Invited paper

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Women must be equal partners in science: gender-balance lessons from biology

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Abstract: Access to scientific careers for women has never been easy, but as biases and barriers slowly begin to diminish, women are becoming more and more involved in science, especially Biological Sciences. Some of the reasons why women do not have the same opportunities to achieve career pathways equal to those of men are discussed. We conclude that there is an ongoing need to design and apply new policies to effect a gender balance throughout the career path. This is seen not simply as an equitable outcome – it is a moral imperative.

Keywords: Biological sciences; discrimination; gender balance; gender gap; IUBS; "leaky pipeline"; policy measures; science; STEM.

Introduction

This paper has been written to ascertain the type of barriers that exist to women who choose Biological Sciences as a career. At the outset, we espouse the current inequalities between women and men in the pursuit of a career in the Biological Sciences, and discuss the results of the Gender Gap in Science (GGS) survey[1] [1]. However, as biologists, we seek to determine not simply the "what?" – but the "how?", the "why?" and even more importantly the "mitigation" measures toward strengthening gender balance in the Biological Sciences.

Inequalities and discrimination affecting women have a long history, and although this does not confer any validity in the behavior, it is worthwhile contemplating just how far back it extends. It is recorded in the written works of philosophers such as Plato and Aristotle when, even in the cradle of democracy, power was vested in a small group of the privileged. And these were all men. In general, women were not permitted to vote, own land, or inherit; the teleology of women was the rearing of children. Granted there were female gods, but in the main, these goddesses were there to ensure fertility *e.g.*, Persephone was the goddess of vegetation and grain.

The European Enlightenment brought forward a paradigm shift in how humans viewed the universe and themselves; but even Charles Darwin, arguably the greatest biologist to have lived, believed men attain

1 The data have been collected using a snowball sampling method and contact databases from partnering organizations to reach students and professional scientists across the globe. Snowball sampling is a non-probability method for data collection and does not result in a statistically representative sample. Analysis methods are described in ref [1].

Article note: A collection of invited papers on the gender gap in science.

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"a higher eminence, in whatever he takes up, than can women – whether requiring deep thought, reason, or imagination, or merely the use of the senses and hands" [2], we can nonetheless be a little grateful that he conceded that women could be trained to make them equal to men[2] [2]. These and many other narratives have influenced the power dynamics and power structure in the scientific enterprise and the scientific community, resulting in less (less equal) opportunities for women in their pursuit of a career in Biological Sciences.

Finally, in closing this section, we contend that the attainment of equal opportunities for women is not simply justice; it is a moral imperative.

Sex, gender and the biological sciences

As a discipline, the Biological Sciences pay specific attention to the differences between the sexes: both within species and across species. This interest ranges from demography (*e.g.*, sex ratios in populations), to morphology (*e.g.*, size-related sexual dimorphism within species), physiology (*e.g.*, hormonal differences), genetics (*e.g.*, mitochondrial DNA) and ethology (*e.g.*, reproductive behavior). Thus when biologists identify the sex of an individual, they utilize the biological characteristics that define individuals as males or as females (*sensu e.g.*, WHO Working Definition[3] and EIGE Definition[4]); nonetheless, biologists do acknowledge that there are individuals in which such characteristics are not so clear-cut – for instance due to different patterns/numbers of sex chromosomes (*e.g.*, Klinefelter's syndrome in humans).

Moreover, within the framework of human biology, studies have also addressed the bio-cultural contexts in which males and females grow and develop, through socio-cultural practices and roles (*e.g.*, life-history and cultural practices related to marriage-related cultural traditions [3]), including gender roles. Here, it is important to recall that the term "gender" is a socio-cultural construct, rather than a biological one;[5] notwithstanding this, some biologists consider that biology plays a major role in determining male and female behavior. The notion of gender as a social norm emerged during the 1980s [4] and led to concepts of multiple gender identities.[6] It is to be noted that while we recognize the many different gender identities in human populations, in this paper we apply the binary concept of gender (male/female) in order to discuss data, studies and policies from universities and scientific organizations/initiatives which have mainly applied the binary approach. However, in order to ensure that the diversity within each of the two genders can be considered and appreciated, we advocate for an intersectionality[7] lens in order to underline different factors (*e.g.*, age, disabilities, and minority-affiliation) which may affect biases/stereotypes and ensuing discrimination.

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2 The full reference: "In order that woman should reach the same standard as man, she ought, when nearly adult, to be trained to energy and perseverance, and to have her reason and imagination exercised to the highest point; and then she would probably transmit these qualities chiefly to her adult daughters …" *The Descent of Man* (1871), vol. 2, p. 329 ref [2].

3 See WHO definition of "sex": "Sex refers to the biological characteristics that define humans as female or male. While these sets of biological characteristics are not mutually exclusive, as there are individuals who possess both, they tend to differentiate humans as males and females (…)" ref [27].

4 See EIGE definition of sex: "Biological and physiological characteristics that define humans as female or male" ref [28].

5 Here we utilize the definition of gender by EIGE "social attributes and opportunities associated with being female and male and to the relationships between women and men and girls and boys, as well as to the relations between women and those between men" ref [28]. See also the definition of WHO: "Gender refers to the socially constructed characteristics of women and men – such as norms, roles and relationships of and between groups of women and men. It varies from society to society and can be changed. While most people are born either male or female, they are taught appropriate norms and behaviors – including how they should interact with others of the same or opposite sex within households, communities and work places (…)" ref [27].

6 See "gender identity" definition by EIGE: Each person's deeply felt internal and individual experience of gender, which may or may not correspond to the sex assigned at birth, including the personal sense of the body (which may involve, if freely chosen, modification of bodily appearance or function by medical, surgical or other means) and other expressions of gender, including dress, speech and mannerisms ref [28].

7 See "intersectionality" definition by EIGE: "analytical tool for studying, understanding and responding to the ways in which sex and gender intersect with other personal characteristics/identities, and how these intersections contribute to unique experiences of discrimination" ref [28].

Social role of biological assumptions in women discrimination

While there is a great diversity of how women and girls are perceived and considered in different cultures around the world, the overall social expectations are very much linked to their reproductive and nurturing role. The latter role generally extends to taking care of the family and/or husband, the elderly and the household. This is confirmed in the GGS survey (in Biology, women (45 %) were more likely than men (25 %) to say they did more of the housekeeping). Such cultural set-up and such "constructed" roles have induced limits/obstacles, biases and stereotypes for women to become "confined" to the domestic sphere and not to be engaged in the professional arena on an equal basis as men. In other words, women are thought to be closer to nature, while men are perceived to be closer to culture, and thus "superior" [5].

During the second half of the 19th century, an intellectual and physical inferiority of women was widely accepted. Biological determinism prevailed and became somehow a proof of the theory of evolution. This subordination and "inferior" role was also observed in different "so-called scientific" arguments related to the role of women. For instance, in Europe during the second half of the 19th century, many scientists/biologists concluded that women are inferior and subordinate by nature and argued that women are less intelligent because female brains are smaller than male brains (this ignores the fact that the female brain is proportional to her body size: thus the brain/body ratio is similar in women and men).

The physiology of women was also an argument to explain why women are weaker than men and should be subordinated to men. In light of this, the education of women was different from that of men – and this extended to the content and breadth of knowledge that they should acquire. Until the mid 1700s, legislation in Europe and the United States barred women from institutions of higher education, and this continued until the mid 1900s when the first colleges for women were established. In the USA, women were not accepted for postgraduate degrees until 1890, but ironically, faculty members were required to have a PhD degree and not be married. In the late 1900s it became easier for women to pursue postgraduate degrees and hold professorships at credible institutions, though some institutions established co-educational facilities for women to avoid this (*e.g.*, Harvard University and Radcliffe College).

In France, up until the end of the 19th century, women could not be members of the Academy or even exercise a scientific profession. The rebels who wanted to do science had to be inventive. They published articles on condition of anonymity or used masculine aliases like the mathematician Sophie Germain, alias Antoine August Leblanc [6]. The botanist Jeanne Barret participated in the Bougainville expedition between 1766 and 1769 disguised as a man [6]. The French Academy, founded in 1666 – elected its first woman at the "Académie des Sciences" in 1979 (a mathematician and physicist, Yvonne Choquet-Bruhat). The Royal Society of London, founded 1660, admitted the first women as fellow in 1945, an X-ray crystallographer Kathleen Lonsdale (1903–1971), and a microbiologist Marjory Stephenson (1885–1948). The National Academy of Sciences (NAS) in the USA, established in 1863, elected Florence Sabin as the first woman as a fellow in 1924.

The much younger African Academy of Sciences, established in 1985, and even most recent the Academy of Science of South Africa, founded in 1996, admitted women fellows from the outset and these are great examples for electing women to governing councils. It is a travesty however, that to this day, membership and leadership of these and most other Academies world-wide remain male-biased with less than 10 % female [7].

Women and biological sciences

Despite the social contexts, numerous monumental achievements and groundbreaking discoveries have been made by women naturalists, but this was often not acknowledged or recognized (or sometimes even attributed to men). Among the women scientists who have made excellent contributions to Biology, we recall Mary Anning (1799–1847) (Figure 1a) who made extraordinary and insightful discoveries in palaeobiology, but who was not admitted to the Geological Society because of her sex. Her contribution to science was eventually

a b

Fig. 1: (a) Mary Anning (1799–1847), "fossil hunter" and palaeobiologist. From a posthumous painting of Anning by B. J. Donne in 1847. (b) Rosalind Franklin (1920–1958), "The Dark Lady of DNA."

recognized by the Royal Society almost two centuries later in 2010, when she was named as being "In the top 10 women who have contributed to Science". Other women biologists to be recalled are those in groundbreaking discoveries in the history of DNA, but who have not been publicly and/or widely acknowledged[8] [8]; the most famous being Rosalind Franklin (Figure 1b) who discovered the crystal structure of DNA, but instead, James Watson and Francis Crick won the Nobel Chemistry Prize in 1953. Others have been acknowledged, but together with their husbands, as it is the case for Margit M. K. Sas who with her husband Sylvan Nass discovered mitochondrial DNA using electron-microscopy.

The barriers to women in science were widespread and formidable: in France, Napoleon's 1804 civil code made women lose the rare gains achieved during the Revolution – with any short-lived freedom again restricted. Women required the consent of their husband or father before any undertaking; they had no assets and thus no independence to pursue a scientific career. It was no better in Britain, for in Mary Anning's time, women could not vote, hold public office or attend university.

More recently, despite policies and practices fostering discrimination against women in scientific careers, some areas in Biological Sciences have fostered women's participation. Among them primatology, which has

8 Ellen Haslbrunner led the development of biochemical assays on highly purified mtDNA fractions with Hans Tuppy and Gottfried Schatz. Esther Lederberg (1922–2006), a microbiologist who discovered lambda phage, a virus that infects *E. coli* bacteria, led to her husband, Joshua Lederberg winning the Nobel Prize in Medicine in 1958 (with Edward Tatum and George Beadle). In 1956, Marthe Gautier identified aneuploidy as the cause of Down syndrome using a poor quality microscope and handed her slides over to Jerome Lejeune to verify the karyotype with his photomicroscope. He subsequently claimed and published it as his own, with her as the middle author (and without her consent or input), an atrocity for which he won the William Allan Award of the American Society of Human Genetics, the highest honor in this field ref [7].

benefitted greatly from the engagement of women in field research as is widely known through media attention given to the so-called "Trimates", namely Dian Fossey, Jane Goodall and Biruté Galdikas. These three women, chosen by the famous palaeoanthropologist Louis Leakey to conduct long-term study of great apes in the wild, demonstrated an extraordinary capacity to run successful, long-term observations of wild animals [9]: this was very innovative at the time – although Jane Goodall was initially accompanied by her mother during her first field season in the Gombe Stream Reserve [10]. This has led to the recognition of great role models and has encouraged further studies on diverse aspects of primatology [11]. The involvement of women scientists allowed the exploration of new approaches, with more attention to the study of differences between male and female behavior that were not previously studied by their male colleagues.

One of the added values of engaging women in the scientific enterprise is that it can trigger the application of the gender lens[9] in research – leading to more comprehensive and robust results. For instance, 10 years ago, just 28 % of *c.*800 preclinical studies included female subjects [12]. However, by 2019, 49 % of studies across nine biological fields included both male and female research subjects. Importantly, earlier papers often excluded the number of male and female subjects studied, denying subsequent researchers this essential information (with only few of them providing explanations for such exclusion) [12].

Women are increasingly recognized for their scientific contributions in Biology, and this has been helped by dedicated prizes (*e.g.*, L'Oréal-UNESCO Awards For Women in Science[10]), but despite national and/or academic gender policies, an overall gender balance, enabling equal opportunities between men and women is still far from being achieved. This is indeed a common trend in science, technology, engineering, mathematics and medicine (STEMM) fields – where women are underrepresented in the overall career-path and/or in leadership/senior roles. However, as demonstrated the above-mentioned GGS survey[1], the gender gaps in the Biological Sciences exhibit some peculiarities which will be discussed here along with some significant new data from Ghent University (UGent) in Belgium as an example.

The GGS survey has shown that enrolments in Biological Sciences in secondary school are comparable for both men (15 %) and women (14 %), demonstrating that Biology is equally attractive to men and women at the start of their studies. This is usually achieved without any particular policy or *ad hoc* awareness-raising initiatives. Furthermore, this balance continues through to doctoral level allowing us to conclude that input into Biological Sciences is gender balanced. However, in the route to senior/leadership positions, women are less represented, this process being termed the "leaky pipeline" phenomenon [13].

Thus, although "input" into Biological Sciences is as good as, or as even better "gender-balanced" than other disciplines, the "outcomes" with respect to women pursuing an entire career in Biological Sciences and attaining leadership positions are as unbalanced as most other disciplines [1, 14]. In this sense, a lack of equal career opportunities is a greater failure in Biology as there is a "larger reservoir" of female talent. This essay examines the problems/failures in fostering positive, career development pathways for women in Biological Sciences as well as policies, processes and protocols available to mitigate the current imbalance. In this context, a specific case study from the UGent[11] which has developed innovative policies towards attaining gender balance, also in leadership positions, is here outlined as a best practice example.

The overall situation at UGent for all sciences, including Biological Sciences, has been observed to be in line with the trends highlighted for the Biological Sciences in the GGS survey. As shown in Figure 2, there is

9 For information on gender lens see ref [23].

10 See *e.g.*, L'Oréal-UNESCO For Women in Science International Awards ref [29].

11 a. "Diversity policy and action plan of Ghent University for 2019–2023", UGent, https://www.ugent.be/nl/univgent/waarvoor-staat-ugent/diversiteit-en-gender/beleidscel/beleidsplan-diversiteit-2019-2023

b. "Historiek van het universitair genderbeleid", UGent, https://www.ugent.be/nl/univgent/waarvoor-staat-ugent/diversiteit-en-gender/gender/historiek-van-het-universitair-genderbeleid

c. "Statistisch rapport m/v Universiteit Gent. Verslag van de eerste fase in de initiatie van een gelijkekansenbeleid aan de Universiteit Gent", Hanneke Pyck, Marysa Demoor, Centrum voor Genderstudies, UGent (www.cgs.ugent.be)

d. Figures for the years 2007–2010 were made available by the Diversity and Gender policy unit of Ghent University (www.ugent.be/diversiteitengender).

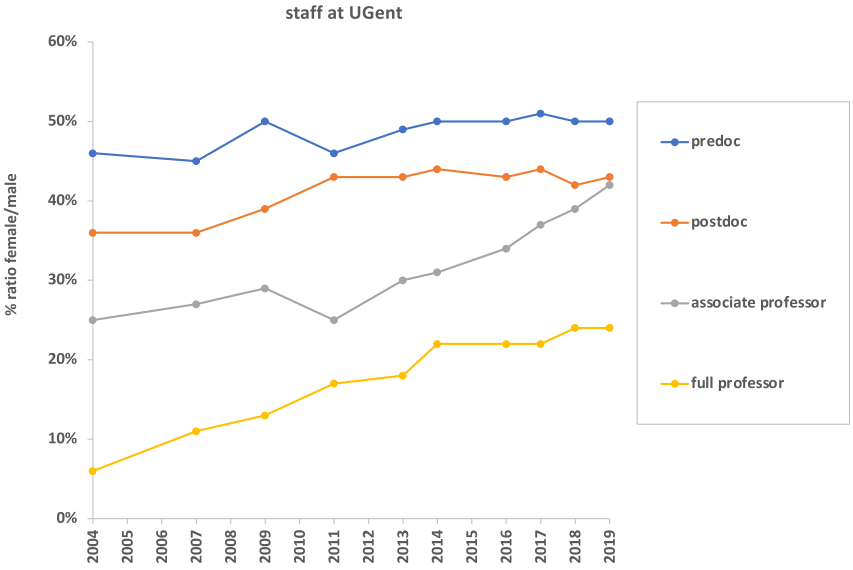

Fig. 2: Evolution in the % female-male ratio at Ghent University from 2004 to 2019 for the groups of postdocs, associate professors (docent) and full professor (hoogleraar) (data from Diversity and Gender, UGent).

gender balance in the first part of the career, followed by a drop in the attainment of senior and leadership positions.

A close analysis of the data shows that the initial gender balance reflects the increase in the number of students in the last quarter of the 20th century – which is almost entirely due to the growth of female enrolments. Between 1970 and 1990, the number of male students remained stable at around 8500, but the number of women doubled from 3260 in 1970/71 to 7381 in 1991/92. Since 1995/96, there have been more women than men: in 2010/11 the ratio was 58/42 % in favor of women (>6000). In 2020/21, this trend remains with the Bachelor- and Master students at UGent. It is clear that women have come a long way since the first female student registered in 1882. Furthermore, it is noted that female students achieved better results than their male colleagues and were more likely to complete their studies. Ever since the small group of 19th century feminists paved the way to higher education for women, an impressive path has been travelled.

However, there is still the problem of advancement: female academic staff members "disappear" with every step up the academic ladder (a classic example of the above-mentioned "leaky pipeline"). However, as compared to the past 10–20 years, the share of female scientific employees has increased in almost all scientific circles (Figure 2). There is a positive evolution seen in the female-male ratio: for instance, the percent of woman undertaking post-doctorates was 36 % in 2004, 43 % in 2011 and 43 % in 2019, while this respective ratio was 25, 25 and 42 % in the group of associate professors (docent). This positive evolution is reflected in the top range of the academic ladder (full professor/hoogleraar) which was 6 % in 2004, 17 % in 2011 and in 2019, 24 % female.

Furthermore, at UGent, significant improvements in the gender balance of the Board of Governors – traditionally male dominated since the founding of the university – has occurred following the application of innovative policies by the university. Such policies were a response to the Flemish government's 2013 binding decree that stipulated that gender balance ranging from 1/3 to 2/3 had to be ensured in the universities' decision-making and advisory bodies. In response to this UGent changed its election procedures for such bodies and, went beyond the legal minimum proportion for the election of its highest decision-making body, the Board of Governors. Instead of proposing a 1/3 share of the underrepresented sex, the new institutional election procedures established a gender-balanced target ranging from 2/5 to 3/5 (or 40/60 %). The rationale for this decision was anticipation of the European Directive that stipulates a minimum gender balance of 60/40 for the Boards of Directors of companies and public institutions by 2017.

Before the new procedure was installed, the number of female professors in the Board varied from zero to two out of 12 (or 0–16 %). Since then, there has been a significant increase in numbers of female professors,

culminating in 2014 when the UGent Board had a 50/50 composition. Importantly, this outcome was not achieved through positive discrimination; of significance is that election attracted the greatest number of voters in the history of the university (>9000 votes).

In 2020, three of the 11 faculty deans are women. They represent the Faculties of Sciences, of Arts and Philosophy, and of Psychology and Educational Sciences. Gender quotas have had a very positive effect on this election result. The quotas, which were imposed in various councils, and the university's commitment to strong "feminization", are finally being addressed and women are encouraged to aim for higher positions.

These best practices, as outlined above for UGent, highlight the importance of targeting different parts of the "pipeline" (career trajectory) with *ad hoc* policies within a systems approach aiming at attaining gender balance and taking into account past and current gender equality and inequality. Therefore, it is important to understand how the work environment affects/enables inequalities in order to provide recommendations towards targeted interventions and policies. We acknowledge that many of those obstacles are common to several scientific fields given similarities in work environment, however, for the purpose of this paper, we limit to those specific challenges (and opportunities) related to the scientific branches of Biology, in order to conclude by providing recommendations for the Biological Sciences community.

The work environment

The work environment can have a significant impact on how women and men are perceived and encouraged in the advancement of their career. In Biology, women answering the GGS survey reported statistically significantly higher levels of discouragement than men due to research funding, interactions with colleagues, workplace environment, personal life, and family obligations. There are many features of the work environment that are unbalanced; these involve recruitment practices, metrics for evaluation/appraisal, work-related policies, leadership, and the actual physical place of work [15]. For instance, work-related policies which address or do not address maternity leave and/or child-care can have a tremendous impact on a women's career (for instance, some scholarship/fellowships do not take maternity leave into account in their stipend and in their timings). The recent GGS survey has reported that in Biology, women (61 %) were significantly more likely than men (51 %) to report that their career has influenced their decisions about children, marriage, or a similar partnership [1].

Some of these limits/obstacles can be related to the life-history related to child-bearing and child-rearing; yet even when these obstacles are removed, there are still biases, stereotypes and prejudices which limit girls and women (and sadly some of these are self-limiting[12]) in the professional arena and in the scientific enterprise. To illustrate this, we have utilized a systems approach to determine when and where sexual harassment may occur whilst studying Biological Sciences (Figure 3). For instance, there are those perceptions and biases based on "statistical discrimination" which is when "people base their assessment of an individual person on group average" [15]. This could also be the basis for the fact that women are not encouraged to further pursue a career in Biology, as we (men and women) are able to observe that only a few of them will attain high/senior/leadership positions and that many of them will drop off the career trajectory.

Other issues and obstacles can be related to metrics used/applied to evaluate achievements and enable promotion. In fact, it is interesting to note that on average, 30 % of women reported in the GGS survey that their careers or rates of promotion were slowed significantly because they were a parent; this compares to 11 % of men. In Biology for 21 % of women and 45 % of men, work or career didn't change much when they became a parent. The metrics often include participation in conferences as an invited speaker, without noting that in Biology there are significant differences between women and men (as shown in the GGS survey, where women (61 %) were less likely than men (74 %) to have given a talk at a conference as an invited speaker). Such a status quo may be the results of different factors. For instance, participation in conferences may entail travel and extended absences from the family/home, and sometimes even in another country: for some cultures, women

12 It is to be noted that the stereotypes and biases are consciously/unconsciously set both in men and women.

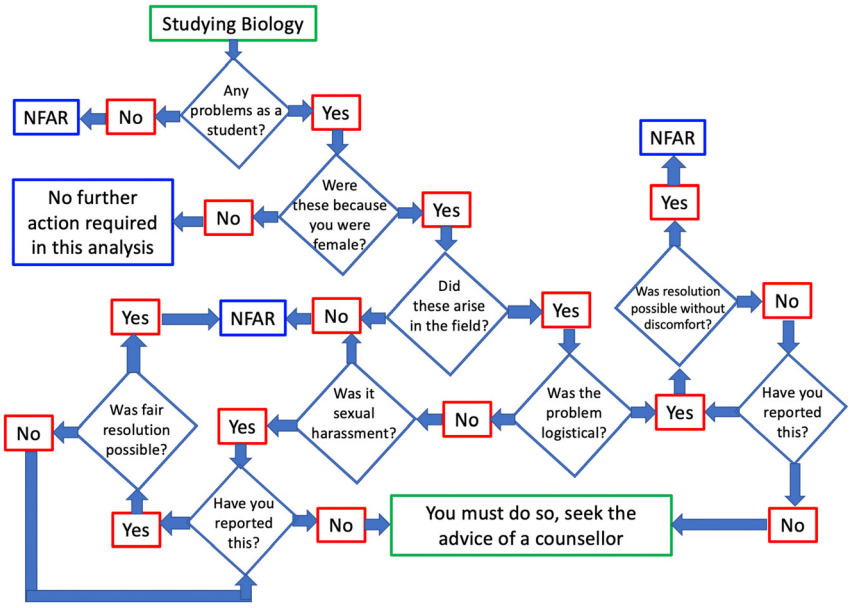

Fig. 3: A systems approach to sexual harassment of women in Biological Sciences. The diagram challenges the reader to carefully evaluate any sexual harassment that she may have been subjected to whilst studying biology. Biological Sciences differs from many other sciences in that for many students, field work is mandatory, both in the undergraduate curriculum and in research. In some situations communication of the issues can lead to a satisfactory resolution, but not always, hence the need to involve an external party (e.g. a student councillor). NFAR = No further action required.

must not travel alone; for many women with children/family travel cannot be feasible; and for other women there maybe issues related to security/safety and related costs (travel safely may be more expensive). Another factor is linked to the fact that women scientists/biologists are generally not the first to be selected to be invited as speakers: this could be related to the fact that not many women have attained leadership positions and hence have less visibility than men (and less "attractiveness" as an invited speaker at major event), as confirmed by initiatives which enable to identify women academics/scientists in a more effective way [16, 17].

In general, differences in opportunities for men and women extend to the supervision of students, with men being more likely than women to advise or supervise graduate students (while no difference was observed with respect to supervision of undergraduate students). Approximately 74 % of respondents of the GGS survey reported having a male supervisor (more men were observed having a male supervisor). Many factors may contribute to this, including the fact that there are more men who are in senior/leadership positions (incl. directors of labs and/or field-stations) and therefore considered a better choice for graduate students with respect to career opportunities. However, there could also be other factors related to stereotypes and biases affecting women and hence enabling gender-based discrimination in the selection of supervisors.

Gender-based biases in the work environment appear to have a profound effect. The GGS survey has reported that in the Biological Sciences women were more likely than men to report gender (women: 49 %, men: 4 %) and age (women: 23 %, men: 13 %) discrimination. And 17 % of women reported discrimination based on pregnancy or responsibilities for children compared to 1 % of men in the GGS survey.

Such practices can be exacerbated through the practice of moral and/or sexual harassment[13] targeting women (and this may be enforced by both men or women). Harassment also develops through the reinforcing of stereotypes related to women and men, taking into account culture, and reinforcing power structures between men and women as well as dominant narratives.

13 See EIGE definition of "harassment": "unwanted conduct related to the sex of a person occurring with the purpose or effect of violating the dignity of that person, and of creating an intimidating, hostile, degrading, humiliating or offensive environment" - source: "Directive 2006/54/EC of the European Parliament and of the Council of 5 July 2006 on the implementation of the principle of equal opportunities and equal treatment of men and women in matters of employment and occupation (recast)" ref [28].

According to the GGS survey, the level of harassment in Biology is similar to other disciplines: 26 % of women answering the survey (5 % of men) said they have personally encountered sexual harassment at school or at work. The average for all disciplines combined in the survey is 29 % of females experienced sexual harassment, with less than 3 % for males. Men (61 %) were more likely than women (44 %) to say they did NOT encounter sexual harassment at school and work in Biology. So, over a quarter of women answering the GGS survey reported experiencing sexual harassment. The results appear to indicate that specific work-settings (*e.g.*, the field or the laboratory) in Biological Sciences do not increase the rate/% at which sexual harassment take place. However, it is worth highlighting that the fear of being accused for sexual harassment by those in senior/leadership positions could also trigger further obstacles for equality and equity in opportunities for career advancement. For instance, some supervisors may decide not to accept the participation by women in fieldwork in order to avoid the risk of accusations which may then jeopardize their work and career: this situation can further reduce career advancement for women biologists, as fieldwork is extremely important in some sub-disciplines of Biology. This perspective is based on the lack of clarity on how to address the harassment in fieldwork which is also exacerbated not only by remote/isolated areas of fieldwork [18–20], but also by the different legal systems at play (namely *e.g.*, the legal systems of the country of the victim, of the country where it occurs) and relevant policies (if any) and culture of the university/research entity.

A number of universities, research entities and other organizations are now working towards organizing workshops and defining advisory notes, policies and training on the issues of sexual harassment, especially in fieldwork [21].

Despite the above-mentioned initiatives and the GGS survey data related to frequency of harassment in the Biological Sciences community, there is still no overall practice to raise-awareness amongst both women and men (being students, faculty members as well as administrators) of measures targeted to the prevention of moral and sexual harassment (and in particular during fieldwork), and for that matter, of the issues of gender biases and gender lens which can avoid overall gender-based discrimination.

Most of the initiatives and actions have been focusing on the empowerment of women, including workshops targeting leadership skills, the creation of specific networks and fellowships (*e.g.*, Organization for Women in Science for the Developing World[14]) and on targeted funding and prizes (*e.g.*, above-mentioned L'Oréal-UNESCO Awards for Women in Science). These initiatives are to be commended and continued providing they accentuate the need for biologists/scientists to be equal partners.

The International Union on Biological Sciences (IUBS) is actively building on the data and analysis of the GGS survey, including the GGS recommendations, and is taking into account the guidelines and recommendations which have been produced for STEM fields (*e.g.*, [14, 22, 23]). Current initiatives include training workshops and programmes involving both developed and developing countries – focusing on the need to empower women in science (incl. online training, *e.g.* [24]).

IUBS fostering women as equal partners in the biological sciences

In the past, it wasn't easy for women to pursue a scientific career in Biology, even though they now represent half of the student intake. There are still some – sometimes too many – obstacles to their career paths but initiatives like the one developed by UGent show how structural adjustment in the university can improve gender equality, especially in leadership positions. One important point remains: the sexual and moral harassment that woman experience is to a much higher degree than men. Indeed, harassment or assault can disrupt a woman's career trajectories significantly, affecting their motivation to pursue research and impacting their academic performance. Nonetheless, if rules of conduct and consequences for breaking them are clearly established, we can expect the incidence of professional misconduct to decrease, and women will evolve in a non-hostile work environment.

14 For more information see OWSD Website, ref [30].

Many universities and scientific organizations are now actively involved in Gender Equality achievement. Including the International Scientific Unions that partnered to establish the Standing Committee in Gender Equality in Science (SCGES) to develop and promote gender equality initiatives. IUBS, like other Unions, has a Working Group dedicated to Gender Equality, in alignment with Sustainable Developments Goals (SDG 4) (Quality Education) and 5 (Gender Equality) initiatives. Particular attention is also now focused on the impact of the COVID-19 pandemic which is exacerbating the obstacles encountered by women in pursuing a successful career in the Biological Sciences [25, 26]. Hence an urgency towards accelerating actions and accountability is recognized by IUBS leadership as of primary importance.

The participation in the GGS Project and related exchanges with other International Scientific Unions has enabled IUBS to identify current internal weaknesses related to gender balance in its operations. This led to the Resolution at the General Assembly that the IUBS Nominations Committee actively promote the nomination of women for IUBS executive positions through National/Ordinary and Scientific member bodies.

Establishment of a Working Group on gender equality in IUBS, including both men and women members ensures the engagement of both men and women in addressing the attainment of a gender balance across all spectrum in the Biological Sciences. The working group is customizing general recommendations for gender/STEM community to the Biological Sciences communities (as well as developing a resource-portal for the community). Training workshops will also be organized in the margins of key events also, to invite members to share best practices and discuss difficulties in their communities. IUBS will also encourage all the national committees to address the gender issues in their country/region.

The working group will also monitor *ad hoc* policies and incentives already in place at IUBS to check/assess their role in making women equal partners in the Biological Sciences. Among these initiatives, IUBS will sponsor conferences only if women are involved in organizing and scientific committees and are also invited as plenary speakers; further, the IUBS grant for young scientists is allotted to conference organizers with the obligation to support the participation of an equal number of male and female young scientists.

It is our responsibility to ensure that all people, regardless of their, sex and social/cultural backgrounds have access to higher education. Biology has shown that diversity is important for adaptation, sustainability, well-being and creativity. In light of this, IUBS considers the attainment of gender balance as a moral imperative towards ensuring that women are considered as equal partners in the scientific enterprise.

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