

AN APPROACH TO WOMEN SCIENTISTS AND PARASITOLOGISTS IN LATIN AMERICA AND THE CARIBBEAN FROM A GENDER PERSPECTIVE

UNA PERSPECTIVA SOBRE LAS MUJERES CIENTÍFICAS Y PARASITÓLOGAS DE AMÉRICA LATINA Y EL CARIBE DESDE UNA PERSPECTIVA DE GÉNERO

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ABSTRACT

In this paper, we discuss the results of a documentary research to highlight the role of women in the development of science, particularly in Parasitology, in Latin America and the Caribbean (LAC). We discuss relevant stories of some pioneers of Parasitology and present the current panorama of parasitology in LAC. Some protagonists have passed away. For those who are alive, we have made a cutoff in those who were born before 1947-1948 so that we highlight the researchers of the first half of the 20th century. The reason is that 1947-1948 marked a fundamental turning point in the evolution of women's condition in the world and in science. In 1947, the United Nations Commission on the Legal and Social Status of Women was established. Finally, we note that although initially the mentors were mostly male, women have gained a relevant place in science in LAC as a promise of a more equitable scientific world to come.

RESUMEN

El siguiente artículo investiga de forma documental, recolecta y selecciona información que resalta el papel que han tenido las mujeres para el desarrollo de la ciencia, y especialmente de la Parasitología en América Latina y el Caribe (ALC). En él relatamos historias dignas de ser contadas de algunas de las pioneras en Parasitología que han trabajado en estos temas en ALC y presentamos el panorama actual de la Parasitología en ALC. Algunas de las protagonistas han fallecido; para las que están vivas establecimos un punto de corte en 1947-1948, destacando las investigadoras que nacieron en la primera mitad del siglo XX siendo estos años un punto de inflexión fundamental en el desarrollo de la mujer en el mundo y en la ciencia, ya que en 1947 se estableció la Comisión de Condición Jurídica y Social de la Mujer de las Naciones Unidas. Finalmente, enfatizamos, que aunque inicialmente lo común eran los mentores varones, las mujeres han ganado un lugar relevante en la ciencia en ALC como promesa de una ciencia mundial más equitativa en el futuro.

Keywords: Women in Science, Parasitology, Latin America, Pioneering Researchers.

Palabras clave: Mujeres en ciencia, parasitología, América Latina, investigadoras pioneras.

1. Introduction

Science, the greatest collective enterprise of humanity, allows better living conditions for society. The progress of education, through the history, constitutes the foundation of enlighten, and thus the scientific progress in diverse fields of knowledge [1]. There are many examples of the ways in which people have acquired know-how, and stories of scientists who

have achieved important goals worldwide, that have led to significant progress for humanity. There are also many cases of women who have ventured into the scientific world and contributed to the development of science and technology.

Today, universities and research centers, as well as corporations such as pharmaceutical companies, contribute with new scientific information through research and development

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During the evaluation of this manuscript, Dr. Olinda Delgado passed away. We highlight this event as a tribute to her long and successful career. She was active until the last day of her life on December 2024.

(R&D) around the world. In addition, their role is crucial in the professionalization of scientists and professors who contribute to the development of nations with the aim to improving the quality of life.

One of these important areas of R&D in tropical countries is parasitology. Most parasitic diseases occur in the tropics; indeed, the field of parasitology has tended to overlap with that of tropical medicine, meaning that the history of these two fields has always been intertwined.

But, how do we define parasitology? Parasitology is the study of parasites and their hosts, and the relationship between them. It is a subdiscipline of biology, its scope includes a metalanguage that is not determined by the (one) organism and its environment, but by how it lives (parasitic life), that is, by its way of life; “it borrows” mechanisms, substrates, and others from the host. Thus, when talking about parasitology, a whole range of disciplines and techniques from fields such as cell biology, bioinformatics, biochemistry, molecular biology, immunology, genetics, evolution and of course, ecology are involved in its development.

At the beginning of scientific research in parasitology and for many decades, it was common for men to be mentors. Over time, women slowly but surely, began to be included in their role as scientists, professors, postdocs, etc. Thus, an increasing number of mentors in many fields of knowledge, including parasitology, began to be women. Therefore, at present, female mentors are actively working with new generations of students, especially women, to improve their interest in science.

In LAC, a significant number of women in medical and health sciences have dedicated their research to parasitology. About 33 Venezuelan female have been internationally recognized for their work in Parasitology. Some of them began their research in the mid-20th century. In Colombia, the first woman to graduate from the School of Medicine, Paulina Beregoff (1920-1970) became a professor of bacteriology and parasitology [2].

Latin American science has made gigantic efforts in entomology and medical parasitology, to promote first the eradication (especially after the Second World War) and then the control of vectors and the testing of populations, to ensure better living conditions. In this context, parasitology has become an important field, and some parasitologists of the region have become world-famous; this behavior also has the aim of counterbalancing the environmental determinism of powerful nations to legitimize their right to dominate the tropics.

Through the following article, we have compiled existing documents related to research in parasitology and its development in LAC, carried out by female scientists. Our aim is to provide results that allow to find how the empowerment of women has affected the development of the field in the region. Our ultimate goal, through the reconstruction of their stories

is to highlight the role that women have had for the development of science, and specifically parasitology in LAC. This article also outlines the challenges women face being scientists and highlights successful female contributors and their role in inspiring future generations of women scientists.

1.1 Some aspects on women in science

The number of women doing research is lower than that of men, despite the progress made by women in their dedication to science, technology, engineering, and mathematics (STEM) careers. As a result, differences in gender parity in research are patent.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics (UIS), one third of the world’s scientific workforce is female [3], and the countries with the highest proportion of women in science are Myanmar and Bolivia (83% and 63% respectively). A recent bibliometric analysis [4] of gender differences in scientific careers, covering all scientific disciplines and a large number of countries worldwide, and following the publication careers of almost six million male and female researchers in the period 1996–2018, describes an increasing trend in the percentage of women starting a career as a researcher (33% in 2000 to around 40% recently). However, women appear to be (not significantly) less likely than men to continue their scientific careers. In biological sciences, men are about 25% more expected than women to be corresponding authors of a publication, thus suggesting that senior positions are more likely to be held by men [4]. Regional figures suggest that Central Asia and LAC lead the world in gender parity in science (48% and 45% respectively) [3] although, gender parity appears to disappear at the postgraduate and higher levels in these countries and regions [5].

Being a scientist in LAC is a challenge for both men and women. After about ten years of research and hard work, students earn a PhD; then they can become postdoctoral fellows, which means that LAC academics qualify for tenured teaching positions when they are in their mid-30s or later.

According to the UNESCO Science Report (2021), LAC countries invest, on average, only < 0.7% of their GDP in research and development (R&D) [6]. By comparison, the richest nations spend between 2-3% of their GDP on R&D [7]. This is one reason why, although LAC represents 8.3% of the world population, only 3.6% of the world’s scientists are from this region. According to UNESCO’s 2022 figures and the UNESCO Science Report (2015), 44% of Latin American researchers are women [8], compared to 28% worldwide. Some regional universities are well ranked in the world, but very few are internationally competitive, even within the continent. As described in **Figure 1**, only universities from Brazil,

Argentina, Chile, Mexico, Uruguay, and Colombia make the best 12 of LAC.

Since a greater percentage of men go to the private sector to earn higher salaries, teaching in universities and research centers in LAC is mostly done by women scientist. This is one of the reasons why women in the region -with similar qualifications-, earn, on average, 30% less than men. In the LAC context, most of the scientific output, in recent decades, has been produced by Brazil, Mexico, Argentina, Chile, and Colombia [9], most of which suffer from a lack of funding (Brazil is the only country with an R&D expenditure >1% of GDP) [10]. Nevertheless, a recent study evaluating women's participation in scientific publishing worldwide over the last decade found that none of these five countries has reached gender parity [11].

Women have been involved in science and contributing to knowledge for many centuries. It was only in the mid-twentieth and twenty-first centuries that their work began to be recognized. In 2020, for example, 29% of the 85 academies of science of the world, were represented by women, an increase from the 21% of the academies that participated in the 2015 survey [12]. Comparing the same cohort of 43 academies that participated in both the 2015 and 2020 surveys, the results for the most recent survey are even slightly lower, being at 28%. Interestingly, together with the National Academy of Sciences in the United States of America (US) (67%), the *Academia de Ciencias Físicas, Matemáticas y Naturales de Venezuela* (67%) and the Global Young Academy (64%), have the highest representation of women in the governing body, suggesting that very few academies, have made concerted effort to include women in their governing body [12]. Science academies in LAC had the highest representation of women (17%) followed by North America (15%) and Central and Eastern Europe (13%). The initiative called *Hermintology* aims to promote the work of women parasitologists and to provide some context behind their work [13]. This initiative was launched in 2021 and promotes and supports women parasitologist, through X (Twitter), Instagram and Facebook pages. Their goal is to reach women at all career

stages and to provide context and background for women working in the field.

The scientific contributions of women have also been recognized through various awards. One of these is the L'Oréal-UNESCO Prize for Women in Science, which has been awarded annually since 1998 and is given to 5 women worldwide (one for each continent) in relevant scientific fields. Only 2% of the laureates have come from the field of parasitology and have been Latin American women [14]. Women in science are promoted through science education programs, starting at the undergraduate level, and for young women scientists, through fellowships and project funding, through programs such as

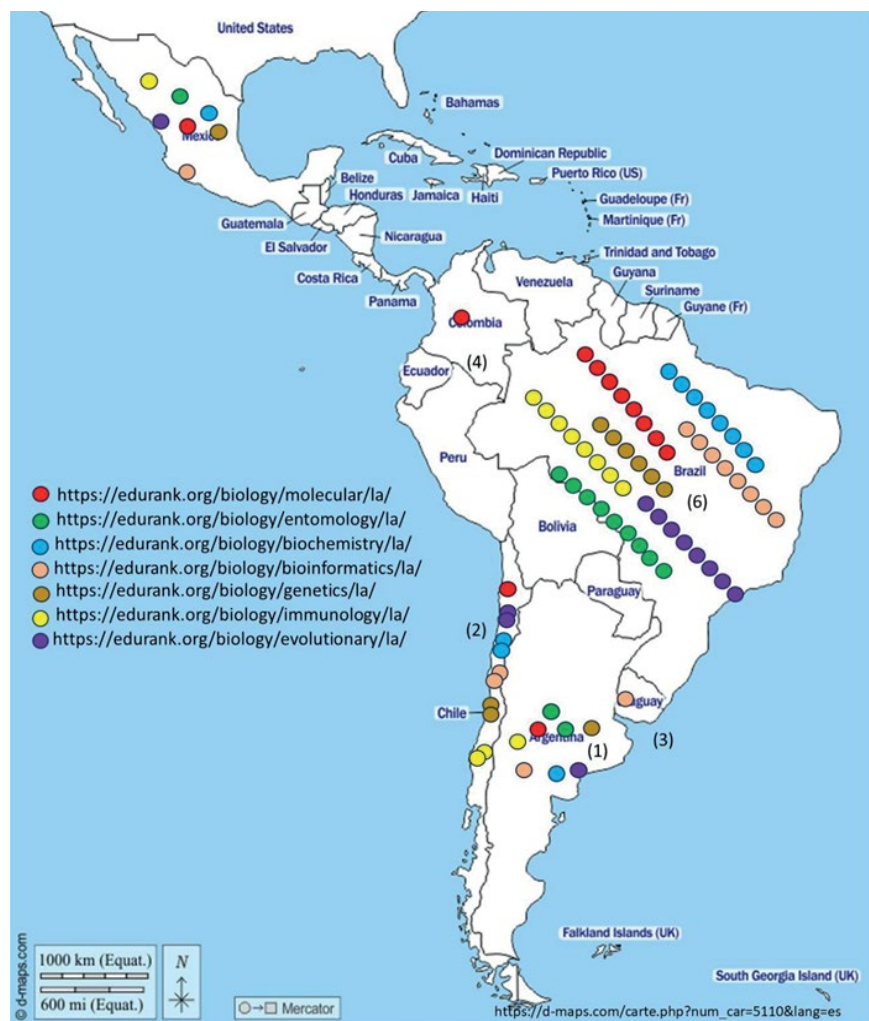


Figure 1. Latin American distribution of the best universities associated with the STEM fields needed for parasitology. The numbers indicate the location of the best universities and their names: (1) Argentina: University of Buenos Aires and University of La Plata; (2) Chile: University of Chile and Pontificia University of Chile; (3) Uruguay: University of Uruguay; (4) Colombia: University of Antioquia; (5) Mexico: The National Autonomous University of Mexico; (6) Brazil: University of São Paulo, Federal University of Minas Gerais, State University of Campinas, Federal University of Rio do Janeiro, Federal University of São Paulo, São Paulo State University, Federal University of Rio Grande do Sul, Federal University of Bahia, Federal University of Viçosa, University of Ribeirão Preto, Fluminense Federal University, Federal University of Santa Catharina, University of San Carlos. The number of colored circles in each country represents the number of top universities related to the represented field.

those promoted by the Inter-American Network of Academies of Sciences (IANAS), or the Drug for Neglected Diseases Initiative (DNDI) or UNESCO among others [15,16,17].

1.2 Challenges for women

Social justice and legal compliance have been the primary motivations to implement policies to promote diverse and inclusive work environments, including for women- and to promote diversity as a competitive advantage for the workforce [18]. In fact, in the XXI century, more women than ever before are entering academia and STEM careers, especially in the biological sciences. However, only a small proportion of them remain in senior academic positions due to the effects of the so-called “**leaky pipeline**”, a fact that is more often observed for women in science during the transition from early career to independent, mid-career researcher [13].

Social, economic and political barriers, affect gender equity in science. Scientific careers may be unattractive to students, who perceive scientific subjects as complex and, in most cases, not lucrative, due to the stigma associated with doing science. These barriers are even greater for young women. However, in 2016, Requena et al. (2016) and Caputo et al. [19, 20] described that the gender gap in Venezuela was close to disappearing. Venezuela is a country where investment in science and technology has decreased dramatically for several decades. Under these conditions, the gender gap is likely to increase [21]. A recent publication by Bonalde (2022) [22] states that Venezuela is the only LAC territory in the region with a negative rate of knowledge production, being now in the eleventh place in the regional classification.

An important aspect to consider when talking about gender parity is what field of science we are talking about. In Venezuela, for example, almost half of all science performed in the country is related to bio-health [19]. A similar conclusion was reached in Colombia, where medical and health sciences are the most represented fields of science [5]. In neither country has parity been achieved in other fields of knowledge. Moreover, in some of these fields, such as engineering, women in LAC appear to be underrepresented at the undergraduate level, with preference for materials, industrial and chemical engineering and low preference for electrical, aeronautical and mechanical engineering, which tend to be preferred by men [2].

In addition, there is still a significant gender gap in science, especially at higher levels and hierarchies. For example, the number of women achieving bachelor's (53%) and master's (53%) degrees may be similar. However, in comparison, the number of women with a PhD (43%) is decreasing, and this percentage decreases even more for female researchers (28%). This is the so-called “**leaky pipeline phenomenon**” [8], which makes the gender gap in science, particularly evident at senior

levels [23]. Women researchers in LAC face many challenges when pursuing a career in science [23, 24, 25], including those related to the Latin American cultural stereotypes [26, 27, 28]. Other findings suggest that female researchers are less internationally mobile, less likely to participate in international research collaborations, and less likely to publish papers as first authors, especially in high-impact journals [29]. Major challenges to achieving gender parity include those listed in **Box 1** [30]:

However, women in the region who aspire to become scien-

<i>Box 1. Common barriers for girls' and women's career development [30]</i>	
•	Lack of awareness of the potential of studying science among younger generations, especially girls.
•	A general misunderstanding in society about careers in science itself. These careers tend to be considered more difficult and harder than other studies and professions, such as those related to the social sciences.
•	Lack of gender-science pedagogy, tools and infrastructure, which affects most public and private schools, especially those located far from urban and cultural centers.
•	Persistent poverty and high socio-economic inequality between national regions affect social access to communication technologies (digital literacy, communication infrastructure and computing devices). Girls and women tend to be more affected by poverty than the population as a whole.
•	Intersectionality factors-interplay of gender with race, LGBTIQ+ identity, and class affects girls and women differently, increasing levels of discrimination that begin in the classroom and continue throughout their academic careers.
•	Sexism in society, and particularly in the academia, is a serious problem that hinders the progress of female students and academics in STEM disciplines and affects the access to senior and leadership positions.
•	Low levels of digital literacy among students and the society, which contributes to the gender gap in science careers and doesn't help change stereotypes about these careers themselves.
•	Lack of female role models to change stereotypes and increase interest in science, particularly among the youngest.

tists are convinced that barriers can be overcome through perseverance, patience and hard work, failure or quitting is not an option. This means that the skills presented by women towards science are remarkable and are summarized in **Box 2** [31].

A fundamental challenge has been the lack of role models and mentors, which is a major detriment to the career progression for women in STEM. And for those trying to “break through the glass ceiling” and consolidate their position in senior management, the lack of sponsors willing to advocate on their behalf appears to be critical. The end result is isolation, feelings of being an outsider or ‘imposter syndrome’ an issue that causes women to question their abilities and occasionally leads to thoughts of leaving the field [18].

Box 2. LAC women's skills in science [31]

<ul style="list-style-type: none"> • Having special sensibilities that allow them to focus deeply on scientific challenges.
<ul style="list-style-type: none"> • Be patient and persistent, even “stubborn” which is important for research.
<ul style="list-style-type: none"> • Being intuitive, which is also important for science.
<ul style="list-style-type: none"> • Having a different way of thinking, which complements that of men.
<ul style="list-style-type: none"> • Having an approach to science, different from that of men, regarding intelligence and activity.
<ul style="list-style-type: none"> • Being committed and secure as women.
<ul style="list-style-type: none"> • Having labs that are more nurturing, inviting and interactive.
<ul style="list-style-type: none"> • Understanding that they are important to model and mentor young women.

1.3 Facing the challenges

But, how to face these tasks? This is a challenge in LAC and in the world, and the answer lies in the fact that there should be a comprehensive approach that counteracts the obstacles.

This should include education and training policies with gender perspective, to ensure that women cultivate skills, interest, and confidence to facilitate their access to STEM jobs; cultural policies to break down gender bias and stereotypes, and give women the confidence to be visible; and policies to achieve a better work-life balance and to promote women to leadership positions [30].

The second path must focus on the implementation and deepening of policy options to reinforce mechanisms for the systematic provision of equity and to strengthen and coordinate the efforts of both the private and public sectors [30].

Most of the tasks required to overcome these inequities (inequalities?) are associated with soft cognitive skills (solving complex problems, adaptability, teamwork, creativity, communication, compassion) [31–36]. Trends in recent years demonstrate a growing demand for these skills to overcome the challenges of gaining professional recognition, even in regions of the world that are lagging behind, such as Latin America.

These challenges affect men and women differently, and this seems to be especially true in a technological world like the one we live in. In fact, according to Bustelo et al. [37], 23% of women and 16% of men are at a risk of being replaced by automated means by the end of the 2020s, since the tasks that are being replaced by technology today are the ones that they perform the most.

Even Argentina, Brazil, and Mexico, the leading countries in LAC, are not immune to these trends, as women are also underrepresented in STEM jobs in these countries. Thus, if we really want to reduce the gender gap in the labor market, it is crucial that more women acquire knowledge and skills that

will be in great request in the future and are already in demand [31]. Having more women in STEM is important to reduce the wage gap, but also to ensure that our economies can quickly close the technology gap. According to Albrieu et al. [38], economies need a workforce with skills, abilities, and knowledge that are compatible and complementary to technology.

Currently in Venezuela, about 3% of university graduates are dedicated to STEM, with a near gender parity. Eighty years ago, there was very little research done in the country, and it was all done by men. Today, three quarters of all activities are carried out by professionals that belong to the biggest public universities and 15% that belong to large public centers and institutes. Research in STEM disciplines is not encouraged, except in those schools of science that are fully in line with their purpose. However, in the last half century, women in our country have made significant progress to reach and sometimes exceed men in number, participation, and performance in STEM disciplines. In fact, an overview of this fact shows that the large gaps that existed between men and women in research and development in the mid-20 century seem to be on their way to disappearing, if they haven't already [39].

A list of strategies and resources to overcome barriers to career advancement in science has been published by Hansen [18]. These include recommendations for individual researchers, such as finding mentors, sponsors and networking opportunities, and for organizations, through the value of providing unconscious bias and diversity training to promote changes in organizational culture, improving strategies for recruiting and retaining female researchers, implementing policies that promote an inclusive workplace and transparent promotion processes, and ensuring pay equity.

2. Parasitology, Women, and LAC

In the relatively short history of humans on Earth, a staggering number of parasites have emerged. Many are rare and accidental parasites; but humans host fewer than 100 relatively common species, a small fraction of which cause some of the world's most important diseases [40]. Most of these parasitic diseases occur in the tropics. This is one of the reasons why the field of parasitology tends to overlap with that of tropical medicine, and the history of the two is intertwined. The history of parasitology is ancient intertwined with the human history and generally seen as a medically dominated narrative of scientific discoveries made by wonderful individuals. The period from the last third of the XIX century up to the first third of the XX century, has been nominated as the Golden Age of Parasitology [39], a period during which a series of concatenated discoveries were made by excellent scientists, also true for Latin America. The growing curiosity of scientists and the development of technologies such as the

microscope were key factors in promoting improvements in the field [41].

Latin America has peculiarities for anyone studying any of the fields of parasitology. In addition to autochthonous parasitic diseases, human parasites from other areas of the world are established in LAC as a result of migration. For example, discovery and colonization of the Americas brought parasites from Europe and Asia to our continent; the traffic with the Far East and nearby areas gave America some of its contingent of parasitosis and, the black slave trade, which flourished from the beginning of the 16th century up to the 19th century, allowed the introduction of not a few parasitic diseases to Latin America, that originally came from Africa. Thus, our continent is a unique scenario for the passion of researchers, in the aim of to increase scientific knowledge and to put that knowledge at the service of the noble cause of improving of the health of the Latin American people.

But how did the study of tropical medicine and parasitology begin to be done in Latin America and the Caribbean? One of the most important stories behind this began in Brazil in 1860. In that year a Brazilian woman, a slave on a sugar plantation, became very ill with the disease we now call Chagas's disease. The disease was profound and despite all the methods available to cure her, she was weak and lost her mental acuity, and became paralyzed. The physicians diagnosed her with a "tropical degeneration", a generic term used to describe several serious diseases that only affect people who visit or live in the tropics [42]. Many years passed before the causal agent could be described and this was done and reported in 1905 by the Brazilian physician Carlos Chagas, who in collaboration with his professor Dr. Oswaldo Cruz found that the trypanosome could infect insect vectors as well as monkeys. These findings were published in the journal *Brasil Médico*. In 1909, Carlos Chagas identified the hemoflagellate, which he later named a *Trypanosoma cruzi*, in honor of Oswaldo Cruz, in a sick girl named Berenice. This discovery was reported to the Brazilian Academy of Medicine, and also toured the world, making Dr. Chagas famous worldwide [43]. Many years later, in 1919, in the city of Mene Grande, in the state of Zulia, Venezuela, Enrique Tejera began the research, critical observations, field work, experiments and scientific findings that led to the description of the first patients and mammals infected with the causative agent of Chagas' disease, *T. cruzi* and the identification of the triatomine insect *Rhodnius prolixus* as the primary vector, responsible for the transmission of this parasite [43]. This fundamental information made Venezuela the second country, after Brazil, to describe the disease on the continent. The story of how the study of Chagas disease began is interesting, but apart from the fact that the etiological agent

was observed to be causing the disease in a woman -Berenice-, all other descriptions related to this story were made by male scientists.

When did women begin to appear in the history of parasitology in LAC? Who were the first women to be a pioneer in the study of parasitology in a systematic way in this region of the world?

Tropical medicine was a term that began to be used and became standard to denote the treatment and classification of diseases considered unique to hot and humid areas of the world.

Leading European scientists considered cases such as the one mentioned here for LAC -Chagas disease-, that were also common in their imperial holdings in South Asia and Africa (for example Huan African Trypanosomiasis) to be evidence that there were fundamental differences between regions of the world that not only increased the likelihood of physical degeneration, but also affected mental and moral capacities [42].

In addition, historians and public health physicians questioned whether the plagues associated with the tropics were primarily due to their climatic conditions or to the prevailing social organization in those places. This was the world at that time and the inherited history that we still have in some places [42].

Indeed, for centuries, tropical medicine and parasitology were considered the domain of imperial powers seeking to protect their settlers and administrators in (colonial) tropical regions or of philanthropic organizations seeking to eradicate diseases that threatened economic interests. However, as early as the 1860s, diseases endemic to tropical regions inspired enthusiastic local researchers to create centers of excellence to understand and control tropical and parasitic diseases [42].

Nevertheless, it is interesting to note that Latin American countries (unlike those in Asia and Africa) were politically independent at the beginning of the nineteenth century and thus free to pursue their own styles of science and medicine [44]. At that time researchers in Latin America faced many obstacles, including being ignored by the world's scientific centers; they were considered incapable of advanced science, according to the same discriminatory logic that assumed the inferiority of tropical climates for human habitation, compared to temperate ones [44]. Last but not least, despite the efforts that Latin American science has made to write a successful history with the promotion in the regional countries, of the eradication of vectors and the testing of populations to ensure better living conditions (especially after Second World War) and to counterbalance the environmental determinism of powerful nations to legitimize their right to dominate the tropics, parasitology has become an important field in LAC and research here has become world-renowned [42]. Vector

eradication is a strategic goal that aims to eliminate or control the spread of vector-borne diseases by reducing or eliminating human contact with vectors. However, it is now recognized that vector eradication is highly unlikely and that good control practices are more likely to be associated with surveillance and control of the diseases. Moreover, eradication efforts in the post Second World War period were soon undermined by population growth and industrial development [43].

An interesting point to illustrate how deep parasitology is in our imaginary, is the fact that, except Bolivia, El Salvador, Guatemala, Haiti and Nicaragua, the rest of the countries either have a tropical medicine, protozoology, parasitology or microbiology societies or similar (see **Figure 2**). It is noteworthy that only 8 of those societies are led by women, which tells us that there is certainly an underrepresentation in this regard in the continent. And again, it is our duty to work in this direction in order to balance the situation and to achieve equality in women's education and further to have the strength to take on responsibilities at higher levels.

2.1 Current panorama of parasitology and women in Latin America

As clearly mentioned by UNESCO [46], as a result of different policies and activities implemented at different levels during the last 20 years, LAC has experienced improvements regarding the inclusion of women in science. In fact, the region is one of the two areas in the world that achieved the best parity in the proportion of female and male researchers. However, despite the increase in female participation, inequalities persist in several countries and in certain disciplinary areas, affecting girls's access to STEM, as well as the recognition of women's work in science and their ability to rise to the leadership positions [44]. Here we summarize the biographies of some female protagonists in the study of these issue in LAC. It is a relevant issue not only for LAC but also for the world. We highlight here, the biographies of the two most recent L'Oréal UNESCO laureates, who are also Latin Americans wor-

king in parasitology, and the biography of the 2023 winner of the Women for Science Program (WfS) of IANAS, Anneke Levelt-Senger's Prize.

In addition, **Table I**, collects a brief description as well as links to the biographies of Latin American -women- researchers, pioneers in studies related to parasitology, who are no longer alive, as well as women parasitologists who are alive



Figure 2. Latin American distribution of academic and scientific societies related to parasitology. Accessed on January 31, 2024. The color codes represent the presence of societies related to the named fields, as well as the place where at least one of the societies is headed by a female scientist. <https://www.wfpnet.org/members/member-societies-by-region/>, <https://protozoologia.org.ar/autoridades-2023/>, <https://sumuy.org.uy/sociedad/>, <https://fr-ca.facebook.com/people/Sociedad-Paraguay-de-Parasitologia/100071343377146/>, <https://spm.com.py/directorio/>, https://www.facebook.com/SOCPEMI/?locale=es_LA, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi1pvjtqYiEAXU6tYQIH-dKUBIMQFnoECA4QAw&url=https%3A%2F%2Fwww.sociedadecuadorianademicrobiologia.org%2F&usg=AOvVaw2UFaLDzAz9oLtvf7_Wt8Ow&opi=89978449, <https://es-la.facebook.com/people/Sociedad-Ecuatoriana-de-Medicina-Tropical-y-Parasitolog%C3%8Da/100082840392736/>, <https://www.acpmt.info/junta-directiva>, <https://www.acmicro.org/>, <https://www.parasitologia.org.br/>, <https://www.facebook.com/acomicropara/>, <https://instituciones.sld.cu/ipk/category/sociedades-cientificas/sociedad-cubana-de-microbiologia-y-parasitologia/>, <https://www.infobioquimica.com/new/tag/sociedad-de-microbiologia-de-el-salvador/>, <https://www.facebook.com/ademicrd/>, <https://smp.cinvestav.mx/>, <https://www.facebook.com/groups/svmaragua/>.

Table I. Brief description and links to the biographies of Latin American -women- researchers, pioneers in studies related to parasitology (¹Born-Dead).

Country	Name	B-D1	Main area of knowledge	Link
Argentina	Delia Mabel Suriano	1933-2023	Herpetology, with emphasis on marine and freshwater Monogenea parasites of fishes, their taxonomic description, biogeographic distribution and host-parasite relationships.	http://sedici.unlp.edu.ar/handle/10915/156796 https://www.cepave.edu.ar/noticias/2023-01-25/delia_mabel_suriano/ https://www.researchgate.net/search.Search.html?query=delia+mabel+suri-ano&type=publication
	Elsa Segura	1940-2020	Chagas disease with emphasis on humoral immune response and dysfunction in chronic disease. Distribution and pathogenicity of <i>Trypanosoma cruzi</i> isolates from different host species.	https://www.fundacionkonex.org/b5551-elsa-segura https://www.researchgate.net/search.Search.html?query=Elsa+segura&type=publication
Brazil	Maria José Von Paumgartten Deane	1917-1995	Chagas disease and its mammalian host, with emphasis on antigenic characterization of <i>Trypanosoma cruzi</i> isolates. Contribution to the knowledge of leishmaniasis, malaria eradication, public health and tropical medicine.	http://memoria.cnpq.br/web/guest/pioneiras-view/-/journal_content/56_INSTANCE_a6MO/10157/902891file:///C:/Users/Asus/Downloads/A_tribute_from_the_Tropical_Medicine_Institute_of_.pdf
	Sônia Gumes Andrade	1928-2022	Pathology and immunopathology of Chagas disease, with emphasis on the classification of the parasite based on the disease outcome and parasitary damage, as well as its response to various chemotherapeutic treatments.	https://acortar.link/9aBaot https://www.bahia.fiocruz.br/fiocruz-bahia-lamenta-falecimen-to-da-pesquisadora-emerita-sonia-andrade/
	Ana María Jansen Franken	1945-	Biological characteristics of the <i>Trypanosoma cruzi</i> complex with emphasis on the interaction of trypanosomes with other mammals, depending on the environment in the eco-pathogenic complex scenario.	https://www.escavador.com/sobre/7345220/ana-maria-jansen-franken , http://www.fiocruz.br/ioc/cgi/cgilua.exe/sys/start.htm?infoid=3042&sid=32
	Bianca Silvana Zingales	1948-	Biochemistry of glycoproteins involved in the host cell invasion process of <i>Trypanosoma cruzi</i> , and the activity of trans-sialidase, a trypanosomatid-specific enzyme. Genetic characterization of trypanosomatids in an evolutionary context.	https://fapesp.br/9010/bianca-zingales , https://www.escavador.com/sobre/8562384/bianca-silvana-zingales , https://www.abc.org.br/membro/bianca-silvana-zingales/
Colombia	María Cristina Ferro	1947-2015	Biology, genetic and geographic distribution of phlebotomine triatomines and mosquito vectors of metaxenic parasites in Colombia, sand fly viruses, vectorial capacity and ecological factors associated with transmission. Biology and ecology of Venezuelan vectors of equine encephalitis virus.	https://doi.org/10.1186/s13071-022-05234-6 https://en.wikipedia.org/wiki/Maria_Cristina_Ferro
	Nancy Gore Saravia	1948-	Host- <i>Leishmania</i> relationship in the endemic context with emphasis on the natural history of infection and disease, host cells and effector molecules involved and pharmacokinetic studies and clinical trials of anti-leishmanial drugs.	https://ysph.yale.edu/profile/saravian/
Honduras	Rina Lisette Girard Rivas de Kaminsky	1936-	Description of parasites such as <i>Cryptosporidium</i> spp. <i>belli</i> , <i>Cyclospora cayentanensis</i> and <i>Ancylostoma duodenale</i> with emphasis on epidemiologic foci of <i>Angiostrongylus costarricensis</i> . Biology and Public Health of Taeniasis/Cysticercosis	http://www.bvs.hn/Honduras/UICF-CM/Rese%F1a%20biografica%20Rina%20G.%20Kaminsky.pdf
Mexico	Ana Esther Hoffmann Mendizábal	1919-2007	Biodiversity, taxonomy and biogeography of mites from Mexico and the Americas. Organization of the most important acarological collection of Mexico of relevance and world reference. Study of ectoparasitic insects, with specimens of medical and veterinary importance.	https://es.wikipedia.org/wiki/Anita_Hoffmann

Table I. Continued...

	Ana Flisser Steinbruch	1944-	Immunologic diagnostic techniques for human cysticercosis. Diagnostic techniques for the treatment and education of patients with taeniasis. Epidemiological study of neurocysticercosis and taeniasis foci in Mexico, development of national guidelines for prevention and control of these diseases.	https://es.wikipedia.org/wiki/Ana_Flisser_Steinbruch
Uruguay	María E. Franca Rodríguez	1925-	Research, serological diagnosis and treatment of Chagas disease. Studies of triatomine vectors in ecoregions of Paraguay. Characterization of patients with acute Chagas disease in Uruguay for epidemiological guidelines.	https://www.smu.org.uy/socios/distinciones/2001/13 https://www.eldiariomedico.com.uy/29%20de%20nov/actualidad%206.htm
Venezuela	Lucila Arcay De Peraza	1928-2015	Immunology and biology of leishmaniasis, trypanosomiasis, toxoplasmosis, cryptosporidiosis and microsporiosis. Search for <i>Cryptosporidium</i> in wildlife. Study of human enteric pathogens as opportunists causing the diarrheal syndrome in AIDS cases.	https://cazadoresdemicrobios.com/consulta_biografia.php?id_biografia=51
	Olinda María Delgado Silva	1930-2024	Chagas disease, cutaneous and visceral leishmaniasis, and toxocariasis, with an emphasis on immunodiagnosis.	https://www.tribunadelinvestigador.com/ediciones/2018/1/art-2/
	Elsa Baez Abreu De Borges	1938-	Diganosis of <i>Onchocerca volvulus</i> , Criptosporidiosis in young children, <i>Microspora</i> as etiologic agent in chronic diarrhea and ocular diseases, with proposals of chemotherapy in these parasites.	https://cazadoresdemicrobios.com/consulta_biografia.php?id_biografia=192 https://ve.scielo.org/scielo.php?script=sci_rttex-t&pid=S1315-25562000000100011
	María Dora Feliciangeli	1940-2017	Entomological studies of vector-borne diseases, with emphasis on genetic variability and phylogeny. Epidemiology of Chagas disease and leishmaniasis, immunological and molecular diagnosis of leishmaniasis, vector-parasite interactions, sand fly and triatomine biology, vector control research and policy.	https://doi.org/10.1186/s13071-022-05234-6 https://www.researchgate.net/publication/327546524
	Hilda Pérez Carvajal	1943-2019	Immunology of schistosomiasis, genetic susceptibility of hosts in cutaneous leishmaniasis, immunological studies derived from infections by bovine trypanosomiasis, taeniasis and toxoplasmosis. Study of the immunology of the host-parasite association in <i>Plasmodium</i> to generate immunological diagnostic tests for major epidemic outbreaks in Venezuela.	https://es.wikipedia.org/wiki/Hilda_P%C3%A9rez_Carvajal https://vitae.ucv.ve/?module=articulo&n=44
	Eva Pérez De Suárez	1947-	Diagnosis of amoebiasis, immunology of amoebiasis, cell biology and biochemistry of <i>E. histolytica</i> , as well as ultrastructural and culture aspects of <i>E. histolytica</i> , study of free-living <i>Acanthamoeba</i> and <i>Naegleria</i> amoebae in Venezuelan patient samples and environmental fluids.	https://www.cazadoresdemicrobios.com/consulta_biografia.php?id_biografia=188
	Elina Rojas	1946-2016	Biology of parasites and their vectors, in the context of integrated control of metaxenic diseases, biomedical sciences, with greater emphasis on the study of cutaneous leishmaniasis. Study the leishmaniasis complex and reservoirs in the Venezuelan Andean region.	<i>Boletín de Malariología y Salud Ambiental</i> versión impresa ISSN 1690-4648. <i>Bol Mal Salud Amb</i> vol.56 no.1 Maracay jul. 2016)

and were born before the years 1947-1948, highlighting those researchers born in the first half of the XX century and considered as pioneers. We will have a slight emphasis on Venezuela, a country that we know better. Although we tried to make an exhaustive search, it was not easy to find the biographies of pioneer women in parasitology research in every country of LAC, but we hope to have highlighted some inspiring ones; again, unfortunately not from every country.

Lúcia Mendonça Previato (<http://www.abc.org.br/membro/lucia-mendonca-previato/>)

Lúcia Mendonça Previato was born in Maceio, Brazil (1949); she moved with her family to Rio de Janeiro at the age of 5, a decision that, in the future, would open doors for the academic to pursue higher education. She graduated in Natural History from the Universidade Santa Úrsula (1971) and holds a doctorate in science (emphasis on microbiology) from the Federal University of Rio de Janeiro (UFRJ, 1976). She completed postdoctoral internships in carbohydrate chemistry (1977-1978), at the National Research Council (NRC), in Canada; in glycobiology (1978-1979), at the University of California-Berkeley, in the United States; and in protein chemistry (1987-1988), at the National Institute of Health and Medical Research, in France. She has experience in the area of glycobiology and biochemistry of microorganisms, with a focus on trypanosomatids, fungi and nitrogen-fixing endophytic bacteria, and in the characterization of glycophenotypes by mass spectrometry and nuclear magnetic resonance spectroscopy. In 2001, she received the Commendation of the National Order of Scientific Merit; in 2004 she received the L'Oréal-UNESCO Awards for Women in Science for her research into the prevention of Chagas disease; and, in 2007, she received the TWAS Prize in Biology from the World Academy of Sciences (TWAS). In addition to being a member of the Academia Brasileira de Ciências, she has also been a member of TWAS since 2008. Known for her prolific publications of scientific articles, she rebases 127 scientific works published in different journals and websites dedicated to science. She is Full Professor at the Federal University of Rio de Janeiro; Regional Vice President (Rio de Janeiro) of the Brazilian Academy of Sciences.

María Esther Orozco Orozco (https://es.wikipedia.org/wiki/Esther_Orozco)

María Esther Orozco Orozco was born in San Isidro Pascual, Chihuahua, Mexico (1945). She is a professor as well as a chemist, bacteriologist, and parasitologist graduated from the Autonomous University of Chihuahua; Master of Science and Doctor of Science, with specialization in Cellular biology, from Cinvestav (National Polytechnic Institute, Mexico). Her research interests include molecular biology, virulence

factors, genetics of multidrug resistance, and organization of the amoeba genome, as well as genes and molecules, and cellular physiological mechanisms involved in the endosomal sorting complexes required for phagocytosis and virulence of *E. histolytica*. She joined the Department of Genetics and Molecular Biology in 1981. Since 1990, Dr. Orozco has been with the Department of Infectomics and Molecular Pathogenesis, Cinvestav, Mexico City. For a decade, she was a researcher at the Howard Hughes Medical Institute. She has been a fellow at several foundations, including the John Simon Guggenheim and the Fogarty International Center. She has also been a visiting professor at Harvard University and the Weizmann Institute, among other international institutions. She was founder of the Research Center for Applied Science and Technology (National Polytechnic Institute). She also created the Postgraduate Course in Genomic Sciences at the Autonomous University of Mexico City (2003), and was member of the Advisory Board of the same institution. She received the Miguel Otero National Award from the Ministry of Health (1985), the Louis Pasteur Medal from UNESCO and the Pasteur Institute (1997), the "Woman of the Year 2004" Award in the field of health by the Master Card corporation and Glamour magazine (2004), the "Women in Science" Award from UNESCO and L'Oréal (2006), the Medal for Citizen Merit in Science from the Legislative Assembly of the Federal District (2006), Omeccihuatl, Medal from the Women's Institute of the Federal District (2004). The Congress of the State of Chihuahua and the Chihuahuense Women's Institute instituted the Outstanding Chihuahuense Recognition, awarded annually to reward "women who with their activities have raised the name of the state where they were born." In the scientific field, the recognition is named after María Esther Orozco Orozco. The magazine Líderes Mexicanos included her in the ranking of the 300 most influential Mexican leaders in Mexico (2020). From 1990 to 1994, she was the Planning Secretary of the Cinvestav of the IPN. In the 1998 elections, she was an external candidate for governorship of Chihuahua for the Party of the Democratic Revolution. Her experiences during the campaign are narrated in the book: Chihuahua, opening paths in the fight for Democracy. From 2006 to 2010, she was the founder and General Director of the Institute of Science and Technology of the Federal District. In April 2010, the University Council elected Dr. Orozco as the new rector of the Autonomous University of Mexico City, a position she held until March 2013. From June 2019 to September 2021, she was a scientific advisor to the Secretary of Foreign Relations of the Mexican Government. During this assignment, she was the coordinator of the technical-scientific group that represented Mexico in the Coalition for Epidemic Preparedness Innovations (CEPI), which was formed in collaboration with

universities, research centers and companies. nationals to face the COVID-19 pandemic. Through this consortium, with international cooperation resources, were sought to fund Mexican projects aimed at developing diagnostic methods and vaccines against the SARS-CoV-2 virus. On September 7, 2021, she was appointed Minister of Cooperation in Science and Technology of the Mexican Embassy in France, a diplomatic position in which she currently holds.

Alicia Rojas (<https://ianas.org/ianas-wfs-dr-alicia-rojas-winner-of-the-anneke-levelt-sengers-prize-2023/>)

Alicia Rojas was born in San José de Costa Rica (1991). She is a microbiologist and parasitologist who graduated from the University of Costa Rica. She obtained her PhD in Animal Sciences from the Hebrew University of Jerusalem in Israel. There she focused her work on parasites of veterinary importance. She then did her postdoctoral research at the Weizmann Institute of Sciences, Israel, where she analyzed host-pathogen interactions of the human malaria parasite.

Dr. Rojas's research focuses on the canine parasitic and oncogenic nematode *Spirocerca lupi*. Her work has greatly increased the knowledge of this parasite and has significantly promoted its study and awareness around the world. Her research is multidisciplinary focusing on the biology of *S. lupi* and spirocercosis, including the proteomic characterization of its secretome, the evolutionary history of the worm, pathogenesis, and molecular and serological diagnosis of the infection. In addition, her dedication to these topics led to the discovery of a new nematode species, *Spirocerca vulpis*, which has since been detected in Spain, Bosnia and Herzegovina, Italy, Portugal, France and Switzerland.

She is affiliated to the Faculty of Microbiology and the Research Center for Tropical Diseases at the University of Costa Rica. In addition to teaching medical helminthology to undergraduate microbiology students and collaborating in community outreach programs aimed at the diagnosis, treatment, and prevention in the pediatric populations of her country, she coordinates the International Network for the Research of *Angiostrongylus costaricensis*, is a consultant of the Tropical Council for Companion Animal Parasites (TroCCAP), is associate editor of the journals *Parasites & Vectors*, *Acta Tropica* and *Current Research in Parasitology and Vector-Borne Diseases*. Her laboratory work focuses on the epidemiology, phylogeography and host-pathogen interactions of parasitic worms of human and veterinary importance from a One Health perspective. Until 2023, she has been very productive (47 peer-reviewed international articles, being corresponding author in 13), has participated in international conferences and was awarded the Odile Prize for Young Parasitologists in 2020. The Bain Odile Prize was created by

the journal *Parasites and Vectors* to “support to young parasitologists and enthusiasm for Parasitology”. Dr. Rojas and her group have been able to elucidate the dynamics of parasite dispersion in the world, the evolutionary history of these pathogens and unravel the complex dynamics by which parasites communicate with their hosts.

She has received the Wfs Anneke Levelt-Senger's Prize (2023), given by the Inter-American Network of Academies of Sciences (IANAS), to highly outstanding scientists with a strong proven track record in the field of research. It is awarded in the category of “Women for Science” and is given in honor of Anneke Levelt Sengers, a Dutch physicist known for her work on the critical states of fluids and in recognition of her outstanding work in promoting women for science in the Americas. According to the jury, the election of Alicia Rojas is in recognition of her outstanding career, as well as a series of fundamental contributions and achievements that she has had in the field of parasitology.

3. Final remarks

Table II taken from [31] summarizes the challenges already mentioned, taking into account why few women choose STEM careers and what kind of challenges they face once they are inserted in the science and technology system. Although we focus on LAC, this is valid for women all over the world.

The implementation of strategies to promote gender equity seems to be a must, and as mentioned by UNESCO, is a global priority of the organization [46, 47]. The organization and implementation of programs that promote the free flow of ideas and the exchange of knowledge on how to reduce the gap and increase women's participation in science seems to be an obligation. The stories we tell here are an inspiration to all those women and girls who would like to make parasitology their passion in life. We have chosen this field of knowledge as an example, but we must stress that despite the great progress made in the recognition of women in science, the gender gap still exists, also in LAC.

In LAC, and especially since the mid-20th century, many women have dedicated their research work to parasitology, thus contributing to the training of new generations of parasitologists and paving the way to highlight the role of women in this field of study.

Although the gender gap appears to be narrowing in some geographic areas and in some scientific fields, it has not narrowed at the global level. Therefore, it is necessary to continue to find ways to reduce this gap. Currently in LAC, the number of female researchers in the field of parasitology is increasing.

When talking about Latin American women scientists, there is a mixed situation; including women into the field of parasitology research could also mean to promoting the mi-

Table II. Challenges faced by women in LAC. Taken from [31].

<i>Few women choose careers in science and technology, why?</i>		<i>Once inserted in science and technology careers, women face many challenges, why?</i>
Primary and secondary school	Professional	Professional development
Inequalities in cultural and social benefits associated with school attendance	Inequities and developmental barriers to career entry	Inequities in the sharing of household responsibilities
Absence of role models near the girls	Few mechanisms for successful transition to the job market	Getting promoted based on masculine criteria
Absence of vocational orientation in schools		Professional disparities in career development

tigation of economic losses, influencing health outcomes and integrating prepared women into professional life. Thus, equity, diversity and inclusion are a must. The training of early career scientist represents an inflexion point of great importance to fully achieve the needed outcomes.

Understanding of the evolving dynamics of parasitic organisms in the anthropogenic era and within the climate change paradigms is imperative from both a human and pragmatic point of view and therefore, probably starting from the training of postgraduate parasitology students learning not only about the parasites themselves but also about the fundamental importance of equity, diversity, and inclusion could be a way to trigger a better way to achieve the needed goals, taking into account the idiosyncrasies of Latin American students and scientists.

For example, the Key Skills in Parasitology module as part of the M.Sc. Parasitology and Pathogen Biology program at (Queen's University Belfast) (<https://www.qub.ac.uk/courses/postgraduate-taught/parasitology-pathogen-biology-msc/>) has the aims to (a) understand the meaning of equity, diversity and inclusion and how these terms relate to science and parasitology, (b) recognize the impact of bias and prejudice on science and in parasitology, and (c) identify unconscious bias in the oneself and others and thus implement ways to influence the bias and prejudice of others through the use of active bystander interventions [48].

Another example is -the creation of the so called intra- or transdisciplinary communities of practice. These are communities where members share a common goal and come together, either formally or informally, to address a problem [49, 50]. Different methods are used to achieve these goals, such as generating and sharing knowledge, catalyzing opportunities to build and maintain relationships and sharing experiences and expertise. Although not yet present in Latin America, these types of transdisciplinary communities of practice have emerged in many areas of the world, both within academia and at the science–society interface, with the aim of promo-

ting women in science and focusing on giving visibility to women scientists [48].

Other examples include, 500 Women Scientists v, Unique Scientists vi, and Wikipedia's WikiProject: Women in Red vii. These communities were an inspiration for the Women in Parasitology (WiP, <https://wipara.weebly.com/>) and Women in Malaria (WiM, <https://womeninmalaria.es/>) initiatives. Both communities began as a list or a website that have grown into searchable databases and information resources for information for the entire community meaning that women in parasitology research are striving to create initiatives to engage in changing the gender narrative in parasitology LAC [48].

Finally, we mention the initiative “For Women in Science” [51] that celebrates the first hundred Mexican scientists supported by the L'Oréal-UNESCO national program. This international program is led by the L'Oréal Foundation and UNESCO together, jointly with the Mexican Academy of Sciences and CONALMEX for its national chapter. Since 2007, this initiative has recognized and supported the scientific work of Mexican women. The award aims to contribute to gender equality in science and promote role models for future generations of women scientists. The spread of this type of initiatives in Latin America is a wonderful boomerang for empowerment of women in science in general and especially in parasitology, our field of interest.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

AP-S was responsible for the conceptualization and data curation of the presented data. AP-S was responsible for the original draft preparation. AP-S, LL and LH were responsible for the writing, review and editing of the final manuscript. All authors have read and agreed to the published version of the manuscript.

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