From Algebra to the Secrets of the Universe: The Fascinating Life of Mary Somerville

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There are many good reasons for investigating the life and work of Mary Somerville (see Fig. 1), the Scottish mathematician who, more than two centuries ago, after a very insignificant childhood, slowly became one of the most prominent scientists in Britain, so well known that when she died in 1872, the obituaries defined her "The Queen of Sciences".

Indeed, the title was appropriate, as although she conducted few scientific investigations herself, Somerville spent a great amount of time of her life exchanging ideas with researchers in the most advanced areas of mathematics, physical science and geography of her time and published four well-reputed books concerning these disciplines. She was commissioned to write them by the Society for the Diffusion of Useful Knowledge, an interesting organization which, during the Victorian age, promoted the production of readable texts on scientific topics for an increasingly literate and educated population, a reflection of the growing focus on science which occurred in the nineteenth century. Yet her success as an author, as a mathematician and an astronomer, was only possible because of the stubborn way in which she pursued her studies, ignoring her lack of academic background and giving a successful example of self-taught education.

Her father, Admiral William Fairfax, began working as a midshipman at the age of ten and was never formally educated, while her mother, a daughter of the Scottish Solicitor of Customs, used to read only the Bible or newspapers. Since her father was constantly employed at sea, her education was in the hands of her mother, who was quite indulgent and only taught her the catechism of the Kirk of Scotland and how to read the Bible, plus some domestic cores such as how to preserve fruit, shell peas and beans, feed poultry, care for the family's cow.

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Fig. 1 Portrait of Mary Somerville, oil on canvas, by James Swinton (1816–1888), Somerville College, Oxford, UK. (Permission granted by the Librarian and Archivist of the Somerville College)

She was raised in Burntisland, a small seaport of the coast of Fifeshire in Scotland and, by her own admission, at nine years old she was "a wild creature", who spent her time roaming the countryside and seashore near her home, observing sea creatures and birds, collecting things and learning the name of the plants around her house. Throughout her life, the associations acquired during her childhood were the strongest, solitude and her intense interaction with nature were the hallmarks not only of her early days, but a deep investment for her future years as a scientist. At night, the stars she could see from her window held equal fascination.

But when she was ten years old, this carefree existence came to an end, as her father returned from a long voyage and discovered that her reading skills were minimal and she couldn't write.

So Mary was sent to a school run by a Miss Primrose, were the teaching techniques were closed to torture. After one year at the school, she returned home and continued her wandering existence, but at least she had increased reading skills that allowed her to enjoy a small number of books in their home.

Mary's interest in mathematics had an outburst during a party: she was paging through a fashion magazine and came across a puzzle. When she looked at the answer, it had x's and y's in the solution. Curious, she asked a friend who told her that it was something called algebra, but she couldn't tell her what it was. She decided to study the subject and in order to get the required books she conspired with her brother's tutor who gave her what she needed, Bonnycastle's *Algebra*, which at that time was in use to teach mathematics in schools. Mary was from that point on her way, as each night after the rest of the household retired, she would study mathematics by candlelight. After some time, the candle supply started to diminish and her mother discovered her peculiar habits, so she couldn't use anymore the night hours to satisfy her interest in science. In general people during that time believed that women's minds couldn't handle intellectual pursuits, as they could drive them crazy. Mary recalls in her autobiography [7] her father saying to her mother: "Peg, we must put a stop to this, or we shall have Mary in a straight-jacket one of these days!".

But the family couldn't ignore for ever her attitude for studying, so she was allowed to move to the house of her grandfather in Edinburgh and there Mary turned into a charming and elegant young lady, without neglecting her studies, as she concentrated on understanding Euclid in addition to practicing the piano, painting and following cooking lessons.

Her family's dislike for her serious studies forced her to marry her cousin Samuel Greig at the age of twenty-four, and her pursuit of mathematics became even more difficult, for she had her own house and soon two sons to look after and her husband shared her family's low opinion of her passion for science. Luckily her marriage was not a long one, as Greig died in 1807, so she gained economic independence and she could go back to her studies. In order to do this properly, she consulted with mathematician William Wallace of the University of Edinburgh and assembled a library of all important works in mathematics and astronomy at that time: the treatises of Newton, Poisson, Euler, Lagrange, Monge, plus the volumes of Laplace's *Mécanique Céleste* and many more. She was not discouraged and, as all these books were written in French, she had to teach herself to read in that language in order to understand their contents.

Her family was deeply worried by her interest in differential calculus, which seemed to them at least eccentric. So in 1812 Somerville was convinced to marry another cousin, William Somerville: he was totally different from Greig, being a handsome and learned army surgeon who was supportive of her studies and defended her against criticism from her family. Together, William and Mary studied geology, collected minerals, travelled and began a family. After a period in Edinburgh, they moved to London in fashionable Hanover Square in Mayfair, where Mary became acquainted with a new set of learned friends, such as the astronomer Sir William Herschel and his son John, whose twenty-foot telescopes she had the chance to see in their house in Slough, twenty miles from London. He had used that telescope for nine years to carry out sky surveys and investigate double stars. And some years later it was from their telescope that she could observe the "glorious appearance of Jupiter" for the first time.

These personal contacts were invaluable in building her career and reputation, today we would say that she was an excellent public relations woman for herself.

During her first trip to Paris, in 1817, she had the privilege of being introduced to Pierre Simon Laplace, who acknowledged and assimilated her into the scientific elite long before she had published anything of lasting significance.

In 1826 Somerville published a study on magnetism in the Philosophical Transactions of the Royal Society of London entitled *On the Magnetizing Power of the More Refrangible Solar Rays*, [1].

Her experimental setup included, of all things, a needle, which she used for totally different purposes than those intended by her Aunt Janet who wanted to transform her in a lady in charge of the linen of her household. Her paper earned her admission into the Royal Astronomical Society in 1835, first woman together with the astronomer Caroline Herschel.

Mary had also a fruitful friendship with another woman in science, Ada Lovelace, the only daughter of Lord Byron and the only person at that time who understood the importance of Charles Babbage early mechanical computer, the so called "analytical engine": for this reason she is regarded as the first computer programmer.

After Somerville published her study on magnetism, her husband received a letter from Lord Brougham, founder of the Society of Useful Knowledge, and at that time member of the House of Commons as Whig Lord High Chancellor. He commissioned her an account of Laplace's *Mécanique Céleste*.

Somerville spent much of the next four to five years (1827–1831) writing the commissioned book. She had studied the *Mécanique Céleste* in detail, but remained self-conscious about her understanding, which she believed could be considered limited, as it didn't take place in an academic setting.

So she extracted a promise from Lord Brougham and her husband that if her work wasn't sufficient, it would be burned. But inside herself she felt she should try, as she believed that the middle class sought to change society and secure their positions through the promotion of science. At the same time she wanted to develop her own abilities and demonstrate that women could succeed in any field of culture.

She organized her work and she began to write for hours, taking care at the same time of the education of her children, visiting with friends and looking after the household. When it was complete, her manuscript, *The Mechanism of the Heavens*, [2], was sent to her friend Sir John Herschel, son of William, who praised it greatly. His only suggestion was that she explain the calculus at the beginning more thoroughly to accommodate readers not as proficient in mathematics as she was.

So she wrote a *Preliminary Dissertation*, [3], which became extremely popular, especially among students at Cambridge. Maria Edgeworth, the Irish novelist and writer of moral tales for children, wrote in a letter to Mary:

"I was long in the same state of a boa constrictor after a full meal… my mind was so distended by the magnitude, the immensity of what you put into it!".

Her work earned her the Victoria Medal and an encouraging review [11] from William Whewell, President of Trinity College in Cambridge.

In 1835 a letter arrived from Sir Robert Peel, a British statesman, who had advised the Crown to grant a civil pension of 200 pounds a year for Mary Somerville

in recognition of her eminence in science and literature and the Prime Minister Lord John Russell added 100 pounds a year to the pension, thereby coming to the rescue of the brilliant scientist's battered fortune, almost completely lost through mismanagement.

She continued writing after this initial success, claiming she couldn't stand to be idle, and published *On the Connexion of the Physical Sciences* [4] in 1846, which became famous not only for its contents, but also because it appears that one of her observations, noting that perturbations in the orbit of Uranus might be indicating the existence of an as yet unknown planet, led the astronomer John Couch Adams to his discovery of the planet Neptune; *Physical Geography* in 1848 [5] and *On Molecular and Microscopic Science* [6] in 1869.

Somerville's extensive writing earned her the respect of the scientific community in England and also in France, where she travelled twice.

During her first Grand Tour with her husband in 1817, she had visited also Italy, and fell in love with Rome. Later, at the beginning of the forties, when her husband was forced to retire for health reasons and compelled to move to a warmer climate, they both settled in Rome with their two daughters.

There she concentrated on her book *Physical Geography*, not only because she was deeply interested in the subject, but also because she was under increasing pressure to write, as her husband, now retired, had half of his former pay. Her Italian life became nomadic: after Rome she spent a period in Florence, were she obtained the permission from the Grand Duke of Tuscany, Leopoldo II, to borrow the books from his private library in the Pitti Palace. The Duke was delighted by these visits from Mary Somerville, as he found someone who could get interested in his work on the drainage of the Maremma, the Tuscan marches.

After Florence it was the turn of Siena, were they were provided with a nice apartment decorated with frescos. But Rome was in her heart, so she moved back to the eternal city were they settled in Palazzo Lepri in Via dei Condotti. Her arrival was greeted by a terrible flooding of the streets caused by the Tiber which burst its banks, but when the situation went back to normal, the Somervilles went on with their usual lives, inviting illustrious visitors and exchanging ideas with all the scientists in town, such as Padre Francesco de Vico, a Jesuit and astronomer, director of the Observatory of the Collegio Romano, who had discovered six comets.

Rome as usual was very hot in the summer, so the family escaped on the hills near Rome, in a villa in Albano, were Mary could write in peace and paint her beautiful landscapes, which are now kept in the Somerville College in Oxford.

Among her favorite friends in Rome, Mary appreciated Don Michelangelo Caetani, Duke of Sermoneta, who loved to invite at his beautiful Palazzo artists and writers. Mary's daughters had the privilege of learning to draw in the studio of John Gibson, a Welsh neoclassical sculptor, who was living in Rome in order to study Canova.

The summers of those years were spent in Perugia and after in Venice, where the Somervilles enjoyed the hospitality of Countess Mocenigo, whose family gave six doges to Venice, writing and painting as usual, while their daughters went to the Academy of Belle Arti for painting lessons.

Mary sent regular reports about her visits to the Italian cities she visited to her son from her previous marriage, Woronzow Greig. The other son had died in infancy and she also lost a daughter, Margaret, in her second marriage, both for infectious diseases.

The letter concerning Venice is among the most charming ones [7]; as a matter of fact, both Mary and William were in very good health, the terrible headaches which tormented her in London had disappeared, and William had recovered from the infectious disease which compelled him to leave his country.

When they went back to Rome, Mary started to carry out experiments to investigate the effect of the solar spectrum on the juices of plants and Sir John Herschel was so enthusiastic about her discoveries, that convinced her to publish her observations in another scientific paper in the Philosophical Transactions of the Royal Society.

While Mary was concentrating on her studies, the situation in the Papal State was in turmoil. Giuseppe Mazzini was working hard towards the unification of Italy, but the Pope, at that time Gregory XVI, didn't agree with the project.

As Mary at that point had finished her book on *Physical Geography*, the family decided to make a trip to London; William was now in good health and this interruption of their Italian lives seemed possible.

But her arrival in England was not a lucky one, as Mary was ill for a while and moreover she discovered that a book similar to her own had just been published under the name of *Kosmos*, by Alexander von Humboldt, a Prussian geographer, naturalist and explorer. Mary was deeply upset by this circumstance and almost threw the manuscript on the fire, but again her friend John Herschel convinced her to print it. When the book came out, Humboldt wrote to her stating that he admired her work.

After this successful outcome, Mary, William and their two daughters went back to Italy and found themselves in the middle of the War of Independence in 1848. They travelled to Turin and there Mary could talk with Baron Giovanni Plana, director of the Observatory, and remembered as a mathematician for the Abel-Plana formula in analysis. Baron Plana found a lovely apartment for the illustrious family in Casa Cavour, which belonged to the brothers Camillo, Minister of the Interior, and Gustavo.

Mary was very fond of the Italian statesman, who was a pleasant companion and they became good friends. She suffered later when he died, leaving people in deep mourning.

After Turin the family moved to Florence where they settled in a nice house in Via del Mandorlo.

Mary could entertain her guests in a beautiful garden, and so she could meet Frances Power Cobbe, a writer who was fighting against vivisection, and the British poetess Elizabeth Browning, who, like William Somerville, was suffering of bad health and needed a warm climate.

Living in Florence during those years meant that Mary witnessed the effects of the war of independence against the Austrians and she actually saw with her own eyes the Imperial family leaving Florence for good, escorted by the Austrian Minister and a part of the diplomatic corps [7].

There was luckily no blood or disorder and the people could walk around as usual, while Bettino Ricasoli, the so called "Iron baron", earned sufficient support to form a government and decide to annex Tuscany to the Kingdom of Italy. Of course the atmosphere in Florence was tense and explosions could be heard all the time, but Mary Somerville was not worried, she was playing the role of a reporter, rather than a scientific writer, as she noted some amusing details about French troops camped at Le Cascine, where she and her daughters saw a soldier skin a rat and put it in the soup-kettle [10].

The Somervilles were invited to watch King Victor Emmanuel's entry into Florence from the balcony of the Corsini Palace, a colourful event which she never forgot.

But fate was again preparing a severe blow on Mary, as on June 26, 1860, William Somerville passed away for another infectious disease. In those times no medicine had yet been found to fight dangerous bacteria, so nothing could be done to save his life.

The loss of her husband was a real tragedy; their marriage had been a happy one, as he was a congenial companion, who had supported and admired her during all the years they has spent together, allowing her to prove her extraordinary capacities, quite unusual for a woman of the Victorian era.

After this sad event, Mary's health was not so good and she left Florence for La Spezia, where she desperately tried to cope with her grief in all possible ways; she even came to the point of hiring a boat at night and rowing away from the shore in order to observe a beautiful comet which had appeared in the sky exactly on the day when she arrived in La Spezia.

At that point she could have decided to go back to London for good, since the main reason for her years in Italy, William's health, was now irrelevant. But she and her two daughters, Martha and Marie Charlotte, loved the country so much that she decided to stay and start a new book, *On molecular and Microscopic Sciences*: her age at that time was almost eighty!

A positive effect on her in that period was produced by her friendship with Lord William Acton, who had been the Minister of Marine and Admiral in the service of the Italian Navy for two years and in La Spezia was director general of the arsenal. He had a deep interest in natural history and therefore he represented a perfect interlocutor for the inexhaustible Scottish lady.

During her staying in La Spezia, in the south of Italy things were moving fast towards unification. Giuseppe Garibaldi had become a legend with his strategic expedition of one thousand volunteers, who landed in Sicily and conquered the Kingdom of the Two Sicilies, ruled by the Bourbons. In 1862, after the battle of Aspromonte which stopped Garibaldi from marching on Rome and the Papal States, the hero was imprisoned by the regular troops and sent to the fort Varignano in La Spezia. His leg was severely injured and he was in a state of great suffering, until a French surgeon saved him from amputation, by extracting a bullet from his ankle. People were asking to visit him in order to express their gratitude for his enterprises, but Mary decided to skip this, she admired him enormously but didn't want to disturb him [10]. So she never actually met Garibaldi, notwithstanding her deep understanding of his actions and his presence in her same city.

Her new book was now finished and she sent it to her editor John Murray who had some doubts due to her advanced age, so he turned to John Herschel for advice, who convinced him to publish it and it was another great success: she took ten years to write it, between the ages of seventy-nine and eighty nine, not an easy task. When the book came out in print, she was living in Naples, the final destination of her long life. Despite her old age and her shaking hands, she started to write her biography, entitled *Personal Recollections* [7], which was published by her daughter Martha after her death. Her handwritten notes are kept in two of the main collections in the Bodleian Library of Somerville College at Oxford [9].

Her friend Lord Acton introduced her in Naples to some of the leading Italian scientists in town, among whom she appreciated the astronomer and mathematician Annibale de Gasparis, who was looking after the Observatory of Capodimonte and had discovered nine asteroids.

After a while Mary became acquainted with all the Neapolitan intelligentsia and she was elected honorary member of the Accademia Pontaniana. She also had the chance to engage in scientific conversations with John Phillips, professor of geology at Oxford University, devoting their time to the geological aspects of the activity of the Vesuvius, which had been intriguing her since the first visit to Naples in 1817. She gave beautiful reports of the eruptions of the volcano in her *Recollections*, as during her last years in Naples some really dangerous ones took place, threatening the villages when the lava pushed its way downs its slopes.

Some interesting news arrived from Britain while she was in Naples regarding issues that were close to her heart.

One was certainly represented by the battle that John Stuart Mill, English philosopher and political economist, was conducting to show the iniquity of British laws regarding women, who were not allowed to vote. He presented a petition to the British parliament for the extension of suffrage to women, and Mary was very glad to be the first one to sign it, even if she did not agitate for woman rights: she just took them!

She received a letter in July 1869 from John Stuart Mill praising her "inestimable service to the cause of women by affording in her own person so high an example of their intellectual capabilities" [7].

Mary was obviously in favor of a proper education for women, something she had never had herself and from which she suffered most extensively. Her enormous effort to become a self-taught scientist convinced in that same year to decide to leave to the newly founded Ladies's College at Girton her scientific library, which obviously represented a treasure for all the women who would enter in that institution.

Moreover she was deeply interested in the theory of evolution to explain biological change developed by the English biologist and naturalist Charles Darwin. She had read his book *On the origin of species by means of natural selection* and she enjoyed it greatly, because of her interest in nature, even if she didn't agree with his theory. One of the main reasons why she liked his work was that Darwin devoted much study to birds, her favorite living creatures. And in any case she believed Darwin to be a man of genius who had contributed a great deal to knowledge of the natural world and its history. She was deeply in favor of the protection of animals and gave her support to the antivivisection movement.

One sad thing that happened when she was in Naples was the loss of her dear and affectionate friend John Herschel, though twelve years younger than her. Mary after his death realized that few of her friends remained and she was nearly left alone.

Strangely enough, one of the last pieces of news to reach her was that foreign troops had broken into Laplace's house in Arcueil, near Paris, in the Val-de-Marne, and that his original handwritten version of *Mècanique Cèleste* had been thrown into the river. Luckily though, someone had rescued the book that had started her career in science.

She kept studying mathematics to the very last day of her life, as she passed away in her sleep on the morning of November 1872, after devoting her last evening to the study of the "quaternions", a number system which extends the complex numbers. She indeed said to her daughter Martha that she had the same readiness and facility in comprehending the formulae which she possessed when she was young.

She was buried in the English Cemetery in Naples, after her friend Frances Power Cobbe made an effort to have her buried in Westminster Abbey in London: but the Astronomer Royal didn't want to sign the authorization to proceed, claiming that he had never read Somerville's books!

After her death, the only members of her family who were left were her daughters Martha and Charlotte, who had no family of their own. Maybe this was the effect of thirty years of nomadic life, but she couldn't change her living style and in any case the education of the two ladies was complete, they were cultured, happy and independent. Mary Somerville maybe could have tried harder to let them follow a path of their own.

In any case, after the death of her mother, Martha decide to accomplish her mother's wish to tell the truth about her life by publishing her *Recollections*. However, Martha didn't use everything her mother had written, but preferred to use only those writings which gave the best possible image of her, avoiding whatever represented a possible damage to a perfect image.

The book came out in 1873, one year after Mary's death. Much later, in 2001, Dorothy McMillan of the University of Glasgow re-edited Mary's Personal Recollections, [8], using the already mentioned manuscripts held in the Somerville Collection in the Bodleian Library in Oxford [9].

Surprisingly this edition doesn't mention the Italian period, which is rather an unforgivable fact, since the last hundred pages of her autobiography are all devoted to Italy and point out in a charming way how much this country meant to her.

In any case her memoir is a very good source of information on her life, so it's really important to read it in order to understand her polyhedric personality and capture the magic of her thoughts.

Those who knew her more superficially often found it difficult to match the height of her intellectual achievements with her rather simple style of conversing and conducting herself, but this features of her character were the reason of her skill in recreating the experience of the scientific sublime for her readers, providing them with a great deal of pleasure.

In a certain way she was a woman of paradoxes, a female intellectual but not a suffragette, a beauty and a charmer hiding controlled pragmatism and mental clarity, plus an extreme precision of thought.

The number of honors she received in her life was outstanding; she became member of all the important academies of her times even in Italy, such as the Accademia di Scienze Naturali in Florence, the Accademia dei Risorgenti in Rome, the Accademia di Scienze, Letteratura e Arti in Arezzo and the Accademia Pontaniana in Naples; this facts were quite unusual at that time for a woman and prove the esteem in which her contemporaries held her and the eminence she achieved in her own way.

Moreover the Somerville College in Oxford was named after her in 1879; initially it was intended for female students (Indira Gandhi, Margaret Thatcher and Dorothy Hodgkin, the British chemist who won the Nobel Prize in 1964, studied there), but in 1992, after extended debate, it ceased to be a women's college and began to admit men [10].

We would be not far from truth if we say that tracing the life and the work of Mary Somerville, who was barely taught to read as a child, but did succeed in learning and mastering science by herself, becoming one of the most outstanding British women scientists and furthermore a popular writer, gives a wonderful example of how some women succeeded in developing their own abilities, demonstrating that they are capable of assuming a higher place in the intellectual world than that usually assigned to them.

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