their trip was a huge success. For the thirty-five-year-old Betti, the newly anointed professor of algebra at Pisa, the trip's high point was meeting the great analyst, geometer, and number theorist Georg Friedrich Bernhard Riemann at Göttingen. Riemann, who would later visit Pisa, had a lasting influence on Betti's approach to mathematics and on Italian mathematics in general. When Betti returned to Pisa, he would translate into Italian Riemann's doctoral dissertation of 1851, "Foundations for a General Theory of Functions of a Complex Variable," for the *Annali di Matematica pura e applicata*, an ambitious new journal intended not just to publish original papers by Italian authors but also to introduce important results by German and English mathematicians to a new generation of Italian mathematicians. Betti's later work would focus almost entirely on problems of mathematical physics, ranging from electrostatics and magnetism to the theory of potentials and drawing inspiration from Riemann's ideas regarding mathematical descriptions of the physical world. Mathematicians today are familiar with Betti numbers from algebraic topology, the study of geometric shapes.[†]

For Betti's colleagues, Brioschi and Casorti, the Alpine crossing had an equally salutary outcome. Brioschi, then thirty-four and a professor at Pavia, plunged into animated conversations first with Leopold Kronecker in Berlin and later with Charles Hermite in Paris, and returned home reinvigorated and ready to adapt their methods to his own work on the theory of the transformation of elliptic and Abelian functions. Casorati, then Brioschi's assistant, also came under Riemann's spell and would return to Berlin in 1864 for further productive discussions with Karl Weierstrass and other mathematicians there. More than a mere trip, that foray across the Alps by Betti and his companions represented an important stage in Italy's evolution into a modern scientific country. Speaking for the first generation of post-unification mathematicians, Vito Volterra told an international assembly of mathematicians in Paris in 1900 that "the scientific existence of Italy as a nation" dated from this continental trip.⁵

By the time Rome had become the capital of the newly created state of Italy in 1870, the Italian mathematical community was undergoing a rebirth of its own. Mathematicians like Betti and Luigi Cremona, both veterans of the 1848 War of Independence, were now members of Parliament. Cremona had been a student of Brioschi and later became the director of the school of engineering at Rome, and his voice carried great weight in the

[†]The question is, How many times can you cut up the surface of a solid shape without separating it into two objects? For example, if you cut through one side of a doughnut-shaped torus, you can straighten it and it's a cylinder. Then if you cut the cylinder's surface parallel to its axis, you can lay it flat and it's a sheet, still one object. Thus a torus has a Betti number two, and a cylinder has Betti number one. Any closed cut of the surface of a sphere separates it into two pieces, so a sphere has Betti number zero.

Senate on educational matters. Betti had recently become the director of the Scuola Normale Superiore at Pisa, a select teachers college connected to the University of Pisa, and there he set about building a paramount school of mathematics whose roster of distinguished alumni (Volterra was among them) grew by the decade. Brioschi, who combined his university position with a ministerial appointment in the new government, helped to establish the Milan Polytechnic Institute, where he was both teacher and administrator. As soldiers, teachers, and politicians, these scientists not only assisted in the building of their state but after 1870 put Italian mathematics on the scientific map of Europe.

From around the turn of the century until Benito Mussolini became dictator in 1925, mathematics was Italy's foremost scientific discipline, and a close-knit circle of largely Jewish Italian mathematicians dominated science in Italy. As Jews, they shared a history and common traditions, and as scientists and Italian citizens, they enjoyed an international reputation. Nor were their interests confined to mathematics. Volterra combined a love of French literature with a passion for rare books and Roman antiquities. He also developed a boundless enthusiasm for international travel: In 1909 he represented Italy at the twentieth anniversary of the founding of Clark University, in Worcester, Massachusetts, and a few years later participated in the inauguration of the Rice Institute, in Houston. After Mussolini came to power, Paris would become, for a time, his second home. Enriques, an authority on algebraic geometry who wrote extensively on the philosophy and history of science, founded and coedited *Scientia*, a culturally grounded international review of scientific ideas. When the end of World War I finally enabled Einstein to make that long-anticipated and, in the event, highly celebrated, trip to Italy, it was Enriques who made the arrangements. Levi-Civita's taste in mathematical problems ranged from the pure to the applied, with a special interest in the general theory of relativity. Castelnuovo, for his part, spent considerable time building up a school of mathematics at the University of Rome, bringing Levi-Civita there from the University of Padua in 1918; Enriques followed from Bologna in 1923. By then, Rome had become an international mecca for mathematicians, ranging from the Russian-born Oscar Zariski to Rockefeller fellows Dirk Struik and Szolem Mandelbrojt to the American Griffith Evans—all at the start of their careers. Vito Volterra's circle of university professors were in the vanguard of what Struik would describe many years later, in a celebrated talk on the history of mathematics in Europe, as "a new phenomenon—namely, the Jewish mathematician."⁶

In the course of compiling brief biographical profiles of more than 300 Italian mathematicians who died between 1861 and 1960, the late Francesco Tricomi, professor of mathematics at the University of Turin, assembled a vast quantity of statistical information: the relatively high number who died a violent death, the dearth of women in their ranks, the length of mathematical careers. (Volterra's is among the longest, since he became a tenured

university professor at an unusually young age.) Many of the published obituaries and commemorations that Tricomi examined glossed over certain matters. He writes, "[O]ne almost never says, even during the pre-Fascist period, whether the person about whom one is writing is Jewish. Why? Particularly since, in our science, that would be almost a title of honor, considering the number and above all the merit of these Jewish mathematicians!" Not himself Jewish, Tricomi supplied the missing data himself, using the letter "E" (for *Ebreo*) to identify the Jewish mathematicians on his list. Of the 371 mathematicians included in his census, 29 (8 percent of the group) have an "E" before their name—an impressively high number, given that Italian Jews had never represented more than a tenth of a percent of the country's citizens.⁷

Before unification, Italian Jews paid a heavy price for being Jewish. Citizens of a Roman Republic and Empire long before Rome became the sacred seat of Christendom, Italy's Jews saw their fortunes rise and fall as emperors, kings, and papal rulers governed the land. During the Counter Reformation and the Inquisition, Jewish books were confiscated and burned. Roman Jews were burned alive in Campo de' Fiori, on the site where a statue of Giordano Bruno, who suffered the same fate in 1600 for his belief in a plurality of worlds, stands today. By the late sixteenth century, most Italian cities had segregated the Jews from the rest of the population, forcing them to live in ghettos. (The very word derives from the Italian *getto*, meaning metal casting, and refers to the location in Venice of the original ghetto, which was set up in 1516 near the site of an iron foundry.) The confinement of Italian Jews in ghettos persisted, with few exceptions, for 300 years.

The nineteenth-century German historian Ferdinand Gregorovius came upon the narrow streets and alleys of the Rome ghetto in the mid-nineteenth century, while working on his monumental history of medieval Rome. He describes it in an essay as "the dreariest quarter in Rome, a corner of filth and poverty." Some 3,800 Jews lived there, a few steps from the Tiber River, in the shadow of the Theater of Marcellus and the Porticus of Octavia, in row houses, "tower-like masses of bizarre design, with numerous flowerpots in the windows and countless household utensils hanging on the walls." When the banks of the Tiber overflowed, the basements of houses built at the river's edge filled with water. "Those who live beneath take refuge in the upper floors, which are intolerably crowded and tainted by pestilential atmosphere," he wrote. "The stoppage of food supply and of work increase the misfortune, and the flood ruins everything that cannot be removed." Prosperous ghetto Jews lived in houses situated on higher land; the wealthiest, who had the means to pay the heavy taxes and tributes levied on Jews in Italy, often bought their way out and emigrated north, to Lombardy and Tuscany—provinces belonging to rulers other than the pope.⁸

Ghetto life was harsh and degrading. Gregorovius observed men and women who would sit

in their doorways or outdoors, which affords scarcely more light than their damp and dismal rooms, and tend their ragged merchandise or industriously patch and sew. The chaos of patching and mending of rags (called *cenci* in Italian) is indescribable. All the world seems to lie about, transformed into Jewish trash, tattered and torn, in countless rags and scraps. Pieces of junk of every kind and color are heaped high before the doors: scraps of golden fringe, pieces of silk brocade, rags of velvet, patches of red, scraps of blue, orange, yellow, black, white, old, torn, threadbare, badly worn scraps and tatters.⁹

The glaring contrast between the dark and foul-smelling streets of the Rome ghetto and the majestic views of ancient Roman ruins on the Palatine and bustling Trastevere just across the river puzzled Gregorovius: How had the Jews managed to survive while the civilizations that had conquered them had vanished? He was still living in Rome in 1870 when the troops of King Victor Emmanuel II entered the city and emancipated its Jews.

It was in the cities under papal rule that the Jews of Italy had endured the most repressive civil, political, and religious restrictions. To facilitate the conversion of Jews to Christianity, houses of catechumens were established in the sixteenth century, where Jews could be held indefinitely against their will, while their "conversions" were monitored. Jews were forced to listen to evangelical sermons. They could not attend public schools at any level, with the exception of the faculty of medicine (so that they could practice on fellow Jews). They were prohibited from owning property, maintaining shops outside the ghetto, remaining outside the ghetto after sundown, or hiring Christian servants—which Jewish families sometimes did anyway, often to their distinct disadvantage.

In Ancona, Modena, Reggio Emilia, and other cities with Jewish populations, the surreptitious baptism of Jewish children by Christian servants was a commonplace event well into the nineteenth century. A case that drew the attention of Cavour, Garibaldi, and other Risorgimento leaders and caused an uproar in England, France, and the United States involved the kidnapping of six-year-old Edgardo Mortara in Bologna in June of 1858 by papal guards. A servant charged with caring for Edgardo during a childhood illness claimed to have baptized him in secret. Under canon law, once a Jewish child was baptized in the Catholic faith, the church had an unimpeachable right to raise him as a Catholic, regardless of the parents' wishes. Accordingly, little Edgardo was taken to Rome, placed in the house of the catechumens there, and adopted by Pius IX, whose refusal to return him to his family only intensified the anticlerical feelings of liberals and democrats in Piedmont and accelerated the downfall of the Papal States.¹⁰ The following year, Bologna, a papal city for more than two centuries, overthrew the papal government and pledged its allegiance to the War of Independence

and the House of Savoy. In the process, Italian Jews in Romagna gained the same civil rights as Christians.

In Piedmont, where the Risorgimento began, Massimo D'Azeglio and other figures active in the movement had linked Jewish emancipation to the political emancipation of the Italian people up and down the peninsula. In 1848 Piedmont became the first state to extend full civil rights to Jews and other non-Catholics living within its borders; Romagna and the other states that were annexed to Piedmont to form the United Kingdom of Italy followed suit in 1859 and 1860. Slowly but surely, the emancipation of Jews spread throughout the country. Italy's Jews firmly believed that they owed their political, economic, and social rebirth to the House of Savoy, the Risorgimento, and revolutionaries like Garibaldi. Ghetto Jews, who saw Garibaldi's cause as their own, fought alongside Garibaldi's volunteers in the Rome campaign of 1849, in the Sicilian expedition of 1860, and in the Trentino in 1868. After 1860, some Jewish families began to choose patriotic names for their newborn children—for the girls, Italia (coupled with a traditional name); for the boys, Victor Emmanuel, Umberto, or Carlo Alberto—and the practice ("the double identity," one writer called it) of coupling traditional Jewish names with an Italian Christian name became widespread.¹¹

The Risorgimento culminated in equal rights for all Italians, including the Italian Jews. They could—and did—live anywhere, stay out all night, buy and sell property in their own names, attend public schools, choose a trade, become university professors. "And all this," the writer Primo Levi once remarked about the Jews of his native Turin, "at a time when in Italy the great majority of the population was illiterate." Noting that Jews had always prized culture, education, and literacy, he added, "Therefore emancipation did not catch them unprepared [and] within one or two generations the Jews out of the ghetto easily moved from crafts and small commerce to the newly born industries, to administration, high public office, the armed forces, and the universities."¹² Levi's characterization of the Jewish communities in Piedmont applies to many Jewish communities in Italy at that time, including that of Ancona, where Vito Volterra was born in 1860.