

PRESIDENTIAL ADDRESS: PARASITOLOGY - DIVERSITY AND INCLUSION FOR THE FUTURE

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In April of this year, I was invited to be one of the speakers for the New York City March for Science—a real honor to be sure. I decided to structure my 4-minute speech at the rally around the parallels between a new field that I had begun working in, microbiomes, with the common message that more diverse microbiomes were “better” and the need for diversity in our scientific institutions. You can read that whole speech on my website if you’re interested. I thought it worked well and so decided to expand upon that theme and use it here for my address.

As biologists, we all understand and appreciate diversity. Maybe it’s because I work at a natural history museum, but I’d be willing to bet that half or more of our weekly seminars begin with background slides that explain how one of our jobs as biologists, particularly those of us who work in the fields of taxonomy and systematics, is to identify the diversity of life around us, describe it, and understand how it arose via evolutionary processes. We understand that diversity is to be valued, for both intrinsic and extrinsic reasons and for reasons that directly benefit humans, as well as reasons that impact non-human aspects of the planet. For example, we rely on diverse microorganisms and plants to provide the very oxygen that we breathe, and our food supply depends on diverse pollinators. Biodiversity in the form of coral reefs and forests both provides habitats and protections but also could hold key compounds that are useful for treating diseases. And digging in deeply, there are other less obvious benefits of biodiversity, like animals that are key seed dispersers of some large trees that play important roles in global climate change via climate sequestration.

As parasitologists, I think that we are *particularly* good at appreciating diversity in the world. For starters, parasites, though not a monophyletic group in and of themselves, are arguably the most diverse type of organisms out there. Many of us frequently use estimates that there are more kinds of parasites than free-living organisms on the planet, if we reason that every potential host has at least 1 kind of parasite in it. We also now better quantify the role of parasites in food webs, for example. For a long time, food webs were constructed by linking together producers and consumers, with some detritivores thrown in so that everything balanced out. Work done by ASP members Armand Kuris, Kevin Lafferty, Ryan Hechinger, and others, however, showed how much is lost when parasites are not part of these webs. In their 2013 paper (Dunne et al., 2013), these authors showed that food webs with only free-living taxa are not only much less diverse, but also much less connected and thus less resilient than ones that also include parasites. Concurrent with caring about biodiversity is caring about its loss. I wanted to take this opportunity to highlight a paper from last winter that also includes several ASP authors, including the woman who just introduced me (Carlson et al., 2017). This was a nice meta-analysis that looked at probabilities of extinction across more than 450 parasite species under various climate change scenarios. The results of this study were very sobering: 5–10% of parasite

species may go extinct by 2070 just from climate-induced changes alone. When host extinctions are layered in as well, as many as 30% of parasitic worm species may be lost.

Of course, we humans also appreciate the aesthetic benefits of biodiversity as well, whether that be a vibrant coral reef, a desert full of wildflowers in bloom, a smorgasbord of colors in our produce aisle, or a myriad of scolex morphologies in tapeworms. We think that having diversity around us is pleasant—perhaps even beautiful. We easily understand the importance of diversity in biological systems. Therefore, I would argue, it should be no problem at all for us to apply these same principles of the benefits of diversity to our scientific institutions, including our universities, our networks, and our scientific societies.

Let’s define what we mean when we say diversity here. One of the most popular metaphors for thinking about diversity is the iceberg. In this analogy, we think about an iceberg floating out in the ocean. We can see it rising above the water level. When we encounter people, there are things about them that are usually noticeable—like the color of their skin, their gender, whether they use a wheelchair or not, the language that they speak, and their relative age. But underneath, there might be lots of other layers to these people, things that might not be immediately obvious, like their sexual orientation, what kind of family they come from or currently have, their income level, and their interests, values, and skills. All of these things are axes of diversity that allow people to bring different types of perspectives to a scenario. Another axis of diversity is often referred to as neurodiversity—it is the diversity of ways that people absorb sensory stimuli and process things. We sometimes refer to people as “right brained” or “left brained,” but of course this is only 1 small dimension of this spectrum. An example that immediately came to mind about being inclusive of neurodiversity is that of colorblindness, a visual condition that affects about 8% of men. There are now programs that you can use to check whether manuscript figures or slides will be difficult for people affected by colorblindness to read.

One of the parallels between the way we think about biological diversity and the processes that produce it as well as create more diverse institutions that occurred to me was this one. During a diversity training session, the leader was talking about the concept of inclusion and used this definition: inclusion is the combination of belongingness and uniqueness. For a systematic biologist, this sounded really familiar—it’s how we think about clade membership (synapomorphies) and the unique lineages (autoapomorphies) within them.

Many of you have no doubt seen that there are now more conversations about diversity. Your campuses likely have an office of diversity. Perhaps you’ve gone to an unconscious bias training session or other types of workshops. I’ve long been interested in various aspects of enhancing diversity and equity, including founding our Women in Science chapter at AMNH and starting a new faculty committee on Development, Diversity, and Equity. But they’re not just buzz words and ways to add administrators to our campuses. It’s actually based on real data from economics and sociology. When I was at NSF as a rotating

DOI: 10.1645/18-114

program officer for a year, I was commuting about 45 minutes each way every day on the subway—which gave me lots of time to read. One of the books that I devoured, and which really changed my way of thinking, was *The Difference*, written by University of Michigan economist Scott Page (Page, 2008). In this book, Page relays the various experiments that he and collaborators have done to show just how powerful adding diversity to problem solving can be. One example that I liked is that of the “wisdom of the crowd.” For example, let’s say there’s a contest to guess the weight of a cow named Penelope. The National Public Radio program “Planet Money” ran this actual experiment (available at <https://www.npr.org/sections/money/2015/08/07/429720443/17-205-people-guessed-the-weight-of-a-cow-heres-how-they-did>), and over 17,000 people made their guesses. Penelope’s actual weight was 1,355 pounds, or 615 kg. The average guess of all respondents was 1,287 pounds (584 kg), which was only about 5% off. The diversity that these people brought to the question actually ended up with a pretty good solution. This “crowd thinking” is similar to the forces that drive stock market prices among other economic variables. Page and collaborators have demonstrated through multiple computer simulations that in most cases of complex problem solving, a large diverse set of people, who each bring their own perspectives and tools, will find better solutions faster than less diverse groups of so-called experts (Hong and Page, 2004). This theorem that they have tested and proved is known as the “Diversity Trumps Ability” theorem. It’s important to note that one of the conditions is that the problem to be solved must be complex. We often visualize these types of problems as landscapes that can contain multiple “good” solutions, but only 1 truly best solution. In the models that Page and his collaborators ran, experts may get stuck on a local optimum because they lack the heuristics to move away and explore other spaces of the landscape. Businesses have really caught on to these ideas and are reaping the benefits of diverse work forces in many ways; diverse sales teams respond better to diverse customers.

Let’s home in on diversity in the sciences now. What are the benefits and how are we doing? We are certainly seeing the benefits of putting diverse groups of people together through what we often call interdisciplinary sciences. One of my favorite examples is that of recent work that has been done on the microbiology of the built environment (National Academies of Sciences, Engineering, and Medicine, 2017). This field combines expertise in microbiology, public health, architecture, and social sciences to design buildings that will be healthier for humans in ways related to the microbes that are present in them. Hospitals, schools, and apartments are now being designed to be healthier places to spend your time.

In terms of equity, though, science is not doing all that great. Minorities (e.g., Black, Hispanic, and Indigenous Americans) make up about a third of college-aged Americans, yet the proportion who are awarded bachelor’s degrees lags behind that number in all fields of science. Even in biological sciences, which is not as disparate as physics, for example, the proportion of underrepresented groups in awarded Ph.D.s is only about 12% (Hodapp and Brown, 2018). But, like in Scott Page’s models, there is clear evidence that diversity in scientific institutions and collaborations is beneficial. A study by Freeman and Huang (2014) looked at the downstream citations when authors were homogeneous or diverse and found that those manuscripts with

diverse authors appeared in higher impact journals and were cited as much as 10% more. The question remained, though, was the science better when created by diverse scientists, or was this an impact of diverse authors sharing the paper in larger networks, which resulted in it being cited more overall? A paper currently in press (available at <https://arxiv.org/abs/1803.02282>) and already publicized by *Nature* (Powell, 2018) dissected this phenomenon a little more closely. It was heroic in its undertaking—they analyzed over 9 million papers across 24 different fields of study. They found that the ethnic diversity of the group of authors itself was what was most strongly correlated with higher citation rates over a 5-year period. The authors also examined whether it was specifically that a paper had diverse authors that resulted in higher citations. They compared 4 scenarios in a 2 × 2 matrix of combinations of diversity. In 2 of them, the authors themselves were diverse, and in 2 of them, there was high individual diversity—that is, each of the authors had an (ethnically) diverse network of collaborators. The largest impact on downstream citations was that of having diverse groups of authors on a given manuscript.

Authorship and citations are clearly 2 of the most important metrics that we are all evaluated on—thus it is important for the system to be fair. That hasn’t always been the case for women. In 2001, the journal *Behavioral Ecology* instituted a new policy whereby not only were reviewers anonymous, but the authors of a given paper were also blind to the reviewers. A study of the impact of this change showed that it resulted in an almost 8% increase in the number of first-authored papers by women (Budden et al., 2008). This was more than 3 times greater than the growth of women in the field, as estimated by the number of graduate students, and represented a 33% increase in representation of female authors.

I was raised by a hard-working single mom in the 1970s, i.e., a feminist, and I often heard her recite the quote, “Whatever women do they must do twice as well as men to be thought half as good. Luckily, this is not difficult.” It turns out that it’s not just a funny thing to put on posters and coffee mugs. It’s actually a reality. Although the study by Wennerås and Wold (1997) is over 20 years old, and I have to believe that things have improved, it’s considered a landmark paper on the sexism that exists in science. These authors showed that in their sample from Swedish postdoctoral positions, in order for a female applicant to be given the same competency score as male colleagues, she needed to publish what equated to 3 *Nature* or *Science* papers, or 20 extra papers in journals with impact scores of 3 and above—in other words, they needed to be two-and-a-half times more productive than her male counterparts just to get the same score!

Finally, I was so happy when this recent study came out just a couple of weeks ago, because it really brings home the messages about the importance of diversity within scientific societies that I wanted to make (Potvin et al., 2018), so I’m going to shamelessly borrow quite a lot from it. The authors make the extremely important point that scientific societies play unique and important roles in our professional development, particularly in early career stages. Society meetings provide opportunities for scientists from geographically disparate places—whether on the regional, continental, or global scale—to all come together. Their activities and structures provide mentorship and role models for junior scientists, and meetings provide valuable networking opportunities in the field for everyone. Despite this importance, the gender

dynamics of scientific societies has not been thoroughly studied. Scientific societies are different from academic institutions and arguably more equitable because of several factors. First, membership is typically something that you get just by paying your dues. You do not need to apply or be accepted. Second, the positions of leadership are more democratic—they are filled via processes of nomination and election, not by search committees or appointment by a single higher-up. And then, these leadership positions turn over frequently—even once a year—which gives many more people opportunities to serve. The authors concluded with a checklist that societies can use to assess their gender equity health. In addition to a diversity and inclusion statement, other factors that promote equity are having committees devoted to diversity, implementing codes of conduct, tracking data on society diversity, creating women and family friendly conditions at meetings such as day care services, and then applying objective rubrics to award selection and offering workshops on diversity at meetings. Figure 1 from their paper shows the leadership of women from data collected from 202 zoological societies around the world. I should note here that I was very disappointed to see that their searches excluded parasitology societies, but otherwise they included most taxonomic disciplines as well as broader societies that focus on conceptual topics like evolution and ecology. In the figure, they compared societies based in 6 geographic regions of the world and compared disciplinary focus versus taxonomically focused societies. Each of the pie charts represents the compositions of boards—equivalent to our council, with darker colors representing women and lighter colors representing men. The bar graphs show the percentages of societies having diversity statements published on their websites. And the female symbols represent the count of women who serve in offices such as president, vice president, secretary, and treasurer. They then ran statistics on multiple variables including the age of the society, the size of the board, and others. Two things stood out. One is that when societies have more women on the board or council, they tend to have a more female-friendly culture, and the other was having a clear diversity and equity statement.

Let's look at how ASP is doing in terms of diversity, particularly gender diversity. In terms of leadership, it has not been great, to be honest. We have had just 6 women be elected to the office of president of ASP: Eloise Cram in 1956, Marietta Voge in 1976, Lilian Mayberry in 1996 (apparently female presidents are like 20-year cicadas!), and then Sharon Patton in 2002, Janine Caira in 2011, and now me in 2018. This is not atypical for a scientific society—I am in no way saying that ASP is worse—in fact, I'd say we were practically ground-breaking for electing a female president as far back as 1956. But I think it is enlightening to see all of the data in front of us like this. The award winner gender balance is quite skewed, though (Fig. 1). Looking at all of the winners over the history of each award or lectureship (Fig. 1A), only 1 woman has won our Distinguished Service award, there have been 2 female Stoll-Stunkard awardees, and 1 female Bueding and von Brand Lectureship winner. This year, Janine Caira becomes the first woman to receive the Clark P. Read Mentor award, and we've had no women win the McGhee Lectureship. But, it's perhaps the Ward Medal skew that is most disturbing to me, since it's a very large sample size and an award given to mid-career scientists. Kirsten Jensen won the Ward Medal in 2014. The last woman before her was Janine Caira—in

1998. The third was Marilyn Scott in 1991. That's it. There's a glimmer of hope with the Ashton Cuckler New Investigator award, though. Over a quarter of those winners have been female. But, of course it's in many ways not fair to summarize this imbalance over our entire history, since for many decades, science was even more male dominated. So, I also compiled the data just for the past 8 years (Fig. 1B). There's a slight improvement when we look at it this way, most noticeably again in the Cuckler New Investigator award, where over half of the last 9 winners have been women. I also did a rough calculation of the gender balance of the current members, which was not perfect in any way, since I did it with easily recognizable names only, but give or take, we are currently 40% female. So, we are clearly recognizing rising talent among our junior female colleagues in parasitology.

ASP has done other things to enhance diversity and be more equitable. For decades, the society has been extremely supportive of students in terms of travel awards, feedback, and accommodations. We have encouraged a policy that there be a student member on each and every one of our committees to ensure that we were hearing the voices of our junior members. This past year the Council asked to receive all of the year's award winners as a single slate, rather than one at a time, which allowed us to at least look at the gender balance easily. And I would argue that having 2 meetings here in Mexico, 1 in Merida, and then this one, has also been a step forward to make sure that we are interacting with scientists from Latin America on a regular basis. Perhaps most significantly, though, was the adoption of our Discrimination and Anti-Harassment Policy in 2016, and I was pleased to have been the ad hoc chair of the committee that formed it. It was modeled after those that had been adopted in astronomy and entomology societies and sets up rules for behavior at our meetings. This is a really important step, as science began its "Me Too" movement even before it hit Hollywood. In study after study, survey after survey, whether it's from anthropologists in the field or women at scientific meetings, it has been shown that women experience an enormous burden of harassment, particularly when they are at off-campus locations and away from the normal protections of their job. In 1 survey, more than half of all women faculty and a quarter to half of all women students reported having experienced sexual harassment (available at <http://smartsconsulting.com/surveyresults/>). As a result of past harassment, a third of respondents in that same survey said that they avoided conference social events, thus missing out on valuable networking opportunities. I can say vaguely, from what I know anyway, that we've only had a few reports in the 2 years that our policy has been in effect—and that's great. But these studies have also shown that more than half of the women who experience harassment do not take it so far as reporting it, for fear of repercussions that might occur. That said, women feel strongly about taking action overall, and 78% said that individuals who repeatedly harass should be banned from all future meetings of the society. Last year, we conducted our first post-meeting survey and collected a little bit of data to help us shed light on the climate at the ASP meetings. Our respondents generally felt that the meetings were a good place to meet new collaborators, and I was extremely happy to see that almost every person indicated that they feel safe and respected at our meetings. We also asked about the perception of diversity in ASP, and while the results were overall positive, more than 27% of respondents were neutral or disagreed that the society values diversity. Clearly, we can do better.

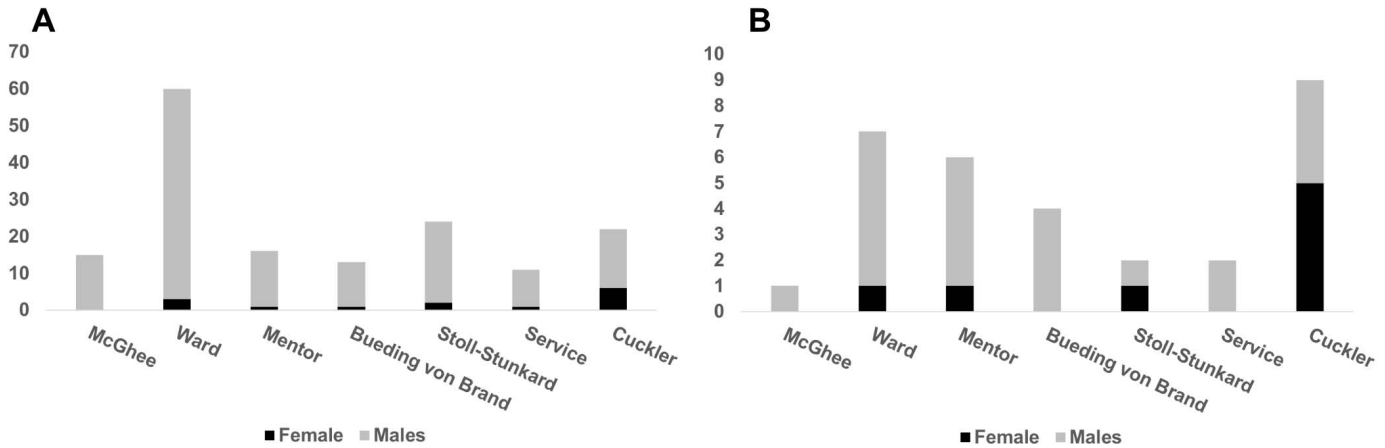


FIGURE 1. Award and lectureship winners by gender. (A) All award winners divided by gender over the history of each award. (B) Award winners over the past 8 years only, divided by gender.

What should we do moving forward? First, I would argue strongly that we should include a diversity and inclusion statement on our website. We already have a policy, so this is low-hanging fruit. As you saw earlier, these simple statements can actually go a long way. We can do other things too, though. One thing that we can all endeavor to do is to get active in the awards process by thinking diversely and casting wide nets for these awards. We sometimes have years pass where no one was nominated for a particular award—let’s vow to not let that happen again. We have excellent, talented members—let’s recognize them. We plan to continue to collect data via the post-meeting survey, and that’s great—soon we will have enough to recognize trends and hopefully nip problems in the bud. But it would also be great to collect other demographic data so that we can easily see if we are becoming more diverse. And then, we can insist that both symposium speakers and reviewers and evaluators of awards are diverse. There have actually been some pretty funny—or should I say pathetic—examples of all-male panels recently, including all-male panels where the topic was “Women in Science!” Don’t do this! There’s no excuse to do it, actually. There’s an amazing resource out there called “Diversify EEB” that includes more than 1,500 scientists who are women and/or from underrepresented groups in Ecology, Evolution, and Behavior (available at <https://diversifyeeb.wordpress.com>). And then, just to toot my own horn a bit, prompted by my graduate students Spencer Galen and Kelly Speer, I created the Early Career Reviewer Database, which now has more than 600 volunteer reviewers who are grad students, postdocs, or junior faculty (available at <https://sites.google.com/view/ecrdatabase/home>). It was super simple to create, and already 78 editors have requested this database. As a final illustration of how easy it is to find female speakers or awardees, I wanted to share this tweet from just this week. Elise English tweeted that she wanted to put together a list of women in the field of parasitology, and in the span of just 2 days, she had a list of 132 women in parasitology!

These things I’ve mentioned so far were all free or low-cost, but there are more substantial things we can do, such as hosting workshops, arranging special socials, like women in science events, or setting up day care. Our meetings are likely too small to really motivate these things just now, but I think they should be considered. Our policy is great, and it’s in the front of your

program, but we could really make it front and center, like the American Society of Microbiology did this past year, with a huge banner that could not be ignored. Going back to the microbiome and the importance of diversity there, we know that it doesn’t just happen. It’s the product of cultivation—by acquiring different microbes throughout life, eating healthy foods, spending time outside, avoiding antibiotics when they aren’t absolutely necessary, and other “probiotic” endeavors.

To sum up, I hope I’ve shown you the following. Diversity is not just a buzzword or an excuse to set up a new office or committee. It’s smart and it’s important. We do still endure a fair number of biases in science, including scientific societies, but these are becoming unveiled via studies and hopefully corrected. Although ASP does show its share of skew, at least when it comes to gender balance of officers and award winners, we’re not unique, and in fact, I would say, we’re clearly on the road to equity. Yet more can be done. Although I will leave my office tomorrow at the business meeting, I stand at your ready to help us continue in this direction. This year marks the 20th anniversary of my membership in ASP and this meeting is my 15th one—in fact, I have not missed an ASP meeting in the past 12 years. In other words, I hope you can see that I am committed to ASP. I’m not going anywhere, and I will do whatever I can to ensure we have a bright future—for everyone.

ACKNOWLEDGMENTS

I am incredibly grateful to Anna Phillips for her warm and wonderful introduction. I wish to thank my lab (Spencer Galen, Kelly Speer, Melissa Ingala, Rachael Joakim, Alexis Brown, Janus Borner, and honorary member Monique Winterhoff)—they inspire me every day to work hard and be my best. I must thank the American Museum of Natural History, for giving me the environment in which to grow and succeed as a scientist. I thank my partner, Matt Shanley, for his patience and support always. I thank my fellow officers through this past year, John Hawdon, Julian Hillyer, and Lee Couch, who made my job as president more fun and the great experience that it was. I thank Victor Vidal-Martinez and Leo Aguirre Macedo and the rest of the local organizing committee for putting on a truly amazing meeting. I must also thank the FIFA scheduling committee for not planning

the Mexico–South Korea game during this address. And finally, and most of all, I thank all of the ASP members for putting your faith in me to serve as your president—it has been my true honor and privilege.

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