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Behind the Double Helix: The Complicated Life of Rosalind Franklin

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Abstract

BACKGROUND: Rosalind Franklin was a British scientist in the 1950s, that in her short career covered a lot of important scientific topics, ranging from coal structure porosity, to biological molecules cristallography, and finally to viruses structure definition.

AIM: This article aimed to underline the important role that she had for the elucidation of the DNA structure, and to reiterate the difficulties, she had to face – prominently as a woman – to be fully accepted in the world of scientific research.

METHODS: An historical research was conducted and summarized, regarding the life of Rosalind Franklin.

RESULTS: This myth overshadowed her intellectual strength and independence both as a scientist and as an individual.

CONCLUSION: As one of the twentieth century's pre-eminent scientists, Franklin's work has benefited all of humanity. The 100th anniversary of her birth in 2020 was prompting much reflection on her career and research contributions, not least Franklin's catalytic role in unraveling the structure of DNA Franklin's premature death, combined with misogynist treatment by the male scientific establishment, cast her as a feminist icon.

Introduction

The European space agency (ESA) gave the name "Rosalind Franklin" to the rover of the 2022 Exomars Mission, from a pool of names chosen by over 36000 citizens from the ESA member state.

It was the 1st time that the rover name was not associated with a personality from the astrophysics world [1]. Moreover, always in 2022, the bacterial genus Novum, *Franklinella*, in the Gram-negative Prokaryotic family of Proteobacteria, *Comamonadaceae*, was described in her honor, as well may prize dedicated to her memory [1].

Furthermore, Google honored Rosalind Franklin with a doodle, showing her gazing at a double helix structure of DNA with an X-ray of *Photo 51* beyond it [1].

This article aimed to underline the important role that she had for the elucidation of the DNA structure, and to reiterate the difficulties, she had to face – prominently as a woman – to be fully accepted in the world of scientific research.

Methods

The British scientist Rosalind Elsie Franklin (1920-1958), whose pioneering research helped lay the groundwork for the modern study and understanding of genetics, was known for her sociability and sense of fun, even as her independent thinking and unusual approaches meant that some of her most critical scientific work was done in isolation.

In this work, an historical research was conducted and summarized, regarding the life of Rosalind Franklin.

Results

Who was this lady?

Rosalind Franklin was a British scientist, most known for her contribution to defining the structure of DNA, a breakthrough in the development of the biological and medical sciences (Figure 1), which won James Watson, Francis Crick, and Maurice Wilkins the Nobel Prize in 1962 [1], [2].

Figure 1: Rosalind Franklin at work (from wikipedia)

Probably in the statement above is already present all the effort, the difficulty that a woman had to face to make her way in the field of experimental sciences, even just a few decades ago; and the fact that she was not awarded that the Nobel Prize is also a scandal that continues today.

Sure, the Nobel rules dictate that the awarding must be given to living people – and Rosalind Franklin died in April 1958 – but its fundamental role in deciphering the structure of DNA was not even been publicly acknowledged, not doing justice to the truth and ultimately projecting a dark cloud to all the other protagonists of the discovery.

The Franklin's pursuit of scientific happiness

Rosalind Elsie Franklin was a passionate researcher, born in London on July 25, 1920, into a wealthy Anglo-Jewish family of bankers. Being of well-off status, the women of her family all had a good culture, but none of them worked, as was often the case at that time. This simple fact alone makes us understand the difficulties that Franklin faced, overcoming them only thanks to his iron determination in wanting to become a scientist.

St. Paul's Girl's, a prestigious and renowned London girls' school, had the privilege of being able to count her among its students, starting from 1932; and it is here, thanks to the teaching of scientific subjects, such as physics and chemistry, that Franklin discovered the experimental sciences, deciding, at the age of 15, that she would become a scientist. Rosalind immediately turned out to be a brilliant student, achieving excellent results not only in science subjects but also in languages and physical education; the only discipline where she did have some difficulties was music [1].

In 1938, she obtained her high school diploma with full marks, and according to some reports, the first friction with her family began, especially with her father, who did not look favorably on Rosalind's choice to enroll at the university to study chemistry and physics, preferring something for her more "suitable for a lady of the good British society." Today phrases like these perhaps make us smile, but in 1938, it was the common way of thinking of the so-called good society about the role of women in society; for this reason, the contribution of strong and determined women of scientists like Rosalind Franklin was truly decisive, truly as a pioneer of new paths and possibilities for all women, especially of future generations. Having kept up with her father's wishes, having therefore enrolled at Newnham College in Cambridge to study the beloved experimental sciences, was a small but significant contribution not only for her scientific progress and for the female scientific career, but probably to improve tout court the female condition.

After just 3 years, in 1941, Franklin brilliantly graduated and decide to stay at Cambridge University as a researcher, working under the supervision of Ronald Norrish – professor of Physical Chemistry – on polymerization of acetaldehyde and formic acid. However, things did not go as planned: Her working relationship with Norrish rapidly soured. Perhaps also due to the need to have to fight to obtain every conquest, Franklin had strong and angular character, a trait that will accompany her in every stage of her scientific career, which certainly contributed to creating multiple frictions with her colleagues. In 1942, she left the university for an assistant position at the British Coal Utilization Research Association (BCURA) at the Kingston's College in London, an extremely significant experience for his future scientific path and also for Great Britain: We must not forget that during wartime, coal processing was of the utmost importance. At BCURA, he was able to work on the atomic and molecular microstructures of coal, in particular on its porosity, which was the thesis topic of his research doctorate, of which he obtained the title in 1945.

Once the Second World War was over, Franklin moved to France, accepting a scholarship to work together with prof. Jacques Mering at the Laboratoire Central des Services Chimiques de L'Etat in Paris. Curiously, her arrival in Paris was facilitated by the friendship that bound her to Adrienne Weill – who was a student of Marie Curie – and she also introduce Rosalind to Marcel Mathieu, director of the Centre National de la Recherche Scientifique, and helped her with the study of the French language.

The stay in Paris was decisive for the fate of Franklin: In fact, here, she began to study X-ray diffractometry applied to the study of amorphous material. Using coal, a material with which she was well acquainted, she published several articles of considerable scientific importance [2].

The 4 years spent in Paris were not only scientifically produced for Franklin but also very happy and serene from her personal point of view; the return home, after obtaining a scholarship at King's College in London, unfortunately, was not so peaceful.

The director of the research unit did not inform his scientists of the change in staff and the replenishment of the various teams that came into effect shortly before Franklin's arrival. Scientists who had worked closely with some of their colleagues suddenly found themselves reassigned to other teams, and the work they were doing and had made great strides on was entrusted to the newcomers.

This was the basis of many of the tensions that arose between Rosalind Franklin and Maurice Wilkins. Raymond Gosling, who worked with Wilkins, was appointed against his existing wishes by Ms. Franklin. With these premises, the experience at King's College promised to be stormy. Furthermore, Rosalind had a very direct way of speaking: she looked people in her eyes, often intensely, and always said what was on her mind: This behavior certainly did not help to ease the mounting tension. Plus, she was absolutely brilliant and generally overshadowed her male colleagues. At a time when women were relegated to the background in science, these characteristics created a lot of discontents. Rosalind, on the other hand, was a strong, determined, particular, and sophisticated woman, in the bigoted world of Cambridge, for having lived in Paris and being of the Jewish religion.

With the equipment at their disposal, Wilkins and Gosling had achieved remarkable results with X-ray photography. When that project was assigned to a newcomer – a woman, too! – they saw years of studies go up in smoke. The two men, whose natures had proved compatible in the field of work, recognized Franklin as responsible for this change of course, and their relations with the young chemist gave birth to a conflict that made history, and which is still discussed today.

Rosalind Franklin had to suffer a lot of abuse in the workplace. Thanks to her great seriousness in the professional field, she still managed to keep her head high and work by applying the skills acquired in France – which ranged from the installation of instruments to the conservation of critical hydration in the samples she analyzed. Her studies led her to discover two different types of DNA: Form A and Form B. The chemical community did not fully discover the secrets of DNA A-form until 60 years later, but DNA B-form seemed easier to study for science.

Director Randall, aware of the tensions in her labpratory, decided to split the research. Franklin, true to her nature, chose to study A-form, leaving Watson to discover the secrets of B-form. Eventually reconciling with both types of DNA, which shared the helix structure, Rosalind jotted down the manuscript and sent it exactly one day before Watson and his fellow researcher Francis Crick built their B-DNA model.

Using data similar to that of the King's College team, Cambridge University, researchers Watson and Crick began building their own B-DNA model. Neither of the two laboratories was aware of the level reached by the other. In a short time, Rosalind developed an innovative technique that used X-rays to photograph the constituents of all living and non-living materials. The device consisted of a micro camera capable of producing high-definition photographs of individual DNA strands. Franklin was therefore able to take the first photograph of the DNA skeleton which allowed her to hypothesize the famous helix shape [3].

According to Lord Dainton, Rosalind Franklin "was a very nice person indeed, though terribly shy and somewhat withdrawn from social contact. For example, she gave us, very perceptively, just the wedding present, she knew that we would like [4]." Franklin's scholarship at King's College was coming to an end; While the scientist was preparing for a transfer to Birkbeck University in London, Wilkins sent to his friends Crick and Watson a message informing them of Franklin's departure, suggesting that they could take advantage of the situation. The implication was clear: With her out of the way, men would work better.

Another factor that undoubtedly helped those men take possession of Franklin's work was the order from director Douglas, which stipulated that Rosalind's work should remain at the King's; she was not allowed to take her notes with him. Wilkins "inherited" all of his photographic evidence of DNA structure, and Rosalind Franklin was precluded from any possible recognition for her work.

Following these developments, Watson made contact with Wilkins, who showed him copies of photographs taken by Franklin, without the scientist's knowledge (which he had secretly reproduced); among these was also the now-famous photo n. 51 (Figure 2), one of the clearest photos ever taken before, which immortalizes a single.

Discussion

For a long time, the story about the discovery of the DNA double helix structure overshadowed the contribution of Rosalind Franklin, endorsing a story about the eccentricity of the scientist and trying to

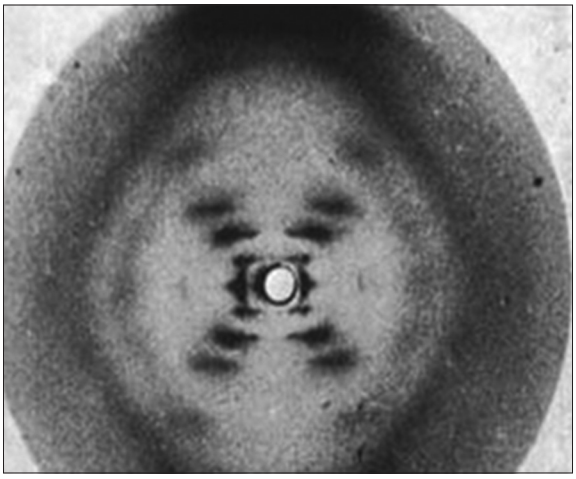

Figure 2: Photo 51 taken by R. Franklin and R. Gosling, published 1953 (from corriere.it)

belittle her merits: And with great sadness, it must be acknowledged that Watson, Crick, and Wilkins themselves helped fuel the legend. Dark lady: This is the nickname that Watson, Crick, and Wilkins gave to Rosalind, as if to emphasize that determined and strong side of hers which in an environment like that of King's College is inevitably negative [6].

In 1968, Watson finally managed to publish his controversial book "The Double Helix" in which he described the story of the discovery of the structure of DNA from his own point of view; even the coauthors of the discovery Crick and Wilkins criticized him harshly, to the point that Harvard University Press, which had initially signed a contract, refused to publish the book, which later came out for another publisher.

Only in the epilogue Watson tries to reduce the contemptuous description given of "Rosy" (as he called her, perhaps in a derisive tone, even though she had always been Rosalind for everyone, even for close friends) in the book and writes: "Since my impressions about him from a scientific and personal point of view [.] were at first often wrong, I mean here [.] that we had come to deeply appreciate his honesty and generosity, realizing, too late, of the struggles that an intelligent woman must face to be accepted in the scientific world.

".... Her hostility stemmed solely from her just aspiration to work with others on an equal footing [7]."

After the dreadful King's College experience, in 1953, Franklin went to work at Birkbeck College, where she collaborated with Aaron Klug exploring the RNA structure in the tobacco mosaic virus and other viruses. Her work in this field was remarkable, publishing several noteworthy papers and ultimately playing a role in professor Klug's Nobel Prize award in 1982 "for his development of crystallographic electron microscopy and for having elucidated the structure of the biologically important nucleic acid-protein complexes [8], [9]."

Conclusion

In the fall of 1956, Rosalind found out that she had ovarian cancer but refused to give up her research work. Rosalind Franklin's passion for research was immense: She sacrificed her own life for science, dying at just 37 years old, perhaps due to excessive X-ray exposure.

Fortunately, today, the situation for women in the various scientific fields is improving significantly, but there is still a lot to do so that it can be said that genuine equal rights and opportunities have really been achieved; after all, as another Nobel laureate woman, Rita Levi-Montalcini, said, "Humanity is made up of men and women and must be represented by both sexes. The difference between a man and a woman is just environmental; they have the same brain, but in men, its (development) was encouraged; in women has been historically repressed." To Rosalind Franklin, scientific research was something natural and spontaneous: Moreover, it was probably her reason for living, which helped her to overcome the enormous difficulties she encountered. It is no coincidence that a simple word was inscribed on her grave in the Willesden Jewish Cemetery in London: "scientist." This is followed by the inscription, "Her research and discoveries on viruses remain of lasting benefit to mankind." Moreover, we think that it perfectly summarizes her deep love for science.

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