
NORTH
AMERICA
EUROPE
AFRICA
ATLANTIC
SOUTH
CANADA 37
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38240
EARLY CANCER DETECTION
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DOMINICA
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MOÇAMBIQUE
MOCAMBIQUE
Falkland Islands
Pitcairn Islands
FRANCE
MAGYAR POSTA
ISRAEL
RÉPUBLIQUE DU TCHAD
GNIFIED



From animalcules to biodiversity:

microscopy putting its stamp on the world and its role in science education

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Abstract and Introduction

How is it one comes to know of life? For over 350 years, the microscope has been a companion on this journey. The microscope's origin at various times and places meant it was used widely, and once perfected, it helped overcome our ignorance of disease. It opened previously unseen worlds in a drop of water. It laid the foundation for cell biology. More recently, it has shown value in studies of biodiversity. However, the microscope's centrality in biology is not in keeping with its diminishing role in education, where images from the microscope are predominantly seen through on-screen applications rather than through a lens.

These observations led to this study's research question: Do achievements, such as presented here and obtained through microscopy, warrant increased investments for education and career development?

To address this question, this paper examines the relevance of multiple points of invention leading up to today's microscopes, followed by illustrative applications as they were used by five scientists. Concluding the section on applications shows microscopy entering the world of art. Postage stamps, or philatelic issuances, highlight and illustrate the issues and diversity found in the text, with over twenty-five countries represented, demonstrating the broad applicability and accessibility of the microscope.

The evidence provided demonstrates the centrality of microscopy across a range of diverse careers. To supply capable individuals for such careers, biology education should ensure that its curriculum allows time for theory and practice of microscopy. Lessons and labs should not only be used to expose students to the scientific value of microscopy, but also for applied studies of biodiversity, as an example. Finally, As seen in multicultural science classes, students can master the microscope regardless of gender, culture or abilities. Such use serves as a built-in tool for addressing diversity, equity, and inclusion in the classroom.

Part I. Overview, Background and Organisation

Prologue

For those of us living today, a journey to the universe, moon and planets remains something of a dream. However, if one can don a wetsuit and scuba gear,

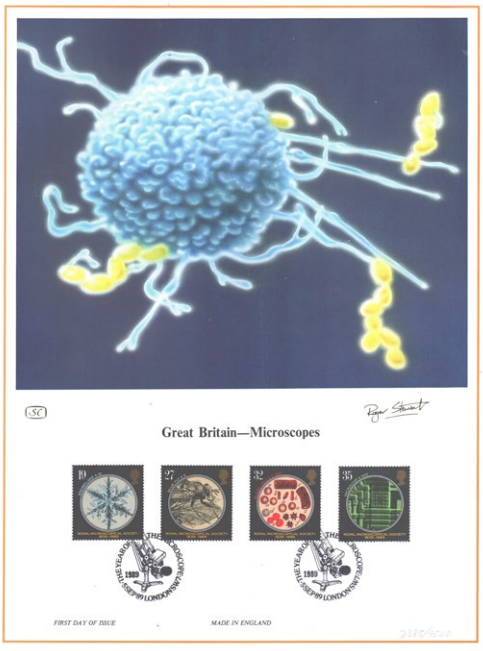


Figure 1. Giant maxi card announcing the first day of issue, 1989, with special cancellation in honour of the 150th anniversary of the Royal Microscopical Society. Signed by image creator, Roger Stewart, whose photograph shows a macrophage with its arms encircling foreign bacteria.



Figure 2. Israeli stamp (2019) depicting "science-oriented youth," showing a microscope among the many technologies and ideas science students are exploring.

then diving to see coral reefs brings us to a place far different from our own terrestrial home, but one can reach it. Yet, for many others, that world is out of their reach as well. But, what of the world around us, the one visible to the naked eye? This world is within our reach, the one where seasons change, migrations come and go, species pass before our eyes, many of which we can reach out and touch. But still, for many, even when immersed in its study, nature can be removed and seem far away.

This brings us to the world featured in this paper, complete with creatures quite foreign in appearance and having life cycles all their own. However, despite these differences between our world and theirs, it is a world within our grasp. With the aid of but a single instrument, we can venture into vernal pools, tide pools, rivers or streams, and study organisms previously seen only as drawings in textbooks. This singular combination of lens, light and specimen makes up the microscope, and it can reveal a universe that does not require oxygen tanks or space suits; no rocket engines or submersibles needed.

Instead, it requires a modest, three-foot square space upon the dining table, from which all that is scientific can be removed when the in-laws come for dinner. It requires time and attention, and your skills of observation - even though at first you couldn't tell the difference between the leg of an ant and a cracked slide. So, just what might be waiting for you?

One can still see organisms that Van Leeuwenhoek first saw in 1674 (Pearle et al. 2010; Ford 2007). These fresh and saltwater microorganisms are still here to explore and conserve, to reflect on how life differs in size, complexity, and habitat. It is in the spirit of this world and its wonderment, as professed by Rachel Carson, that this paper was prepared. "A lens-aided view into a patch of moss reveals a dense tropical jungle, in which insects large as tigers prowl amid strangely formed, luxuriant trees" (Carson 1937). With microscope in hand, you have a front-row seat to your own discoveries, and when found, the enjoyment of what was accomplished and learned about the world.

Educators arise and bring back the microscopes

With the ongoing and ever-rapid increase in biological and molecular technologies, and their

incorporation into STEM education (Figure 2), is there still a time and place for microscopic studies? To begin, let's consider reasons why ensuring time for students to prepare and observe specimens directly through microscopes should remain a vital part of instruction (Wellner 2021).

First, educators should encourage students to take a firsthand look at life through the microscope, and explain how it can open doors of perception not possible otherwise. Such labs help students learn how to focus on a given specimen and compile their observations. By extension, the presence of cultured, living organisms can lead directly into a unit embracing each of the kingdoms (Cohen 2020) as seen through the microscope.

Second, understanding the rise of complex life forms can be facilitated by the microscope. Here, fixed specimens can be used to demonstrate the rise of complexity which follows the transition from prokaryote to eukaryote. In these early lessons, students can also observe asexual means of reproduction as found in many protists.

Third, discussing the history and evolution of the microscope itself can give students insight into how ideas are conceptualised, as well as what happens when different individuals designed and constructed the microscope around the same time.

Fourth, the microscope has proven to be 'gender neutral', meaning that both men and women and of various ethnic/cultural groups have all made important discoveries. The fifth "positive attribute" is that because of this type of success, students can also achieve a level of competence and discovery, which then allows them to become mentors and teach others, student to student. In addition, this factor makes microscopy a science with a message of diversity, equity, and inclusion, as attested by the images that follow.

Research Study Question

The general and guiding question for this study was: Do past achievements obtained through microscopy, such as those to be found in this paper, warrant continued investments to provide for education and future careers?

Given this question, is it clear that microscopes are not just tools from the past, but also part of the present and future? In fact, the sixth benefit comes from the facts and examples collected for this study. They demonstrate new uses of microscopy, such as in forensics, infectious disease, and agriculture. Stamps and microphotographs taken using other innovative techniques are also represented.

How will examples and evidence be presented?

The surprising images from the work of van Leeuwenhoek (1632-1723; Ford 2007) and Robert Hooke (1635-1703) continue to amaze us today, as evidenced by Figures 3 to 8. These early pioneers, who realised the wonder and power of magnification, took what could be done by a drop of water and made this power appear whenever one gazed through a ground glass lens made by their own hands. Once others understood how such magnification could be obtained, the size, shape, and particular utility of what eventually became the microscope increased exponentially, with specific manufacturers labelling their work in a proprietary manner.

As microscopes became more specialised, their utility found its way into every aspect of science and engineering around the world. This study provides a topical survey of this diversity and reinforces the fact that, far from reaching an endpoint, the microscope and new innovative techniques continue to advance. These pages contain numerous philatelic examples across the scientific spectrum and will be illustrated and further discussed using the five categories listed below:

- Historical developments of the microscope conveyed on postage stamps
- Medical, scientific, and agri-food discoveries
- Biodiversity applications

- Scientists who used microscopes for their research, and
- Images taken from an array of topics and scopes

It is hoped that these pages will provide encouragement for forthcoming students and scientists to continue such explorations and careers.

Part II. How the Microscope Got Its Start

For a good many centuries, medical practitioners were plagued by misconceptions and enemies so small that they remained unseen. This invisibility led to a plethora of theories and practices, which, while well-intended, did little good, or could even create a great deal of harm. However, as microscopes came into use, what had remained invisible to the unaided eye was now recognisable. These instruments gave doctors a look into a patient's blood as never before possible. No longer were doctors fooled or misguided. Wherever a microscope appeared, the identity of the causative organism of a major health concern at the time gradually became recognisable.



Figure 3. Netherlands. Stamp issued 1937. The image closely resembles a portrait of Leeuwenhoek by Verkolje from 1686.

Finally, the seeming invisibility of these organisms had been overcome. Next came calls to perfect the microscope, and many private enterprises took up the challenge. The better the quality of the microscope, the more assured doctors and others were as to correctly identifying what they saw, many doing so for the first time. But how did all of this come about? What turned human interest to the lens, and not only that, but to the compound effect of multiple lenses as well? First, attempts were made to imitate the effect of magnification seen when staring through a drop of water on a leaf, as one example. It was not long after making this observation that many groups from around the world began making their own version of what became known as "microscopes". Here, those already versed in the art of grinding lenses to bend and refract light, now found that instead of building lenses to observe the distant galaxies (hence "tele"), they could just as well make lenses to visualise the smallest pieces of life (or "micro.")



Figure 4. Grenada. Stamp was issued in 2000. Portrait of Leeuwenhoek and his microscope. Selected as part of the Millennium 2000 series.

It all began following the remarkable applications and observations of what are often considered the world's first such instruments, with one marking the starting point of the "compound microscope," so called because it compounds the additive "eye power" of one lens near to the object, while the second lens is some distance away, carefully adjusted to give that second boost of "eye power" to the viewer. This microscope, the first of its kind, was described by others, but it is still attributed to the brothers Jansen of the Netherlands in 1590 (Gardner 1972; p.188; chronology). With that development, the word was out (Clay and Court 1975), and by the middle of the 17th century, several other designers produced their own version of the compound microscope (Clay and Court 1975), enabling further investigations of the microbial world. The next advancements came from two individuals, one in England and one in The Netherlands. The Englishman, Robert Hooke, was soon to publish his Micrographia (1665).

Meanwhile, in the Netherlands, Antony van Leeuwenhoek designed and used an ingenious one-lens scope, which revealed to him the wondrous life that could be seen, among other places, in a drop of pond water (1674-1677). Rather than attempt a



Figure 5. Antigua and Barbuda. Issued in 1992. An original Leeuwenhoek microscope, held at Utrecht University Library, Netherlands.



Figure 6. Republic of Djibouti stamp commemorating Robert Hooke.



Figure 7. Grenada. Robert Hooke's iconic flea etching. Stamp issued in 2000.

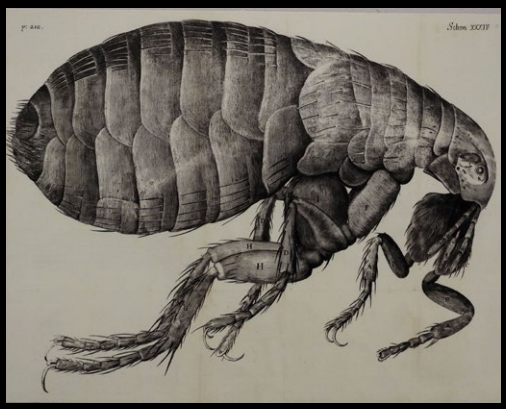


Figure 8. A photo blow-up of Hooke's flea is hung in a special exhibit on Natural History at the St. Louis Museum of Science.



Figure 9. German postage. Issued in 1981. One of eight historic optical instruments made in Germany. Caption reads: binokulamikroskop um 1860. (Bifocal microscope).



Figure 10. German postage. Issued in 1981. One of eight historic optical instruments made in Germany. Caption reads: mikroskop 1790. (Monofocal).



Figure 11. Canada. One of a set of four stamps issued in honor of Canada Day, 1988. Image of an electron microscope dated 1938.

book, Leeuwenhoek reported his findings through a series of letters to the Royal Society of London, which incorporated itself in 1662. Unfortunately, Leeuwenhoek's images were not accepted until Robert Hooke was able to view them himself, and later show them to the Society (Snyder 2023).



Figure 12. Exterior view of drum microscope with its case and rare Victorian era slide. Authors collection.

By the time Robert Brown (1773-1858), a Scottish botanist, was appointed as the first Keeper of the Botanical Department at the British Museum, microscopy was so widespread that it had become fashionable (Allen 1976). Brown's greatest love and specialty was plant taxonomy, and his skills with the microscope



Figure 13. German Democratic Republic (GDR), known as East Germany: 1949 to 1990. Stamps were issued in August 1980. Microscopes made by Carl Zeiss, from 1710-1873. All in museums.



Figure 14. Author's microscope, made in England; compound microscope design with a flexible mirror and two lenses. Used in the Colonies.

enabled observations of cells and of what he called the nucleus. Brown became one of those contacted by Charles Darwin for the provision of expert advice, for which Brown accommodated the young naturalist before and after his voyage aboard the HMS Beagle (See details in Part IV).

Part III. Scientific Discoveries from Seeing the Unseen

Part III contains stamps grouped together to illustrate how microscopes provided the means to find and determine actual disease-causing organisms. These applications accomplished two things; first, they could identify and make certain which pathogen was present in the patient, and by doing so, were able to ensure the correct treatment was applied. By using the microscope in this manner (experimentation, observation and then diagnosis) it was possible to identify and treat smallpox, various pulmonary infections, tuberculosis, and ensuring that the correct pathogen was treated. In addition, there are a series of stamps for engraving, biodiversity, malaria and smallpox campaigns, cancer campaigns, agricultural research and diagnosis, livestock disease diagnosis, healthy meals, and the World Health



Figure 15. Harvey Wiley with a microscope, in honour of the U.S. 50th anniversary of the pure food and drug laws.



Figure 16. 1981 issue, Republic of South Africa, recognising the 50th year celebration for the National Cancer Society.



Figure 17. Israel. Stamps for the Fight Cancer campaign, also featuring a microscope.

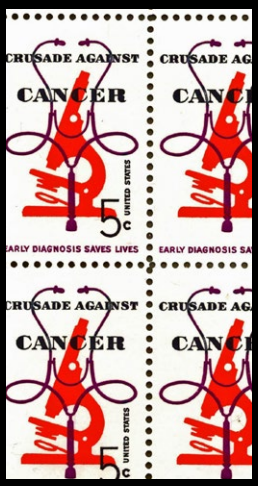


Figure 18. US Postage stamps 'crusade against cancer', showing a microscope as an image to encourage early detection.



Figure 19. Korean stamp (1971) to encourage overall healthy meals and to see an expert.



Figure 20. 1968 Pitcairn Island se-tenant pair, saluting the World Health Organisation. Microscope being used diagnostically.



Figure 21. India, 2006 stamp commemorating 100 years of service from the ICAR, Indian Council for Agricultural Research.



Figure 22. USA 1996. George W. Carver, included in "Celebrate the Century" for the 1910s, is an honour for him and his work with a microscope.



Figure 23. Chad, 1972. Farcha Veterinary and Zoological Research Lab.



Figure 24. Canada. 1957-58: International Geophysical Year. Microscopes are seen as central to discoveries.



Figure 25. Ghana issued a stamp in 1967, honouring the use of the microscope at the Cocoa Research Institute and its 25th Anniversary.



Figure 26. Turkey, 1967. Se-tenant format for large and small animal vets.



Figure 27. Germany. 1971. Material science research using microscopes since concept.



Figure 28. Bahamas. A quartet of stamps commemorating progress in the fight against lung diseases.



Figure 29. Monaco. The application of microscopy to engraving and printing.

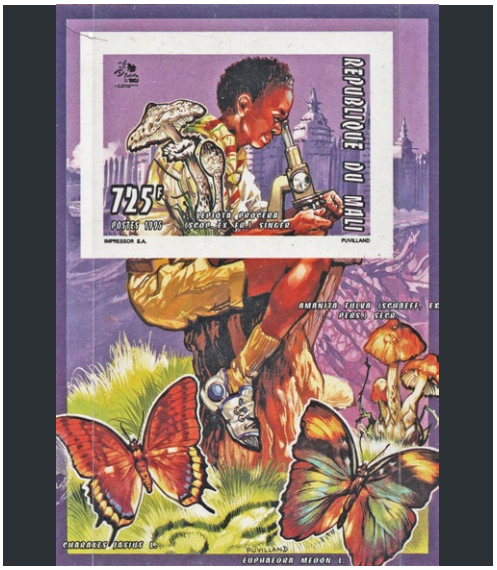


Figure 30. Mali. Microscopes are most recently playing a significant role in biodiversity collection, examination, and naming. Here, insects are being examined from a collection made by a boy.



Figure 31. Nigeria. Souvenir sheet with four stamps, each attesting to the importance of tropical medicine.



Figure 32. Germany. 2000. Celebrating the 100th anniversary of the Bernhard Nocht Institute for Tropical Medicine.

Part IV. Career Beginnings - Five Pioneers and Their Microscopic Worlds

Spend considerable time with a microscope and a partnership develops between humans and technology. While modern microscopes may appear much the same, scientists still find their own personal niche in where to work, and how to work. When it comes to revealing more of life's seemingly endless forms, we turn to the microscope, and now, we can do so for artistry as well as taxonomy or anatomy. To illustrate these partnerships, five individuals were selected, from beginner status to those formally

instructed in the modern microscope. Each person's accomplishments are described here as undertaken with the aid of the microscope.

The scientists selected for this section are arranged in chronological order by date of birth, beginning with Charles Darwin, and his recognition of the need for and utility of a microscope on his voyage aboard the HMS Beagle, as well as later studies at Down House. Second, comes Mary Ward, who had minimal opportunities for formal schooling, but nonetheless, generated scientific illustrations of the worlds she saw through the microscope, proving the power of connection between observation, detailed illustrations, and success as a woman author.

The third individual is Edmond Locard. He is responsible for bringing the microscope into the forensics laboratory, and thus beginning scientific-based diagnostics. Then comes Dr. Barbara McClintock, who won a Nobel Prize for her work on transportable elements in maize. Her microscope is now stored at the Smithsonian Institute's National Museum of American History, where this author was allowed to come for notes and observation.

The fifth individual is Rachel Carson, best known for her environmental writings, but equally a scholar of the sea and an important marine biologist and environmentalist. Her later works could read like warning signs to civilisation. But even at the end of her life, while ill from cancer, one could still find and share in the joy from her writings of the minute creatures she gathered and had seen in her stroll down from her cabin home in Maine to the rocky tide pools at the ocean's edge.

CHARLES DARWIN (1809-1882)

Charles Darwin immersed himself in an extensive network of colleagues, ranging from pigeon breeders, to fellow students, and even college professors. While at Cambridge he befriended Mr. John M. Herbert, who so much appreciated what Darwin taught him on their excursions together that he made a gift of appreciation to mark their friendship. It was a Coddington's Microscope, which Darwin said was a "most magnificent gift," (Desmond and Moore 1991), especially as it would contain a "Coddington lens," ground around the equator of the glass (Clay and Court 1975). It perfectly suited Darwin's fascination with insects and his desire to work fast on specimens from the field.



Figure 33. Darwin's microscope aboard the Beagle. It is self-contained in a box. A "simple" scope, with only one ground lens. Falkland Islands, 1982.

However, when it came to the voyage that lay ahead of him, he consulted with a key individual from the British Museum, this time. This was Robert Brown, the senior botanist at the Museum. It was Brown who introduced the young naturalist to the Bank's single lens scope (pictured, Figures 33 and 34). It



Figure 34. Stamps on the left and right show Darwin using the microscope while on the Beagle. These are from Mozambique, 1982.

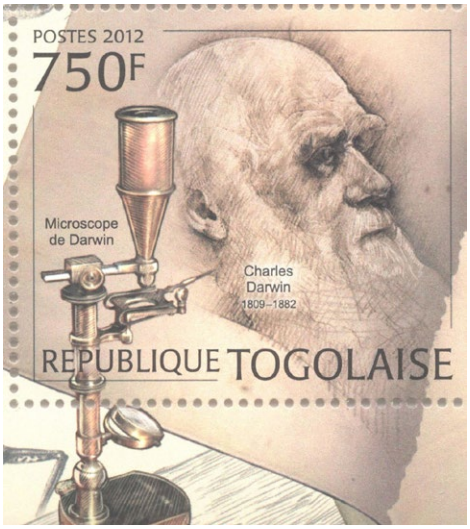


Figure 35. A Togo stamp from 2012 shows one of Darwin's microscopes at home. Stamp honours 130th anniversary of Darwin's death.

served Darwin well and was easy to fold into its box, thus affording more cabin room when needed while aboard the cramped officers' cabins on the Beagle. Upon return, he used a compound scope, as seen in Figure 35.

Darwin wrote in his collected letters, "During this time I saw a good deal of Robert Brown; I often used to call and sit with him during his breakfast on Sunday mornings, and he poured forth a rich treasure of curious observations and acute remarks (Darwin 1898). On one occasion he asked me to look through a microscope and describe what I saw. This I did, and I believe now that it was the marvellous currents of protoplasm in some vegetable cell. I then asked him what I had seen; but he answered me, "That's my little secret."

MARY KING WARD (1827 – 1869)

Such was the success which followed Mary King Ward's adventures with the microscope and her detailed illustrations, that 250 copies of her book on microscopy (Sketches with the Microscope), sold almost immediately. As if to show readers all that was possible in a context they could relate to, Mary Ward conducted all her investigations, drawings and completed her book on microscopy

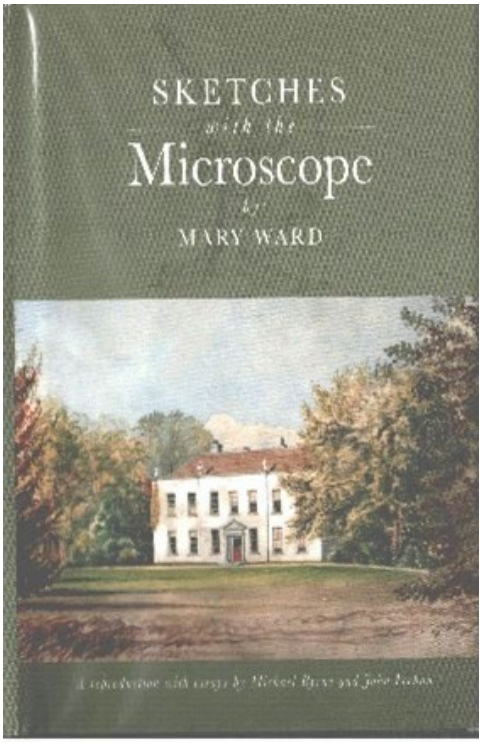


Figure 36. A recent edition of Ward's work contains the two illustrations below (Figures 37 and 38).

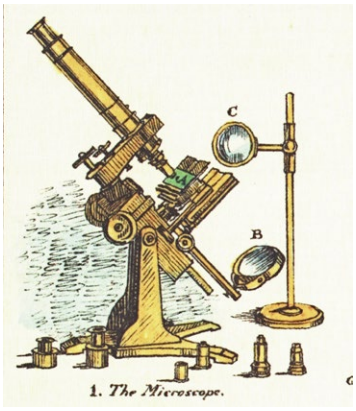


Figure 37. Ward's microscope. Made by Hull's lab.

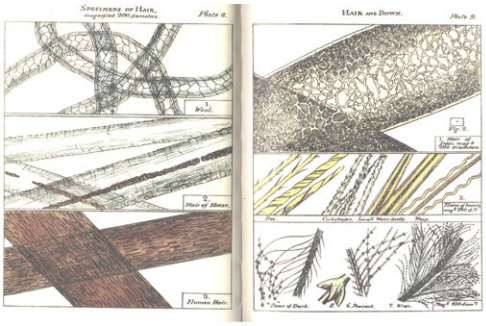


Figure 38. Hair samples through the microscope and hand-drawn by Mary Ward. Please see Acknowledgements for full information on Ward.

from home. She was the first woman to have such a publication, and the book's design, illustrations, and text made it an instant hit.

In London, a professional publisher (Groombridge and Sons) retained a copy of her book, and he proposed to print it as a hardbound book under the title, "A World of Wonders Revealed by the Microscope," which also did remarkably well. And this was at a time when the writing and production of a solo publication by a woman, was practically an impossibility (Cohen 2022).

The detail apparent in her hand-drawn illustrations is indicative of what comes from careful examination and subsequent observations of each specimen. In so doing, she became a scientist at home, keeping meticulous records of her investigations while teaching herself the art of sketching what she observed through the lens.

A recently produced copy of the book (Figure 36), done with expert care and attention, is based on Ward's 1857 publication, "Sketches with the Microscope in a Letter to a Friend." Her observations were made while using a good quality Ross microscope her father bought (Figure 37). This microscope was so important to her that she included her own drawing of it in the book.

Ward died suddenly and tragically in an automobile accident, something unheard of at the time. However, in her 42 years, much was accomplished. The letter, written to her friend Emily, begins by stating, "You have expressed a wish to receive tidings from the world of wonders that surrounds us, and which is revealed only by the microscope" (Ward 1857).

This sense of wonderment was a guiding theme throughout her work. Over time, this grew ever more diverse. For example, one week she found herself working on the wings of the butterfly, dragonfly, and flying beetle (including detailed drawings of the scale patterns on the butterfly wings). Then, hair — from all kinds of animals (Figure 38), each carefully drawn with magnification recorded.



Figure 39. Edmond Locard. Stamp commemorating the 60th anniversary of Locard's death. The French stamps are mounted on a Giant Maxi Card, along with a brief biography.

EDMOND LOCARD, ESQUIRE, AND M.D. (1877-1966)

Forensic science owes its birth to two men working in the city of Lyon. Alecsandre Lacasagne and his best student, Edmund Locard, set up the world's first forensic science laboratory in the Lyon courthouse. When they started, this branch of science was unheard of among detectives. Soon, however, forensic anthropology (examination of bodies and bones after death), forensic ballistics (study of guns and bullets used in crimes) blood spatter analysis, trace evidence (dust, hair, fibres) developed, with the microscope playing a central role.

Originally, detectives thought of their work as limited to one person. Deliberately following in the footsteps of Sir Arthur Conan Doyle's creation, Sherlock Holmes, it seemed as if Edmond Locard

might have been a model for Holmes, rather than the other way around. Locard's most ardent adherents were very familiar with Holmes's use of deductive reasoning and his skills in the branches of science that would most aid his consulting detective persona.

The microscope was a key part of this duality. Like Holmes, Locard used every source of evidence he could muster, often relying on things the regular police force failed to consider or simply dismissed. Much of this inborn commitment to evidence was summarised in his famous precept, to be called, "Locard's Exchange Principle," stating, "When two things come into contact, each object will leave trace amounts of itself on the other," (Artieres 2016).

BARBARA MCCLINTOCK (1902-1992): Nobel Prize Recipient

Barbara McClintock was honoured by a United States commemorative stamp in 2005 for her scientific achievements leading to the Nobel Prize



Figure 40. The Bausch & Lomb Optical Co. microscope used by Dr. McClintock in her cytogenetic research on selected maize varieties.



Figure 41. USA. Barbara McClintock's stamp was issued in 2005, as one in a group of four American Scientists.



Figure 42. A Swedish entry into the world of molecular genetics, picturing Barbara McClintock with an ear of corn segregating kernels behind her.

in 1983 (Figure 41) and by Sweden in 1989 (Figure 42). When finally awarded, coming after years of



Figure 43. Maize ears that were used in Dr. McClintock's research at Cold Spring Harbor. Studying kernel colour transmission enabled her to eventually explain the jumping genes.



Figure 44. This 2006 US stamp features the same type of coloration shown in corn as the previous figure.

disbelief in her chromosomal explanations and data, it was, and still is the only 'solo' medal in Medicine or Physiology to have been won by a woman (Bjerklie 2018).

The Bausch & Lomb Optical Co. microscope used by McClintock in her cytogenetic research on selected maize varieties is seen in Figure 40. It is monocular,



Figure 45. The second of Barbara McClintock's microscopes. This is a dissecting scope, used to study whole ears of corn and kernel properties.



Figure 46. The pollinating crew at Cornell and Cold Spring Harbor. Photo courtesy of Dr. Walton C. Galinat. Two eventual Nobel Prize winners in this early photo.

with a mechanical revolving stage specifically designed for photomicrography. It currently has a 40X objective, with a set of achromatic lenses held separately. McClintock preferred the single objective because it offered a direct line of light available for photographing chromosomes. This work laid the foundation for what would become a Nobel Prize.

Shown in Figure 43 are actual corn selections tabulated for effects from "jumping genes," as they were known then, with Figure 44 showing resultant colours. For close examination of such kernels and other material, a dissecting scope was used (Figure 45). Finally, when corn tests and line development were required, Dr. McClintock became part of the pollinating crew in Ithaca, NY (figure 46).

RACHEL CARSON, MARINE BIOLOGIST AND ENVIRONMENTALIST (1907-1964)

Long before Rachel Carson turned her attention to environmental concerns (Carson 1962; Figure 47), she wrote about the ocean as "the home of living things so small that your two hands might scoop up as many of them as there are stars in the Milky Way. And it is because of the flowering astronomical numbers of these diminutive plants, known as

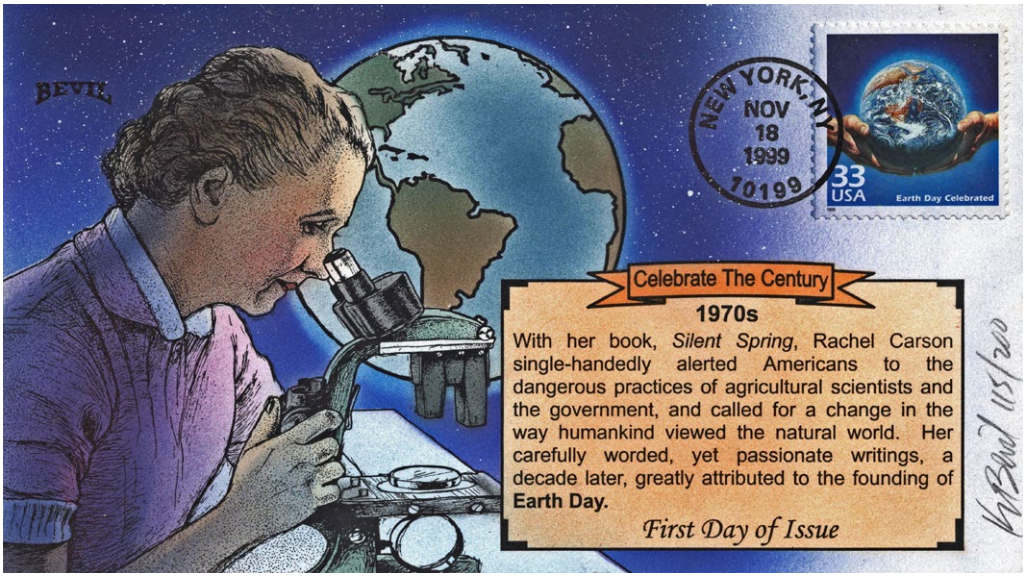


Figure 47. Stamp itself issued to commemorate the first Earth Day, which many attribute to Rachel Carson's book, Silent Spring (published in 1962).

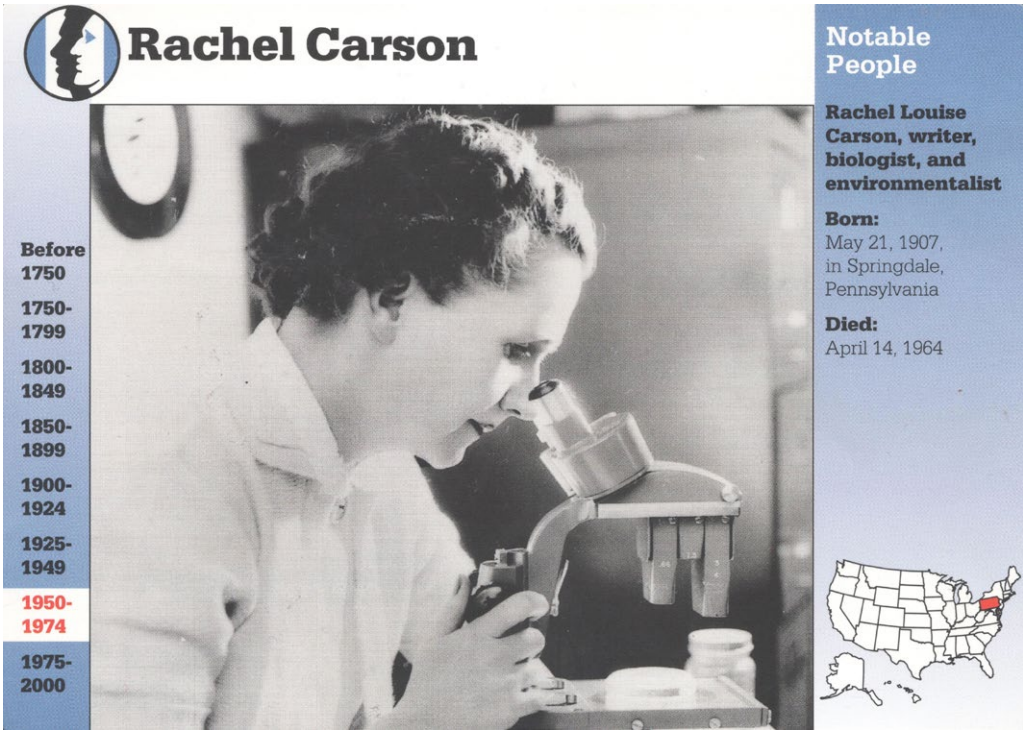


Figure 48. A 'Notable People' card, this one for those who lived during the period of 1950–1974. Carson is listed on the card as a "writer, biologist and environmentalist." Always shown with her microscope.

diatoms, that the surface waters of the ocean are boundless pastures" (Carson 1937). One can just imagine Carson sitting in her wood-paneled study in Maine, light pouring through the three windows, and a slide of diatoms gathered from below on the water's edge (Figure 48).

Best known for her environmental literature that came late in her painfully short life, Carson's beginnings were rooted in the sea. A reflection of her hallmark "narrative scientific" style is seen in the previous paragraph, and through such, Carson imbued life into the organisms she studied, making



Figure 49. Rachel Carson is pictured among sixteen events/personalities considered to be Environmental Heroes of the 20th Century. Stamps issued in 1999 by Palau.



Figure 50. In addition to her international prominence, Carson was also featured on this US stamp, issued in 1981.

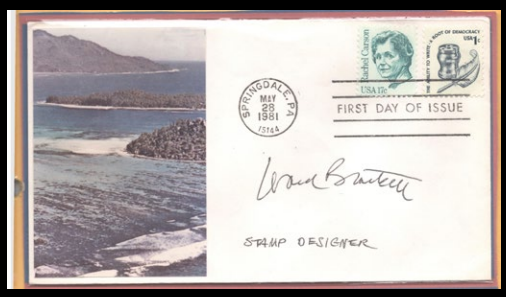


Figure 51. The stamp featured on the first-day cover, signed by its designer, Ward Brackett, which placed Rachel Carson within the Great Americans Stamp Series (Cohen 2019).

Other scientists advancing our understanding of microscopy



Figure 52. Edward Jenner, UK.



Figure 53. Louis Pasteur, France.



Figure 54. Robert Koch, Germany.



Figure 55. Albert Schweitzer, Hungary.



Figure 56. South Africa Mail, issued in 1991: South African Scientists. A four-value set featuring the microscope, Sir Arnold Theiler (a veterinarian), microscope and bacteria on the stamp.

them understandable to those reading her books. Such skilled writing was enlivened by the careful illustrations provided by wildlife artist, Bob Hines. Together, they were able to bring organisms from the ocean depths and make them seem real in one's living room, tackling one after the other, from microbes to whales.

The significance of her work is still being felt, as shown by commemorations from other countries (Figure 49), and in the USA (Figures 50 and 51).

Part V. Microscopic images – an ever-expanding repertoire

THE ROYAL MICROSCOPICAL SOCIETY. In 1989, a set of stamps (Figure 57 overleaf) was issued with four carefully selected images based on



Figure 57. Issued in 1989, Royal Mail salutes the 150th Anniversary of the Royal Microscopical Society (RMS; Hutchison 2023). For this occasion, four stamps were issued along with their respective magnifications.

CUTTING EDGE IMAGERY FROM USPS – LIFE MAGNIFIED. The souvenir sheet (below) is from the U.S. Postal Service, and was designed by Tagide de Carvalho (see caption for details).



Figure 58. Tagide de Carvalho is the microscopist and artist behind the scenes of the images captured here. She is the director of the Keith R. Porter Imaging Facility in UMBC's College of Natural and Mathematical Sciences. As with others seeking such expressions, she has combined her artistic work with skills learned over the years at the lab bench. Her work has now been recognised nationwide. The stamps begin with red blood cells, and then progress to the end with an oak leaf surface.

IMAGERY: SET OF ARTFUL MICROSCOPICAL STAMPS FROM GREECE. These stamps and images come from the microscopy of Maria Lambropoulou of Greece (see caption for details).

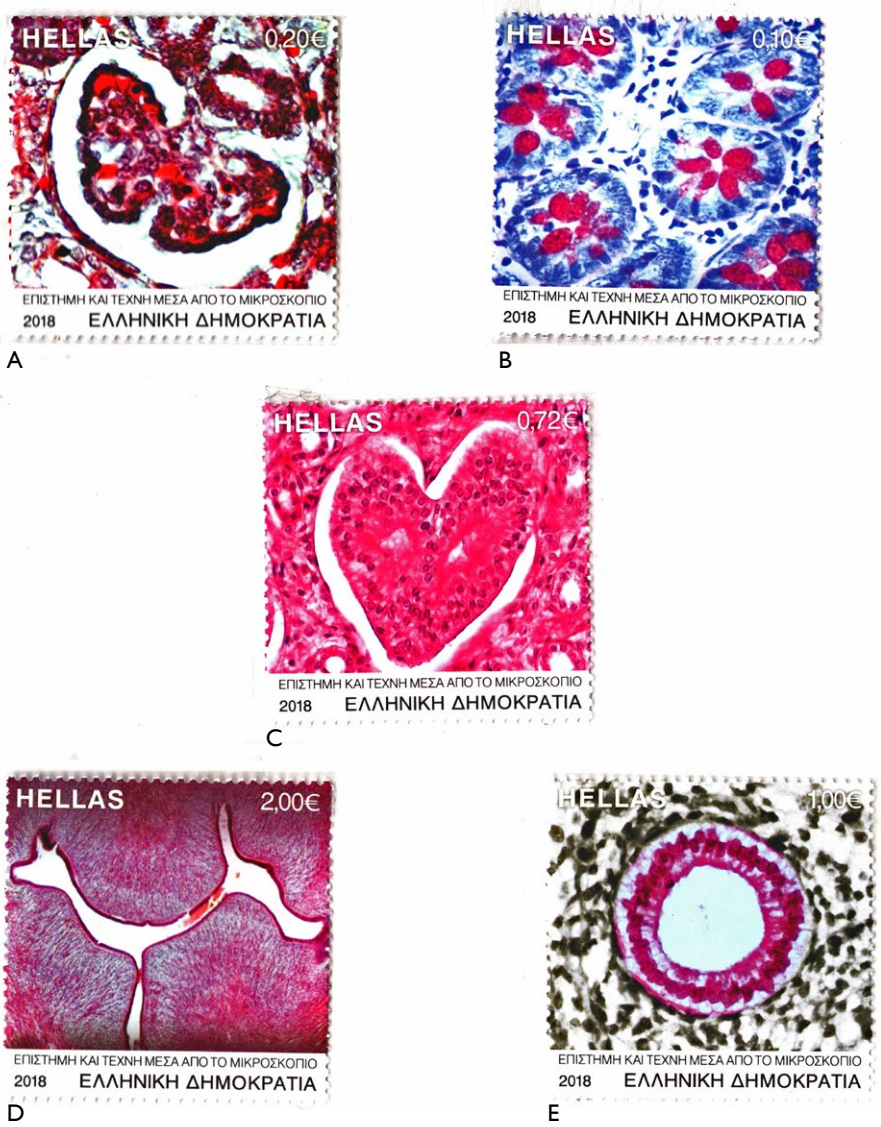


Figure 59. A set of five stamps that were issued by Greek Post in 2018 and stemmed from the microscope and imagination of Dr. Maria Lambropoulou, who is a pathologist and professor at the Democritus University Medical School. Stamp A is tissue seen as flowers; B is tissue seen as butterflies; C is in the shape of a heart; D shows a beautiful, primitive deer; while E presents a wreath formation. Unfortunately, no further information was provided on the source of the tissues and organs being examined.

observations from the microscope. They include the snowflake, house fly, blood cells of multiple types, and a microchip, the full details of each can be found in the article. by Evennett (1989). When it was introduced, it came with a presentation packet and complete set of first day covers.

Note that the two issuances that follow overleaf (Figures 58 and 59), one from the USPS and one from Greece, Hellenic Post, have been produced by women who are skilled in both microscopy and in the art behind their final productions.

Epilogue

This paper brought together images of microscopy from over twenty countries, showing the importance of the research so illustrated at the local, national,



Figure 60. Set of six student activities from China, 1979. The stamp second from right shows students working together to learn and explore the microscope.



Figure 61. Microscopes are pictured on each of the two UN stamps: the 25th UN Anniversary, and for control of Malaria.



Figure 62. "gift stamp" for the holidays, including the microscope in their catalogue, done with UNESCO.

and international level. Such work can be inspiring and lead to new skill acquisition in school classes and professional positions, as well as student to student teaching (Fig 60). In addition, these stamps attest to the use of the microscope across gender, ethnic, and cultural backgrounds, making it one approach to technology in the context of diversity, equity, and inclusion. Applications of microscopy have grown along with new innovations, and users are seeking out such things as art in nature, and how to see and appreciate it through the microscope (Figure 59) as well as traditional roles – for example, attempts to control malaria (figure 61). It remains an eye on the world (Figure 62) that continues to open the doors of perception, offering one way to find what is most probably a humble beginning to all that life on earth has to offer.

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